Research in

Economics, Management and Quantitative Methods

2026

EDITED BY

Giulio Guarini and Barbara Pancino

PhD Program in Economics, Management and Quantitative Methods
University of Tuscia

Book funded by the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia

ISBN 978-88-382-5759-9

Studium
edizioni

Index

Introduction
Giulio Guarini, Barbara Pancino 3

The New Social and Civil Economy: Governing the great transitions by learning to think as a community
Luca Raffaele, Lorenzo Semplici 6

A bibliometric analysis of artificial intelligence in the accounting profession (1984–2025)
Gaia Buttaroni, Vincenzo Sforza 14

Innovation, Resilience and Sustainability in Production Supply Chains: Toward a New Industrial Model
Irene Cardelli, Andrea Campo 26

Employment, Geographical Location, and Sectoral Heterogeneity in Italian Green and Non-green Business Network Agreements
Valentina Ceccarelli, Luca Correani, Patrizio Morganti 34

Beyond cost: a quality management capability-based framework for reshoring decisions
Federica De Iasi, Alessandro Lanfranco Bruno, Stefano Poponi 46

The application process of Viterbo for European Capital of Culture 2033
Maria Chiara Giovannelli 58

Sorting Public Value: Source-Separated Waste Collection as a Regulated-Material Service Exchange
Veronica Giuliani, Simone Marziali, Enrico Maria Mosconi 70

Accessibility and mobility poverty: a case study for Italy
Filippo Gregori, Federico Bacchi, Luca Secondi 79

Educational poverty and digital divide from a multidimensional perspective: theoretical framework and evidence from the Italian context
Matteo Stampella, Ilaria Benedetti, Tiziana Laureti 91

Introduction

Giulio Guarini[1], Barbara Pancino[2]

The book is a collection of contributions from students of the PhD Program in Economics, Management and Quantitative Methods at the University of Tuscia. In addition, the volume features an essay by Luca Raffaele and Lorenzo Semplici, who occupy, respectively, the position of Managing Director and Head of the Research and Evaluation Center of NeXt Economia, a national network of organisations, businesses, local authorities, communities and third sector bodies. Furthermore, Raffaele is a member of the Advisory Board of the PhD Program. The PhD Program provides advanced training in the disciplines of economics, business and management, and mathematics and statistics, with the objective of cultivating professionals who possess the capacity to comprehend the challenges confronting the contemporary economy, including the socio-environmental sustainability of economic development and the utilisation of natural resources, as well as the transformation of production, consumption, labour, and markets that is resulting from innovation. The PhD Program integrates the expertise of the members of the Academic Board across three curricula. The *Agri-food Economics and Policy curriculum* is designed to provide a comprehensive understanding of the economic analysis of agri-food systems, the policies that affect them, and their interdependencies with overall economic development at both global and local levels. The *Management curriculum* has been meticulously designed to offer a multidisciplinary educational pathway in management studies, encompassing a comprehensive array of research areas. These include corporate governance and strategy, excellence models for global competition, corporate environmental, ethical and social responsibility, technological innovation, digital transformation, new circular business models, and quality management. The *Economics and Statistics curriculum* is designed to provide a comprehensive foundation in the study and analysis of socio-economic and monetary-financial phenomena at the macro-, meso-, and micro-economic levels. This is achieved through the application of economic and statistical-economic theories, models, and econometric methods. The three curricula are grounded in interdisciplinary training in economic theories.

The book reflects the main research areas of the PhD Program, focusing on innovation and sustainability across three dimensions: economic, social, and environmental. The interplay among different economic disciplines and perspectives provides a rich set of analytical tools that can help firms, institutions, and civil society address the complex socioeconomic challenges currently faced at the global, national, and local levels. The book opens with the essay *The New Social and Civil Economy: Governing the great transitions by learning to think as a community* by Luca Raffaele and Lorenzo Semplici which put in evidence the potential significance role of social and civil economy to govern the five great transitions: ecological, digital, demographic, social and geopolitical, by drawing the 2026 Report on the New Social and Civil Economy in Italy. Authors explain the characteristics of this New Economy by considering its roots in the history of economic thought, its demand side by considering the finding of a survey on citizens and its supply side by investigating organisations, ESG practices and energy communities. Finally, they underline some structural problems and propose important reforms the launch and support this new economy.

[1]The Coordinator of the PhD Program in Economics, Management and Quantitative Methods, Full Professor of Economics at University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, giulioguarini@unitus.it.

[2] The Vice-coordinator of the PhD Program in Economics, Management and Quantitative Methods, Associate Professor of Agricultural and Food Economics at University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, bpancino@unitus.it.

All chapters written by PhD students were supervised by their tutors and are presented in alphabetical order by author. Two main groups of contributions can be identified. The first examines issues relevant to firms and production systems, such as artificial intelligence, supply chains, networking, and reshoring. The second focuses on the economic analysis of important social dimensions, including territorial cohesion, poverty, and civic participation. The collection includes both conceptual and empirical research.

The first section concerning enterprises is composed of the following four papers. Gaia Buttaroni and Vincenzo Sforza in *A bibliometric analysis of artificial intelligence in the accounting profession (1984–2025)* study how and when the literature has moved from considering Artificial Intelligence as a technical instrument to examining its implications for accountants' roles, identities, and professional work. In particular, authors investigate: how Artificial Intelligence research in accounting has developed, and what intellectual framework supports it; how the conceptual structure of the field has evolved, and when the professional dimension enter its vocabulary; finally, whether the field shows a transition from an Artificial Intelligence-centred to an accounting-centred orientation, or a tool-oriented approach still prevails. Irene Cardelli and Andrea Campo in *Innovation, Resilience and Sustainability in Production Supply Chains: Toward a New Industrial Model* point out the relevance of the concept of production supply chains to complement the horizontal dimension with a vertical one and to shift the focus from individual sectors to the sequence of interconnected industries involved in the production process. Moreover, they put in evidence that in light of the profound transformations affecting the global economy, marked by the growing centrality of technology, innovation, and sustainability, as well as increasing demands for resilience and competitiveness, the need to redesign industrial policy around the concept of production supply chains has become increasingly evident. Valentina Ceccarelli, Luca Correani and Patrizio Morganti in *Employment, Geographical Location, and Sectoral Heterogeneity in Italian Green and Non-green Business Network Agreements* explore how Italian Business Network Agreements contribute to the so-called "just transition," namely a fair shift towards a sustainable economy. They consider Business Network Agreements as an example of open innovation mode, focusing on their structural characteristics. Specifically, the relationship between employment, cross-sectoral heterogeneity, and geographical location -with a distinction between green and non-green BNAs- is analysed, by using a one-step system GMM estimator on a sample of 18702 Italian network firms from 2014 to 2023. Federica De Iasi, Alessandro Lanfranco Bruno, Stefano Poponi in *Beyond cost: a quality management capability-based framework for reshoring decisions* aim to explain how Quality Management capabilities support firms' strategic reassessment of offshoring strategies through the identification, interpretation and evaluation of the hidden quality-related costs associated with globally dispersed production systems. While previous studies have extensively investigated the economic, operational and geopolitical drivers of reshoring, the role of Quality Management in shaping manufacturing location choices remains theoretically fragmented. To address this gap, a structured narrative literature review and qualitative thematic synthesis integrate contributions from the reshoring, supply chain management, Total Quality Management and Quality 4.0 literature, leading to the development of a capability-based conceptual framework.

The second section, devoted to the economic study of territorial cohesion and social inclusion, is composed of the following four papers. Maria Chiara Giovannelli in *The application process of Viterbo for European Capital of Culture 2033* describes the application process undertaken by Viterbo for the European Capital of Culture (ECoC) initiative, that contributes to determine a long-term cultural and urban strategy beyond the ECoC year, and to empower the citizens' self-esteem and civic pride. The Author analyses data collected during the laboratories in October 2025 organized to foster the citizen participation, using the Integrated Model of Destination Competitiveness, including the Social Conditions determinant proposed by Aquilino et al. (2019) in the assessment of Matera, ECoC 2019. Veronica Giuliani, Simone Marziali and Enrico Maria Mosconi in *Sorting Public Value: Source-*

Separated Waste Collection as a Regulated-Material Service Exchange inspect how source-separated municipal waste collection can be conceptualized as a regulated, asymmetric and socially constructed public-service exchange. Authors propose the construct of value-in-regulated-material context: household participation creates public value only when sorting practices become materially usable, institutionally recognized and publicly legitimate. Building on Public Service Logic, Service-Dominant Logic, co-production research and Edvardsson, Tronvoll and Gruber's social-construction approach, they adapt value-in-social-context to municipal waste collection by combining an instrumental integrative review, a diagnostic bibliometric gap audit and theory adaptation. Filippo Gregori, Federico Bacchi, Luca Secondi in *Accessibility and mobility poverty: a case study for Italy*, empirically study two of the four dimensions of transport poverty, namely accessibility and mobility poverty. The former can be defined as the ease of reaching activities such as work, education, health services and shops at reasonable cost, while mobility poverty refers to the lack of adequate transportation infrastructures. They verify the spatial distribution of transport infrastructure availability and accessibility using datasets from the Italian National Institute of Statistics and the Transport Poverty Hub to apply Global and Local Moran's. Matteo Stampella, Ilaria Benedetti and Tiziana Laureti in *Educational poverty and digital divide from a multidimensional perspective: theoretical framework and evidence from the Italian context* examine the overlap between educational disadvantage and digital vulnerability in Italian households, drawing on Sen's capability approach where poverty is understood not only as economic deprivation, but as a limitation of the substantive freedoms and capabilities that allow individuals to pursue valuable life trajectories. Using microdata from the 2023 ISTAT Aspects of Daily Life Survey, the study constructs three household-level indicators of educational-digital poverty, based respectively on lack of full digital access, low digital skills among key adults, and the simultaneous presence of both conditions in households with low educational capital.

The New Social and Civil Economy: Governing the great transitions by learning to think as a community

Luca Raffaele[1], *Lorenzo Semplici*[2]

Abstract

Drawing on the 2026 Report on the New Social and Civil Economy in Italy[3], this essay argues that the civil economy tradition offers not a corrective at the margins of the market but a constitutive grammar for economic life in an age of ecological, digital, demographic, social and geopolitical transitions. Survey evidence on more than six thousand Italian citizens reveals a society whose values run ahead of its capabilities: awareness of the need for a new economic model is widespread, while the knowledge, participation and action required to enact it lag structurally behind. Read through the capability approach, this gap points to two fractures, one institutional, one in civil human capital, and to three policy trajectories: reforming the information architecture of the market, building a national system for the recognition of civic capabilities, and granting the community legal standing as an economic agent.

Keywords: Civil economy, Social economy, Capability approach, Civic participation, Public happiness.

1. A paradigm for governing the transitions

The great transitions of our time, ecological, digital, demographic, social and geopolitical, have progressively exposed the limits of an economic paradigm built upon a series of reductionisms: the isolated *homo oeconomicus*, the firm conceived exclusively as a maximiser of shareholder value, gross domestic product treated as an exhaustive measure of progress, public policy designed as a top-down exercise, and research imagined as an activity separated from civic responsibility. None of these assumptions is innocent. Each has shaped institutions, curricula, balance sheets and ministries; together they have produced a growing distance between economic growth and the effective well-being of persons and communities, alongside rising inequality, environmental crisis and a visible weakening of democratic participation.

The 2026 Report on the New Social and Civil Economy in Italy, the third in its series, produced by NeXt Economia with the University of Rome Tor Vergata as scientific partner, within the framework of the National Observatory on the Social and Civil Economy (ON-ESC), takes this diagnosis as its point of departure and submits it to an unusual discipline: measurement[4]. Rather than restating the critique of economic reductionism in normative terms, the Report asks how far Italian society has

[1]Director General of NeXt Nuova Economia per Tutti, President of VERSO Innovation Center S.r.l. Società Benefit (University of Florence) and President of NeXt Social Commerce (Gioosto) and PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, luca.raffaele@nexteconomia.org.

[2] PhD in Civil Economy Sciences, Guest Lecturer in Statistics at the Pontifical Faculty of Educational Sciences "Auxilium," Head of the Research and Evaluation Center at NeXt Economia,lecturer and trainer on Civil Economy topics for Master's programs and advanced training courses, lorenzo.semplici@nexteconomia.org.

[3] The authors are the editors of the Report on which this essay draws.

[4] L. Becchetti – L. Raffaele – L. Semplici (a cura di), *Rapporto 2026 sulla Nuova Economia Sociale e Civile. La prospettiva per governare le transizioni e pensarsi comunità*, NeXt Economia – ON-ESC, Roma 2026 («Rapporti di Nuova Economia Sociale e Civile», n. 3/2026), ISBN 979-12-80634-47-4; hereafter: *Rapporto 2026*. Unless otherwise indicated, all data cited in this essay are drawn from the *Rapporto 2026* and its Appendices. https://nexteconomia.org/landing/onesc-osservatorio-nazionale-sulla-nuova-economia-sociale-e-civile/.

actually travelled towards a different paradigm, on both the demand side (citizens) and the supply side (organisations, enterprises, communities), and where precisely the journey is interrupted.

A conceptual clarification governs the whole exercise. The civil economy and the social economy are not synonyms, nor rivals: they stand to one another as a scientific paradigm stands to a policy paradigm, in the sense Thomas Kuhn gave to these terms[5]. The civil economy, the tradition that runs from the Neapolitan and Milanese Enlightenment to its contemporary revival, is a way of understanding what the economy is: a practice of mutual assistance among persons, in which reciprocity, trust and the intention of public happiness are constitutive rather than residual features of exchange. The social economy, as codified by the European Union's Social Economy Action Plan (2021–2031), with its more than sixty actions for enabling ecosystems, access to finance and public recognition, is a way of organising policy around a specific family of actors: cooperatives, mutuals, associations, foundations and social enterprises[6]. Under the umbrella of the civil paradigm there is room for several policy models, of which the social economy is the most consolidated; the converse does not hold. The perimeter of the civil economy is wider, embracing not only third-sector entities but sustainable enterprises, responsible citizens, districts, financial intermediaries and, more generally, the whole constellation of intermediate bodies through which society organises itself between the individual and the State[7].

2. An ancient lineage for a new economy

That constellation has deep roots. When Antonio Genovesi assumed in Naples, in 1754, the first university chair of economics in the world, a chair, significantly, of «commerce and mechanics» established within a project of civil reform, he described commercial society as a network of mutual assistance held together by *fede pubblica*, public trust, and oriented towards public happiness[8]. The market, in this lineage, is not the antithesis of community but one of its expressions; and the wealth of nations depends less on the accumulation of capital than on the quality of relationships, what contemporary scholarship has conceptualised as relational goods, social capital and generativity[9].

The *new* social and civil economy is therefore new in a precise and limited sense: not the invention of a doctrine, but the encounter of an ancient tradition with three contemporary developments. First, the European institutionalisation of the social economy as a strategic ecosystem for the resilience of the single market. Second, the diffusion of instruments, ESG metrics, non-financial reporting, impact evaluation, shared administration, renewable energy communities, that make it technically possible to observe, measure and reward the civil quality of economic behaviour. Third, the availability of data infrastructures, such as the open platforms of the ON-ESC, that permit a systematic, longitudinal reading of the phenomenon. What follows summarises what that reading shows.

3. The demand side: a society that wants what it cannot yet do

The core of the Report's demand-side analysis is a national survey (CATI methodology) of a representative sample of more than six thousand Italian citizens, from which a composite indicator of

---

[5] T.S. Kuhn (1962). On the application of the distinction to the civil economy / social economy pair, see *Rapporto 2026*, cit., Part 1.

[6] European Commission (2021).

[7] On the notion and taxonomy of intermediate bodies, see L. Becchetti – V. Bobbio – D.M. Bova – M. Decaro – C. Longarini – L. Raffaele – L. Semplici (2026), pp. 255-320.

[8] A. Genovesi, *Lezioni di commercio o sia di economia civile* (1765-1767), a cura di M.L. Perna, Istituto Italiano per gli Studi Filosofici, Napoli 2005. The notion of *pubblica felicità* had been placed at the centre of the reform programme of the Italian Enlightenment by L.A. Muratori, *Della pubblica felicità oggetto de' buoni principi* (1749).

[9] See L. Bruni – S. Zamagni, *Civil Economy: Another Idea of the Market*, Agenda Publishing, Newcastle upon Tyne 2016; L. Becchetti – L. Bruni – S. Zamagni, *The Microeconomics of Wellbeing and Sustainability: Recasting the Economic Process*, Academic Press, London 2020.

the Level of New Social and Civil Economy (NESC) is constructed[10]. The indicator aggregates eight psychometrically validated determinants: the capacity for thought (the time regularly devoted to reflecting on the impact of one's choices, and of public events, on the common good); relational intelligence (listening, gratitude, reciprocity, empathy); functional emotions (good humour, positive outlook, enthusiasm); the level of virtues (courage, honesty, perseverance, fairness, prudence, self-control and their cognates); awareness of the urgency of ecological and social transition; knowledge of the instruments of the new economy; sustainable actions in consumption, saving and investment; and civic participation.

The headline result is a national NESC index of 0.55 on a normalised 0–1 scale. More instructive than the level, however, is the structure. The value-relational determinants score systematically high: relational intelligence at 0.70, awareness at 0.65, functional emotions at 0.64. The operational determinants score systematically low: actions at 0.51, participation at 0.44 and, above all, knowledge of the instruments at 0.32. The gap between the two families, 0.66 against 0.42, is statistically significant, structurally stable and irreducible to demographic controls.

Behind these averages lie findings that deserve to be quoted in their starkness. Sixty-nine per cent of respondents are aware of the need to change the economic model; eighty-eight per cent consider the transformation of consumption models urgent, and eighty per cent say the same of production models. Yet seventy-seven per cent do not know the ESG criteria, and forty-one per cent never seek information on the sustainability of what they buy. More than half perceive a concrete risk of greenwashing in corporate communication. Italy in 2026, the Report concludes, is a society with a conscious and socially diffused demand for a new economy, in which what is missing is not the will but the civil human capital, the technical-operational literacy, required to translate intention into action.

Two further results qualify the picture. The first concerns well-being: individuals with higher NESC levels report significantly higher life satisfaction (hedonic happiness), sense of life (eudaimonic happiness) and perceived territorial well-being — that «public happiness» which the civil tradition has always treated as the true end of economic life. Econometric analysis suggests the relationship is not merely associative: participation in the civil economy produces well-being, and not only the reverse. The second concerns territory. The regions of the Alpine arc combine strong value activation with efficient social and environmental conversion factors, cohesive communities, cooperative structures, welfare protections, and translate values into behaviour with regularity; in the Mezzogiorno, an evident personal and relational activation meets bottlenecks in the surrounding conversion factors, dispersing latent potential before it consolidates into effective capabilities.

4. Thinking as activation: a capability reading

The vocabulary of "conversion factors" is deliberate. The Report formalises the NESC model within Amartya Sen's capability approach, resources, converted through personal, social and environmental factors into capabilities and then into functionings, enriched by Martha Nussbaum's emphasis on practical reason and by the theory of dynamic capabilities (sensing, seizing, transforming) developed in the strategic management literature[11]. Two theoretical innovations are proposed and tested econometrically through structural equation modelling.

The first treats the capacity for thought, what the Report calls *contempl-active intelligence*, the habit of reflecting alone and with others on the common good, not as one resource among many but as an activation factor operating along the whole capacitation chain. Conversion factors cease to be

[10] *Rapporto 2026*, cit., Part 2, Chapter 1; the questionnaire, the legend and the descriptive statistics of all variables are reproduced in Appendices 1 and 2.

[11] A. Sen (1999); M.C. Nussbaum (2011); D.J. Teece – G. Pisano – A. Shuen (1997); M. Zollo – S.G. Winter (2002).

exogenous constants and become endogenous functions of practical reasoning: thinking well enlarges the very ecosystems, micro and macro, within which the person acts. The second innovation is a double flow of capacitation, in which the operational NESC (actions and participation) figures first as a functioning, the output of a process that runs from thought through conversion factors to awareness and knowledge, and then, in a second flow, as a conversion factor in its own right, expanding the individual capacity to transform ordinary resources into multidimensional well-being.

The empirical results are consistent and, in places, striking. The capacity for thought exerts a significant direct impact on the personal, social and environmental conversion factors of the new economy, and the resulting latent capability translates effectively into knowledge, action and, most strongly, active participation. In the second model, thought acts twice: it activates the conversion factors and it improves well-being directly, «thinking does us good twice», in the Report's formula, while the NESC itself, as a fourth conversion factor, exhibits a robust direct effect on perceived well-being. The policy implication is anything but rhetorical: strategies for the new economy must include systematic interventions that free time and space for personal and social reflection, because the reflective act is the cognitive switch that removes economic behaviour from impersonal automatism and founds what the Report calls the *rationality of the we*, the capacity to think of oneself as a community.

5. The supply side: organisations, ESG practices and energy communities

If the demand side reveals a bottleneck of capabilities, the supply side reveals an ecosystem in formation. As of 31 December 2025, the ON-ESC platforms map 1,274 subjects of the civil economy: 745 belonging to the social economy in the strict sense, cooperatives, third-sector entities and renewable energy communities in their various configurations, and 529 enterprises of the sustainable economy, defined as those scoring above the sufficiency threshold in the NeXt Index ESG evaluations, a multidimensional, multi-stakeholder rating methodology developed by organised civil society before, and independently of, regulatory compliance[12].

The analysis of thousands of item-level scores yields a differentiated portrait of Italian organisations. The social dimension is the most mature: corporate welfare and work-life balance, ongoing training, gender equality, customer care and participation in territorial development appear as declared themes in well over ninety per cent of the evaluated organisations, usually with measurement indicators attached. The environmental dimension shows solidity on supply-chain traceability and the sustainability of production inputs, with weaker performance on soil protection and environmental education. The governance dimension is the most fragile: the participation of workers in company management is declared by fewer than half of the organisations analysed, and the disclosure of controversies by barely more than a third; across all pillars, moreover, the presence of explicit improvement objectives is systematically rarer than the declaration of themes, a distance between narrative and commitment which constitutes, in itself, an operational measure of greenwashing risk.

The most innovative section of the supply-side analysis concerns renewable energy communities. The platforms census 376 initiatives, 173 in the North, 103 in the Centre, 100 in the South, spanning collective self-consumption groups, energy communities proper (CER), solidarity-based communities (CERS) and communities with an explicit social-impact constitution (CERIS)[13]. The Report reads these experiences not as technical devices for distributed generation but as social

[12] The ESG and CER open platforms were developed by NeXt Economia with the University of Rome Tor Vergata within the PNRR-funded GRINS project (Growing Resilient, Inclusive and Sustainable, Mission 4, Component 2, Investment 1.3) and now form part of the shared infrastructure of the ON-ESC. Data as of 31 December 2025: *Rapporto 2026*, cit., Chapters 2 and 3, and Appendix 5.

[13] *Rapporto 2026*, cit., Chapter 4 and Appendix 6. The census covers 376 initiatives, including collective self-consumption groups; renewable energy communities in the strict sense number 351.

infrastructures: their density correlates with pre-existing relational capacity and associative networks; their most effective governance models are participatory and multi-stakeholder; their measured effects include reduced energy costs, contrast to energy poverty, local investment activation and the accumulation of social capital. The first predictive multidimensional impact assessment of a solidarity energy community, conducted with the Civil Impact methodology on the Esquilino–Monti CERS in Rome, indicates the direction in which evaluation practice is moving: from output accounting to the estimation of generativity.

6. Two fractures: institutions and civil human capital

Read together, the two sides of the inquiry disclose two fractures, and it is here that the Report makes its most original analytical contribution.

The first fracture is institutional. The coexistence of near-universal awareness with minimal instrumental knowledge is not a paradox of public opinion; it is the predictable signature of a market failure that economic theory has long formalised[14]. George Akerlof showed that under informational asymmetry about quality, markets expel honest sellers and reward dishonest ones, a dynamic that, in the field of sustainability, manifests itself as systemic greenwashing and adverse selection against genuinely virtuous organisations. Joseph Stiglitz generalised the analysis to all goods whose decisive characteristics are unobservable, and sustainability is unobservable by construction: no individual consumer can verify supply chains, labour contracts and environment

al impacts. Douglass North added that institutions, the formal and informal rules of the game — determine transaction costs and therefore the direction of incentives. The knowledge deficit measured at 0.32 is thus not a cultural failing of the Italian population; it is the consequence of an informational architecture designed to signal productive efficiency and technical quality, not civil impact. Within such an architecture, the sustainable choice is structurally more expensive, in time, attention and cognitive resources, than the conventional one. The transmission between values and behaviour breaks down not at the moment of preference but at the moment of action.

The second fracture concerns the distribution of civil human capital. The generative ecosystem of the new economy is concentrated in a triad of catalysts: the civil entrepreneur (NESC 0.696), the citizen with tertiary education (0.689) and the structured volunteer (0.667), against a national mean of 0.55 and a distributional tail represented by the pensioner outside civic networks (0.440). The finding is not sociologically obvious, for it is not reducible to income, age or geography: a civil entrepreneur from the Mezzogiorno displays systematically higher NESC profiles than a wealthy pensioner from the North-East. The explanatory variable is exposure to relational and generative economic experience, contexts in which reciprocity, collective responsibility and impact on third parties are endogenous to one's ordinary activity, and in which knowledge of the instruments is daily practice rather than optional information. The deficit of knowledge and participation, in other words, is corrected neither by acting on values (which are already present) nor by disseminating information in the abstract, but by multiplying the contexts of relational economic experience and by cultivating the habit of thinking one's own actions in terms of the common good.

7. Three trajectories

From the two fractures the Report derives three trajectories, deliberately framed as directions rather than measures, since the design of instruments belongs to the competent institutions.

The first is the reform of the informational architecture of economic life. If the market cannot read values, the answer is not to exit the market but to rewrite the rules of information that govern it:

[14] G.A. Akerlof (1970); J.E. Stiglitz (2002), pp. 460-501; D.C. North(1990).

completing and extending the European disclosure framework opened by the Corporate Sustainability Reporting Directive and recalibrated by the subsequent Omnibus packages, with graduated mechanisms for small and medium organisations[15]; building public infrastructures of civil rating, conceived as public goods in the manner of energy labels or land registries rather than as competitive private services, and extending the digital product passport across merchandise sectors; and mobilising public procurement, more than one hundred and fifty billion euro of annual purchases, the largest single buyer in the Italian economy — as a structural lever, through quality criteria already available in law. The aim is that the daily exercise of «voting with the wallet», the choice of consumers, savers and investors to reward civilly generative organisations, should cost no more than the conventional alternative[16]. Instruments generated by organised civil society, such as the NeXt Index ESG, already exist and are coherent with the regulatory framework; the step that the data render urgent is their institutionalisation as reference systems for procurement, fiscal benefits and the accountability of publicly supported enterprises.

The second trajectory is the construction of a national system for the recognition and development of civic capabilities. If the new economy diffuses through relational experience, education policy must treat civic capabilities, participating in collective governance, evaluating the impact of one's economic choices, building trust across differences, reading a sustainability report, as core rather than accessory competences, from secondary schooling to higher and continuing education, along the lines of the OECD Learning Compass 2030[17]. Symmetrically, the organisations of the social and civil economy should cease to be conceived merely as recipients of welfare policy and be recognised as privileged environments for the formation of civil human capital: laboratories in which the relational knowledge that formal education does not yet generate is produced, tested and transferred, with corresponding recognition within competence-certification systems, active labour policies and the universities' Third Mission. The most urgent constituency is the excluded one: pensioners outside civic networks, low-income households, residents of areas with low institutional density, for whom the gap is not one of values but of access to enabling contexts.

The third trajectory is the recognition of the community as an economic subject of law. The energy communities mapped by the Observatory, together with community cooperatives, solidarity purchasing groups, districts and network pacts, are the embryonic form of an economic actor that is neither market nor State nor civil society in the traditional sense, but combines the logics of all three: it allocates resources through collective deliberation, produces goods and services efficiently, generates positive externalities for its territory and accumulates social capital among its members. Karl Polanyi described modern economic history as a double movement, the expansion of the self-regulating market and the protective counter-movement of society[18]. The new social and civil economy is not a variant of the second movement, a defence against the market; it is the more ambitious construction of markets that are civically constituted from the origin. Italian law already contains fragments of this recognition, the Third Sector reform of 2017, the legislation on renewable energy communities, the long tradition of cooperative mutualism[19]; what the data render urgent is their systematisation into a coherent doctrine of communal economic agency, with proportionate rights of access to resources, obligations of transparency and mechanisms of accountability.

8. Conclusion: the measure of public happiness

[15] Directive (EU) 2022/2464 of 14 December 2022 on corporate sustainability reporting (CSRD), as subsequently recalibrated by the Omnibus simplification packages.
[16] L. Becchetti (2008).
[17] OECD (2019).
[18] K. Polanyi (1944)
[19] Legislative Decree no. 117 of 3 July 2017 (Third Sector Code) and Legislative Decree no. 199 of 8 November 2021, implementing Directive (EU) 2018/2001 with regard to renewable energy communities.

The thesis that the 2026 Report advances, with the solidity of the available evidence and the prudence its complexity demands, can be stated briefly. The new social and civil economy is not a market segment, nor a complement to public welfare, nor a niche of ethically minded consumers. It is a constitutive mode of the economy: the form economic relations take when reciprocity is structural rather than residual. The Italian data show that this mode is already present in society in sufficient measure to constitute a critical mass of transformation; what is missing is the institutional architecture that would render it as efficient as the conventional one. Building that architecture is the task of politics; measuring its progress, through the National Observatory and its emerging regional articulations, conceived as multilevel infrastructures of proximity that connect data, tools and territorial experience in a bottom-up logic, is the task of research.

There is a final, properly humanistic implication. The strongest empirical regularity in the entire inquiry is the double benefit of thought: the habit of reflecting on the common good both activates civil behaviour and directly improves well-being. Two and a half centuries after Genovesi taught that the end of the economy is public happiness and its means is mutual assistance, a representative survey of his compatriots confirms the intuition with the instruments of psychometrics and structural modelling. The transitions we must govern are, before anything else, transitions in our way of thinking; and an economy capable of thinking of itself as a community is not a utopia to be preached, but a capability to be built, patiently, institutionally, measurably. The data will decide.

References

Akerlof G. A. (1970). The Market for “Lemons”: Quality Uncertainty and the Market Mechanism *Quarterly Journal of Economics* 84(3), pp. 488–500.

Becchetti L. (2008). *Il voto nel portafoglio. Cambiare consumo e risparmio per cambiare l'economia* Il Margine, Trento.

Becchetti L., Bobbio V., Bova D. M., Decaro M., Longarini C., Raffaele L., Semplici L. (2026). I corpi intermedi per l'innovazione e l'inclusione sociale. In Brunetta R. (ed.), *Corpi intermedi, società civile ed economia sociale. Per un governo delle transizioni* Il Mulino, Bologna, pp. 255–320.

Becchetti L., Bruni L., Zamagni S. (2020). *The Microeconomics of Wellbeing and Sustainability: Recasting the Economic Process* Academic Press, London.

Becchetti L., Raffaele L., Semplici L. (eds.) (2026). *Rapporto 2026 sulla Nuova Economia Sociale e Civile. La prospettiva per governare le transizioni e pensarsi comunità* NeXt Economia – ON-ESC, Roma, Rapporti di Nuova Economia Sociale e Civile, 3/2026, ISBN 979-12-80634-47-4.

Bruni L., Zamagni S. (2016). *Civil Economy: Another Idea of the Market* Agenda Publishing, Newcastle upon Tyne.

European Commission. (2018). *Directive (EU) 2018/2001*.

European Commission. (2021). *Building an Economy that Works for People: An Action Plan for the Social Economy* COM(2021) 778 final, Brussels, 9 December 2021.

European Commission. (2022). *Directive (EU) 2022/2464 of 14 December 2022*.

Genovesi A. (2005). *Lezioni di commercio o sia di economia civile* (1765–1767), Perna M. L. (ed.) Istituto Italiano per gli Studi Filosofici, Napoli.

Italian Legislative Decree No. 117. (2017). *Legislative Decree No. 117 of 3 July 2017 (Third Sector Code)*.

Italian Legislative Decree No. 199. (2021). *Legislative Decree No. 199 of 8 November 2021*.

Kuhn T. S. (1962). *The Structure of Scientific Revolutions* University of Chicago Press, Chicago.

Muratori L. A. (1749). *Della pubblica felicità oggetto de' buoni principi*.

North D. C. (1990). *Institutions, Institutional Change and Economic Performance* Cambridge University Press, Cambridge.

Nussbaum M. C. (2011). *Creating Capabilities: The Human Development Approach* Harvard University Press, Cambridge (MA).

OECD. (2019). *OECD Future of Education and Skills 2030: Learning Compass 2030* OECD Publishing, Paris.

Polanyi K. (1944). *The Great Transformation: The Political and Economic Origins of Our Time* Farrar & Rinehart, New York.

Sen A. (1999). *Development as Freedom* Oxford University Press, Oxford.

Stiglitz J. E. (2002). Information and the Change in the Paradigm in Economics *American Economic Review* 92(3), pp. 460–501.

Teece D. J., Pisano G., Shuen A. (1997). Dynamic Capabilities and Strategic Management *Strategic Management Journal* 18(7), pp. 509–533.

Zollo M., Winter S. G. (2002). Deliberate Learning and the Evolution of Dynamic Capabilities *Organization Science* 13(3), pp. 339–351.

A bibliometric analysis of Artificial Intelligence in the accounting profession (1984–2025)

Gaia Buttaroni[1] *and Vincenzo Sforza*[2]

Abstract

This study investigates how the accounting literature has addressed the impact of Artificial Intelligence (AI) on the accounting profession. Although the diffusion of AI across auditing, financial reporting and management control systems has been widely documented, existing bibliometric reviews remain predominantly technological, only partially addressing whether scholarship has moved from assessing AI as a technical instrument to questioning accountants, roles, judgement and professional identity. Adopting the *AI-centric/accounting-centric distinction* (Stratopoulos and Wang, 2025) as an interpretive continuum, the study combines performance analysis and science mapping through Bibliometrix. Following a PRISMA protocol, the corpus comprises 720 documents (1984–2025) from Scopus and Web of Science, restricted to accounting journals ranked in the AJG 2024. Three phases emerge: latency (1984–2016), structural growth (2017–2019) and exponential expansion (2020–2025). The findings reveal a persistent asymmetry: the field remains accounting-based in its empirical domain, where auditing holds the highest centrality, yet AI-centric in its conceptualisation of innovation, with ethics and the accounting profession as peripheral nodes. Large language models emerge as the most significant discontinuity and a potentially autonomous research trajectory. The study therefore points to the training and governance frameworks required to work critically with AI, and to research more explicitly centred on the profession itself.

Keywords: Artificial intelligence, Accounting profession, Bibliometric analysis, Auditing, Management control.

1. Introduction

Digital transformation has increasingly reshaped socio-economic systems, and Artificial Intelligence (AI) now represents one of its most powerful drivers and a central topic in contemporary academic debate (Kraus et al., 2022). In accounting, the paradigmatic impact of AI, anticipated by Warren et al. (2015), has become visible across auditing, financial reporting, control systems and professional practice (Kokina & Davenport, 2017; Moll & Yigitbasioglu, 2019; Lehner et al., 2022). At the same time, AI does not merely introduce new tools into accounting work; it also questions the boundaries, methods and epistemological foundations of the discipline (Argento et al., 2025; Stratopoulos & Wang, 2025).

Although research on AI and accounting has grown rapidly, existing bibliometric studies have mainly focused on the evolution of the field (Camilli et al., 2024), emerging technologies in accounting information systems, or AI-based forecasting (Kureljusic & Karger, 2023). However, these contributions tend to adopt a predominantly technological perspective and only partially address the long-term transformation of the accounting profession, especially after the rise of generative AI. This leaves an important gap: how and when has the literature moved from considering AI as a technical

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, gaia.buttaroni@unitus.it.
[2] Full Professor of Business Economics at University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, sforza@unitus.it.

instrument to examining its implications for accountants' roles, identities, and professional work? Accordingly, this study addresses three research questions:

- RQ1) How has AI research in accounting developed, and what intellectual framework supports it?
- RQ2) How has the conceptual structure of the field evolved, and when did the professional dimension enter its vocabulary?
- RQ3) Does the field show a transition from an AI-centred to an accounting-centred orientation, or does a tool-oriented approach still prevail?

To answer these questions, the study adopts a bibliometric design, which is particularly well-suited to analysing large bodies of literature using objective, reproducible procedures (Donthu et al., 2021). The analysis combines Scopus and Web of Science Core Collection data to strengthen robustness and representativeness (Lim et al., 2024) and uses Bibliometrix to conduct performance analysis and science mapping (Aria & Cuccurullo, 2017; Lim et al., 2024). The final corpus includes 720 documents published between 1984 and 2025.

The study contributes both theoretically and practically. Theoretically, it reconstructs the evolution of AI-related accounting research over four decades, showing how technological vocabulary has advanced more rapidly than reflection on professional transformation. Practically, it helps scholars, practitioners and professional bodies understand where the debate remains unbalanced: while AI is increasingly central to accounting processes, its consequences for judgement, ethics, accountability and professional identity remain only partially developed.

2. Methodology

2.1 *Research design*

The study adopts a bibliometric design structured in two complementary sections, in line with the procedural guidelines proposed by Donthu et al. (2021): performance analysis, which describes the intellectual structure of the field, and science mapping, which aims to highlight the evolution of knowledge relating to the research topic.

2.2 Data collection

The systematic collection of data involved two sequential stages:

I) The search string was developed through a preliminary exploratory review based on Camilli et al. (2024) and Moll & Yigitbasioglu (2019). Core technological terms related to AI and the internet (e.g. "*big data*", "*blockchain*", "*machine learning*") were extracted from these studies. These keywords were then iteratively tested to optimise the final query, ensuring maximum relevance and comprehensiveness of the retrieved results. Based on the exploratory analysis, two lexical strings were identified, relating respectively to the technological sphere and to the accounting profession, reported in Table 1. To consult the databases, the two research strings were combined using the Boolean operator *AND* and applied to the *title*, *abstract* and *authors' keywords* search fields, to identify publications positioned at the intersection of the two domains. The records obtained from each database were subsequently subjected to a progressive sequence of in-database exclusion and inclusion criteria, as described in the next phase.

Table 1. Strings used in the composition of the search query.

AI's string	*"artificial intelligence" OR "ai" OR "machine learning" OR "deep learning" OR "algorithm*" OR "robotic*" OR "automation" OR "computer vision" OR "neural networks" OR "cloud" OR "big data" OR "blockchain" OR "language model*" OR "LLM*" OR "expert system*"*
Accountants' string	*"accounting profession*" OR "accounting professional*" OR "accountant*" OR "auditor*" OR "controller*" OR "accountancy profession" OR "accountant role"*

II) The selection of contributions to analyse. The PRISMA 2020 flow diagram (Page et al., 2021), as illustrated in Figure 1, summarises the selection process for defining the final bibliometric corpus. The initial search identified records from two databases, Scopus and Web of Science, producing a very large pool of potentially relevant publications. After screening 466,440 records, the selection was progressively narrowed by applying specific eligibility criteria: only English-language articles and reviews published in accounting journals ranked in the AJG 2024 were retained. This reduced the corpus to 747 reports. After the final inclusion and analytical stage, 720 studies were selected for the review, forming the dataset used for the bibliometric analysis.

Figure 1. PRISMA 2020 visualisation.

2.3 Data analysis

The analysis of the 720 documents was carried out through a bibliometric approach, divided into two parts: a performance analysis, offering a quantitative overview of the literature considered, and a science mapping, reconstructing the field's conceptual and intellectual networks. In operational terms, the analysis combined descriptive indicators of productivity and impact with longitudinal science-mapping outputs, including trend topics, co-occurrence networks, and thematic evolution. These tools were used sequentially: first to identify the historical intensity of publication activity, then to trace the movement of concepts across periods, and finally to interpret whether central or peripheral nodes reveal stable or emerging research priorities. The whole analysis was carried out using *Bibliometrix* (Aria & Cuccurullo, 2017), an open-source R package developed for comprehensive science mapping and has already been employed in relevant accounting research with a historical orientation (Camilli et al., 2026).

Both performance analysis and science mapping are read through the lens of Stratopoulos and Wang (2025), whose distinction between *AI-centric and Accounting-centric orientations* provides the interpretive key adopted here and summarised in Table 2. The framework is not used as a rigid classification scheme, but as an interpretive continuum. *AI-centric research* is understood as work in which accounting data or problems primarily serve to test, design or evaluate technologies; by contrast, *accounting-centric research* treats AI as a context for understanding accounting theory, professional identity, work practices, ethics and institutional change. This distinction makes it possible to read bibliometric patterns as evidence of disciplinary orientation rather than only topic frequency.

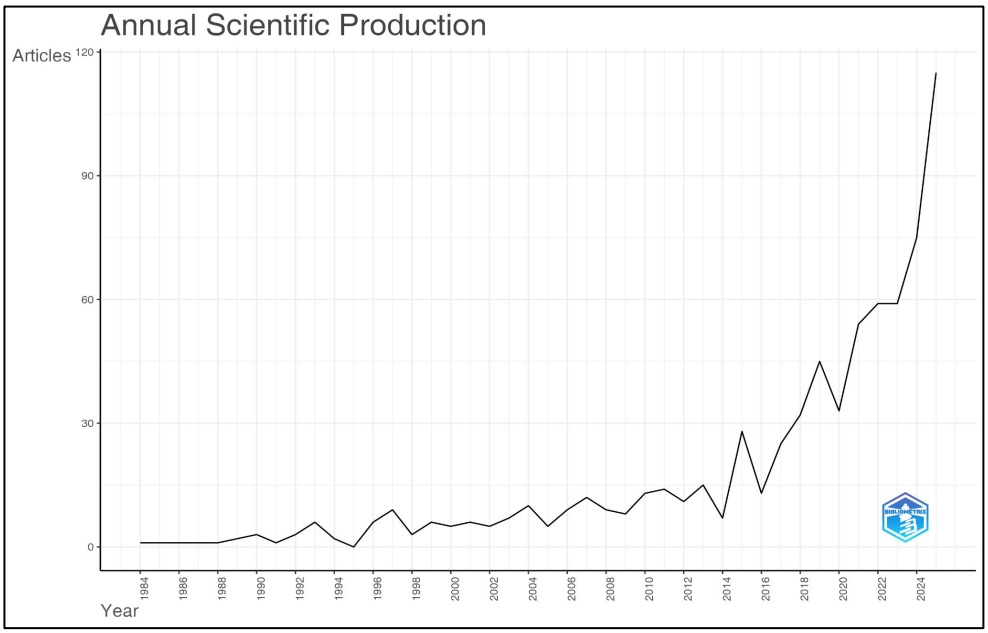
Table 2. A comparative and summary table about the implementation of the framework by Stratopoulos & Wang (2025).

Type	Guiding question	Primary contribution
Accounting-centric	What do we learn about accounting through, or in the context of, AI?	Accounting theory, practice, institutions, or phenomena
AI-centric	What do we learn about AI by using accounting problems or data?	AI methods, models, performance, design, or evaluation

3. Findings and discussion

Scientific output on the AI–Accounting relationship follows an asymmetrical trajectory (Figure 2), marked by early research activity in the mid-1980s and a sharp acceleration over the last decade. The chronological trend reveals three main stages. The first is a latency period (1984–2016), comprising 223 publications and reflecting an embryonic research phase in which interest remained limited to specific operational applications, such as early neural networks for fraud detection and business risk assessment (Green & Choi, 1997; Calderon & Cheh, 2002). The second stage, a phase of structural growth, occurred between 2017 and 2019, during which 102 papers were published. This period, driven by big data, cloud computing, and deep learning, marked the transition from *narrow AI*, understood as a tool for automating defined tasks, to *disruptive AI*, capable of reshaping work organisation and professional roles (Moll & Yigitbasioglu, 2019). The third stage covers 2020–2025, with 395 publications and a peak of 115 papers in 2025 alone. This exponential growth is associated with the rise of generative AI and *large language models*, whose ability to analyse and produce natural language in complex contexts extends beyond statistical data processing and has renewed scholarly debate in the field (Agbon, 2024; Dong et al., 2024; Eulerich et al., 2024).

Figure 2. Annual scientific production of accounting literature on AI and profession.



Read through the AI-centric/accounting-centric distinction; these three stages indicate that the field's growth is not only quantitative; it also marks a gradual shift from early technical applications toward a more explicit, though still limited, concern with the accounting profession. Indeed, this trajectory suggests that AI has progressively shifted from being treated as a technical support for specific accounting and auditing tasks to becoming a broader factor of professional reconfiguration. The increase after 2020 is therefore not only evidence of growing academic attention to AI, but also of a changing concern with how accountants, auditors and controllers redefine their expertise, judgement and accountability in technologically mediated environments.

Figure 3. Most globally cited documents of accounting literature on AI and profession.

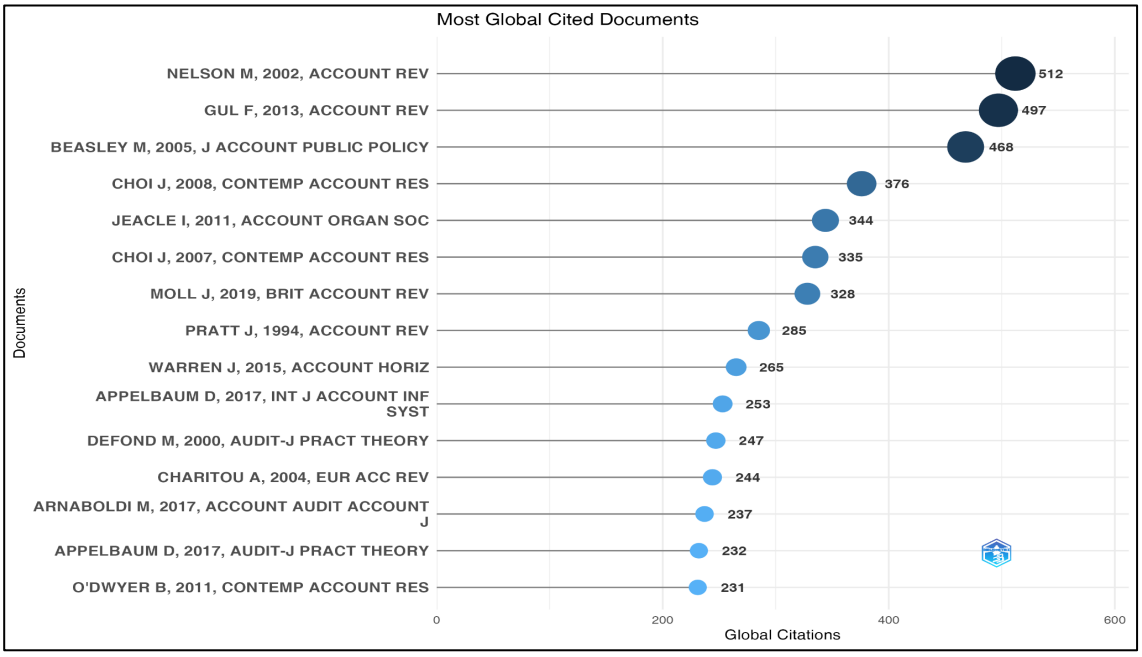
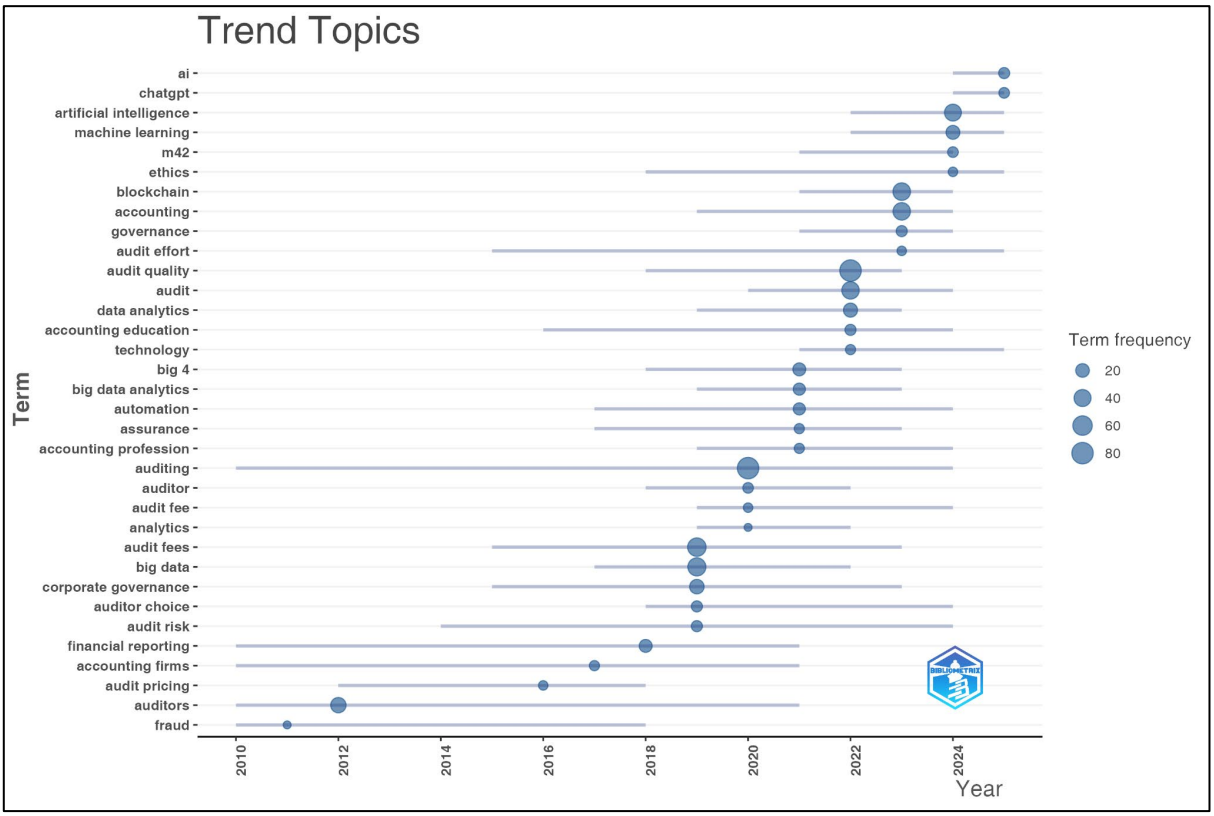


Figure 3 shows that the most frequently cited documents are mainly rooted in the classical accounting research tradition and precede the recent technological turn, addressing topics such as earnings management (Nelson et al., 2002), audit quality and pricing (Gul et al., 2013), enterprise risk management (Beasley et al., 2005), and trust-based accounting frameworks (Choi et al., 2008; Jeacle & Carter, 2011). However, the emergence of Moll and Yigitbasioglu (2019), with 328 citations and the highest annual citation rate, signals a shift towards an accounting-centric perspective focused on technology's impact on professional roles. Overall, the citation structure suggests that AI has entered accounting mainly through auditing, analytics, risk assessment, fraud detection and assurance functions.

Figure 4. Trend topics of accounting literature on AI and profession.



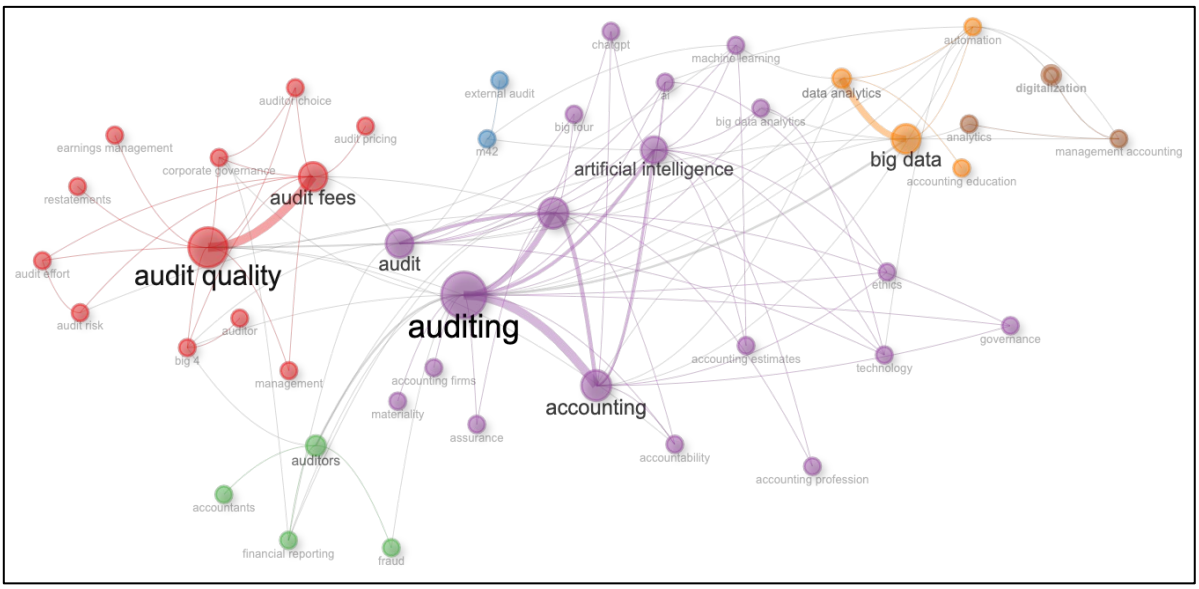
From the visualisation of trending topics (Figure 4), we can observe three distinct time periods. The early period (2010–2017) includes terms such as "*fraud*", "*auditors*", "*audit pricing*" and "*financial reporting*" and is associated with the advent of neural networks for fraud detection and predictive models of insolvency (Charitou et al., 2004; Perols, 2011). The middle period (2018–2019) is limited to topics relating to big data, corporate governance, analytics and the Big Four, reflecting the debate on analytics and audit automation (Appelbaum et al., 2017; Schmitz and Leoni, 2019). The recent period (2020-2025) includes topics such as artificial intelligence, machine learning and ethics, including the first contributions on generative technology (Dong et al., 2024; Eulerich et al., 2024; Gu et al., 2024), the future of the profession (Boritz and Stratopoulos, 2023) and ethical implications (Munoko et al., 2020; Zhang et al., 2023). This transition is particularly relevant because the vocabulary of ethics and professional work appears only after the consolidation of AI-centric terms such as "*analytics*", "*automation*" and "machine learning".

On the chart, where terms are ordered by median year of occurrence, the smaller diameter of recent nodes, compared to historical ones, shows that these concepts are still emerging and don't have a leading role in the literature. However, looking at this timeline through the *AI-centric* vs *Accounting-centric lens*, the trends topic shows that while the early stages are characterised by a strictly technical and tool-oriented focus (e.g. *detection, analytics, automation*), the recent period sees the development of generative technology combined with a vocabulary focused on disciplinary implications (e.g. *ethics, the accounting profession).* The simultaneous emergence of generative models and the ethical dimension demonstrate how generative AI is situated within the scientific debate on deontological reflection.

From the perspective of the accounting profession, the trend-topic analysis shows a gradual enlargement of the debate. Earlier topics such as fraud, auditors, audit pricing and financial reporting

refer mainly to traditional professional tasks, where technology is used to improve detection, prediction and control. The subsequent emergence of big data, analytics, and automation indicates a shift toward redesigning work processes and professional competences. In the most recent period, the emergence of artificial intelligence, machine learning, ethics and the accounting profession suggests that the literature is beginning to address AI not only as a technical tool but also as a force affecting professional judgement, ethical responsibility and the boundaries of accounting expertise.

Figure 5. Co-occurrence network of accounting literature on AI and profession.



Source: Biblioshiny.

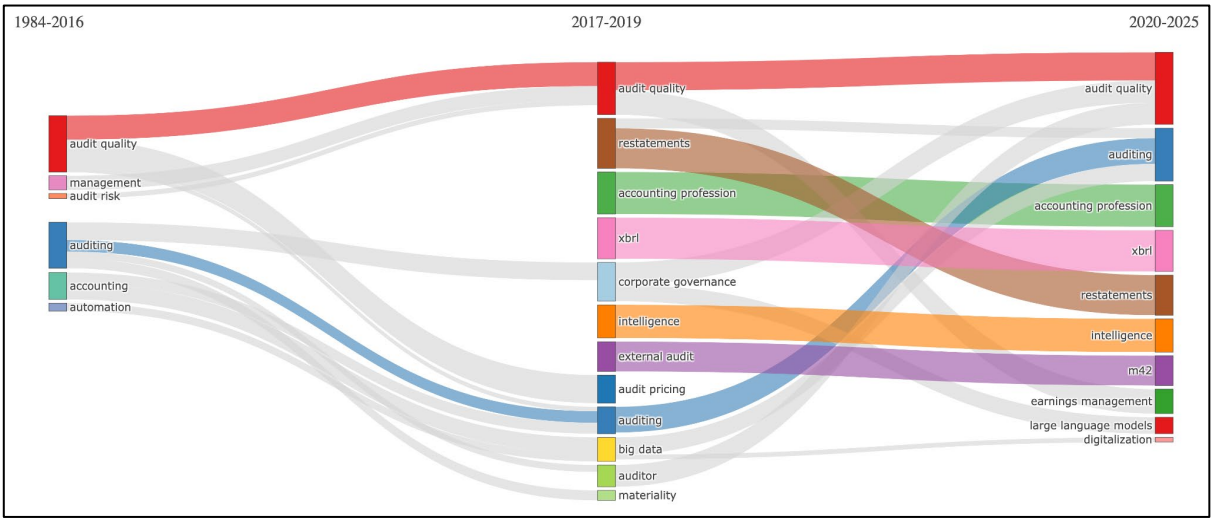
The co-occurrence network analysis (Figure 5) reveals a central core (*auditing, accounting, artificial intelligence, audit*) dominated by the "*auditing node*", which has the highest degree of centrality. The graph's periphery is clearly divided into two sections: one distinct cluster collects topics related to auditing economics (e.g., *audit quality, audit fees and earnings management*), while on the opposite side, two different clusters combine technological and analytical terms (e.g., *big data, data analytics, automation, digitalisation*). In this architecture, the term "*artificial intelligence*" occupies an intermediate position between the main core and the technological pole, serving as a bridge node. This distribution confirms that accounting-centric concerns do not yet occupy the core of the network, even as they have become increasingly visible in recent debate.

According to the theoretical framework, the graph's morphology reveals a distinct AI-centric orientation, framing innovation as merely a tool for connecting audit practices and analytical systems. By contrast, the Accounting-centric terminology is confined to the surrounding area. Terms such as ethics and the accounting profession emerge as low-centrality, detached nodes. These findings support the hypothesis that, although ethical and professional implications have emerged in the debate, they still haven't become a central focus of accounting research, remaining limited to a minority of articles (Hsieh et al., 2020; Tiron-Tudor & Deliu, 2022).

The co-occurrence network is particularly informative from an accounting profession perspective. The dominance of auditing as the most central node indicates that the professional debate on AI remains strongly anchored in assurance-related activities. AI is therefore mainly connected to the

transformation of audit work, rather than to the accounting profession as a whole. At the same time, the peripheral position of terms such as "*ethics*" and "*accounting profession*" suggests that issues concerning professional identity, responsibility, judgement and role change have not yet become structurally embedded in the field. This confirms that the literature still tends to frame AI as a tool for enhancing professional tasks, rather than as a phenomenon capable of redefining the professional role itself.

Figure 6. Thematic evolution of accounting literature on AI and profession.



Source: Biblioshiny.

The thematic evolution map (Figure 6) reveals three main phases in the development of the literature: 1984–2016, 2017–2019, and 2020–2025. The first period is dominated by a traditional accounting and auditing framework, centred on auditing, audit quality, accounting and automation as the main technological driver. The intermediate phase shows a more fragmented structure, with the emergence of instrumental digital themes such as intelligence and big data, as well as the first explicit references to the accounting profession. In the most recent period, the field has moved more clearly towards digital transformation, with digitalisation and large language models gaining visibility. Nevertheless, established themes such as XBRL, restatements, audit quality, and auditing remain persistent, indicating continuity within the broader accounting domain.

Interpreted through the framework proposed by Stratopoulos and Wang (2025), the map suggests a progressive refinement of the AI-centric dimension. The literature evolves from broad references to automation in the first period, towards intelligence and big data in the second, and finally to more specific constructs such as digitalisation and large language models in the most recent phase. This trajectory indicates that technological innovation is increasingly conceptualised through more specialised terminology. However, the accounting-centric dimension remains comparatively underdeveloped. Although the accounting profession appears from the intermediate period onwards, it remains a stable but isolated vector, without generating further conceptual branches. This suggests that professional issues are acknowledged but have not yet become an autonomous research stream.

Overall, the thematic evolution confirms a persistent imbalance between technological and professional perspectives. The field remains accounting-based in its empirical domain, as its core themes continue to concern auditing, audit quality, accounting practices, XBRL and restatements. At

the same time, it is largely AI-centric in its conceptualisation of innovation, with AI primarily framed as an instrument for improving accounting and auditing tasks. Less attention is devoted to how AI may reshape professional judgement, ethical responsibility, accountability and occupational boundaries. The emergence of large language models represents the most significant discontinuity, suggesting that generative AI could become an autonomous research trajectory and a catalyst for future theoretical development.

4. Conclusions

This study answers the three research questions by showing that the literature on AI and the accounting profession has evolved through a sequence of continuity and disruption. Regarding RQ1, the field developed from early applications aimed at fraud detection and insolvency prediction (Green & Choi, 1997; Charitou et al., 2004), through the expansion of Big Data, analytics and deep learning (Warren et al., 2015; Sun, 2019; Ding et al., 2020), to the recent acceleration driven by generative AI and large language models (Dong et al., 2024; Eulerich et al., 2024). However, this growth remains anchored in traditional accounting and auditing concerns. Regarding RQ2, the professional dimension has only recently entered the vocabulary and remains peripheral. Regarding RQ3, the field remains predominantly AI-centric: AI is primarily treated as a tool for improving accounting and auditing tasks, while its broader implications for professional identity, judgement and responsibility remain underdeveloped.

The practical implication is that accounting professionals, firms and standard setters should not limit their attention to the adoption of AI tools. The findings suggest that the main challenge is not only technical implementation, but the redefinition of competences, responsibilities and ethical safeguards. The marginality of socio-professional reflection, already noted in relation to the transition of accounting work (Leitner-Hanetseder et al., 2021), indicates the need for training models and governance frameworks that prepare accountants to work critically with AI rather than merely operate AI-based systems.

Theoretically, the study contributes by demonstrating that the AI-accounting literature has refined its technological vocabulary faster than its accounting-centred conceptual framework. Future research should therefore move beyond the instrumental view of AI and investigate how generative technologies reshape professional judgement, accountability, occupational boundaries and institutional legitimacy. In this sense, AI no longer asks accounting scholars only what technology can do for the profession, but what the technology is doing to the profession itself.

References

Agbon G. (2024). Who speaks through the machine? Generative AI as discourse and implications for management *Critical Perspectives on Accounting* 100, 102761.

Appelbaum D. Kogan A. Vasarhelyi M. Yan Z. (2017). Impact of business analytics and enterprise systems on managerial accounting *International Journal of Accounting Information Systems* 25, pp. 29-44.

Argento D. Dobija D. Grossi G. Marrone M. Mora L. (2025). The unaccounted effects of digital transformation: implications for accounting, auditing and accountability research *Accounting, Auditing & Accountability Journal* 38(3), pp. 765–796.

Aria M. Cuccurullo C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis *Journal of Informetrics* 11(4), pp. 959-975.

Beasley M. S. Clune R. Hermanson D. R. (2005). Enterprise risk management: An empirical analysis of factors associated with the extent of implementation *Journal of Accounting and Public Policy* 24(6), pp. 521-531.

Boritz J. E. Stratopoulos T. C. (2023). AI and the Accounting Profession: Views from Industry and Academia *Journal of Information Systems* 37(3), pp. 1–9.

Calderon T. G. Cheh J. J. (2002). A roadmap for future neural networks research in auditing and risk assessment *Int. J. Account. Inf. Syst.* 3, pp. 203-236.

Camilli R. Mechelli A. Coronella L. (2026). History Of Behavioral Accounting Research (1960–2023): A Bibliometric Analysis *Journal of Management History* 32(1), pp. 195-211.

Camilli R. Mechelli A. Hristov I. (2024). History of accounting research on Artificial Intelligence applications (1984-2023): a bibliometric analysis *RIREA* 1, pp. 40-56.

Charitou A. Neophytou E. Charalambous C. (2004). Predicting corporate failure: empirical evidence for the UK *European Accounting Review* 13(3), pp. 465-497.

Choi J. H. Kim J. B. Liu X. Simunic D. A. (2008). Audit Pricing, Legal Liability Regimes, and Big 4 Premiums: Theory and Cross-country Evidence *Contemporary Accounting Research* 25(1), pp. 55-99.

Ding K. Lev B. Peng X. Sun T. Vasarhelyi M. A. (2020). Machine learning improves accounting estimates: evidence from insurance payments *Review of Accounting Studies* 25(3), pp. 1098-1134.

Dong M. M. Stratopoulos T. C. Wang V. X. (2024). A scoping review of ChatGPT research in accounting and finance *International Journal of Accounting Information Systems* 55, 100715.

Donthu N. Kumar S. Mukherjee D. Pandey N. Lim W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines *Journal of Business Research* 133, pp. 285-296.

Eulerich M. Waddoups N. Wagener M. Wood D. A. (2024). The Dark Side of Robotic Process Automation (RPA): Understanding Risks and Challenges with RPA *Accounting Horizons* 38(2), pp. 143–152.

Green B. P. Choi J. H. (1997). Assessing the Risk of Management Fraud Through Neural Network Technology *Auditing: A Journal of Practice & Theory*.

Gu H. Schreyer M. Moffitt K. Vasarhelyi M. (2024). Artificial intelligence co-piloted auditing *International Journal of Accounting Information Systems* 54, 100698.

Gul F. A. Zhou G. Zhu X. (2013). Investor Protection, Firm Informational Problems, Big N Auditors, and Cost of Debt around the World *Auditing: A Journal of Practice & Theory* 32(3), pp. 1–30.

Hsieh T. Kim J. Wang R. R. Wang Z. (2020). Seeing is believing? Executives' facial trustworthiness, auditor tenure, and audit fees *Journal of Accounting and Economics* 69(1), 101260.

Jeacle I. Carter C. (2011). In TripAdvisor we trust: Rankings, calculative regimes and abstract systems *Accounting, Organizations and Society* 36(4-5), pp. 293-309.

Kokina J. Davenport T. H. (2017). The emergence of artificial intelligence: how automation is changing auditing *Journal of Emerging Technologies in Accounting* 14(1), pp. 115-122.

Kraus S. Durst S. Ferreira J. J. Veiga P. Kailer N. Weinmann A. (2022). Digital transformation in business and management research: An overview of the current status quo *International Journal of Information Management* 63, 102466.

Kureljusic M. Karger E. (2023). Forecasting in financial accounting with artificial intelligence – A systematic literature review and future research agenda *Journal of Applied Accounting Research*.

Lehner O. M. Ittonen K. Silvola H. Ström E. Wührleitner A. (2022). Artificial intelligence based decision-making in accounting and auditing: ethical challenges and normative thinking *Accounting, Auditing and Accountability Journal* 35(9), pp. 109-135.

Leitner-Hanetseder S. Lehner O. M. Eisl C. Forstenlechner C. (2021). A profession in transition: actors, tasks and roles in AI-based accounting *Journal of Applied Accounting Research* 22(3), pp. 539–556.

Lim W. M. Kumar S. Donthu N. (2024). How to combine and clean bibliometric data and use bibliometric tools synergistically: Guidelines using metaverse research *Journal of Business Research* 182, 114760.

Moll J. Yigitbasioglu O. (2019). The role of internet-related technologies in shaping the work of accountants: New directions for accounting research *The British Accounting Review* 51(6), 100833.

Munoko I. Brown-Liburd H. L. Vasarhelyi M. (2020). The Ethical Implications of Using Artificial Intelligence in Auditing *Journal of Business Ethics* 167, pp. 209–234.

Nelson M. W. Elliott J. A. Tarpley R. L. (2002). Evidence from Auditors about Managers' and Auditors' Earnings Management Decisions *The Accounting Review* 77(s-1), pp. 175–202.

Page M. J. McKenzie J. E. Bossuyt P. M. Boutron I. Hoffmann T. C. Mulrow C. D. ... Moher D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews *BMJ* 372.

Perols J. L. (2011). Financial statement fraud detection: An analysis of statistical and machine learning algorithms *Auditing: A Journal of Practice & Theory* 30(2), pp. 19-50.

Schmitz J. Leoni G. (2019). Accounting and Auditing at the Time of Blockchain Technology: A Research Agenda *Australian Accounting Review* 29(2), pp. 331-342.

Stratopoulos T. C. Wang V. X. (2025). Artificial intelligence and accounting research: A framework and agenda *International Journal of Accounting Information Systems* 56, 100760.

Sun T. (2019). Applying Deep Learning to Audit Procedures: An Illustrative Framework *Accounting Horizons*.

Tiron-Tudor A. Deliu D. (2022). Reflections on the human-algorithm complex duality perspectives in the auditing process *Qualitative Research in Accounting & Management* 19(3), pp. 255–285.

Warren J. D. Moffitt K. C. Byrnes P. (2015). How Big Data Will Change Accounting *Accounting Horizons* 29(2), pp. 397–407.

Zhang C. Zhu W. Dai J. Wu Y. Chen X. (2023). Ethical impact of artificial intelligence in managerial accounting *International Journal of Accounting Information Systems* 49, 100619.

Innovation, Resilience and Sustainability in Production Supply Chains: Toward a New Industrial Model

Irene Cardelli[1], Andrea Campo[2]

Abstract

This position paper examines the evolution of supply chains in the context of profound economic, technological, and geopolitical transformations reshaping the global industrial system. The analysis highlights how increasing supply chain vulnerabilities, technological competition, and the digital and ecological transitions, together with the growing relevance of economic security, require moving beyond a linear and sector-based view of production systems. The paper proposes an integrated supply chain approach, encompassing both vertical and horizontal integration through the exchange of resources, knowledge, products, and technologies and the development of industrial symbiosis. From this perspective, innovation, sustainability, quality, resilience, and competitiveness emerge as interconnected dimensions of a new industrial model. Particular attention is given to digital technologies and artificial intelligence as enabling factors for monitoring operations, managing risks, sharing information, and reconfiguring production processes. Finally, the paper emphasizes the need for integrated industrial policies combining vertical, horizontal, and territorial approaches and fostering cooperation among firms, institutions, research centers, and territories.

Keywords: Supply Chains, Resilience, Digital Innovation, Sustainability, Industrial Policy.

1. Introduction

Following the globalization process of recent decades, the global industrial and trade landscape has progressively diversified. Production supply chains, now global in scope, represent an essential component of the contemporary economy and of the broader socio-industrial context.

Technological innovation and the ecological transition have further accelerated this process of transformation, in which supply chains play a fundamental role by integrating complex and diversified networks to deliver products and services to global markets.

Moreover, the global dimension of supply chains inevitably entails an active role for states and institutions, which operate through agreements and industrial policies and often directly or indirectly control strategic segments of business processes. This generates additional political and economic tensions, while also introducing a further layer of competition not only among firms but also among countries, incorporating geopolitical considerations that must be considered.

States' foreign policy actions have a direct impact on logistics and international trade. International conflicts, trade and tariff policies, economic sanctions, and broader phenomena such as the rise of protectionism and the dissolution of international agreements represent significant geopolitical risk factors (Mykyta, 2025).

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, irene.cardelli@unitus.it.

[2] Research Fellow, University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, andrea.campo@unitus.it.

Production supply chains are a key element of the modern industrial landscape. A purely horizontal analysis of a single sector is inadequate for interpreting competitive dynamics, as it overlooks interdependencies with vertically related activities and sectors within an increasingly complex system of integration and relationships. This system no longer aims solely at maximizing industrial margins, but also at safeguarding production stability and ensuring national security and the well-being of citizens. The supply chain approach broadens the analytical perspective by complementing the horizontal dimension with a vertical one, shifting the focus from individual sectors to the sequence of interconnected industries involved in the production process (Tolomeo, 2013).

In light of the profound transformations affecting the global economy, marked by the growing centrality of technology, innovation, and sustainability, as well as increasing demands for resilience and competitiveness, the need to redesign industrial policy around the concept of production supply chains has become increasingly evident. As highlighted in the *Green Paper on Industrial Policies* by the Italian Ministry of Enterprises and Made in Italy (2024), modern industrial policy is no longer limited to correcting market failures, but must take on a broader role of guidance and strategic vision. It must equip the economic system with the tools needed to prevent and respond to external shocks, such as pandemics, natural disasters, and conflicts, particularly armed ones, support the achievement of ecological and technological transition goals, and safeguard national competitiveness, which will increasingly depend on the ability to operate within an international context characterized by growing tensions and hostilities (Italian Ministry of Enterprises and Made in Italy, 2024).

The major economic and geopolitical shocks of recent years have highlighted how the resilience of an economic system depends not only on the performance of individual sectors, but above all on the quality of relationships and connections linking firms, skills, and territories. Furthermore, modern supply chains are highly vulnerable to crises, which may arise from catastrophic events in distribution centers, disruptions in healthcare supply systems during pandemics, food supply chain breakdowns during food crises, large-scale product recalls by suppliers, or partner insolvency (Durugbo and Al-Balushi, 2025).

In this context, supply chains increasingly emerge as a strategic lever for resilience and innovation, grounded in cooperation among economic actors and in the circulation of knowledge throughout the production process. These elements are essential for fostering innovation across all stages of the supply chain and enhancing the competitiveness of the firms involved. At the same time, the concept of the supply chain itself has progressively expanded in both theoretical and operational terms: from a traditional, predominantly linear and sector-based view to a more modern conception characterized by a systemic and integrated approach to production processes. To some extent, this systemic approach effectively incorporates the evolution of production models toward the circular economy, an economic model based on continuous processes of resource exchange, reuse, and recovery, which can significantly extend the traditional boundaries of production sectors.

This transformation is particularly relevant in the case of the Italian production system, which continues to exhibit a complex and articulated structure. Alongside large, high-tech firms, there exists an extensive network of small and medium-sized enterprises that forms the backbone of *Made in Italy* and represents one of the defining features of the national industrial model. However, the strength and competitiveness of this production network increasingly depend on firms' ability to adapt to new economic paradigms and to successfully navigate the major ongoing transitions, particularly the digital and sustainable ones.

2. The Socio-Economic Context

Over the past decade, the global economy has been undergoing a period of substantial transformation, particularly at strategic and geopolitical levels.

From an economic perspective, these changes are reflected in an increasingly close interconnection between industrial policy and national security strategy. Strategic autonomy is increasingly regarded as a key objective of industrial policy, and this concept is more frequently used to identify sectors or production supply chains that require targeted support, both in terms of productivity and resilience (Criscuolo et al., 2022). This convergence, driven by geopolitical tensions, supply chain vulnerabilities, and technological competition, marks a departure from the free-market-oriented economic policies that dominated the period following the end of the Cold War (Hauge et al., 2025).

Indeed, during the 1990s, the role of the state in industrial development was significantly reduced. Due to the perceived inability of governments to identify strategic sectors, public intervention was largely confined to horizontal measures aimed at correcting market inefficiencies. However, the systemic crises of 2008 and 2020 triggered a reversal of this trend, leading to a renewed emphasis on industrial planning, with public authorities regaining a central role in shaping economic growth trajectories (Italian Ministry of Enterprises and Made in Italy, 2025).

In the past decade, the rise of China as a global manufacturing power, supply chain disruptions caused by the COVID-19 pandemic and intensifying technological competition have prompted the adoption of policies aimed at ensuring supply chain security, protecting and developing strategic industries, and maintaining technological advantages. Following the pandemic crisis, the European Union has focused on building more resilient and diversified supply chains, especially in critical sectors such as pharmaceuticals, semiconductors, and raw materials (Rosén and Meunier, 2023).

Critical raw materials are playing an increasingly important role as a factor of competitiveness, as they lie at the beginning of all industrial value chains and constitute the material foundation of any production activity. Moreover, many of these resources are essential for achieving broader objectives such as technological progress, ecological transition, and national security (Italian Ministry of Enterprises and Made in Italy, 2025).

Competition policy plays a fundamental role in strengthening the competitiveness of the European Union. Its objective is to ensure that economic integration results in open, competitive, and efficient markets across all Member States. By creating a level playing field for firms and consumers, it transforms the legal framework of the Single Market into an economic reality (Duso, 2025).

These issues were also highlighted in the report presented by Mario Draghi during a joint press conference with the President of the European Commission, Ursula von der Leyen. The Draghi Report (2024) emphasizes that the European Union has experienced relatively low growth, partly due to a slowdown in productivity. This condition has been exacerbated by three main factors: the expansion of global trade, which has increased competitive pressure on European firms; the disruption of relations with Russia, a key energy supplier to the EU; and evolving geopolitical scenarios, including the questioning of the U.S. security umbrella that had previously allowed the EU to allocate defense spending to other priorities.

Consequently, according to the Draghi Report, an agenda aimed at strengthening competitiveness should primarily focus on increasing productivity and reinforcing security, which is considered a fundamental prerequisite for sustainable development from environmental, economic, financial, and social perspectives (Draghi, 2024).

With regard to Italy, its deep integration into international markets and the European Union makes its production system highly sensitive to geopolitical instability. Since Italian GDP is closely tied to global value chains, a worsening of global economic fragmentation, leading to reduced trade, would put the Italian industrial model at risk. This model is characterized by long production supply chains in which the country's strength lies more in transformation processes than in primary production.

For the European Union as a whole, trade fragmentation also represents a threat to the ongoing dual transition, ecological and digital. These processes are highly capital-intensive and depend heavily on the import of strategic raw materials, without which the autonomy required to complete these structural transformations cannot be achieved (Italian Ministry of Enterprises and Made in Italy, 2025).

For this reason, in June 2023, the European Commission and the High Representative of the Union presented a communication on the European Economic Security Strategy. This strategy is based on three main pillars: first, promoting the Union's competitiveness by strengthening the Single Market, investing in skills, and supporting the EU's industrial, technological, and research base; second, protecting economic security through the updating of existing instruments and the introduction of new ones; and third, strengthening relationships with third countries that share similar interests in economic security, including through the promotion and conclusion of new trade agreements and the reinforcement of a rules-based international economic order and multilateral institutions (European Commission, 2023).

As stated in the White Paper on Industrial Policies by the Italian Ministry of Enterprises and Made in Italy (2025), public policies for industrial development can be structured according to three main approaches. The first is the vertical approach, which focuses intervention on specific production systems considered strategic, often identified through interdependent ATECO classification codes. The second is the horizontal approach, which targets the entire business sector and is based on the creation of favorable general conditions for development; in this case, public intervention often involves discretionary decisions regarding the selection or support of specific technologies. Finally, there are territorial policies, which direct interventions toward firms located in specific geographic areas, based on criteria related to local conditions and cohesion objectives.

The Italian production system is characterized by a dual specialization, both sectoral and territorial, and therefore requires industrial policies capable of combining horizontal, vertical, and territorial instruments. In this context, an industrial policy approach structured along production supply chains and adaptable to the specific needs of each of them represents an appropriate response to these challenges (Italian Ministry of Enterprises and Made in Italy, 2025).

3. Position

The concept of "integrated supply chains," understood not only in a vertical sense but also horizontally, through the exchange of resources, products, and services, as well as mechanisms of industrial "symbiosis", now represents a strategic response to the growing global need for resilience, competitiveness, and continuous adaptation of contemporary economies. The shocks that have profoundly reshaped economic and productive balances in recent years have highlighted how the economic and industrial strength of a country largely depends on the quality of connections among firms, skills, and territories. In this context, the development and strengthening of integrated supply chains are becoming increasingly central, emerging as a key strategic lever to enhance the resilience of production systems and support long-term competitiveness (4Manager Report, 2025).

Integrated supply chains entail not only the strengthening of linkages among firms and across different stages of the production process, but also the systemic integration of strategic dimensions such as innovation, sustainability, and quality within production processes. From this perspective, the adoption and integration of digital technologies and artificial intelligence models into supply chain management systems represent a fundamental enabling factor. In particular, the combination of process digitalization and sustainability-oriented management models makes it possible to simultaneously pursue objectives of economic efficiency, resource optimization, and environmental

responsibility, thereby contributing to the strengthening of both competitiveness and resilience of production supply chains (Yan et al., 2025).

With regard to innovation, it clearly emerges that new technologies and digital innovation represent a paradigm capable of enhancing supply chain resilience and fostering sustainable development (Ding et al., 2024). Moreover, organizations endowed with strong innovation capabilities are better positioned to seize opportunities, generate differentiated competitive advantages, and respond proactively to evolving customer needs and market dynamics (Rotjanakorn et al., 2020).

In the literature, digital innovation is generally conceptualized as a multifaceted phenomenon comprising three core components: the adoption of digital technologies, the innovation processes through which these technologies are integrated into organizational activities, and the resulting innovative outputs (Fang et al., 2024). Within production supply chains, tools such as blockchain and big data offer numerous advantages: they enable continuous monitoring of operational conditions, the timely detection of changes in both internal and external environments (Schmidt, 2019), and the precise identification of key risks, thereby supporting proactive risk management strategies (Feng et al., 2025).

The use of artificial intelligence-based methods can further enhance the competitiveness, autonomy, and resilience of supply chains. Several studies highlight how AI technologies enable firms, among other benefits, to implement more advanced control systems, promptly identify critical areas, and address issues more rapidly and effectively across the entire supply chain (Fosso Wamba et al., 2024; Gupta et al., 2021).

Digital technologies also promote information sharing, process synergy, and resource integration, allowing firms to rapidly adapt the structure of production supply chains (Han, 2022), reconfigure existing resources to cope with environmental changes (Cheng, 2023), and activate risk response plans. Thanks to these capabilities, organizations can collaborate more effectively with partners and alternative suppliers, increasing flexibility, resilience, and responsiveness to disruptions (Scholten, 2015) (Habibi, 2023) (Rice, 2003).

Innovation also plays a central role in strengthening supply chain resilience. The latter, defined as the ability of supply chains to anticipate and manage external shocks, promptly identify potential risks, and rapidly restore operational activities (Tukamuhabwa et al., 2015), represents a crucial factor in the current context characterized by uncertainty and disruption. It is also important to emphasize that resilience not only enables a return to pre-disruption performance levels but can also lead to the achievement of more efficient and robust operational configurations (Tukamuhabwa et al., 2015).

At the same time, supply chain resilience contributes to improving firms' sustainable performance, as it enables rapid responses to external shocks and the effective restoration of operations (Papanagnou, 2022).

In this context, ensuring resilient production supply chains in the face of geopolitical instability has become a strategic priority for both firms and governments (Mykyta, 2025).

At the national level, within the framework defined by Law 206/2023 and the *Made in Italy 2030* Green Paper, digitalization emerges as a cross-cutting strategic driver of the triple transition (green, digital, and geopolitical), representing a key lever for the sustainability and competitiveness of supply chains (4Manager Report, 2025).

In this framework, the degree of integration among different supply chains becomes particularly relevant. Supply chains with a higher level of integration tend to be more competitive and resilient. This awareness highlights the need to promote a renewed business culture, based on widespread managerial capabilities and the adoption of integration strategies both along and across supply chains (4Manager Report, 2025).

A significant example in Italy of collaboration among high-tech sectors is represented by the aerospace, defense, and security industries, which together constitute one of the main drivers of the national economy (MiSE & MIUR, 2015). In particular, the security sector, as broadly defined by the European Commission, is closely interconnected with the aerospace sector. This example underpins the proposal to promote integration among different supply chains by developing structured forms of cooperation capable of fostering the transfer and cross-application of technologies across distinct but functionally interdependent domains.

In light of the above, technology, innovation, resilience, and competitiveness emerge as the guiding principles for building supply chain integration strategies capable of strengthening the industrial fabric and promoting sustainable and long-term growth.

4. Conclusions

Integrated production supply chains represent a key strategic lever for strengthening the competitiveness and resilience of industrial systems in a context characterized by geopolitical complexity and rapid technological change. Strengthening integrated supply chains, through the introduction of co-design practices, partnerships, and knowledge sharing among the various actors involved, can take on significant political relevance, requiring targeted industrial policies capable of identifying strategic sectors, promoting selective investments, and coordinating actions among public institutions, firms, and research centers.

The integration of different sectors and supply chains can foster cross-sectoral synergies, knowledge circulation, and technology transfer, all of which are essential to sustaining innovation and responding effectively to a wide range of external shocks. Within this framework, digital technologies and artificial intelligence, even in their more basic applications, constitute indispensable enabling tools. Systems based on blockchain, big data, and advanced monitoring not only improve the efficiency and sustainability of supply chains, but also enhance their resilience and adaptive capacity in complex environments.

A strategic approach to integrated supply chains therefore requires effective governance tools, incentives for innovation, and investments in human and technological capital, fostering collaboration among large firms, SMEs, and local territories. Only through a structured and technologically advanced industrial policy is it possible to build a more robust and competitive national and European production system, capable of addressing the challenges of the digital, ecological, and geopolitical transitions.

References

4Manager. (2025). Seventh Annual Report: Production Supply Chains in the Era of Augmented Knowledge *Confindustria & Federmanager*.

Ammannati L., (2024). “For a common industrial policy: Governance choices of the European Union” *Journal of Market Regulation* (2), pp. 374–392.

Bontadini F., Evangelista R., Meliciani V., Savona M., (2024). “Technology, global value chains and functional specialisation in Europe” *Research Policy* 53(2), 104908.

Cheng C., Wang L., Xie H., Yan L., (2023). Mapping digital innovation: A bibliometric analysis and systematic literature review *Technological Forecasting and Social Change* 194, 122706.

Criscuolo C., et al. (2022). “An industrial policy framework for OECD countries: Old debates, new perspectives” *OECD Science, Technology and Industry Policy Papers* No. 127, OECD Publishing, Paris.

Dabbous A., Merhej Sayegh M., Aoun Barakat K., Veglianti E., (2025). Corporate artificial intelligence readiness and its contribution to supply chain resilience: Insights from complexity theory *International Journal of Production Research* 64(6), pp. 2331–2353. https://doi.org/10.1080/00207543.2025.2578299

Di Carlo D., Schmitz L., (2023). "Europe first? The rise of EU industrial policy promoting and protecting the single market" *Journal of European Public Policy* 30(10), pp. 2063–2096.

Ding Y., Li J., Song Y., Sahut J., (2024). How does the cross-border M&A network affect digital innovation? Empirical evidence from Chinese listed companies *Research in International Business and Finance* 70, 102382.

Draghi M., (2024). The Future of European Competitiveness Report *Italian Chamber of Deputies – Office for Relations with the European Union*.

Durugbo C. M., Al-Balushi Z., (2025). Supply chain management in times of crisis: A multi-case study *Production Planning & Control* 36(11), pp. 1529–1557.

Duso T., Peitz M., (2025). "Aligning competition policy and industrial policy in the EU" *DIW Discussion Papers* 2145.

Fang X., Liu M., (2024). How does digital transformation drive digital technology innovation of enterprises? Evidence from enterprise digital patents *Technological Forecasting and Social Change* 204, 123428.

Feng X., Yu R., (2025). How does digital transformation affect corporate risk-taking? Evidence from China *International Review of Economics and Finance* 97, 103614.

Fontagné L., Reshef A., Santoni G., Vannelli G., (2024). Automation, global value chains and functional specialization *Review of International Economics* 32(2), pp. 662–691.

Fosso Wamba S., Queiroz M. M., Wu L., Sivarajah U., (2024). Big data analytics-enabled sensing capability and organizational outcomes: Assessing the mediating effects of business analytics culture *Annals of Operations Research* 333(2), pp. 559–578. https://doi.org/10.1007/s10479-020-03812-4

Gupta S., Modgil S., Meissonier R., Dwivedi Y. K., (2021). Artificial intelligence and information system resilience to cope with supply chain disruption *IEEE Transactions on Engineering Management* 71, pp. 10496–10506. https://doi.org/10.1109/TEM.2021.3116770

Habibi F., Chakrabortty R. K., Abbasi A., (2023). Evaluating supply chain network resilience considering disruption propagation *Computers & Industrial Engineering* 183, 109531.

Han H., Trimi S., (2022). Towards a data science platform for improving SME collaboration through Industry 4.0 technologies *Technological Forecasting and Social Change* 174, 121242.

Hauge J., Houtzager B., Hörmann A. J., (2025). The new economic nationalism: Industrial policy and national security in the United States, China, and the European Union *Geoforum* 166, 104382.

Italian Ministry of Enterprises and Made in Italy. (2024). *Made in Italy 2030: Green Paper for a New Industrial Policy Strategy for Italy*.

Italian Ministry of Enterprises and Made in Italy. (2026). *Made in Italy 2030: Towards a New Industrial Strategy*.

Italian Ministry of Economic Development & Italian Ministry of Education, University and Research. (2015). *Smart Specialisation Strategy*.

Mykyta S., (2025). Global trends in logistics: The impact of geopolitical factors on supply chains *The American Journal of Management and Economics Innovations* 7(03), pp. 46–55.

Papanagnou C., Seiler A., Spanaki K., Papadopoulos T., Bourlakis M., (2022). Data-driven digital transformation for emergency situations: The case of the UK retail sector *International Journal of Production Economics* 250, 108628.

Rice J. B., Caniato F., (2003). Building a secure and resilient supply chain *Supply Chain Management Review* 5, pp. 22–30.

Rosén G., Meunier S., (2023). Economic security and the politics of trade and investment policy in Europe *Politics and Governance* 11(4).

Rotjanakorn A., Sadangharn P., Na-Nan K., (2020). Development of dynamic capabilities for automotive industry performance under disruptive innovation *Journal of Open Innovation: Technology, Market, and Complexity* 6(4), 97. https://doi.org/10.3390/joitmc6040097

Schmidt C. G., Wagner S. M., (2019). Blockchain and supply chain relations: A transaction cost theory perspective *Journal of Purchasing and Supply Management* 25, 100552.

Scholten K., Schilder S., (2015). The role of collaboration in supply chain resilience *Supply Chain Management* 20, pp. 471–484.

Tukamuhabwa B. R., Stevenson M., Busby J., Zorzini M., (2015). Supply chain resilience: Definition, review and theoretical foundations for further study *International Journal of Production Research* 53, pp. 5592–5623.

Yan M.-R., Yan H., Chen Y.-R., Zhang Y., Yan X., Zhao Y., (2025). Integrated green supply chain system development with digital transformation *International Journal of Logistics Research and Applications* 29(3), pp. 394–415. https://doi.org/10.1080/13675567.2025.2492217

Zurstrassen D., (2025). Learning from the past? EU industrial policy challenges *Governance* 38, pp. 1–16.

Employment, Geographical Location, and Sectoral Heterogeneity in Italian Green and Non-green Business Network Agreements

Valentina Ceccarelli[1], Luca Correani[2], Patrizio Morganti[3]

Abstract

This paper investigates how Business Network Agreements (BNAs) contribute to the so-called "just transition," a fair shift towards a sustainable economy, in Italy. We have considered BNAs as example of open innovation mode, and we focus on their structural characteristics; we analyse the relationship between employment, cross-sectoral heterogeneity, and geographical location by distinguishing between green and non-green BNAs. Using a one-step system GMM estimator on a sample of 18702 Italian network firms from 2014 to 2023, we find that both sectoral heterogeneity and greater average network distance are negatively correlated with employment. Notably, these adverse effects are mitigated in case of green networks, suggesting that environmentally oriented BNAs may better support the just transition process. Due to higher and more complex and technological skills required by green BNAs, they are more effective in mitigating just transition processes.

Keywords: Business Networks Agreements, Employment, Sectoral heterogeneity, Strategic location, Just transition.

1. Introduction

The Italian production system is widely composed of Small and Medium-sized Enterprises (SMEs) that, despite resilience and strong regional embeddedness, often face limited financial and managerial resources. Law 33/2009 introduced Business Network Agreements (BNAs), enabling firms to collaborate to enhance innovation and competitiveness. Evidence shows BNAs improve firm performance and profitability (Dickson et al., 2021; Fabrizi et al., 2022).

Depending on their activity, they can be interpreted as forms of open innovation and open eco-innovation, respectively. As they facilitate knowledge exchange, and green/non-green skill development, they generate positive externalities. BNAs support issues like the *just energy transition*. Based on the subject description, networks were classified as "green" or "non-green." The classification is based on the identification of keywords in the network subject pertaining to environmental areas of intervention as suggested by Fabrizi et al. (2022).

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, valentina.ceccarelli@unitus.it.
[2] Associate Professor of Applied Economics, University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, correani@unitus.it.
[3] Assistant Professor of Applied Economics, University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, morganti@unitus.it.

Table 1 - Green and Non-Green Business Networks Agreements in Italy (2010 – 2024).

Year	Non - Green Net.	% of Non-Green Net. on yearly total	Green. Net.	% of Green. Net. on yearly total	Total	in % of Total
2010	12	80.00%	3	20.00%	15	0.16%
2011	128	87.07%	19	12.93%	147	1.55%
2012	239	88.85%	30	11.15%	269	2.84%
2013	463	88.87%	58	11.13%	521	5.50%
2014	355	92.93%	27	7.07%	382	4.04%
2015	475	94.62%	27	5.38%	502	5.30%
2016	544	92.99%	41	7.01%	585	6.18%
2017	770	94.02%	49	5.98%	819	8.65%
2018	670	93.31%	48	6.69%	718	7.59%
2019	638	92.20%	54	7.80%	692	7.31%
2020	722	91.86%	64	8.14%	786	8.30%
2021	836	90.28%	90	9.72%	926	9.78%
2022	891	89.55%	104	10.45%	995	10.51%
2023	919	89.14%	112	10.86%	1,031	10.89%
2024*	778	89.32%	93	10.68%	871	9.20%
Missing subject**					206	2.18%
Total	**8,440**	**89.17%**	**819**	**8.65%**	**9,465**	**100.00%**

*Data are updated to 3rd October 2024 - Source: our elaboration on Infocamere data
**Due to missing data. classification is unattainable

Prior studies document a positive relationship between BNAs and employment (Fabrizi et al., 2022), while often overlooking structural characteristics such as sectoral heterogeneity and network distance (Ceccarelli et al., 2024; Cabigiosu, 2024; Dickson et al., 2021). This study investigates how Cross-Sectoral Heterogeneity (Sect. Het.) and spatial configuration, measured through Network Average Distance (Net. Avg. Dist.), affect employment outcomes. Employment is used as a proxy for firm performance within a dynamic labour demand framework estimated via a one-step system GMM approach (Fabrizi et al., 2022; Lachenmaier & Rottmann, 2011). We analyse, first, the relationship between employment and firm-level Sect. Het., and second, the effect of Net. Avg. Dist. on employment. Furthermore, we distinguish between green and non-green networks to capture environmental dimensions and assess BNAs' contribution to the just transition. Empirically, we merge BNAs data from Infocamere[4] with Bureau van Dijk AIDA over the 2014–2023 period[5].

This study contributes to the literature in three main ways. First, following Frenken et al. (2007), it uses an entropy-based measure of firm variety to assess its impact on performance. Second, it analyses firms' strategic location by jointly considering agglomeration economies and geographical positioning. Third, it examines BNAs' structural characteristics by distinguishing between green and non-green networks and their activities.

[4] The open access database of Italian firms BNAs is available on: https://contrattidirete.registroimprese.it/reti/.
[5] We selected data of Italian firms from the 2014 period to 2023 due to lack of data availability.

Our research addresses three questions: (i) how network structural characteristics affect firm performance, (ii) how Sect. Het. and Net. Avg. Dist. influence employment levels, and (iii) what differences emerge between green and non-green networks.

Cross-Sect. Het. negatively affects employment, while agglomerated networks boost it through externalities and coordination (Cainelli & Iacobucci, 2015; Sedita et al., 2016; Cainelli & Ganau, 2019). These negative effects are weaker in green BNAs due to higher skill and expertise requirements for green innovation (Barbieri et al., 2020).

The chapter is arranged as follows: Section 2 reviews the literature and hypotheses, Section 3 presents the data, Section 4 outlines the empirical strategy and econometric model, Section 5 discusses the results, and Section 6 concludes.

2. Related Literature and Research Hypotheses

This study advances the business networks framework by focusing on the Italian context, assessing green and non-green networks' role in supporting a just transition.

BNAs enhance firm innovativeness and competitiveness by facilitating knowledge flows, fostering SMEs growth, and generating positive employment effects. They are considered tool of open and open eco-innovation, depending on the activity they produced (Horbach et al., 2012). Green networks focus on environmental innovations requiring specialized expertise and delivering higher efficiency gains, while non-green networks generate standard innovations (Ghisetti et al., 2015). Green BNAs represent a win–win strategy, combining economic and environmental objectives. They generate strong environmental and knowledge spillovers that enhance innovation and firm performance beyond local regions. Their technologies are more valuable knowledge spillover because they involve greater technological complexity and systemic integration, increasing the demand for advanced, diverse, and highly skilled workers (Barbieri et al., 2020). These dynamics boost productivity, agglomeration effects, and the spatial concentration of green economic activities.

Analysing skill and human capital heterogeneity entails examining both firm- and network-level activities, together with geographical spillovers and location-based externalities. The literature shows that BNAs improve firm performance, but the effects of structural features such as sectoral diversity and spatial configuration remain underexplored. Recent studies on Italian BNAs show that greater Sect. Het. is linked to larger networks and wider geographical reach, strengthening interactions and knowledge exchange among firms (Ceccarelli et al., 2024). In addition, industrial composition, and diversity shape employment outcomes. Caineilli & Iacubucci (2015) and Sedita et al. (2016) find that employment is negatively associated with specialization and vertical integration. Consistently, Cainelli & Ganau (2019) report short-term negative impacts of unrelated variety on employment. Not only Sect. Het. but also, geographical proximity and localised density play a key role in BNAs, reinforcing network externalities among firms. Agglomeration and spatial concentration dynamics generate benefits, including specialized labour pooling, stronger supplier linkages, and intensified knowledge exchange, all of which contribute to higher productivity and innovation (Figueiredo et al., 2009). Empirical evidence confirms that agglomeration strengthens firm performance and employment outcomes. Further, Cainelli et al. (2018) link agglomeration to higher innovation and economic performance through inter-firm knowledge spillovers. Agglomeration also supports employment growth as encourages network externalities that enhance technological efficiency and act a key driver of both productivity and employment growth.

We propose three hypotheses: HP1 and HP2, Sect. Het. and Net. Avg. Dist.[6] in networks negatively affects employment; HP3, green firms mitigate the negative effects of both heterogeneity and distance.

2. Data and Descriptive statistics

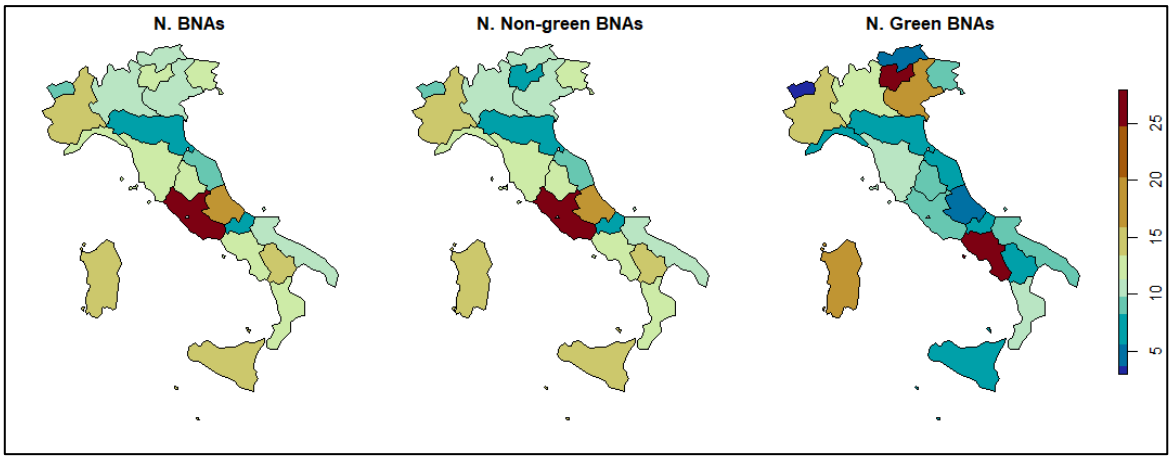
Based on network subject, Fabrizi et al. (2022) classify green networks into seven areas: energy renewal, renewable energy, energy efficiency, waste, sustainability, compatibility, and general issues (horizontal). Green networks were identified via keyword-based dummy variables from network objectives[7]. Using Infocamere and AIDA data (2014–2023), the sample includes 18,702 firms, of which 1,382 participate in green networks.

Table 2 - Statistics about our Sample.

	N. of companies	N. of companies with Green Net.	in %	N. of companies with Non - green Net.	in %
Total	49,863	3,915	7.85%	45,948	92.15%
With Bureau van Dijk AIDA Data	30,407	2,267	7.46%	28,140	92.54%
Our subsample with complete data	18,702	1,382	7.39%	17,320	92.61%

Source: our elaboration on Infocamere and Aida data. Data available upon request.

Figure 1. Number of Italian BNAs.



Source: our elaboration on Infocamere Data.

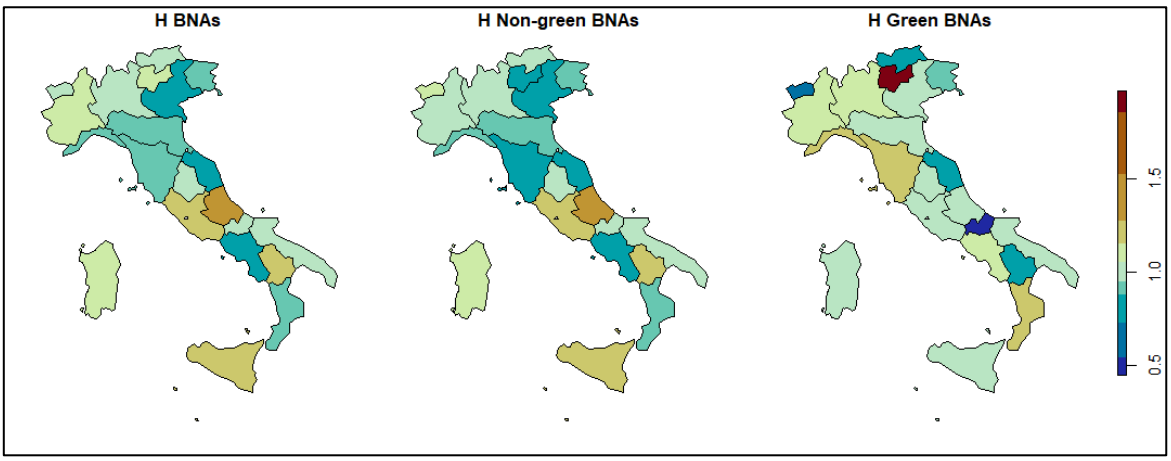
[6] We observe network agglomeration (or spatial proximity) when the Net. Avg. Dist. is equal to 0.
[7] Further details regarding the classification criteria are provided in the appendix, which is available upon request.

Sectoral Heterogeneity

Network Sect. Het. is computed as: $Sect.Het._{it} = \frac{H(x_h)}{Log(VA_{it})}$ in which the numerator represents the ratio of the entropy index and the natural logarithm of value added. The entropy index measures the degree of heterogeneity among the activities carried out by each form of the network. It is computed considering the first two numbers of the five-digit version of ATECO Code to distinguish the sectors of activities. Formally the entropy index for a single network is given by $H(X_h) = -\sum_{i=1}^{K} P(x_i) log P(x_i)$ where k indicates the sum of the firms belonging to the same BNA, i indicates the i-firm in the network h and $P(x_i)$ is the probability that a specific activity x_i occurs in the network[8]. As in Ceccarelli et al. (2024), it ranges from 0 in the case of maximum homogeneity among enterprises belonging to the same network to $log(k)$ when all network firms carry out different activities.

This entropy-based approach follows the variety framework established in the seminal work of Frenken et al. (2007). Our measure captures heterogeneity exclusively between sectors; heterogeneity within sectors is not considered. The variable captures how skill differences among network firms affect production outcomes. Unlike prior studies focused on regional variety, this study extends Frenken et al. (2007)'s framework beyond geographic proximity.

Figure 2. Cross-Sectoral Heterogeneity of Italian BNAs.



Source: our elaboration on Infocamere Data.

[8] The probability of activity x_i in a network depends on the frequency of its ATECO code and its outcome is strictly linked with the number of firms that are part of the same network. For instance, in a 5-firm network with five different ATECO codes, $P(x_i) = 1/5$.

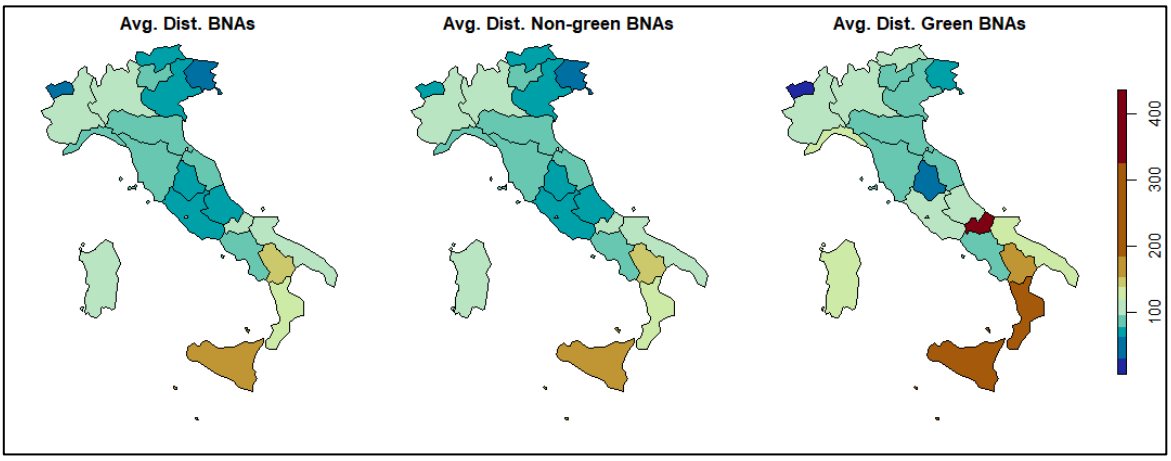
Network Average Distance

As firm may not be necessarily co-located, we assess the degree of physical spatial proximity among firms participating in the same network. We computed:

$$Net.Avg.Dist._{it} = \log\left(\frac{1+Avg.\ Dist_h}{VA_{it}}\right)$$

where the numerator represents the average distance among firms within the same network, and the denominator is value added. The addition of one to the numerator ensures that the logarithmic transformation is defined even when the average distance is zero. Average distance is calculated using a matrix of physical distances between network firms, expressed in km of networks firm's city using the following formula: $\overline{x_h} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij}}{n(n-1)}$, where i and j are firms in the same network h. Euclidean distance in km is calculated from latitude and longitude using the sf R package (Edzer, 2018). Entropy and average distance are time-invariant network variables, weighted by value added to account for temporal variation (Fabrizi et al., 2022).

Figure 3. Average Distance of Italian BNAs.



Source: our elaboration on Infocamere Data.

Table 3 - Variables Description.

Variables	Description	Source
Empl	Log of employees	Aida database
Wages	Log of wages per employee	Aida database
Va	Log of added value	Aida database
Inv	Growth rate of tangible fixed assets	Aida database
Sect. Het. (Sectoral Heterogeneity)	Ratio of network entropy on log of value added (Cross-Sectoral Heterogeneity)	Our Elaboration on Infocamere and Aida database
Net. Avg. Dist. (Network Average Distance)	Log of the ratio of Network Average Distance on added value	Our elaboration on Infocamere and AIDA database

Table 4 - Whole-Sample Summary Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Empl	134,218	2.726	1.449	0.000	11.835
Wages	134,218	2.982	0.670	-9.402	10.135
Va	134,218	6.428	1.727	-4.510	16.007
Inv	110,195	0.099	0.591	-8.887	9.119
Sect. Het.	134,218	0.096	0.200	-24.793	18.700
Net. Avg. Dist.	134,218	-4.363	3.033	-16.007	9.761

Table 5 - Non-Green Firms Summary Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Empl	124,054	2.720	1.446	0.000	11.835
Wages	124,054	2.973	0.674	-9.402	10.135
Va	124,054	6.407	1.727	-4.510	16.007
Inv	101,805	0.098	0.587	-8.887	9.119
Sect. Het.	124,054	0.096	0.204	-24.793	18.700
Net. Avg. Dist.	124,054	-4.359	3.027	-16.007	9.761

Table 6 - Green Firms Summary Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Empl	10,164	2.793	1.477	0.000	8.637
Wages	10,164	3.094	0.613	-8.377	6.866
Va	10,164	6.682	1.713	-1.874	13.465
Inv	8,390	0.113	0.628	-6.814	6.392
Sect. Het.	10,164	0.102	0.131	-0.586	4.021
Net. Avg. Dist.	10,164	-4.419	3.098	-12.561	7.221

Table 7 – Whole-Sample Correlation Matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Empl	1.000					
(2) Wages	0.228	1.000				
(3) Va	0.890	0.522	1.000			
(4) Inv	0.008	-0.010	0.006	1.000		
(5) Sect. Het.	-0.119	-0.089	-0.145	-0.028	1.000	
(6) Net. Avg. Dist.	-0.464	-0.259	-0.510	-0.036	0.400	1.000

Table 8 – Non-Green Firms Correlation Matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Empl	1.000					
(2) Wages	0.225	1.000				
(3) Va	0.889	0.525	1.000			
(4) Inv	0.007	-0.010	0.006	1.000		
(5) Sect. Het.	-0.118	-0.090	-0.145	-0.027	1.000	
(6) Net. Avg. Dist.	-0.464	-0.265	-0.513	-0.035	0.391	1.000

Table 9 – Green Firms Correlation Matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Empl	1.000					
(2) Wages	0.257	1.000				
(3) Va	0.904	0.468	1.000			
(4) Inv	0.008	-0.015	0.010	1.000		
(5) Sect. Het.	-0.146	-0.086	-0.178	-0.055	1.000	
(6) Net. Avg. Dist.	-0.454	-0.182	-0.483	-0.049	0.622	1.000

3. Empirical methodology and econometric specification

We employ a dynamic panel data approach using a one-step system GMM (GMM-SYS) estimator, suitable for addressing endogeneity in panel data. Model validity is assessed by Wald and Hansen J-tests. AR(1) shows first-order autocorrelation, while AR(2) confirms no second-order serial correlation in the GMM framework. To assess our empirical hypotheses, we employ a dynamic stochastic labour demand equation (Fabrizi et al., 2022; Lachenmaier & Rottmann, 2011). We expect labour costs to exert a negative effect on labour demand, while output is anticipated to have a positive impact. Investment has an ambiguous effect: it can be labour-augmenting, supporting firm growth, or labour-saving via new technology (Piva & Vivarelli, 2018).

Specification 1 is:

$$Empl_{it} = \beta_0 + \beta_1 Empl_{it-1} + \beta_2 Wages_{it} + \beta_3 Va_{it} + \beta_4 Inv_{it} + \beta_6 Sect.\ Het._{it} + \varepsilon_i + v_{it} \quad (1)$$

and specification 2 is:

$$Empl_{it} = \beta_0 + \beta_1 Empl_{it-1} + \beta_2 Wages_{it} + \beta_3 Va_{it} + \beta_4 Inv_{it} + \beta_6 Net.\ Avg.\ Dist._{it} + \varepsilon_i + v_{it} \quad (2)$$

for firm i=1, …., 18702 and reference year t= 2014, …., 2023. The dependent variable *Empl* is the logarithm of the levels of employees. Key regressors include *Wages,* which is the log of real wages per employee, *Va* indicates the log of added value, and *Inv* suggests the growth rate of tangible fixed assets. Finally, β_0 indicates a constant, ε_i shows the idiosyncratic, individual, and time-invariant firm fixed effect, and v_{it} a white noise residual, respectively. We also include dummy variables in all the specifications for time, region, and sectors to capture the difference in employment over time, across regions and sectors, respectively. The monetary variables are deflated and using a gross domestic product deflator centred on the year 2015[9] to isolate real economic effects.

The models include Sect. Het. and Net. Avg. Dist. to test HP1 and HP2 on how network structures influence employment dynamics, while HP3 compares all firms, green networks, and non-green networks. These variables capture distinct network characteristics: Sect. Het. examines how diversity in network activities affects employment, whereas Net. Avg. Dist. evaluates how coordination costs and agglomeration patterns shape interactions and employment levels.

4. Results

Wages negatively affect employment, while added value, investment growth, and lagged employment show positive and significant effects, consistent with prior literature. Sect. Het. has a negative impact on employment across all networks. In the short run, a 1% increase in heterogeneity reduces employment by 1.397% overall, 1.269% in non-green networks, and 0.986% in green networks,

[9] https://data.worldbank.org/indicator/NY.GDP.MKTP.CN?end=2023&locations=IT&start=2010.

indicating a weaker effect in green networks. In the long run, heterogeneity lowers employment by 5.07% overall. The negative long-term effect remains significant in non-green networks but disappears in green networks, supporting HP1 and HP3 and align with prior evidence from Italy (Cainelli & Iacubucci, 2015; Sedita et al., 2016; Cainelli & Ganau, 2019). The analysis shows that Sect. Het. negatively affects employment. While this effect is partly mitigated in green networks in the long run, overall higher heterogeneity leads to lower employment. The results suggest that more homogeneous firms are generally more conducive to job creation, with a less pronounced effect in green networks. The weaker effect of Sect. Het. in green networks can be explained by their technological and structural features. Green innovation relies on complex knowledge flows, external inputs, and open eco-innovation practices, enhancing productivity (Ghisetti et al., 2015; Marzucchi & Montresor, 2017). Green jobs are more skill-intensive, especially in STEM (Consoli et al., 2016), while spillovers stimulate innovation and demand (Colombelli et al., 2025). Non-green networks boost competitiveness and knowledge flows, improving spillovers from existing, especially dirty, technologies they replace (Dechelêpetre et al., 2015).

Table 10 - Employment and Network Sectoral Heterogeneity.

	Model (1) Networks	**Model (2) Non - Green Net.**	**Model (3) Green Net.**
L.Empl	0.724***	0.674***	0.801***
	(0.0631)	(0.0669)	(0.0676)
Wages	-0.239**	-0.301***	-0.194*
	(0.0934)	(0.0903)	(0.1173)
Va	0.272***	0.324***	0.186***
	(0.0683)	(0.0707)	(0.0696)
Inv	0.194**	0.157*	0.128*
	(0.0767)	(0.0815)	(0.0686)
Sect. Het.	**-1.397*** **	**-1.269*** **	**-0.986** **
	(0.4645)	**(0.4609)**	**(0.4360)**
Time, Regional, Sectoral Dummies	Yes	Yes	Yes
Constant	-0.228	-0.227	-0.0184
	(0.2794)	(0.2746)	(0.3313)
Observations/firms	110,195/**18,702**	101,805/**17,320**	8,390/**1,382**
AR1 (p-value)	0.000	0.000	0.000
AR2 (p-value)	0.155	0.246	0.901
Hansen-J (p-value)	0.353	0.233	0.435
Wald test equality of coeff. (p-value)	0.000	0.000	0.000

The regression coefficients are estimated using the system GMM estimation approach. The dependent variable is the natural logarithm of L.Empl. stands for the one-lag variable. Values in parentheses indicate standard errors. The estimated coefficients on the time dependent dummy variables and constants are not reported for brevity. AR (1) and AR (2) tests for autocorrelation in differences. Hansen is the test for overidentifying restrictions. *, **, *** denote, respectively, statistical significance at 10%, 5% and 1%.

All variables are significant at the 10% level. On average, a 1% increase in Net. Avg. Dist. reduces employment by 0.099% in the short run and 0.322% in the long run. The negative effect is weaker in green networks (−0.045%) than in non-green networks (−0.082%). Instead in the long term, green networks show no significant effect of Net. Avg. Dist. on employment, while in non-green networks

a 1% change of Net. Avg. Dist. exhibits a decline of 0.248% in employment levels on average, ceteris paribus. These findings validate the research hypothesis and highlight an inverse relationship between Net. Avg. Dist. and employment.

Our findings show green networks are more resilient to increases in network distance, limiting negative employment effects. They transfer knowledge more effectively and benefit from agglomeration. Physical proximity is less crucial, as shown by long-run insignificance, likely due to their advanced, technology-driven activities (Consoli et al., 2016; Barbieri et al., 2020). Agglomeration produces positive externalities that foster employment through knowledge spillovers, improved information flows, access to specialized services, and higher productivity (Cainelli & Ganau, 2019). It also supports labour pooling, scale economies, and supplier specialization, strengthening value chains and job creation. Spatial proximity further accelerates eco-innovation diffusion, reduces costs, and enhances learning-by-interacting, and technological development (Aldieri et al., 2023). Green networks are more resilient to distance effects, relying less on physical proximity in the long run due to their knowledge-intensive nature (Consoli et al., 2016; Barbieri et al., 2020).

Table 11 - Employment and Network Average Distance.

	Model (1) Networks	**Model (2) Non - Green Net.**	**Model (3) Green Net.**
L.Empl.	0.693***	0.671***	0.755***
	(0.0682)	(0.0738)	(0.0577)
Wages	-0.383***	-0.394***	-0.265**
	(0.1193)	(0.1137)	(0.1117)
Va	0.229***	0.269***	0.228***
	(0.0861)	(0.0867)	(0.0598)
Inv.	0.174*	0.188*	0.219***
	(0.1014)	(0.1130)	(0.0674)
Net. Avg. Dist.	**-0.099*** **	**-0.082*** **	**-0.045* **
	(0.0362)	**(0.0317)**	**(0.0262)**
Time, Regional, Sectoral Dummies	Yes	Yes	Yes
Constant	-0.144	-0.258	-0.280
	(0.3247)	(0.2982)	(0.3167)
Observations/firms	110,195/**18,702**	101,805/**17,320**	8,390/**1,382**
AR1 (p-value)	0.000	0.000	0.000
AR2 (p-value)	0.572	0.450	0.727
Hansen-J (p-value)	0.763	0.446	0.808
Wald test equality of coeff. (p-value)	0.000	0.000	0.000

The regression coefficients are estimated using the system GMM estimation approach. The dependent variable is the natural logarithm of L.Empl. stands for the one-lag variable. Values in parentheses indicate standard errors. The estimated coefficients on the time dependent dummy variables and constants are not reported for brevity. AR (1) and AR (2) tests for autocorrelation in differences. Hansen is the test for overidentifying restrictions. *, **, *** denote, respectively, statistical significance at 10%, 5% and 1%.

In summary, Cross-Sect. Het. and Net. Avg. Dist. reduce employment, but green BNAs mitigate these effects through advanced skills and technological processes, supporting HP3.

5. Conclusions

We examine Italian BNAs, focusing on how network structural characteristics – Sect. Het. and Net. Avg. Dist. - affect employment, with attention to the just transition and differences across network types. We distinguish between green and non-green networks and assess their labour effects using an entropy-based approach (Frenken et al., 2007), while accounting for firms' location (Ceccarelli et al., 2024).

Our results show a statistically significant and negative impact of both network structural characteristics on employment outcomes, supporting the literature (Cainelli & Iacubucci, 2015; Sedita et al., 2016; Cainelli & Ganau, 2019). These effects are smoothed in case of green BNAs, which rely on advanced skills and efficiency in developing innovations in renewable energy, waste, and eco-processes (Ghisetti et al., 2015; Marzucchi & Montresor, 2017). Green BNAs also improve energy efficiency and drive the green transition, fostering knowledge creation and open innovation systems (Fabrizi et al., 2022).

This study makes three contributions: 1. it empirically examines how network structural characteristics affect employment outcomes, 2. explores networks within a just transition framework, and 3. apply the entropy-based approach across multiple regions. In line with prior research, we encourage policy makers to expand BNAs as it improves firm performance. Indeed, networks help overcome structural limitation, reduce cognitive distance to market knowledge, and strengthen internal capabilities and absorptive capacity.

Green networks support a just transition by mitigating the negative employment effects of Sect. Het. and Net. Avg. Dist., enhancing green skill diffusion. They foster green innovation and start-up, creating new employment opportunities and open eco-innovation systems (Cerere & Mazzanti, 2017). As noted by Dechezleprêtre et al. (2015) and Conti et al. (2018), non-green BNAs also support just transition by generating technological knowledge from carbon-based systems which green BNAs can recombine and transform into sustainable innovations.

This study has some limitations. Future research should combine sectoral heterogeneity and spatial agglomeration measures, examine absorptive capacity, include other collaboration forms, and extend the analysis to European green networks and transnational climate-neutral innovation.

Acknowledgments

The authors thank the 66th Annual Conference of the Italian Economic Association and Prof. Roberta Sestini for their valuable feedback and suggestions. This research is supported by PNRR – DM 118-2023.

References

Aldieri L., Bruno B., Makkonen T., Vinci C. P. (2023). Environmental innovations, geographically mediated knowledge spillovers, economic and environmental performance *Resources Policy* 81, 103423.

Barbieri N., Marzucchi A., Rizzo U. (2020). Knowledge sources and impacts on subsequent inventions: Do green technologies differ from non-green ones? *Research Policy* 49(2), 103901.

Cabigiosu A. (2024). *Osservatorio Nazionale sulle reti d'impresa 2023* Edizioni Ca' Foscari.

Cainelli G., Ganau R. (2019). Related variety and firm heterogeneity. What really matters for short-run firm growth? *Entrepreneurship & Regional Development* 31(9-10), pp. 768-784.

Cainelli G., Ganau R., Giunta A. (2018). Spatial agglomeration, global value chains, and productivity. Micro-evidence from Italy and Spain *Economics Letters* 169, pp. 43-46.

Cainelli G., Iacobucci D. (2015). Local variety and firm diversification: an evolutionary economic geography perspective *Journal of Economic Geography* 16(5), pp. 1079-1100.

Ceccarelli V., Correani C., Morganti P. (2024). Heterogeneity and geographical location in Italian Business Networks *Journal of Industrial and Business Economics* 51(4), pp. 793-814.

Cecere G., Mazzanti M. (2017). Green jobs and eco-innovations in European SMEs *Resource and Energy Economics* 49, pp. 86-98.

Colombelli A., D'Ambrosio A., Le Masle B., Ravetti C., Tubiana M. (2025). Knowledge spillovers, green entrepreneurship and the demand for sustainability: evidence from Italian innovative startups *The Journal of Technology Transfer* pp. 1-26.

Consoli D., Marin G., Marzucchi A., Vona F. (2016). Do green jobs differ from non-green jobs in terms of skills and human capital? *Research Policy* 45(5), pp. 1046-1060.

Conti C., Mancusi M. L., Sanna-Randaccio F., Sestini R., Verdolini E. (2018). Transition towards a green economy in Europe: Innovation and knowledge integration in the renewable energy sector *Research Policy* 47(10), pp. 1996-2009.

Dechezleprêtre, A., Martin, R., Mohnen, M. (2014). Knowledge spillovers from clean and dirty technologies (CEP Discussion Paper No. 1300). Centre for Economic Performance, London School of Economics and Political Science.

Dickson M. M., Espa G., Gabriele R., Mazzitelli A. (2021). Small businesses and the effects on the growth of formal collaboration agreements: additional insights and policy implications *Applied Economics* 53(46), pp. 5397-5414.

Edzer P. (2018). Simple features for R; Standardized support for spatial vector data *The R Journal* 10(1), pp. 439-446.

Fabrizi A., Guarini G., Meliciani V. (2022). Environmental networks and employment creation: Evidence from Italy *Journal of Cleaner Production* 359, 132056.

Figueiredo O., Guimaraes P., Woodward D. (2009). Localization economies and establishment size: was Marshall right after all? *Journal of Economic Geography* 9(6), pp. 853-868.

Frenken K., Van Oort F., Verburg T. (2007). Related variety, unrelated variety and regional economic growth *Regional Studies* 41(5), pp. 685-697.

Ghisetti C., Marzucchi A., Montresor S. (2015). The open eco-innovation mode. An empirical investigation of eleven European countries *Research Policy* 44(5), pp. 1080–1093.

Horbach J., Rammer C., Rennings K. (2012). Determinants of eco-innovations by type of environmental impact - The role of regulatory push/pull, technology push and market pull *Ecological Economics* 78, pp. 112-122.

Lachenmaier S., Rottmann H. (2011). Effects of innovation on employment: A dynamic panel analysis *International Journal of Industrial Organization* 29(2), pp. 210-220.

Marzucchi A., Montresor S. (2017). Forms of knowledge and eco-innovation modes: Evidence from Spanish manufacturing firms *Ecological Economics* 131, pp. 208-221.

Piva M., Vivarelli M. (2018). Is innovation destroying jobs? Firm-level evidence from the EU *Sustainability* 10(4), 1279.

Sedita S. R., De Noni I., Pilotti L. (2016). Out of the crisis: an empirical investigation of place-specific determinants of economic resilience *European Planning Studies* 25(2), pp. 155-180.

Beyond cost: a quality management capability-based framework for reshoring decisions

Federica De Iasi[1], Alessandro Lanfranco Bruno[2], Stefano Poponi[3]

Abstract

Reshoring has become an increasingly important strategic response to the growing complexity and uncertainty of global production networks. While previous studies have extensively investigated the economic, operational and geopolitical drivers of reshoring, the role of Quality Management in shaping manufacturing location choices remains theoretically fragmented. The aim of this study is to explain how Quality Management capabilities support firms' strategic reassessment of offshoring strategies through the identification, interpretation and evaluation of the hidden quality-related costs associated with globally dispersed production systems. To address this gap, a structured narrative literature review and qualitative thematic synthesis integrate contributions from the reshoring, supply chain management, Total Quality Management (TQM) and Quality 4.0 literature, leading to the development of a capability-based conceptual framework. The framework conceptualises Quality Management as the organisational capability through which firms recognise and assess quality-related challenges arising from increasing supply chain complexity and evaluate the long-term sustainability of offshore production configurations. The study extends traditional cost-oriented explanations of reshoring by integrating operational, organisational and strategic perspectives and provides a theoretical foundation for future empirical research on the role of Quality Management capabilities in the reconfiguration of global manufacturing systems.

Keywords: Reshoring, Quality Management, Quality 4.0, Supply Chain Management, Offshoring.

1. Introduction

Over the past three decades, the increasing globalisation of markets and the international fragmentation of manufacturing activities have profoundly transformed firms' production strategies. Seeking greater efficiency and enhanced competitiveness, many manufacturing companies have relocated production activities to countries characterised by lower labour costs and favourable economic conditions, leading to the widespread adoption of offshoring strategies and the development of increasingly complex Global Value Chains (GVCs) (Gray et al., 2013; Ellram et al., 2013; McIvor & Bals, 2021). By exploiting geographical differences in production costs, firms have pursued economies of scale, improved operational efficiency and greater access to international supplier networks, making offshoring one of the dominant manufacturing strategies of the last decades.
Although offshoring has generated significant economic benefits, the increasing geographical dispersion of production has also introduced substantial managerial challenges. Coordinating suppliers distributed across multiple countries, maintaining process visibility, ensuring consistent quality standards and governing complex supply chain networks have become progressively more difficult. Christopher and Peck (2004) argue that the increasing complexity of global supply chains exposes firms to higher levels of operational disruption and organisational vulnerability. Similarly,

[1]Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, federica.deiasi@unitus.it.
[2]Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, alessandro.bruno@unitus.it.
[3] Full Professor of Commodity Sciences at University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, poponi@unitus.it.

McIvor and Bals (2021) emphasise that managing globally dispersed production systems requires organisations to continuously balance efficiency, flexibility, governance and risk in order to preserve competitive performance.

These challenges have become increasingly evident in recent years. Geopolitical instability, trade tensions, transportation disruptions, rising logistics costs and greater environmental uncertainty have progressively questioned the assumption that manufacturing activities should always be located where production costs are lowest (Ellram et al., 2013; Barbieri et al., 2018). Consequently, an increasing number of firms have started to reconsider previous offshoring decisions, giving rise to the growing phenomenon of reshoring, commonly defined as the relocation of manufacturing activities previously offshored back to the home country or to geographically closer locations (Gray et al., 2013; Fratocchi et al., 2014). Within this perspective, reshoring reflects a broader strategic reassessment of firms' global production configuration rather than a simple reversal of offshoring (McIvor & Bals, 2021).

The growing diffusion of reshoring has attracted considerable attention within operations and supply chain management research. Existing studies identify numerous drivers influencing manufacturing relocation decisions, including labour costs, transportation costs, automation, proximity to customers, resilience, sustainability and geopolitical uncertainty (Ellram et al., 2013; Wiesmann et al., 2017; Barbieri et al., 2018; McIvor & Bals, 2021). More recently, reshoring has increasingly been interpreted as the outcome of multiple interacting economic, operational and strategic factors, reflecting the growing complexity of manufacturing location decisions (Pedroletti & Ciabuschi, 2023).

Within this evolving body of literature, quality consistently emerges as a relevant factor influencing firms' reassessment of offshore production. Product quality problems, supplier coordination difficulties, limited process visibility and reduced control over geographically dispersed manufacturing systems are frequently identified as critical challenges associated with global production networks (Christopher & Peck, 2004; Uluskan et al., 2016; Ancarani et al., 2015; Engström et al., 2018). However, these contributions primarily examine quality-related issues from an operational perspective, focusing on specific challenges such as quality control, supplier management and manufacturing performance. As a consequence, the broader organisational role of Quality Management in supporting manufacturing location decisions remains insufficiently conceptualised, leaving fragmented the theoretical understanding of how quality-related challenges contribute to reshoring.

This gap becomes even more evident when considering the evolution of Quality Management research. Since the emergence of Total Quality Management (TQM), quality has progressively evolved into a comprehensive management philosophy centred on continuous improvement, process management, supplier integration and customer orientation (Flynn et al., 1994; Powell, 1995). More recently, the development of Quality 4.0 has expanded these principles through the integration of digital technologies, including artificial intelligence, the Internet of Things, big data analytics and predictive quality systems, strengthening organisations' capabilities to monitor processes, manage suppliers and support data-driven decision-making (Dias et al., 2022; Antony et al., 2022). These developments suggest that Quality Management represents an organisational capability extending well beyond product conformity and quality control, with the potential to support strategic manufacturing decisions.

From this perspective, the sustainability of offshoring depends on firms' ability to govern increasingly complex production networks while maintaining process visibility, supplier coordination, quality performance and supply chain reliability. As global production systems become more difficult to manage, quality-related challenges progressively generate hidden organisational costs that reduce the attractiveness of offshore production and encourage firms to reassess their manufacturing configuration.

To address this theoretical gap, the aim of this study is to explain how Quality Management capabilities shape firms' strategic reassessment of offshoring strategies through the identification,

interpretation and evaluation of the hidden quality-related costs associated with globally dispersed production systems, ultimately supporting manufacturing location decisions. To achieve this objective, the study develops a Quality Management Capability-Based Reshoring Framework (QMCR Framework) integrating insights from the reshoring, supply chain management, Total Quality Management and Quality 4.0 literature. The proposed framework conceptualises Quality Management as a strategic organisational capability supporting firms' strategic reassessment of manufacturing location decisions. By integrating operational, organisational and strategic perspectives, the framework extends existing cost-oriented explanations of reshoring and provides a theoretical foundation for future empirical research on the role of Quality Management capabilities in manufacturing location decisions.

2. Methodology

This study adopts a conceptual research design aimed at advancing the theoretical understanding of reshoring through the integration of insights from the reshoring and Quality Management literature. Conceptual research contributes to theory development by synthesising existing knowledge, identifying unexplored relationships and generating new theoretical explanations (MacInnis, 2011; Jaakkola, 2020). In this perspective, the study seeks to explain how Quality Management capabilities shape firms' strategic reassessment of offshoring strategies and support manufacturing location decisions.

The study forms part of a broader research programme investigating the relationship between Quality Management and reshoring. As an initial stage of this research programme, a preliminary exploration of the literature was conducted using the search query *"TITLE-ABS-KEY(("quality management" OR "quality 4.0" OR quality) AND reshoring)"* in the Scopus database. This preliminary investigation revealed that quality-related concepts are consistently associated with reshoring research but are predominantly examined from an operational perspective, while the broader organisational role of Quality Management remains insufficiently conceptualised. These insights motivated the present study and provided the basis for the subsequent theory-building process.

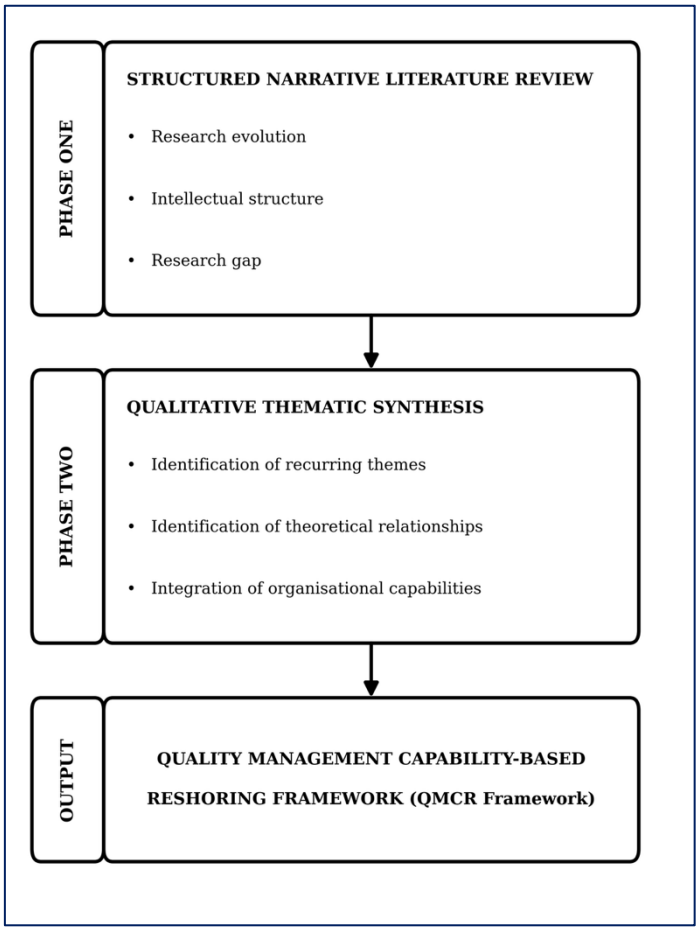
Building upon these preliminary insights, the present study adopts a theory-building approach articulated into two complementary stages: a structured narrative literature review and a qualitative thematic synthesis (Jaakkola, 2020).

The first stage consisted of a structured narrative literature review aimed at integrating the principal theoretical perspectives linking reshoring and Quality Management. Narrative literature reviews are particularly appropriate for conceptual research because they facilitate the integration of knowledge originating from different research streams and support the development of new theoretical perspectives (Snyder, 2019). The literature was selected through purposive sampling based on theoretical relevance (Patton, 2015), including both seminal and recent peer-reviewed studies addressing reshoring, Total Quality Management (TQM), Quality 4.0, supply chain management and manufacturing location decisions. Particular attention was devoted to contributions explaining how quality-related challenges influence the governance of globally dispersed production systems and their implications for strategic manufacturing decisions.

The second stage involved a qualitative thematic synthesis. Following an iterative and interpretative analytical process (Braun & Clarke, 2006), the selected studies were systematically compared to identify recurring concepts, converging interpretations and complementary theoretical perspectives concerning the relationship between offshoring, Quality Management and reshoring. The analysis focused on themes related to product quality, supplier quality, process visibility, coordination, traceability, supply chain reliability, digital quality capabilities and manufacturing location decisions. The thematic synthesis enabled the integration of these concepts into a coherent theoretical explanation and clarified the relationships among the principal organisational capabilities emerging from the literature.

The recurring themes identified through the thematic synthesis were subsequently integrated through a theory-building process (Jaakkola, 2020) leading to the development of the proposed framework that conceptualises Quality Management as a strategic organisational capability through which firms identify, interpret and evaluate the hidden quality-related costs associated with globally dispersed production systems. Through these capabilities, operational evidence generated within global production networks is transformed into strategic knowledge that supports firms' reassessment of offshoring strategies and manufacturing location decisions.
Figure 1 summarises the theory-building process adopted in the present study.

Figure 1. Methodological process adopted for theory building.



Source: Authors' own elaboration

3. Results and discussion

The present study builds upon a broader research programme investigating the relationship between Quality Management and reshoring. Consistent with the theory-building process illustrated in Figure 1, the results are presented according to two complementary stages. The first stage builds on a preliminary literature investigation conducted through a structured narrative literature review, which provided an understanding of the evolution of the research field, its intellectual structure and the main research gap. The second stage develops the theoretical interpretation through a qualitative thematic synthesis, leading to the development of the proposed Quality Management Capability-Based Reshoring Framework (QMCR Framework).

The preliminary literature investigation revealed a clear evolution in the development of reshoring research. Early contributions primarily interpreted reshoring as the reverse of offshoring, explaining manufacturing relocation through changes in labour costs, transportation expenses and production efficiency (Gray et al., 2013; Ellram et al., 2013). As the field has matured, reshoring has progressively been conceptualised as a more complex strategic phenomenon in which economic, operational and organisational dimensions jointly shape the reconfiguration of global manufacturing systems (Wiesmann et al., 2017; McIvor & Bals, 2021; Pedroletti & Ciabuschi, 2023). This evolution reflects a broader shift from predominantly cost-oriented explanations towards perspectives recognising the increasing importance of governance, supply chain management and organisational capabilities in globally dispersed production systems.

The preliminary literature investigation also highlighted an important characteristic of the existing body of knowledge. Although reshoring, offshoring and manufacturing remain the dominant themes within the literature, quality-related concepts are distributed across different research streams and are predominantly associated with operational topics such as quality control, supplier management and manufacturing performance. Consequently, quality is consistently recognised as a relevant factor influencing reshoring, yet its broader organisational role in supporting firms' strategic reassessment of offshore production remains insufficiently conceptualised. These findings identify an important theoretical gap and provide the conceptual foundation for the theory-building process developed in the present study.

Building upon these preliminary insights, the structured narrative literature review and qualitative thematic synthesis provide a deeper understanding of the organisational mechanisms underlying the evolution of reshoring research. While the preliminary literature investigation identified the principal research themes and the fragmented treatment of quality within the literature, the thematic synthesis reveals that these findings are rooted in the increasing complexity characterising globally dispersed production systems.

As manufacturing activities become geographically fragmented and firms rely on increasingly extensive international supplier networks, the governance of production systems becomes progressively more demanding. The literature consistently indicates that the management of globally dispersed operations requires organisations to coordinate multiple actors operating across different geographical, institutional and cultural contexts, increasing both organisational complexity and managerial uncertainty (Christopher & Peck, 2004; McIvor & Bals, 2021). Consequently, global manufacturing configurations are no longer assessed exclusively in terms of production cost differentials but increasingly incorporate considerations related to governance, coordination and the long-term sustainability of global production networks.

This interpretation reflects the broader evolution of reshoring research observed over the last decade. Earlier studies largely explained manufacturing relocation as a consequence of changing economic conditions, particularly rising labour costs and transportation expenses (Gray et al., 2013; Ellram et al., 2013). More recent contributions, however, increasingly interpret reshoring as the outcome of a strategic reassessment of global manufacturing configurations, in which firms evaluate the cumulative implications of operational complexity, supply chain governance, resilience and organisational performance (Wiesmann et al., 2017; McIvor & Bals, 2021; Pedroletti & Ciabuschi, 2023). Within this perspective, reshoring represents a dynamic strategic response to the growing challenges associated with governing globally dispersed production systems rather than a simple reaction to changes in production costs.

Christopher and Peck (2004) argue that the geographical dispersion of supply chains inherently increases organisational vulnerability by reducing visibility across production networks and exposing firms to a broader range of operational disruptions. Similarly, McIvor and Bals (2021) emphasise that globally dispersed manufacturing requires organisations to continuously balance efficiency, flexibility, governance and risk in order to preserve competitive performance. Collectively, these studies suggest that the long-term sustainability of offshoring depends not only on the economic

advantages initially expected from manufacturing relocation but also on firms' capability to effectively govern increasingly complex global production systems.

Within this increasingly complex organisational context, the thematic synthesis identifies quality as one of the most recurrent and consistently discussed dimensions across the reshoring literature. Rather than representing a single driver of reshoring, quality emerges through a set of interconnected operational challenges affecting the governance of globally dispersed production systems. Across the analysed studies, recurring themes include product quality deterioration, supplier quality deficiencies, reduced process visibility, coordination difficulties and limited traceability (Ancarani et al., 2015; Huq et al., 2016; Engström et al., 2018; Uluskan et al., 2016). Although these issues are examined in different industrial contexts, they collectively describe the increasing difficulty experienced by firms in maintaining effective control over offshore manufacturing activities.

The thematic synthesis further indicates that these quality-related challenges should not be interpreted as isolated operational problems. Instead, they progressively interact and reinforce one another. Difficulties in coordinating geographically dispersed suppliers reduce process visibility, making production monitoring more complex. Lower visibility limits traceability and delays the identification of process deviations, while reduced coordination compromises the effectiveness of corrective actions across the supply network. Consequently, organisations are required to devote increasing managerial effort to supplier supervision, communication, inspection activities and process coordination in order to maintain acceptable quality standards.

These findings suggest that the consequences of quality-related challenges extend beyond operational performance. The literature increasingly indicates that firms incur a series of hidden quality-related costs associated with governing globally dispersed production systems. Such costs are not limited to direct quality failures but also include the additional organisational resources required to coordinate suppliers, monitor production processes, ensure information exchange, manage corrective actions and preserve process reliability across geographically dispersed manufacturing networks (Christopher & Peck, 2004; Ellram et al., 2013; McIvor & Bals, 2021). As these managerial efforts progressively increase, they erode the competitive advantages originally associated with offshoring and contribute to a broader reassessment of manufacturing location decisions.

From this perspective, the thematic synthesis suggests that the strategic relevance of quality does not derive exclusively from product conformity or manufacturing performance. Rather, quality becomes an indicator of organisations' ability to effectively govern the complexity of global production networks. As hidden quality-related costs accumulate over time, firms progressively reconsider whether the expected advantages of offshore manufacturing remain sustainable. This interpretation helps explain why recent reshoring studies increasingly describe manufacturing relocation as a strategic reassessment of global production configurations rather than as a simple response to changing production costs (McIvor & Bals, 2021; Pedroletti & Ciabuschi, 2023).

Empirical evidence further supports this interpretation. Ancarani et al. (2015) show that persistent quality-related problems frequently accelerate the interruption of offshore manufacturing experiences. Similarly, Zhai et al. (2016) identify product quality among the principal factors motivating U.S. manufacturing firms to relocate production from China. Engström et al. (2018) further demonstrate that quality encompasses not only product conformity but also supplier performance, communication effectiveness, infrastructure and production management throughout the manufacturing network. Collectively, these contributions suggest that quality progressively acquires strategic significance because it influences firms' overall evaluation of the long-term sustainability of offshore manufacturing.

The thematic synthesis, however, reveals that an important theoretical issue remains unresolved. Although the reshoring literature consistently recognises the strategic relevance of quality-related challenges, it provides only limited explanation of the organisational process through which these operational signals influence manufacturing location decisions. Existing studies extensively document the occurrence of product quality problems, supplier deficiencies, coordination failures and reduced process visibility, yet they rarely explain how organisations recognise their cumulative

implications when reassessing offshore manufacturing. Consequently, the literature provides substantial evidence regarding why quality matters for reshoring, while offering a more limited understanding of how quality-related information contributes to firms' strategic evaluation of globally dispersed production systems.

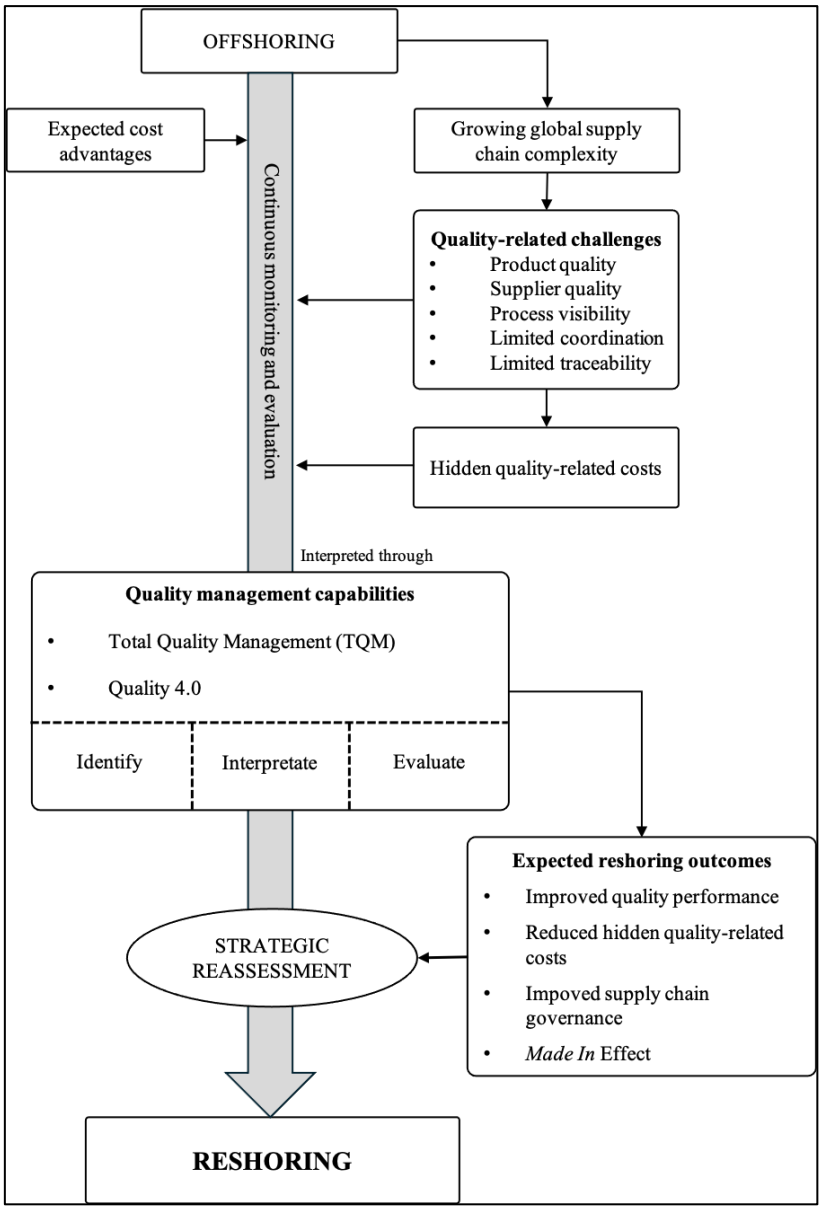
This limitation appears to derive from the predominantly operational perspective adopted within the reshoring literature. Quality is generally examined through individual dimensions such as product quality, supplier quality, quality control and manufacturing performance. Although these studies successfully identify the principal quality-related motivations encouraging firms to reconsider offshore production, they rarely conceptualise the organisational mechanisms through which these factors are collectively interpreted during strategic decision-making. As a consequence, the relationship between operational quality challenges and manufacturing location decisions remains only partially theorised.

The Quality Management literature offers a complementary perspective capable of addressing this gap. Since the emergence of Total Quality Management (TQM), quality has progressively evolved from a production-oriented activity focused on inspection and defect detection into an organisation-wide management philosophy supporting continuous improvement, process integration, supplier collaboration and organisational learning (Flynn et al., 1994; Powell, 1995). More recently, the development of Quality 4.0 has further strengthened this perspective by integrating digital technologies such as artificial intelligence, Internet of Things, big data analytics and predictive quality systems, significantly improving organisations' ability to monitor processes, analyse operational information and support evidence-based decision-making (Dias et al., 2022; Antony et al., 2022).

Viewed together, these contributions suggest that Quality Management should not be interpreted solely as a set of practices aimed at improving product or process quality. Rather, it represents an integrative organisational capability through which firms continuously identify, interpret and evaluate information generated throughout global production networks. From this perspective, Quality Management enables organisations to recognise recurring patterns emerging from quality-related challenges, assess their cumulative organisational implications and support the strategic evaluation of offshore manufacturing configurations. Recent empirical evidence also highlights the contribution of AI-enabled production and supply chain capabilities to improving operational visibility, resilience and organisational control, reinforcing the role of Quality 4.0 within the Quality Management capability proposed in this study (Kinkel & Richter, 2025).

Building upon these findings, the present study proposes that Quality Management constitutes the organisational capability connecting operational performance with strategic manufacturing decisions. Rather than considering quality-related challenges as isolated operational failures, the proposed perspective interprets them as organisational signals that progressively reveal the sustainability of globally dispersed production systems. Through the identification, interpretation and evaluation of quality-related operational evidence and the associated hidden quality-related costs, Quality Management transforms dispersed information into strategic knowledge, enabling firms to reassess the long-term sustainability of offshoring strategies and supporting manufacturing location decisions.

Figure 2. Quality Management Capability-Based Reshoring Framework (QMCR Framework).



Source: Authors' own elaboration

Figure 2 presents the Quality Management Capability-Based Reshoring Framework (QMCR Framework) developed in this study. The QMCR Framework synthesises the principal relationships emerging from the structured narrative literature review and the subsequent thematic synthesis, illustrating how Quality Management capabilities support firms' strategic reassessment of offshoring strategies. The framework conceptualises reshoring as a dynamic organisational process in which firms progressively recognise the implications of increasing supply chain complexity through Quality Management capabilities.

The framework begins with offshoring, initially adopted to achieve the expected cost advantages associated with lower production costs and access to global supplier networks. As manufacturing activities become increasingly geographically dispersed, organisations experience growing global supply chain complexity, making production systems progressively more difficult to coordinate,

monitor and govern. This increasing complexity generates a series of interconnected quality-related challenges, including product quality issues, supplier quality deficiencies, reduced process visibility, limited coordination and limited traceability. These challenges progressively reinforce one another, increasing the organisational effort required to govern offshore production activities.

As these quality-related challenges accumulate, organisations experience increasing hidden quality-related costs associated with supplier monitoring, communication, coordination, inspection activities and quality assurance across geographically dispersed manufacturing systems. Collectively, these hidden costs provide evidence of the growing organisational complexity associated with offshore production and progressively challenge the long-term sustainability of globally dispersed manufacturing configurations.

Throughout this process, continuous monitoring and evaluation enable organisations to systematically observe the evolution of quality-related operational evidence. The framework proposes that these operational signals are addressed through Quality Management capabilities, represented by the complementary contributions of Total Quality Management (TQM) and Quality 4.0. Acting as an integrative organisational capability, Quality Management enables firms to identify recurring quality-related patterns, interpret their organisational implications and evaluate their cumulative impact on the long-term sustainability of offshore manufacturing. Through this capability, dispersed operational evidence is progressively transformed into strategic organisational knowledge.

The framework identifies the expected outcomes associated with reshoring emerging from the literature. These include improved quality performance, reduced hidden quality-related costs and enhanced supply chain governance through greater control, coordination and visibility across manufacturing activities. In addition, reshoring may strengthen the *Made-in* Effect, particularly in industries where country of origin contributes to brand value and customers' quality perceptions (Ancarani et al., 2015). Although this outcome depends on industry-specific characteristics and extends beyond the Quality Management capability itself, it represents an additional strategic benefit that may reinforce the rationale for reshoring.

Ultimately, this process culminates in the strategic reassessment of offshore manufacturing strategies. As organisations progressively recognise the organisational implications associated with hidden quality-related costs and increasing supply chain complexity, they reassess the long-term sustainability of existing offshore production systems. When the organisational burden associated with governing globally dispersed manufacturing outweighs the expected advantages of maintaining offshore production, firms may reconfigure their global manufacturing activities, ultimately resulting in reshoring.

Overall, the proposed QMCR Framework conceptualises reshoring as the outcome of a dynamic organisational process in which continuous monitoring and evaluation, supported by Quality Management capabilities, enable organisations to identify, interpret and evaluate quality-related operational evidence generated across globally dispersed production systems. By positioning Quality Management as the organisational capability that transforms dispersed operational information into strategic organisational knowledge, the framework extends traditional cost-oriented explanations of reshoring and offers an integrated capability-based perspective for understanding reshoring as a process of strategic reassessment of offshoring strategies.

4. Conclusions

The increasing complexity of global production networks has progressively transformed the way firms evaluate manufacturing location decisions. While the reshoring literature has traditionally explained manufacturing relocation through economic, operational and geopolitical factors, this study demonstrates that these explanations can be further enriched by considering the organisational capabilities through which firms identify, interpret and evaluate the quality-related implications of

globally dispersed production systems. Adopting a capability-based perspective contributes to a more comprehensive understanding of how organisations strategically reassess offshore manufacturing.

To address this theoretical gap, the study developed the Quality Management Capability-Based Reshoring Framework (QMCR Framework) by integrating insights from the reshoring, supply chain management, Total Quality Management (TQM) and Quality 4.0 literature. The framework conceptualises reshoring as the outcome of a continuous strategic evaluation process in which increasing global supply chain complexity generates interconnected quality-related challenges that progressively accumulate into hidden quality-related costs. Through Quality Management capabilities, firms identify, interpret and evaluate these operational signals, transforming dispersed operational evidence into strategic knowledge. The QMCR Framework therefore explains the organisational mechanism through which quality-related information contributes to the strategic reassessment of offshoring strategies.

From a theoretical perspective, this study contributes to the literature in three principal ways. First, it shifts the analytical focus towards the organisational process through which firms evaluate the long-term sustainability of offshore manufacturing. Second, it establishes a conceptual bridge between the reshoring and Quality Management literature, integrating two research streams that have largely evolved independently. Third, it introduces the QMCR Framework as an integrated capability-based explanation of reshoring, illustrating how quality-related operational evidence is transformed into strategic knowledge supporting manufacturing location decisions.

The proposed framework also offers several managerial implications. Managers are encouraged to interpret quality-related challenges as strategic signals concerning the long-term sustainability of globally dispersed production systems. Investments in Quality Management capabilities, combining established TQM principles with the digital technologies associated with Quality 4.0, can strengthen organisations' ability to continuously monitor production systems, evaluate supplier performance and identify the hidden quality-related costs that progressively reduce the expected advantages of offshore manufacturing. Manufacturing location decisions can therefore benefit from integrating traditional economic indicators with systematic assessments of quality performance, process visibility, supplier governance and the organisational implications associated with increasingly complex global production networks.

Despite these contributions, the study presents several limitations. As a conceptual paper, the QMCR Framework has not yet been empirically validated and the relationships among the proposed constructs remain theoretical. Furthermore, the framework focuses specifically on the organisational mechanisms through which Quality Management capabilities support manufacturing location decisions. Additional determinants frequently discussed in the reshoring literature, including geopolitical uncertainty, environmental sustainability, institutional pressures and public policy interventions, were intentionally left outside the scope of the present framework and represent promising directions for future research.

Future research should empirically validate the proposed framework across different organisational and industrial contexts. Multiple case studies, large-scale surveys and structural equation modelling could be employed to examine how firms identify, interpret and evaluate quality-related operational evidence when reassessing offshore manufacturing strategies. Further studies could also investigate the contribution of emerging digital technologies, including artificial intelligence, digital twins and predictive analytics, to strengthening Quality Management capabilities and supporting manufacturing location decisions. Comparative analyses across industries and countries would further contribute to assessing the generalisability of the QMCR Framework and refining its theoretical assumptions under different competitive and institutional conditions.

The QMCR Framework conceptualises reshoring as the outcome of a dynamic and continuous strategic evaluation process through which organisations reassess the sustainability of globally dispersed production systems. Within this perspective, Quality Management assumes the role of the organisational capability that enables firms to identify, interpret and evaluate quality-related operational evidence, transforming it into strategic knowledge supporting manufacturing location

decisions. By integrating reshoring and Quality Management within a single capability-based perspective, the framework advances the theoretical dialogue between these two research streams and provides a foundation for future empirical research on the strategic role of Quality Management in manufacturing relocation decisions.

References

Ancarani A., Di Mauro C., Fratocchi L., Orzes G., Sartor M. (2015). Prior to reshoring: A duration analysis of foreign manufacturing ventures *International Journal of Production Economics* 169, pp. 141–155. Scopus. https://doi.org/10.1016/j.ijpe.2015.07.031

Antony J., McDermott O., Sony M. (2022). Quality 4.0 conceptualisation and theoretical understanding: A global exploratory qualitative study *The TQM Journal* 34(5), pp. 1169–1188. https://doi.org/10.1108/TQM-07-2021-0215

Barbieri P., Ciabuschi F., Fratocchi L., Vignoli M. (2018). What do we know about manufacturing reshoring? *Journal of Global Operations and Strategic Sourcing* 11(1), pp. 79–122. https://doi.org/10.1108/JGOSS-02-2017-0004

Braun V., Clarke V. (2006). Using thematic analysis in psychology *Qualitative Research in Psychology* 3(2), pp. 77–101. https://doi.org/10.1191/1478088706qp063oa

Christopher M., Peck H. (2004). Building the Resilient Supply Chain *The International Journal of Logistics Management* 15(2), pp. 1–14. https://doi.org/10.1108/09574090410700275

Dias A. M., Carvalho A. M., Sampaio P. (2022). Quality 4.0: Literature review analysis, definition and impacts of the digital transformation process on quality *International Journal of Quality & Reliability Management* 39(6), pp. 1312–1335. https://doi.org/10.1108/IJQRM-07-2021-0247

Ellram L. M., Tate W. L., Petersen K. J. (2013). Offshoring and Reshoring: An Update on the Manufacturing Location Decision *Journal of Supply Chain Management* 49(2), pp. 14–22. https://doi.org/10.1111/jscm.12019

Engström G., Hilletofth P., Eriksson D., Sollander K. (2018). Drivers and barriers of reshoring in the Swedish manufacturing industry *World Review of Intermodal Transportation Research* 7(3), pp. 195–220. Scopus. https://doi.org/10.1504/WRITR.2018.093550

Flynn B. B., Schroeder R. G., Sakakibara S. (1994). A framework for quality management research and an associated measurement instrument *Journal of Operations Management* 11(4), pp. 339–366. https://doi.org/10.1016/S0272-6963(97)90004-8

Fratocchi L., Di Mauro C., Barbieri P., Nassimbeni G., Zanoni A. (2014). When manufacturing moves back: Concepts and questions *Journal of Purchasing and Supply Management* 20(1), pp. 54–59. https://doi.org/10.1016/j.pursup.2014.01.004

Gray J. V., Skowronski K., Esenduran G., Johnny Rungtusanatham M. (2013). The Reshoring Phenomenon: What Supply Chain Academics Ought to know and Should Do *Journal of Supply Chain Management* 49(2), pp. 27–33. https://doi.org/10.1111/jscm.12012

Huq F., Pawar K. S., Rogers H. (2016). Supply chain configuration conundrum: How does the pharmaceutical industry mitigate disturbance factors? *Production Planning and Control* 27(14), pp. 1206–1220. Scopus. https://doi.org/10.1080/09537287.2016.1193911

Jaakkola E. (2020). Designing conceptual articles: Four approaches *AMS Review* 10(1–2), pp. 18–26. https://doi.org/10.1007/s13162-020-00161-0

Kinkel S., Richter D. (2025). Reshoring intention in challenging times – the direct and moderating influence of AI use in production and supply chain management *SSRN*. https://doi.org/10.2139/ssrn.5420854

MacInnis D. J. (2011). A Framework for Conceptual Contributions in Marketing *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1845968

McIvor R., Bals L. (2021). A multi-theory framework for understanding the reshoring decision *International Business Review* 30(6), 101827. https://doi.org/10.1016/j.ibusrev.2021.101827

Patton M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (Fourth edition) SAGE.

Pedroletti D., Ciabuschi F. (2023). Reshoring: A review and research agenda *Journal of Business Research* 164, 114005. https://doi.org/10.1016/j.jbusres.2023.114005

Powell T. C. (1995). Total quality management as competitive advantage: A review and empirical study *Strategic Management Journal* 16(1), pp. 15–37. https://doi.org/10.1002/smj.4250160105

Snyder H. (2019). Literature review as a research methodology: An overview and guidelines *Journal of Business Research* 104, pp. 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Uluskan M., Joines J. A., Godfrey A. B. (2016). Comprehensive insight into supplier quality and the impact of quality strategies of suppliers on outsourcing decisions *Supply Chain Management* 21(1), pp. 92–102. Scopus. https://doi.org/10.1108/SCM-04-2015-0140

Wiesmann B., Snoei J. R., Hilletofth P., Eriksson D. (2017). Drivers and barriers to reshoring: A literature review on offshoring in reverse *European Business Review* 29(1), pp. 15–42. Scopus. https://doi.org/10.1108/EBR-03-2016-0050

Zhai W., Sun S., Zhang G. (2016). Reshoring of American manufacturing companies from China *Operations Management Research* 9(3–4), pp. 62–74. Scopus. https://doi.org/10.1007/s12063-016-0114-z

The application process of Viterbo for European Capital of Culture 2033

Maria Chiara Giovannelli[1]

Abstract

This chapter describes the application process undertaken by Viterbo for the European Capital of Culture (ECoC) initiative. The application process for the ECoC initiative is of strategic importance. It contributes to determine a long-term cultural and urban strategy beyond the ECoC year, and to empower the citizens' self-esteem and civic pride. From the outset, Viterbo has actively engaged major public stakeholders and the municipalities across the Province to establish a multi-level governance approach. In parallel, citizen participation has been fostered through a public call and co-design laboratories. Data collected during the laboratories in October 2025 were analysed using the Integrated Model of Destination Competitiveness, including the Social Conditions determinant proposed by Aquilino et al. (2019) in the assessment of Matera, ECoC 2019. A total of 86 competitiveness indicators were evaluated, and the internal consistency of the questionnaire was verified using Cronbach's alpha coefficient. The empirical results indicate that Inherited Resources and Image Conditions are largely perceived as competitive, whereas Supporting Resources, Social Conditions, Management and Organisation require further development. These findings provide insights for planners and policymakers involved in the application process while identifying directions for future research.

Keywords: citizen participation, cultural governance, destination competitiveness, European Capital of Culture, urban development.

1. Introduction

The European Capital of Culture (ECoC) programme, established in 1985 on the initiative of the Greek Minister of Culture Melina Mercouri, represents one of the longest-standing and most significant cultural policy initiatives of the European Union. Initially conceived to unifying peoples and strengthen a sense of European belonging, the programme has progressively acquired a strategic role in urban development and social cohesion (Immler and Sakkers 2014; Aquilino et al. 2019). For a year, the designated ECoC has the opportunity to host cultural events with European dimension, to attract visitors, and generate relevant economic, social and cultural benefits (Falk and Hagsten 2017; Gomes and Librero-Cano 2018). The first criterion for the candidate cities, set by the Decision No. 445/2014/EU of the ECoC programme, is to foster growth with a long-term strategy that goes beyond the flows of tourists, and beyond the ECoC year. Even in the absence of ad hoc indicators, relevant emphasis has always been dedicated to legacy, and social and cultural impacts as evidence of programme's success (Giovannelli et al. 2026). The literature on competitiveness is aligned, stating that the goal for a destination is not competing for tourists but is the accomplishment of a long-term prosperity plan while preserving the well-being of resident and the sustainability of local resources (Ritchie and Crouch 2000; Dwyer and Kim 2003). This study examines the ongoing application process of Viterbo for ECoC 2033, focusing on the construction of a multilevel governance structure and on the citizen participation through a public call and co-design laboratories. Participants'

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, mchiara.giovannelli@unitus.it.

perceptions of Viterbo's destination competitiveness were assessed through a structured questionnaire based on the Integrated Model of Destination Competitiveness expanded with the Social Conditions determinant introduced by Aquilino et al. (2019).

2. Literature Review

Destination competitiveness is both a relative and multidimensional concept, as well as a dynamic theory shaped by different levels of economic development (Porter et al. 2001; Dwyer and Kim 2003). Since the 1990s, the literature has deeply investigated this concept and assessed it from three different perspectives: the economic perspective, focused on comparative advantage and price-related determinants (Porter 1990; Dwyer et al. 2000); the strategic and managerial approach (Grant 1999; Go and Govers 2000); and the sociocultural and political perspective (Hassan 2000; Porter et al. 2001). Nevertheless, the definition of destination competitiveness has evolved (Xu and Au 2023). Early contributions defined it on the ability to attract tourists, and to increase the well-being of residents (Ritchie and Crouch 2000). Subsequent contributions incorporated aspects such as the quality of the experience and innovation (Dupeyras and MacCallum 2013), and the value creation for future generations (Azzopardi and Nash 2016). Despite these different perspectives, there is broad consensus in considering competitiveness as embedded in the sustainability concept (Dwyer and Kim 2003; Ritchie and Crouch 2000; Armenski et al. 2011). As argued by Ritchie and Crouch (2000, 5) 'to be competitive, a destination's development of tourism must be sustainable, not just economically and not just ecologically, but socially, culturally and politically as well'. Therefore, combining the ability to create additional values by managing assets and processes while ensuring an economic and social model preserving future generations, is of essence (Turok 2004; Camagni and Capello 2013).

From a theoretical perspective, this approach extends beyond the tourism sector to encompass broader local development strategies, in which identifying the strengths and weaknesses of a destination's competitive positioning becomes a prerequisite for effective policy design (Armenski et al. 2011). The value of the competitiveness assessment is therefore twofold. On one hand, it provides insights into current management strategies and potential impacts, while identifying areas requiring further investment (Crouch and Ritchie 1999; Dwyer and Kim 2003). On the other hand, it offers tourism stakeholders recommendations for more effective and sustainable planning (Aquilino et al. 2019). In the ECoC initiative, this dual function allows planners and policymakers to identify structural gaps at a stage when interventions are still possible and most effective.

3. The case of Viterbo

The Municipality of Viterbo initiated the application process for the ECoC title following the Resolution No. 12 of the City Council, dated 7 February 2023, unanimously approved. From the outset the city has prioritized governance and participation to determine a long-term cultural and urban strategy, and to foster citizen engagement, as required by Decision No. 445/2014/UE art. 5. The multi-level cultural governance structure was adopted to ensure greater institutional stability and enhance stakeholders involvement, addressing the governance weaknesses identified by the European Commission in the assessment of ECoC experiences from 2007 to 2019 (2012, 11). The Municipality actively engaged the major stakeholders and signed the Memorandum of Understanding (MoU) with the Lazio Region; Province of Viterbo; the Diocese; the Superintendency of archaeology, fine arts and landscape for the Provinces of Viterbo and Southern Etruria; the Regional Directorate of Museums of Lazio; the Monumental Villas of Tuscia; the University of Viterbo 'La Tuscia'; the Chamber of Commerce Rieti Viterbo; the Viterbo Consortium Library; and the Carivit Foundation. The MoU establishes a Steering Committee responsible for providing guidance and strategic support, and for instituting a Scientific Committee to conceptualize the themes of the bid book (Giovannelli

and Genovese 2025). Furthermore, the Municipality obtained the institutional support from more than 50 municipal councils across the Province of Viterbo through formal resolutions. This inclusive and multi-level governance structure ensures broad institutional coordination and alignment, straightening the capacity to implement a coherent and long-term cultural and urban strategy (Garcia and Cox 2013; European Commission 2012), while acting as a catalyst for synergistic networks across the Province. In parallel, citizen participation was encouraged through a public call and co-design laboratories. Participation is not merely a procedural requirement, but a critical condition for legacy, with long-term implications for local engagement and governance (Ganga et al. 2021). The call, published in April 2025, invited the entire provincial population to submit project proposals for Viterbo ECoC 2033. At the deadline, 14 proposals were received and divided into 4 thematic areas: Regeneration and Sustainability; Nature; Dance, Arts and Performance; and Storytelling. These served as the basis for co-design laboratories involving the proposals' authors together with professionals, businesses, and organisations operating in the cultural and creative industries in the Lazio Region. The laboratories were conducted in October and November 2025, arranged by Lazio Innova, the regional agency for culture and innovation. A total of 101 participants registered, with 60 actively participating. Participants were divided into 6 groups and supported by project development experts in the conceptualization of 6 projects ideas for the bid book. In this context, participants' perception of Viterbo's competitiveness was assessed through a structured questionnaire based on the statistical approach proposed by Aquilino et al. (2019) for Matera, ECoC 2019.

4. Methodology

The literature on destination competitiveness can be broadly divided into studies that have used and adapted the models developed by Dwyer and Kim (2003) and by Ritchie and Crouch (1993). This study adopts the Integrated Model of Destination Competitiveness proposed by Dwyer and Kim (2003), incorporating the Social Conditions determinant introduced by Aquilino et al. (2019). Compared to the more linear Conceptual Model of Competitiveness of Ritchie and Crouch (1993), the Integrated Model assumes mutual dependence among determinants and offers a more comprehensive and systemic perspective, synthesizing elements of national and firm-level competitiveness (Porter 1990) with core components from tourism studies (Hassan 2000; Ritchie and Crouch 2000). By integrating both supply and demand-side determinants, it addresses the limitations of the Conceptual Model focused only on supply (Omerzel and Mihalic 2008). The Integrated Model classifies destination competitiveness into five categories: Inherited Resources, Created Resources, Supporting Resources, Destination Management and Organisation, and Image and Awareness Conditions. Aquilino et al. (2019) expanded this framework by introducing a sixth determinant: the Social Conditions to improve local wellbeing. This inclusion is consistent with the ECoC literature showing that social impacts such as civic pride, local identity and quality of life are strengthened when communities are actively involved in event organisation (Näsholm and Blomquist 2015; Farmaki et al. 2019), and that improved access to culture enhances residents' quality of life and urban competitiveness (Liu 2016; Sanetra-Szeliga 2022). Within this framework, destination competitiveness is understood not as an end of policymaking, but as an intermediate goal contributing to the broader economic and social prosperity. Data were collected both online and through paper distribution during the co-design laboratories in October and November 2025. The questionnaire was based on a seven point Likert scale from 1 (less competitive) to 7 (most competitive). Competitive indicators are those with means that exceed 4.0. Respondents include professionals, businesses, and organisations operating within the cultural and creative industries in the Lazio Region, in line with studies that emphasize the relevance of expert-based evaluations of competitiveness (Kouskoura et al. 2024). Table 1 presents the main characteristics of the sample.

Table 1. Sample demographics.

Sample	**%**
Gender	
Male	60
Female	40
Place of residence	
Viterbo	65
Lazio region	20
Elsewhere	15
Level of Education	
PhD	16.7
Master	21.7
Bachelor	45
High School	15
Secondary School	1.6

Sample	**%**
Age	
30–39	16.7
40–49	28.3
50-59	40
60-69	8.3
70-79	5
80-89	1.7
Employment Status	%
Employed	48.3
Self-Employed	45
Retired	5
Unemployed	1.7

Type of Employment or Expertise	%
Culture & Tourism	66.6
Professional services	13.3
Education & Communication	10
Public Administration	6.7
Art	1.7
Volunteering	1.7

5. Results

Internal consistency was assessed for each category with the Cronbach's Alpha. Table 2 shows that the alpha coefficients are satisfactory for all factors and significantly exceed the minimum value of 0.7 (Nunnally 1978; Aquilino et al. 2019).

Table 2. Internal consistency of factors extracted.

Competitiveness Category	*Cronbach's Alpha*
Inherited Resources	0.740
Created Resources	0.908
Supporting Resources	0.887
Destination Management and Organisation	0.954
Social Conditions to improve Local Wellbeing	0.926
Image and Awareness Conditions	0.909

Inherited Resources concerns environmental, cultural and architectural elements. The responses indicate that Viterbo is a hospitable and clean city with an ideal climate. It has sufficient space to host cultural events and the natural environment adds value to the destination (Table 3).

Table 3. Inherited Resources.

Indicators	*X*	*SD*	*α*
Sufficient space to host events and cultural activities	4.33	1.65	0.79
Presence of cultural assets	5.93	1.13	0.67
The aesthetic, artistic, and architectural features add value	6.08	1.15	0.69
The natural environment adds value	6.18	0.81	0.76
The city has an ideal climate for tourists	5.27	1.32	0.69
The city is clean	4.12	1.58	0.74

Created Resources supporting cultural events are equally divided into elements perceived as less and highly competitive (Table 4). The first category regards the diversification of cultural and leisure offerings and supporting infrastructure. Respondents indicate that cultural activities for younger, including the availability of evening events, are limited. Moreover, accommodation capacity and local transportation are perceived as inadequate to support visitor flows. Elements perceived as highly competitive are existing cultural infrastructure and entertainment opportunities for people over 55. Additionally, the quality of food and the variety of food service facilities emerge as competitive assets of the destination.

Table 4. Created Resources.

Indicators	*X*	*SD*	*α*
Quality of local transportation	3.10	1.58	0.90
Variety of food service facilities	4.47	1.21	0.90
Quality of food	5.38	1.24	0.90
Accommodation capacity allows for increased visitors	3.72	1.50	0.90
Value for money of accommodation	4.32	1.21	0.90
Variety of shopping experiences	3.42	1.11	0.90
Opportunities for evening events	2.95	1.24	0.89
Entertainment opportunities and cultural activities satisfy the interests of young people (under 18)	2.87	1.29	0.90
Entertainment opportunities and cultural activities satisfy the interests of young adults (18 - 35 years)	3.17	1.45	0.89
Entertainment opportunities and cultural activities satisfy the interests of adults (35 - 55 years)	3.85	1.36	0.89
Entertainment opportunities and cultural activities satisfy the interests of people over 55 years	4.18	1.44	0.90
Sufficient number of event venues to organise indoor events and cultural activities	4.05	1.52	0.90
Availability of urban areas to host outdoor events and larger cultural activities	4.28	1.34	0.90
Availability of spaces outside urban areas to host outdoor events and larger cultural activities	4.42	1.51	0.90

The perception of competitiveness about Supporting Resources (Table 5) is considerably lower than for the Inherited and Created Resources. The availability of medical facilities and online booking system is perceived as competitive. The lowest results are recorded for key services as transport accessibility and the availability of training programme in tourism and event management. Weaknesses also emerge in financial and exchange services, digital accessibility and sufficient and multilingual tourist information.

Table 5. Supporting Resources.

Indicators	*X*	*SD*	*α*
Accessibility of Viterbo in terms of transport	2.68	1.46	0.88
Convenient flight prices to the immediate surroundings	3.30	1.45	0.89
Availability of financial institutions and currency exchange services	3.08	1.29	0.87
Availability of medical resources and hospitals	4.52	1.26	0.88

Wi-Fi, apps and information services can be easily used by tourists	3.65	1.48	0.86
Tourist signature and information in different languages	3.40	1.43	0.87
Websites and online information about attractions and events	3.57	1.49	0.86
Online bookings	4.20	1.46	0.87
Training programmes in tourism and event management	2.98	1.36	0.86
Regular training programmes for tourism and event-related work	3.02	1.30	0.86

Table 6 shows low scores across most indicators related to destination management and organisation. The lowest levels of perceived competitiveness concern the ability of tourism managers to plan innovative cultural events and develop a clear strategic vision for their activities. Weaknesses are also related to the organisational efficiency in event management and strategic planning, including the lack of market analysis and promoting activities. Positive elements are nevertheless identified: the recent strengthening of the cultural offer, the recognition by the public sector of the importance of cultural development and its related support. The highest score is associated with the perceived necessity of foreign investment to support growth in this sector.

Table 6. Destination management and organisation.

Indicators	*X*	*SD*	*α*
Managers in tourism or events understand the importance of providing quality service	3.77	1.36	0.95
Market analyses are informing tourism policy, event planning, and city development	3.62	1.06	0.95
Research is conducted on nearby markets to compare the event offer	3.37	1.07	0.95
The offer of events and cultural activities has recently strengthened	4.07	1.42	0.95
Events and cultural activities are popular year-round	3.35	1.35	0.95
Tourism managers and employees are efficient in solving organisational problems	3.32	1.28	0.95
Event managers are efficient in solving organisational problems before and during events	3.55	1.11	0.95
Tourism/event managers are innovative in planning and providing new products for events and cultural activities	3.27	1.36	0.95
Clear vision among tourism/event managers to deliver creative events and cultural activities	3.13	1.17	0.95
Managers are responsive to visitor needs	3.37	1.16	0.95
People are informed about new events and cultural attractions	3.28	1.28	0.95
Health and safety practices comply with standards	3.85	1.15	0.95
Risk assessments are adequate and emergency evacuation plans are clear	3.93	1.18	0.95
The public sector recognizes the importance of sustainable development of the cultural activities	4.02	1.50	0.95

The public sector informs citizens about development plans and programs related to upcoming events and cultural activities	3.87	1.52	0.95
The public sector recognizes and supports the organisation of cultural activities	4.15	1.55	0.95
The private sector recognizes and supports the organisation of events and cultural activities	3.93	1.30	0.95
The resident population supports the organisation of events and cultural activities	3.47	1.28	0.95
Residents are hospitable towards tourists	3.83	1.40	0.95
Foreign investment and external funding are necessary to support growth in the events sector	5.20	1.63	0.95
Tourism marketing emphasizes the city's events and cultural activities	3.97	1.44	0.95
Involvement of the National Tourism Agency in promoting events and cultural activities	3.48	1.50	0.95
Involvement of local and regional DMOs in promoting events and cultural activities	3.62	1.49	0.95
Use of technology and social media to support the marketing of events and cultural activities	4.07	1.67	0.95

About the Social Conditions indicators (Table 7), although respondents recognize that the organisation of cultural events generates benefits and strengthens local pride, they also highlight that locals are not adequately involved, trained or informed about cultural programmes. Additional critical aspects emerge in the lack of structured policies, including social tourism initiatives and measures supporting disadvantaged groups.

Table 7. Social Conditions.

Indicators	*X*	*SD*	*α*
The city has clear policies on social tourism that benefit locals	3.33	1.39	0.92
There is mutual understanding and tolerance between citizens and tourists	3.58	1.48	0.91
Citizens are involved in the organisation of cultural activities and support events	3.25	1.36	0.91
Citizens benefit from cultural events	4.23	1.50	0.92
Adequate tourism, events and cultural education programmes at local higher education institutions	3.78	1.26	0.92
Focus on the strengths of local businesses and encouraging local entrepreneurial opportunities	3.83	1.42	0.92
Plans to assist people from disadvantaged communities	3.37	1.26	0.92
Initiatives are in place to support people with disabilities	3.70	1.39	0.92
Local pride is enhanced through the organisation of cultural events	4.52	1.63	0.92
Volunteer programmes to engage citizens	4.13	1.24	0.92

Incentives for training and citizen participation in cultural events	3.17	1.32	0.91
Local population is aware of cultural programmes and the benefits of hosting cultural events	3.22	1.37	0.91
Interest among citizens in promoting tourism and organising cultural events	3.45	1.49	0.91

Image and Awareness Conditions (Table 8) are generally perceived as competitive. Viterbo benefits from a positive overall image, political and economic stability, and a strong sense of visitor safety. Respondents also recognise that new events and cultural activities present effective tools for destination branding and visibility. Weaknesses remain in terms of international recognition and the ability to attract an international audience.

Table 8. Image and Awareness Conditions.

Indicators	*X*	*SD*	*α*
Overall image of the city is positive	4.12	1.32	0.91
Political and economic stability	4.13	1.36	0.91
Strong sense of visitors safety	4.43	1.53	0.90
Correspondence between the event and the participants' preferences	4.15	1.12	0.90
Correspondence between the promoted image and the tourism experiences provided	4.15	1.36	0.90
People globally know well about the city's events	3.63	1.39	0.90
Festivals, exhibitions, cultural experiences are recognized globally	3.45	1.62	0.90
The city is known worldwide for hosting cultural activities	3.22	1.87	0.90
New initiatives are designed to attract an international audience	2.87	1.63	0.90
Event and cultural activities are an effective tool for destination branding	4.85	2.05	0.91
Social/user-generated online content contribute to the image and awareness of the city	4.38	1.82	0.91
New events and cultural activities help the image and awareness of the city	4.85	1.82	0.91

6. Conclusions

This study investigated the ongoing application process of Viterbo for the ECoC initiative, examining the participants' assessment of destination competitiveness during the co-design laboratories. The empirical results indicate that Inherited Resources and Image Conditions are largely perceived as competitive, whereas Supporting Resources, Social Conditions, Management and Organisation require further development. The city's natural environment, architectural elements and cultural assets constitute a distinctive and valuable identity as a cultural destination. Political and economic stability, together with a strong sense of visitor safety, are very positive elements. The city's weaknesses lie in both tourist and cultural sectors: inadequate accommodation capacity, poor transport and digital accessibility, limited multilingual tourist information, insufficient evening

entertainments, and a limited capacity to attract a global audience. Strategic planning, market analysis, and innovation capacity among tourism and event managers should be strengthened. Social Conditions results are relevant in the ECoC context: while respondents recognise that cultural events generates benefits and strengthens local pride, they highlight a lack of structured policies for social inclusion, limited citizens' involvement, and low awareness of cultural programmes among locals. Addressing these gaps is essential to transform the application process in a long-term strategy for lasting legacy. Overall, the areas requiring investments and policy intervention are: improving transport and digital infrastructures, developing training programmes for the tourism sector, broadening the cultural offer to engage younger and international audience, and strengthening social inclusion and citizen participation.

Finally, it is essential to acknowledge the inherent limitations of this research. Awareness of potential biases in local expert perspectives, as well as of the limitations of the quantitative approach, which may not fully capture the complexity of social dynamics, is crucial. Future research should broaden and diversify the sample and place greater emphasis on qualitative and mixed-methods approaches. Moreover, longitudinal assessments conducted during and after the ECoC process would provide valuable insights into the evolution of these determinants over time, contributing to a more complete and dynamic understanding of how the ECoC initiative shapes urban and cultural development.

References

Aquilino L., Armenski T., Wise N. (2019). Assessing the Competitiveness of Matera and the Basilicata Region (Italy) Ahead of the 2019 European Capital of Culture *Tourism and Hospitality Research* 19(4), pp. 503–517. DOI: 10.1177/1467358418787360

Armenski T., Marković V., Nemanja D., Jovanovic T. (2011). Integrated Model of Destination Competitiveness *Geographica Pannonica* 15, pp. 58–69. DOI: 10.5937/GeoPan1102058A

Azzopardi E., Nash R. (2016). A Framework for Island Destination Competitiveness – Perspectives from the Island of Malta *Current Issues in Tourism* 19(3), pp. 253–281. DOI: 10.1080/13683500.2015.1025723

Camagni R., Capello R. (2013). Regional Competitiveness and Territorial Capital: A Conceptual Approach and Empirical Evidence from the European Union *Regional Studies* 47(9), pp. 1383–1402. DOI: 10.1080/00343404.2012.681640

Crouch G. I., Ritchie J. R. B. (1999). Tourism, Competitiveness, and Societal Prosperity *Journal of Business Research* 44(3), pp. 137–152. DOI: 10.1016/S0148-2963(97)00196-3

Dupeyras A., MacCallum N. (2013). Indicators for Measuring Competitiveness in Tourism: A Guidance Document *OECD Tourism Papers* 2013(2). DOI: 10.1787/5k47t9q2t923-en

Dwyer L., Forsyth P., Rao P. (2000). The Price Competitiveness of Travel and Tourism: A Comparison of 19 Destinations *Tourism Management* 21(1), pp. 9–22. DOI: 10.1016/S0261-5177(99)00081-3

Dwyer L., Kim C. (2003). Destination Competitiveness: Determinants and Indicators *Current Issues in Tourism* 6(5), pp. 369–414. DOI: 10.1080/13683500308667962

European Commission. (2012). *Commission Staff Working Document. European Capitals of Culture post 2019 Accompanying the document Proposal for a Decision of the European Parliament and of the Council establishing a Union action for the European Capitals of Culture for the years 2020 to 2033* Publications Office of the European Union.

Falk M., Hagsten E. (2017). Measuring the Impact of the European Capital of Culture Programme on Overnight Stays: Evidence for the Last Two Decades *European Planning Studies* 25(12), pp. 2175–2191. DOI: 10.1080/09654313.2017.1349738

Farmaki A., Christou P., Saveriades A., Spanou-Tripinioti E. (2019). Perceptions of Pafos as European Capital of Culture: Tourism Stakeholder and Resident Perspectives *International Journal of Tourism Research* 21(2), pp. 234–244. DOI: 10.1002/jtr.2257

Forte A., Peiró-Palomino J., Tortosa-Ausina E. (2015). Does Social Capital Matter for European Regional Growth? *European Economic Review* 77, pp. 47–64. DOI: 10.1016/j.euroecorev.2015.03.013

Ganga R. N., Wise N., Perić M. (2021). Exploring Implicit and Explicit Cultural Policy Dimensions through Major-Event and Neoliberal Rhetoric *City, Culture and Society* 27, 100401. DOI: 10.1016/j.ccs.2021.100401

Garcia B., Cox T. (2013). *European Capitals of Culture: Success Strategies and LongTerm Effects* European Parliament.

Giovannelli M. C., Genovese A. (2025). Modelli Giuridici Di Governance e Strumenti Digitali Nel Progetto "Viterbo Capitale Europea Della Cultura 2033" *Rivista Trimestrale Di Scienza Dell'Amministrazione* 4. DOI: 10.32049/RTSA.2025.4.09

Giovannelli M. C., Oldani C., Franco S. (2026). The European Capital of Culture: A Systematic Review of the Literature *Journal of Policy Research in Tourism, Leisure and Events* pp. 1–18. DOI: 10.1080/19407963.2026.2636571

Go F. M., Govers R. (2000). Integrated Quality Management for Tourist Destinations: A European Perspective on Achieving Competitiveness *Tourism Management* 21(1), pp. 79–88. DOI: 10.1016/S0261-5177(99)00098-9

Gomes P., Librero-Cano A. (2018). Evaluating Three Decades of the European Capital of Culture Programme: A Difference-in-Differences Approach *Journal of Cultural Economics* 42(1), pp. 57–73. DOI: 10.1007/s10824-016-9281-x

Grant R. (1999). The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation *California Management Review* 33, pp. 3–23. DOI: 10.1016/B978-0-7506-7088-3.50004-8

Hassan S. (2000). Determinants of Market Competitiveness in an Environmentally Sustainable Tourism Industry *Journal of Travel Research* 38, pp. 239–245. DOI: 10.1177/004728750003800305

Immler N. L., Sakkers H. (2014). (Re)Programming Europe: European Capitals of Culture: Rethinking the Role of Culture *Journal of European Studies* 44(1), pp. 3–29. DOI: 10.1177/0047244113515567

Kouskoura A., Kalliontzi E., Skalkos D., Bakouros I. (2024). Evaluating Experts' Perceptions on Regional Competitiveness Based on the Ten Key Factors of Assessment *Sustainability* 16(14), 5944. DOI: 10.3390/su16145944

Liu Y.-D. (2016). Event and Quality of Life: A Case Study of Liverpool as the 2008 European Capital of Culture *Applied Research in Quality of Life* 11(3), pp. 707–721. DOI: 10.1007/s11482-015-9391-1

Näsholm M. H., Blomquist T. (2015). Co-Creation as a Strategy for Program Management *International Journal of Managing Projects in Business* 8(1), pp. 58–73. DOI: 10.1108/IJMPB-10-2013-0063

Nunnally J. C. (1978). *Psychometric Theory* McGraw-Hill.

Omerzel D., Mihalic T. (2008). Destination Competitiveness—Applying Different Models, the Case of Slovenia *Tourism Management* 29, pp. 294–307. DOI: 10.1016/j.tourman.2007.03.009

Porter M. (1990). *The Competitive Advantage of Nations* Palgrave Macmillan UK. DOI: 10.1007/978-1-349-11336-1

Porter M., Sachs J., Mcarthur J. (2001). *Executive Summary: Competitiveness and Stages of Economic Development*.

Ritchie J. R. B., Crouch G. I. (2000). The Competitive Destination: A Sustainable Tourism Perspective *Tourism Management* 21, pp. 1–7. DOI: 10.1079/9780851996646.0000

Ritchie J. R. B., Crouch G. I. (2003). *The Competitive Destination: A Sustainable Tourism Perspective* CABI. DOI: 10.1079/9780851996646.0000

Sanetra-Szeliga J. (2022). Culture and Heritage as a Means to Foster Quality of Life? The Case of Wrocław European Capital of Culture 2016 *European Planning Studies* 30(3), pp. 514–533. DOI: 10.1080/09654313.2021.1959724

Smith A. (2012). *Events and Urban Regeneration: The Strategic Use of Events to Revitalise Cities* Routledge. DOI: 10.4324/9780203136997

Turok I. (2004). Cities, Regions and Competitiveness *Regional Studies* 38, pp. 1069–1083. DOI: 10.1080/0034340042000292647

Xu J. (Bill), Au T. (2023). Destination Competitiveness since 2010: Research Themes, Approaches, and Agenda *Tourism Review* 78(3), pp. 665–696. DOI: 10.1108/TR-10-2022-0494

Sorting Public Value: Source-Separated Waste Collection as a Regulated-Material Service Exchange

Veronica Giuliani[1], Simone Marziali[2], Enrico Maria Mosconi[3]

Abstract

Source-separated municipal waste collection depends on household participation, yet it cannot be explained as recycling behaviour or as a technical operation alone. This contribution theorises source separation as a regulated, asymmetric and socially constructed public-service exchange. Building on Public Service Logic, Service-Dominant Logic, co-production research and Edvardsson, Tronvoll and Gruber's social-construction approach, it adapts value-in-social-context to municipal waste collection. The method combines an instrumental integrative review, a diagnostic bibliometric gap audit and theory adaptation. The analysis shows extensive behavioural recycling research but a smaller and dispersed bridge literature on co-production, value co-creation, public services and waste management. The article introduces value-in-regulated-material context and advances five propositions on alignment, capability, asymmetry, recursive legitimacy and value co-destruction.

Keywords: source-separated waste collection, co-production, Public Service Logic, Service-Dominant Logic, public value.

1. Introduction

Municipal waste collection is often framed as a technical, behavioural or governance problem. Technical studies focus on collection, logistics, treatment and recovery. Behavioural studies explain household recycling through attitudes, intentions, norms, convenience, trust and awareness. Governance studies address regulation, participation and institutional coordination. Each lens matters, but none is sufficient on its own.

Source-separated waste collection depends on household participation that is active but constrained. Households sort, store and present waste fractions according to rules set elsewhere. Their action affects material quality and downstream recovery. Yet they do not define the categories, calendars, tariffs, infrastructures, sanctions or destinations through which the service is organised. Despite this, households are not passive consumers. Yet neither are they fully autonomous co-producers. They are regulated participants in a public-service exchange.

This creates a specific gap. Co-production, value co-creation and resource integration already appear in waste-management research. Existing studies address logistics service triads, separate collection performance, recycling ecosystems, digital platforms, fiscal incentives, administrative burdens and conflict (Halldórsson et al., 2019; Landi and Russo, 2022; Helmefalk et al., 2023; Fiorillo and Merkaj, 2024; Wang and Zhang, 2024; Pillai et al., 2025; Mersico et al., 2026; Zhang et al., 2026). This is not an unexplored research area. Its limitation lies in the fragmentation of existing studies, which address behavioural willingness, information framing, administrative burdens, logistics, fiscal policy,

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, veronica.giuliani@unitus.it.

[2] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, simone.marziali@aeronautica.difesa.it.

[3] Full Professor of Commodity Sciences, University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, enrico.mosconi@unitus.it.

engagement, brokerage and conflict, but do not yet converge into a unified account of source-separated waste collection as a regulated public-service exchange.
This article therefore asks how source-separated municipal waste collection can be conceptualised as a regulated, asymmetric and socially constructed public-service exchange. It answers by proposing the construct of value-in-regulated-material context: household participation creates public value only when sorting practices become materially usable, institutionally recognised and publicly legitimate.

2. Methodological approach

The article uses an instrumental integrative review supported by a diagnostic bibliometric gap audit. The review was not a full systematic review. It delimited the literatures relevant to theory adaptation and tested whether the proposed gap was plausible. Searches were conducted in Scopus and Web of Science on 14 June 2026. The search period was limited to publications from 2008 to 2026. Only English-language journal articles and reviews were retained. Non-journal and non-research items, data papers and retracted or withdrawn records were excluded. Records were deduplicated by normalised DOI and, where DOI was absent, by normalised title. Corpus E was refined to exclude technical-industrial uses of co-production in energy and engineering literatures.
Table 1 reports the five-corpus design. Corpus E contained 50 deduplicated records before manual screening and 38 retained bridge records after screening. Fourteen were classified as core-threat studies because they directly connected waste management with co-production, Public Service Logic, Service-Dominant Logic, value co-creation, administrative burdens or policy instruments.

Table 1. Corpus construction and diagnostic function.

Corpus	Label	Final records	Diagnostic function
A	Public Service Logic / value co-creation	824	Maps Public Service Logic, public-service-dominant logic, public value co-creation and co-production in public management and administration.
B	Municipal / household source-separated waste	1,681	Maps the broader waste-management literature on municipal waste, household waste, source separation, separate collection, waste sorting and recycling.
C	Behavioural recycling literature	1,747	Identifies behavioural research on recycling and waste sorting, including attitudes, intentions, social norms, perceived behavioural control, awareness, convenience, trust and participation.
D	Social construction / legitimacy / asymmetry	799	Retrieves socio-institutional contributions dealing with legitimacy, trust, accountability, fairness, asymmetry, participation, environmental justice and socially constructed meanings in waste-related contexts.
E	Bridge corpus	50 (pre-screening); 38 retained	Identifies records connecting public-service co-production, value co-creation, Service-Dominant Logic, Public Service Logic or service exchange with municipal, household or source-separated waste management.

The bibliometric component was used diagnostically, not inferentially. Its function was to support theoretical positioning by assessing whether behavioural, socio-institutional and service/co-production literatures were already integrated or remained analytically fragmented. The strongest overlap was between the municipal/household waste corpus and the behavioural recycling corpus (B and C: 671 shared records). The retained bridge corpus remained small and weakly overlapping with the others ($A \cap E = 8$; $B \cap E = 5$; $C \cap E = 9$; $D \cap E = 8$). Keyword maps supported the same diagnosis. Corpus C was behavioural. Corpus D linked waste management with participation, governance,

justice, trust and norms. Corpus E linked co-production, public services, Service-Dominant Logic, Public Service Logic and value co-creation, but without a compact theoretical core.
A sensitivity search added "service triad", "first-mile", "reverse logistics" AND household, "resource integration" AND waste, and "service ecosystem" AND waste. It also checked work on information frames, policy instruments, administrative burdens and willingness to participate. Wang and Zhang (2024) and Zhang, Wang and Zhao (2026) were incorporated as core threats. Within the searched databases, eligibility criteria and sensitivity checks, no study was identified that uses Edvardsson, Tronvoll and Gruber's social-construction approach to build a regulated-material theory of source-separated municipal waste collection.

3. Literature positioning and theoretical anchor

The article sits at the intersection of four research streams. The behavioural literature explains household recycling and waste sorting through attitudes, intentions, subjective norms, perceived control, habits, awareness, convenience, trust and participation. Two recent experimental studies refine the picture. Wang and Zhang (2024) show that information framing affects citizens' willingness to coproduce waste sorting. Zhang, Wang and Zhao (2026) show that policy instruments shape that willingness through administrative burdens, building on Moynihan, Herd and Harvey (2015). These studies clarify what activates willingness. They do not theorise the public-service exchange through which willingness becomes materially usable separation and, eventually, public value.
A second stream is public-service co-production. Outcomes may depend on joint contributions by public agencies and citizens (Parks et al., 1981; Ostrom, 1996; Bovaird, 2007). Public Service Logic later reframed public organisations as facilitators of co-production rather than unilateral providers (Osborne et al., 2016; Osborne, 2018). Voorberg, Bekkers and Tummers (2015) reviewed the field; Alford (2016) stressed interdependence and publicness; Landi and Russo (2022) brought the lens directly to separate waste collection. The tradition is rich, but most contributions focus on specific mechanisms rather than on the service interface as a theoretical object.
Service-Dominant Logic provides a third frame. Vargo and Lusch (2004, 2008) shifted attention from goods to service, resource integration and value-in-use; their institutional extension placed rules, norms and shared meanings at the centre of service ecosystems (Vargo and Lusch, 2016). Waste-related studies have used this perspective on logistics triads, recycling ecosystems and digital platforms (Halldórsson et al., 2019; Helmefalk et al., 2023; Mersico et al., 2026). Source-separated waste collection, however, is not voluntary market engagement. It is regulated, materially consequential and asymmetric. A critical strand resists treating co-production as inherently consensual. Pillai, Luke and Narayanan (2025) document conflict, power asymmetries and politically mediated mobilisations in Indian solid-waste co-production. Fiorillo and Merkaj (2024) connect waste co-production to fiscal incentives and distributive choices. The service-marketing literature on value co-destruction reinforces the caution: misaligned resources, practices or expectations may erode value (Plé and Cáceres, 2010; Echeverri and Skålén, 2011), and Cui and Osborne (2023) extend the argument to public services. Households may be formally invited to participate yet experience participation as duty, burden or administrative requirement. Co-production becomes value-generating only when responsibilities are matched by clarity, feedback, recognition and credible downstream outcomes.
The central theoretical anchor is Edvardsson, Tronvoll and Gruber (2011). Their social-construction approach treats service-exchange relationships and the co-creation of value as processes that take place within social systems. Value is shaped by the structures of those systems, by the role distributions, by the positions of the actors, by their interactions and by the recurrent reproduction of shared meanings. This is the starting point, not a literal transfer. Source separation requires a context that is social, regulated and material at the same time. Households interpret institutional categories; municipalities define obligations and tariffs; providers organise collection; the separated fraction may

be clean or contaminated. Hence the shift from value-in-social-context to value-in-regulated-material context.

4. Theory adaptation: from value-in-social-context to value-in-regulated-material context

Figure 1 presents the conceptual synthesis. It uses Edvardsson et al. (2011) as a theoretical anchor for service-exchange relationships set within social systems, but adds the institutional-regulatory layer, the material-operational layer, asymmetric responsibility and recursive legitimacy.

The framework contains six constructs: regulated public-service exchange, situated co-production capability, material value of separation, asymmetric responsibility, recursive legitimacy and value-in-regulated-material context.

1) Regulated public-service exchange is the structured interaction among households, municipalities and providers. It is shaped by rules, tariffs, standards, calendars, infrastructures and possible sanctions. The household is user, taxpayer, waste holder, regulated subject, operational co-producer and evaluator of legitimacy.

(2) Situated co-production capability is the household's practical capacity to contribute effectively. It depends on time, domestic space, sorting knowledge, containers, access, clarity of rules, trust, feedback and habit. It is not reducible to willingness.

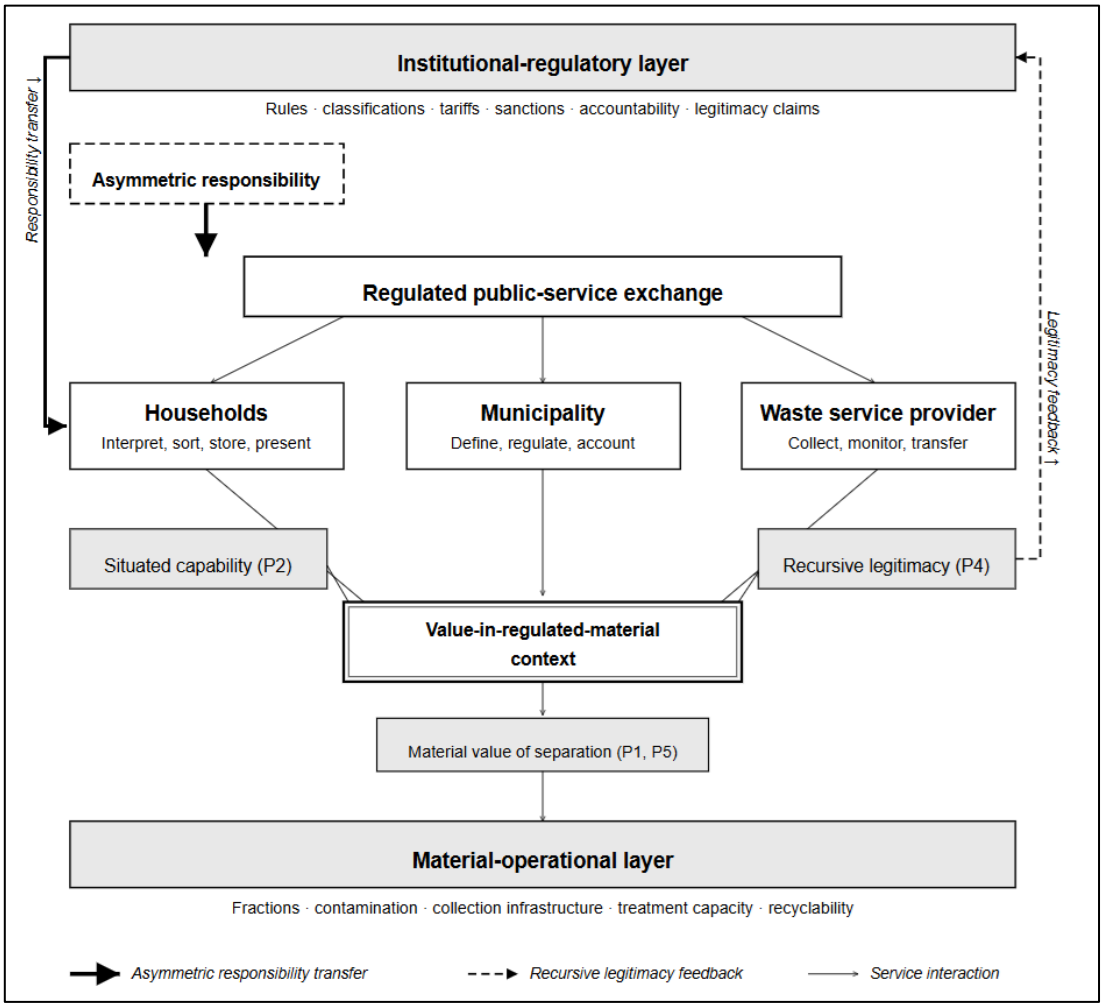
(3) Material value of separation is the value generated when a fraction is clean, classifiable and usable in collection, treatment or recycling. Waste categories are socially and institutionally defined, but contamination and poor separation have material effects.

(4) Asymmetric responsibility is the distribution of operational responsibility and institutional control. Households perform upstream classification and presentation. Municipalities and providers retain control over rules, calendars, infrastructure, quality standards, data, sanctions and downstream destinations.

(5) Recursive legitimacy is built or eroded through repeated encounters: instructions, collections, missed collections, rejected bags, sanctions, complaints, notifications and feedback.

(6) Value-in-regulated-material context is the overarching construct. Public value emerges when household practices, public rules, service infrastructures, material fraction quality and legitimacy judgements are aligned.

Figure 1. Value-in-regulated-material context in source-separated waste collection.



The diagram is an original visual synthesis. It uses Edvardsson et al. (2011) as theoretical anchor and adds the regulated-material layers, asymmetric responsibility and recursive legitimacy.

5. Theoretical propositions

The framework advances five propositions. P1 and P5 are original to the regulated-material domain: they address alignment and misalignment-induced value co-destruction. P2, P3 and P4 adapt three arguments from Edvardsson, Tronvoll and Gruber (2011): that resource assessment depends on context; that service exchange may be asymmetric; and that roles evolve dynamically within adaptive service systems. The adaptation is non-trivial. Waste collection replaces market-based value-in-use with regulated public-service obligations, makes material quality constitutive of value, and treats legitimacy as recursive.

Table 2. Core constructs, propositions and contribution status.

Construct	Core meaning	Linked propositions	Status
Regulated public-service exchange	Service interaction among households, municipalities and providers, structured by rules, obligations, tariffs, calendars, standards and sanctions.	P1	Original
Situated co-production capability	The household's concrete capacity to co-produce the service correctly through time, space, knowledge, infrastructure, trust and feedback.	P2	Adapted (Edvardsson et al., 2011, P2)
Material value of separation	Value generated when the separated fraction is sufficiently clean, classifiable and usable in subsequent treatment or recycling processes.	P1, P5	Original
Asymmetric responsibility	Condition in which households assume upstream operational responsibility while municipalities and providers retain control over rules, infrastructure, data, standards and downstream destination.	P3	Adapted (Edvardsson et al., 2011, P3)
Recursive legitimacy	Process through which the service becomes more or less legitimate to users through repeated interactions with rules, information, collections, sanctions, complaints and feedback.	P4	Adapted (Edvardsson et al., 2011, P4)
Value-in-regulated-material context	Process through which public value emerges from the alignment of household practices, public rules, service infrastructures, material quality and institutional legitimacy.	All	Original

P1. Public value depends on regulated-material alignment. Public value emerges when household sorting practices are aligned with institutional waste classifications, service infrastructures and downstream material requirements. Participation alone is not enough. A separated fraction becomes value-generating only if it is recognised by the service system and can be collected, treated or recycled.

P2. Household co-production depends on situated capability, not only willingness. Effective co-production depends on operational, cognitive-informational and institutional resources. Attitudes and intentions matter, but so do time, space, containers, access, knowledge, trust and feedback. Learning, psychological and compliance costs can block willing households from becoming effective co-producers.

P3. Asymmetric responsibility shapes the legitimacy of co-production. Legitimacy is affected by the balance between responsibilities assigned to households and the visibility, feedback and control retained by municipalities and providers. Zhang, Wang and Zhao (2026) show that coercive instruments may increase psychological and compliance costs. Responsibility without support can undermine sustained participation.

P4. Legitimacy is recursively produced through service encounters. Households experience the service through rules, bins, calendars, collections, missed collections, sanctions and feedback. These encounters accumulate and shape whether the service is perceived as reliable, fair and effective. This connects the dynamic view of roles in Edvardsson et al. (2011) with Giddens' (1984) structuration logic.

P5. Value co-destruction may arise from misalignment within the service interface. Co-destruction occurs when household practices, institutional rules, infrastructures and material requirements do not fit. It may result from ambiguous categories, poor communication, inaccessible infrastructure, product-design complexity, changing rules, lack of feedback or distrust in downstream recovery. The proposition adapts service research on co-destruction to public-service waste collection (Plé and Cáceres, 2010; Echeverri and Skålén, 2011; Cui and Osborne, 2023).

6. Discussion and policy relevance

The framework shifts the explanatory unit from the household, the bin or the directive to the household–municipality–provider interface. Source separation is produced when behaviour, infrastructure and regulation meet in a service interface that households can understand, enact and trust.

The central implication for co-production theory concerns conditional value. In source-separated waste collection, citizen contribution takes material form. The sorted fraction is the artefact through which co-production succeeds or fails. A willing household may still generate little public value if categories are unclear, containers are unsuitable or the fraction is contaminated. Participation must therefore be assessed not only by willingness, but also by material adequacy and downstream usability.

The regulated-material specification of value-in-context is the paper's principal contribution to service-exchange theory. Edvardsson et al. (2011) show that value is shaped by social structures, roles and reproduced meanings. In waste collection, those structures are also legal, operational and material. Rules define what counts as a fraction, a correct presentation, an error, a sanction and a recoverable material. Infrastructure defines what households can realistically do. Material quality defines whether co-produced output remains usable downstream.

At the governance level, the framework connects performance and legitimacy. Collection rates, contamination, residual waste and recycling yields are not only technical or behavioural indicators; they are also indicators of the service interface. Unclear rules, poor infrastructure or absent feedback may prevent willingness from becoming recoverable material. Arbitrary obligations or disproportionate sanctions may preserve compliance while weakening legitimacy. Each collection, missed collection, rejected bag or notification becomes part of the way the service is judged and reproduced.

The EU policy context sharpens the point. Directive 2008/98/EC established the Waste Framework Directive and the waste hierarchy. Directive (EU) 2018/851 strengthened EU circular-economy waste law and introduced municipal-waste recycling targets of 55% by 2025, 60% by 2030 and 65% by 2035. These targets require household co-production that is understandable, supported, materially effective and publicly legitimate.

7. Limitations and future research

The article is theoretical. It does not test the propositions empirically. The bibliometric component is diagnostic and does not replace a full systematic review. Corpus E is small, although the sensitivity search did not invalidate the fragmentation diagnosis. Another limitation is procedural: Scopus filters were embedded in the database query, while Web of Science records were harmonised through post-processing. The inclusion criteria are equivalent, but the workflow is not perfectly symmetrical.

Future research can proceed in four directions. Qualitative studies could examine how households interpret categories. Surveys could test the relationships among situated capability, administrative burden, trust, feedback and legitimacy. Operational datasets could link household-facing service conditions with contamination rates, missed collections and residual-waste shares. Comparative work could analyse how different regulatory and infrastructural models shape the legitimacy and material value of source separation. The EU context is a useful comparative ground because targets are increasingly harmonised, while implementation remains local and heterogeneous.

References

Alford J. (2016). Co-production, interdependence and publicness: Extending public service-dominant logic *Public Management Review* 18(5), pp. 673–691. DOI: 10.1080/14719037.2015.1111659

Bovaird T. (2007). Beyond engagement and participation: User and community coproduction of public services *Public Administration Review* 67(5), pp. 846–860. DOI: 10.1111/j.1540-6210.2007.00773.x

Cui T., Osborne S. P. (2023). Unpacking value destruction at the intersection between public and private value *Public Administration* 101(4), pp. 1207–1226. DOI: 10.1111/padm.12850

Echeverri P., Skålén P. (2011). Co-creation and co-destruction: A practice-theory based study of interactive value formation *Marketing Theory* 11(3), pp. 351–373. DOI: 10.1177/1470593111408181

Edvardsson B., Tronvoll B., Gruber T. (2011). Expanding understanding of service exchange and value co-creation: A social construction approach *Journal of the Academy of Marketing Science* 39(2), pp. 327–339. DOI: 10.1007/s11747-010-0200-y

European Parliament and Council. (2008). Directive 2008/98/EC of 19 November 2008 on waste and repealing certain Directives *Official Journal of the European Union* L 312, pp. 3–30.

European Parliament and Council. (2018). Directive (EU) 2018/851 of 30 May 2018 amending Directive 2008/98/EC on waste *Official Journal of the European Union* L 150, pp. 109–140.

Fiorillo F., Merkaj E. (2024). Municipal strategies, fiscal incentives and co-production in urban waste management *Socio-Economic Planning Sciences* 92, 101817. DOI: 10.1016/j.seps.2024.101817

Giddens A. (1984). *The constitution of society: Outline of the theory of structuration* Polity Press.

Halldórsson Á., Altuntas Vural C., Wehner J. (2019). Logistics service triad for household waste: Consumers as co-producers of sustainability *International Journal of Physical Distribution & Logistics Management* 49(4), pp. 398–415. DOI: 10.1108/IJPDLM-02-2019-0065

Helmefalk M., Palmquist A., Rosenlund J. (2023). Understanding the mechanisms of household and stakeholder engagement in a recycling ecosystem: The SDL perspective *Waste Management* 160, pp. 1–11. DOI: 10.1016/j.wasman.2023.01.030

Landi S., Russo S. (2022). Co-production "thinking" and performance implications in the case of separate waste collection *Public Management Review* 24(2), pp. 301–325. DOI: 10.1080/14719037.2020.1823726

Mersico L., Aureli S., Foschi E. (2026). Exploring the role of digital platforms in promoting value co-creation: Evidence from the Italian municipal solid waste management system *Sustainability Accounting, Management and Policy Journal* 17(1), pp. 233–266. DOI: 10.1108/SAMPJ-03-2024-0317

Moynihan D., Herd P., Harvey H. (2015). Administrative burden: Learning, psychological, and compliance costs in citizen-state interactions *Journal of Public Administration Research and Theory* 25(1), pp. 43–69. DOI: 10.1093/jopart/muu009

Osborne S. P. (2018). From public service-dominant logic to Public Service Logic: Are public service organizations capable of co-production and value co-creation? *Public Management Review* 20(2), pp. 225–231. DOI: 10.1080/14719037.2017.1350461

Osborne S. P., Radnor Z., Strokosch K. (2016). Co-production and the co-creation of value in public services: A suitable case for treatment? *Public Management Review* 18(5), pp. 639–653. DOI: 10.1080/14719037.2015.1111927

Ostrom E. (1996). Crossing the great divide: Coproduction, synergy, and development *World Development* 24(6), pp. 1073–1087. DOI: 10.1016/0305-750X(96)00023-X

Parks R. B., Baker P. C., Kiser L., Oakerson R., Ostrom E., Ostrom V., Percy S. L., Vandivort M. B., Whitaker G. P., Wilson R. (1981). Consumers as coproducers of public services: Some economic and institutional considerations *Policy Studies Journal* 9(7), pp. 1001–1011. DOI: 10.1111/j.1541-0072.1981.tb01208.x

Pillai S., Luke M., Narayanan N. C. (2025). Coping with conflicts in the co-production of solid waste management services: Experience with a real-world lab in India *Ecology and Society* 30(3), 25. DOI: 10.5751/ES-16339-300325

Plé L., Cáceres R. C. (2010). Not always co-creation: Introducing interactional co-destruction of value in Service-Dominant Logic *Journal of Services Marketing* 24(6), pp. 430–437. DOI: 10.1108/08876041011072546

Vargo S. L., Lusch R. F. (2004). Evolving to a new dominant logic for marketing *Journal of Marketing* 68(1), pp. 1–17. DOI: 10.1509/jmkg.68.1.1.24036

Vargo S. L., Lusch R. F. (2008). Service-Dominant Logic: Continuing the evolution *Journal of the Academy of Marketing Science* 36(1), pp. 1–10. DOI: 10.1007/s11747-007-0069-6

Vargo S. L., Lusch R. F. (2016). Institutions and axioms: An extension and update of Service-Dominant Logic *Journal of the Academy of Marketing Science* 44(1), pp. 5–23. DOI: 10.1007/s11747-015-0456-3

Voorberg W. H., Bekkers V. J. J. M., Tummers L. G. (2015). A systematic review of co-creation and co-production: Embarking on the social innovation journey *Public Management Review* 17(9), pp. 1333–1357. DOI: 10.1080/14719037.2014.930505

Wang Y., Zhang J. (2024). Promoting citizens' willingness to participate in coproduction in public service through information frames *Public Administration* 102(2), pp. 479–499. DOI: 10.1111/padm.12932

Zhang Y., Wang H., Zhao M. (2026). Policy instruments, administrative burdens, and coproduction preferences: Experimental evidence from household waste sorting *Review of Policy Research* 43(2), e70027. DOI: 10.1111/ropr.70027

Accessibility and mobility poverty: a case study for Italy

Filippo Gregori[1], *Federico Bacchi*[2], *Luca Secondi*[3]

Abstract

This study investigates transport poverty across Italy by examining two of its key dimensions: mobility poverty and accessibility. Datasets from the Italian National Institute of Statistics and the Transport Poverty Hub are used to apply Global and Local Moran's in order to analyze the spatial distribution of transport infrastructure availability and accessibility. Mobility poverty is measured using the minimum travel time from each municipality to the nearest railway station, highway, port, and airport. Accessibility is assessed using travel times to healthcare and school facilities by both public transport and private vehicle. The results reveal that the most disadvantaged areas are concentrated along the Apennine and Alpine mountain ranges and on the islands.

Keywords: Transport poverty, Accessibility, Mobility poverty, Healthcare inequality, Education inequality.

1. Introduction

Transport poverty refers to a lack of adequate transport services necessary to access general services and work, or to the inability to pay for these transport services (European Parliament, n.d.) Transport poverty is composed of four dimensions: affordability, accessibility, mobility and negative externalities (Lucas et al., 2016; Alonso-Epelde et al., 2023). Accessibility can be defined as the ease of reaching activities such as work, education, health services and shops at reasonable cost (SEU, 2003; Lucas et al., 2016), while mobility poverty refers to the lack of adequate transportation infrastructures (Lucas et al., 2016).

1.1 Spatial analysis of transport infrastructure and accessibility in Italy

Mobility poverty and accessibility are increasingly recognised as a multidimensional condition in which limited access to adequate transport options constrains individuals' opportunities to participate fully in economic and social life.

Focusing on mobility poverty in Italy, a growing body of empirical research has examined uneven mobility options at local level. Armenise et al. (2024) conduct a spatial analysis using a Real Accessibility Index based on travel-time distances to major transport infrastructures and investigate its association with municipal age and nationality composition. Licio and Pinna (2026) document pronounced spatial inequalities in mobility options across municipalities in Sicily and Sardinia, while Gambacurta (2026) analyses the determinants of accessibility and dependence on major infrastructures across Sicilian provinces.

In Italy, studies have shown significant spatial inequalities in accessibility. Poor access to essential services is associated with lower healthcare service use and reduced mobility (Perucca et al., 2016), while better public transport integration improves the benefits of healthcare and education services (Conigliani et al., 2025). Accessibility challenges are particularly evident for older adults (Carpentieri

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, filippo.gregori@unitus.it.
[2] Research Fellow in Economic Statistics, University of Siena, Department of Economics and Statistics, federico.bacchi2@unisi.it.
[3] Full Professor of Economic Statistics at University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, secondi@unitus.it.

et al., 2020), and changes in public transport supply significantly affect travel times to key services (Dabagh et al., 2024).

Finally, the study aims at addressing two main Research Questions (RQs):

RQ1: Do accessibility and mobility poverty exhibit spatial dependence across Italy?

RQ2: Which are the most disadvantaged areas in Italy in terms of accessibility and mobility poverty?

This study draws on the analysis of mobility poverty presented in Chapter 5 and the accessibility analysis developed in Chapter 6 of the technical report on transport poverty by Benedetti et al. (2026). In particular, the accessibility analysis is further extended by providing an assessment of the travel times required to reach schools, considering both private and public transport modes.

2. Methods and Materials

The presented analysis of Transport Poverty was undertaken on geo-referenced data. More specifically, the statistical techniques for the analysis areal data, where the locations of the observations are assumed to be fixed and the associated values generated according to some unknown statistical process, were adopted.

Let $r = 1, \ldots, R$ denote the geographic areas, and y the variable of interest. Suppose to be interested in the detection of the presence of a spatial structure in the distribution of y across the study area composed of R contiguous zones. A common way to infer this information is to rely on the concept of spatial autocorrelation, that is, the correlation of a variable with itself due to the spatial location of the observations.

In literature, there are many indices measuring spatial autocorrelation (see, for instance, Loonis and de Bellefon, 2018, for an extensive overview) that all require the definition of two necessary preliminary concepts: the neighbourhood and the weight matrices.

The neighbourhood matrix **N** of a set of R regions is a $R \times R$ matrix which codifies the neighbourhood structure of the geographic units. There are several ways to determine whether two distinct regions are neighbours; in the present work, geographic areas were treated as neighbours if they shared at least one point in the space (Queen neighbourhood matrix).

The weight matrix **W** of the same set of R regions is a $R \times R$ matrix which codifies the weighting structure of the geographic units. In the present work, for each area r, the weight associated to another area s is set to $w_{rs} = 0$, if s is not in the neighbourhood of r, or to $w_{rs} = \frac{1}{N_r}$, if s is one of the N_r neighbours of r. This mode of assigning weights is known in literature as line standardization or W-coding scheme.

Then, after having defined matrices **N** and **W**, it is finally possible to measure spatial autocorrelation. For this purpose, the most widely used index is the Moran's I statistic (Moran, 1950), that might be computed as follows:

$$I_W = \frac{n}{\sum_r \sum_s w_{rs}} \frac{\sum_r \sum_s w_{rs} (y_r - \bar{y})(y_s - \bar{y})}{\sum_r (y_r - \bar{y})^2}, \quad r \neq s. \tag{1}$$

It is worth nothing that the value of I_W depends on the weight matrix **W**. Furthermore, also the boundaries of I_W depend on **W**, but they are commonly close to $[-1; +1]$, making it possible to interpret the values similarly to Pearson's correlation coefficients: positive values indicate the presence of positive autocorrelation, i.e. neighbouring geographic areas tend to show similar values

of y, while negative values indicate the presence of negative autocorrelation, i.e. geographic areas with high values of y are typically surrounded by neighbouring areas with low values of y, and vice versa.

In addition to quantifying spatial autocorrelation, Moran's I might be used as a test statistic for the hypothesis H_0 of the absence of autocorrelation, since $E(I_W) = \frac{1}{R-1}$ and $\frac{I_W - E(I_W)}{\sqrt{Var(I_W)}} \sim N(0,1)$. In this context, the inference was conducted under the randomisation hypothesis: the estimated statistic computed from the data was compared with the distribution obtained by randomly re-ordering the data.

Moran's I statistic is a measure of Global autocorrelation, meaning that it is based on the implicit assumption that the spatial structure underlying the distribution of y is homogeneous. However, this might not always be the case. For this reason, Local Indicators of Spatial Association (LISA) were introduced in Anselin (1995). LISA measure the intensity and significance of local autocorrelation between the value of a variable in a region and the value of the same variable in the neighbouring regions. One of the most used LISA is the Local Moran's I, defined as

$$I_r = (R-1)\frac{y_r - \bar{y}}{\sum_{r'=1}^{R}(y_{r'} - \bar{y})^2}\sum_s w_{rs}(y_s - \bar{y}), \qquad (2)$$

for every geographic area r. When global autocorrelation is detected, the Local Moran's I helps to identify regions that have a particular impact on the global process or, on the other side, which stand out from it. As the analogous global index, also the Local Moran's I might be used as a test statistic for the hypothesis of absence of local autocorrelation in each of the R regions. In the present work, the hypothesis of conditional randomization (Sokal et al., 1998), i.e. I_r is compared with its mean value when all the observations except r are permuted, was adopted.

2.1 Mobility Poverty

The described methodology was, first, applied to data on Mobility Poverty. The relevant information was obtained from "Accessibility of municipalities to major transport infrastructures" project by Italian National Institute of Statistics ISTAT (ISTAT, 2023a). In this context, ISTAT measured accessibility to four different infrastructures - railway stations, motorway network, commercial airports, and ports with passenger traffic - as the minimum travel time to reach at least one destination from a given origin. Travel time was calculated exclusively as the road travel time by private vehicle from the coordinates assigned to each municipality to the nearest selected infrastructure. Due to its large territorial extent, the Municipality of Rome was initially subdivided into its 15 administrative districts for the accessibility analysis. However, in all other datasets, Rome was represented as a single observation rather than by individual districts. To ensure consistency across datasets, the accessibility values calculated for the 15 districts were aggregated into a single value for Rome by computing the arithmetic mean of each accessibility variable.

ISTAT (2023b) clarifies how the node infrastructures were selected. First, 258 railway stations with active passenger service - at least three trains per day - and long-distance train traffic were considered. Second, of the 39 airports of national interest, four were excluded because their passenger traffic was either negligible or non-existent. Third, access points to the motorway network were identified by considering all access points to the motorway system. Fourth, in 2022, Italy had a total of 143 statistical ports. Only the main ports were considered, excluding the ports grouped under them. Furthermore, a minimum level of annual passenger traffic - at least 10,000 passengers per year - recorded at each port was imposed, leading to a final sample of 54 ports with passenger traffic.

The statistical analysis presented in this work was based on the four variables representing the minimum travel time to reach the closest infrastructure. Table 1 provides the main summary statistics of these variables for the $R = 7{,}903$ municipalities existing at 01-01-2021.

Table 1 - Summary statistics.

Infrastructure	Min.	Q1	Median	Q3	Max.	Mean	Missing
Railway	0.8	18.8	28.7	42.3	400.7	32.9	0
Motorway	0.9	10.7	19.2	34.3	354.4	25.4	0
Airport	3.5	38.2	53.4	71.3	201.4	56.9	0
Port	0.0	58.3	84.8	114.0	295.3	88.6	0

The four variables were, then, used as poverty predicates to define four dimension-specific fuzzy Mobility Poverty indices according to the following membership function:

$$MP_{rk} = \begin{cases} 1, & if\ x_{rk} \geq q_{k,\beta} \\ \dfrac{q_{k,\beta} - x_{rk}}{q_{k,\beta} - q_{k,\alpha}}, & if\ q_{k,\alpha} < x_{rk} < q_{k,\beta} \\ 0, & if\ x_{rk} \leq q_{k,\alpha} \end{cases} \tag{3}$$

where x_{rk} is the time distance of municipality r from infrastructure k, $q_{k,\alpha}$ and $q_{k,\beta}$ are the α-quantile and the β-quantile ($\alpha, \beta \in [0; 1]$, $\alpha < \beta$) of the variable representing the time distance from infrastructure k. Then, the four dimension-specific indices were aggregated in a Composite Mobility Poverty index by performing a weighted sum:

$$CMP_r = \sum_k w_k MP_{rk}, \tag{4}$$

where w_k is a vector of dimension-specific weights.

2.2 Accessibility

The accessibility data was obtained from the transport poverty hub (TPH), managed by the Joint Research Centre (Transport Poverty Hub, 2025), which provides harmonized indicators for assessing transport poverty across Europe. This study uses four accessibility indicators for 2023, representing the minimum travel time to the nearest primary school and healthcare facility by public transport and private vehicle. Primary schools (public and private) and healthcare facilities (hospitals and other healthcare services) were geolocated using Eurostat GISCO data. Public transport accessibility was estimated using static timetable data from the National Access Points, with reference dates selected to represent a typical weekday morning service. Road accessibility was based on the TomTom MultiNet 2023 road network. Origins and destinations were connected to the transport network through the five nearest junctions within a 4 km radius, assuming a fixed driving speed of 15 km/h.

Accessibility indicators were computed from the centroids of the GISCO 2021 populated 1 km² grid cells, representing residential locations, to the nearest destination. Table 2 reports the descriptive statistics of the four variables employed for the global and local Moran's I: minimum travel time by public transport to the nearest primary school (Minutes 1) and healthcare facility (Minutes 2), and by private vehicle to the nearest primary school (Minutes 3) and healthcare facility (Minutes 4).

Table 2 - Summary statistics.

Infrastructure	Min.	Q1	Median	Q3	Max.	Mean	Missing
Minutes 1	0.45	8.08	12.27	23.52	93.93	23.32	1465
Minutes 2	2.76	39.13	66.59	90.00	94.93	62.57	1183
Minutes 3	0.15	1.98	2.56	3.74	90.00	3.62	356
Minutes 4	0.95	9.01	13.56	19.63	90.00	15.22	0

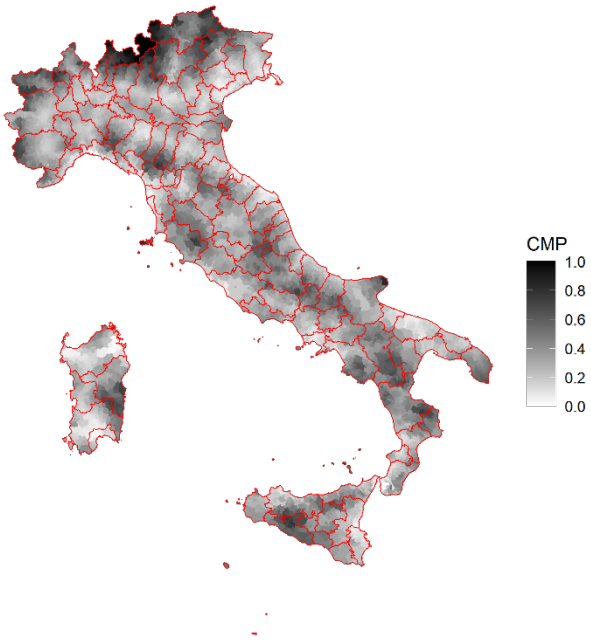
3. Results

The main results obtained with the application of the methodologies described in the previous section are outlined in the following. Section 3.1 focuses on Mobility Poverty, while Section 3.2 focuses on Accessibility.

3.1 Mobility Poverty

The Composite Mobility Poverty index was obtained by adopting and comparing three different vectors of weights (see Fig. 1 for the spatial distribution).

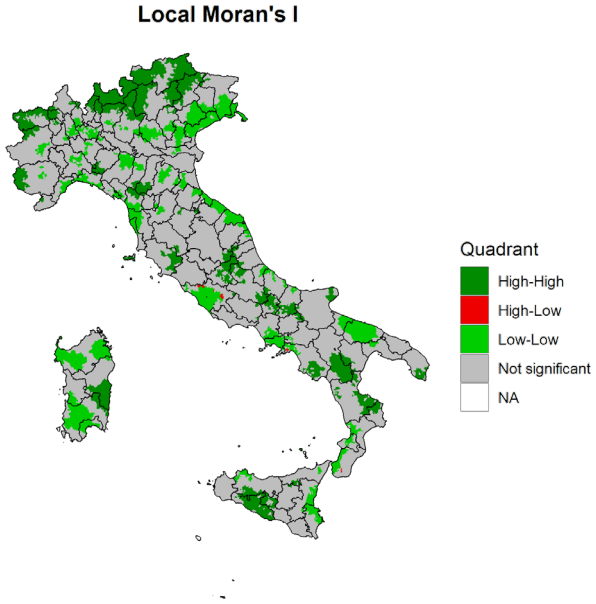
Figure 1 - Cartograph of the spatial distribution of the Composite Mobility Poverty index.



Source: R Project for Statistical Computing.

The spatial structure underlying the distribution of CMP was, first, investigated at global level by computing Moran's I according to the Eq. (1). The obtained value of the index ($I_W = 0.900$) suggested the presence of a strong positive autocorrelation phenomenon. Furthermore, the test based on Moran's statistic led to the conclusion that the null hypothesis of absence of autocorrelation should be rejected ($p < 0.001$). Then, the Local Moran's indices were computed for each municipality according to Eq. (2) and their significance was tested. As a result, 2,000 municipalities were found to be affected by a significant local autocorrelation phenomenon. Most of these municipalities were grouped into clusters of positive local autocorrelation (858 in the High-high quadrant, and 1,134 in the Low-low quadrant) but there were 8 remaining municipalities located in the High-low quadrant. The spatial distribution of these clusters is presented in Fig. 2.

Figure 2 - Cartograph of the significant local Moran's indices based on the distribution of the Composite Mobility Poverty index.

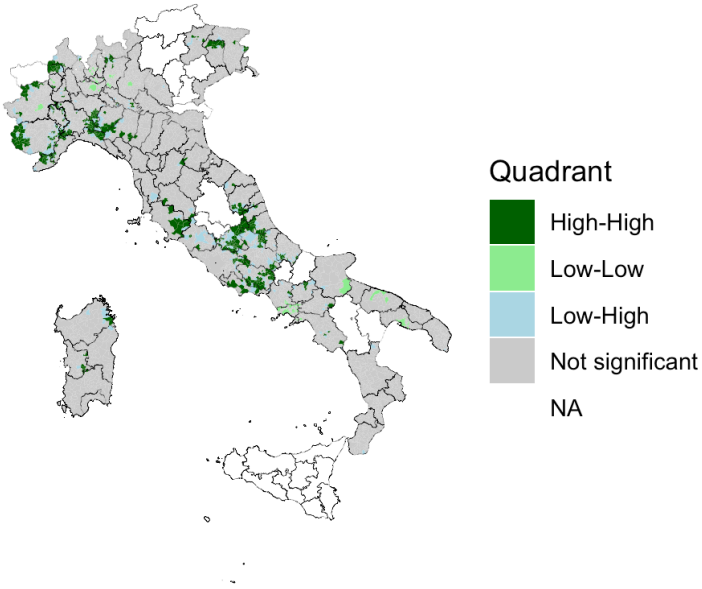


Source: R Project for Statistical Computing.

3.2 Accessibility

The test based on Moran's statistic, according to the Eq. (1), led to the conclusion that the null hypothesis of absence of autocorrelation should be rejected ($p < 0.001$) for all analysis. Then, the Local Moran's indices were computed for each municipality according to Eq. (2) and their significance was tested. As a result, municipalities were found to be affected by a significant local autocorrelation phenomenon. The first LISA analysis indicates a strong prevalence of non-significant spatial associations (5,674). Among the significant patterns, High-High clusters (475) are the most frequent. Low-High (230) and Low-Low clusters (49) are less common. The spatial distribution of these clusters is presented in Fig. 3.

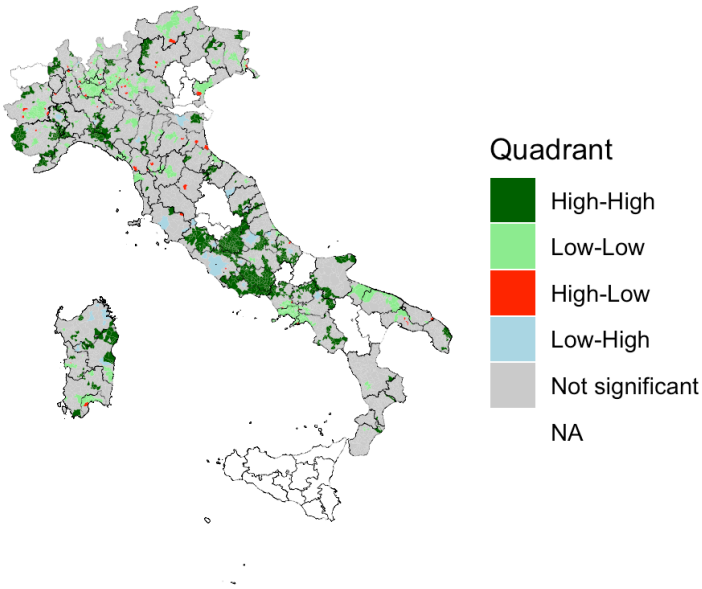
Figure 3 - Public transport accessibility to primary school facilities.



Source: R Project for Statistical Computing.

The second LISA analysis shows a prevalence of non-significant spatial associations (4,792). Low-Low (981) and High-High clusters (846) are the most frequent, while High-Low (57) and Low-High (34) patterns are limited.

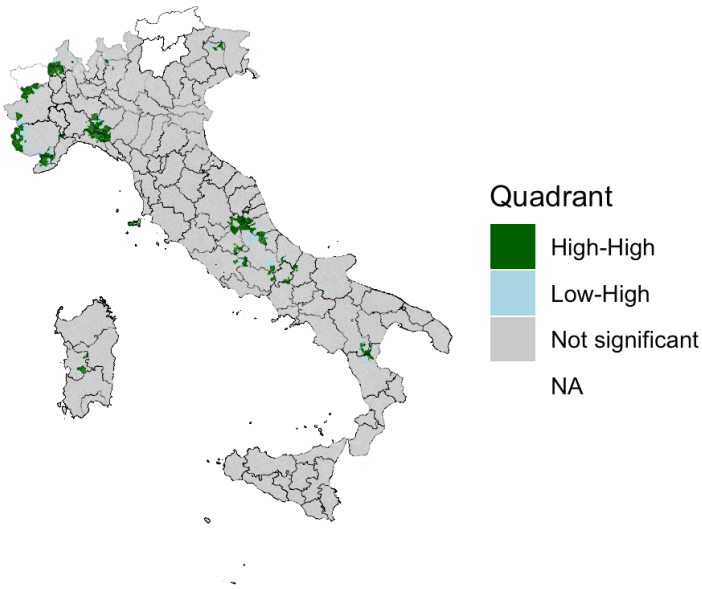
Figure 4 - Public transport accessibility to healthcare facilities.



Source: R Project for Statistical Computing.

The third LISA analysis shows a predominance of non-significant spatial associations (7219). High-High clusters (257) is the most frequent significant quadrant. The Low-High pattern (61) is rare. The spatial distribution of these clusters is presented in Fig. 5.

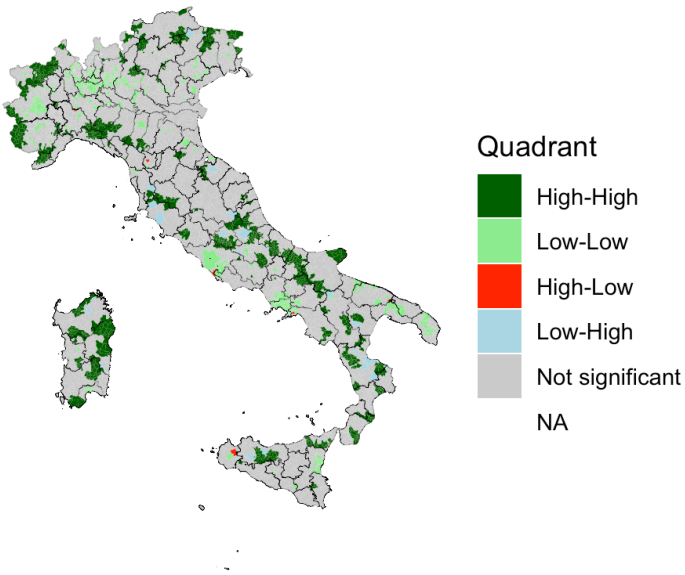
Figure 5 - Driving accessibility to primary school facilities.



Source: R Project for Statistical Computing.

The fourth LISA analysis shows a predominance of non-significant spatial associations (6,198). Among the significant patterns, High-High clusters (944) and Low-Low clusters (717) are the most frequent. The High-Low (6) and Low-High patterns (28) are rare. The spatial distribution of these clusters is presented in Fig. 6.

Figure 6 - Driving accessibility to healthcare facilities.



Source: R Project for Statistical Computing.

4. Discussion

The spatial analyses of two considered dimensions of TP, mobility poverty and accessibility, described in the previous section suggested many interesting insights. With respect to Mobility poverty and Accessibility, a strong positive global autocorrelation structure was detected. However, the computation of Local Moran's I revealed that some spatial heterogeneity needs to be taken into account.

Considering mobility poverty, a large group of municipalities has been reported to belong to High-high clusters, meaning that they were characterized by strong deprivation of mobility options as long as their neighbours. These clusters are mostly located in the Alps, in some specific areas of the Apennines - for instance, at the borders between Tuscany and Emilia-Romagna, the provinces of Rieti and L'Aquila, and in the provinces of Potenza and Cosenza -, in Sicily and Eastern coast of Sardinia. Nonetheless, a strict minority of municipalities was found to belong to High-low clusters, i.e. they were characterized by a significantly higher mobility transport poverty with respect to their neighbours. Six of these municipalities are located at the border of the province of Rome, probably reflecting a higher distance from its facilities with respect to the other municipalities in the same province, and the remaining are both located in the South (Tramonti, in the province of Salerno, and Roccaforte del Greco, in the province of Reggio di Calabria).

The analysis of public transport accessibility to primary schools shows that the most disadvantaged areas are located in the Eastern Alps, the Ligurian and Central Apennines, and in the provinces of Latina, Frosinone, and Grosseto. The analysis of public transport accessibility to hospitals indicates that the most disadvantaged areas are concentrated along the Apennine and Alpine regions, throughout the Lazio region (with the exception of the province of Rome), in Sardinia, and in the provinces of Foggia, Brindisi, Grosseto, Ancona, and Ferrara. In addition, scattered hotspots of disadvantage are observed across the Po Valley. The analysis of private transport accessibility to

primary schools reveals that the most disadvantaged areas are located in the provinces of Oristano and Pordenone, as well as in the Eastern Alps and the Ligurian, Central, and Calabrian Apennines. The analysis of private transport accessibility to healthcare facilities shows that the most disadvantaged areas are distributed along the Apennine mountain range, from Calabria to Liguria, in the Western and Eastern Alps, across the provinces of Sardinia, and in the provinces of Messina, Palermo, Siracusa, Grosseto, Lucca, Pesaro and Urbino, and Foggia.

5. Conclusions

This study employed data from the ISTAT and the TPH to analyse the availability of infrastructures and the accessibility to healthcare and primary school facilities across Italy. Specifically, Global and Local Moran's I were applied to assess the presence of spatial dependence and to identify spatial clusters. The results show that the Apennine and Alpine mountain ranges, as well as the islands, experience disadvantages in both dimensions. Future research could extend this analysis by adopting a longitudinal approach.

Supplementary Materials: The code can be downloaded on Github. Repository: M-A Link: https://github.com/Accessibility-Italy/M-A.

Funding: This work was supported by the PRIN 2022 PNRR "HAC VIA - a compreHensive Analysis for promoting evidenCe-based policies to tackle and alleVIAte transport poverty" project funded by the Italian Ministry of University and Research (MUR) [Next Generation Eu, Missione 4 Componente 1 Cup J53D2301691000].

References

Alonso-Epelde E., García-Muros X., González-Eguino M. (2023). Transport poverty indicators: A new framework based on the household budget survey *Energy Policy* 181, 113692. DOI: 10.1016/j.enpol.2023.113692

Anselin L. (1995). Local indicators of spatial association—LISA *Geographical Analysis* 27(2), pp. 93–115.

Armenise M., Benassi F., Carella M., Misuraca R. (2024). Accessibility and older and foreign populations: exploring local spatial heterogeneities across Italy *Economies* 12(9), 248.

Benedetti, I., Secondi, L., Bacchi, F., Duttilo, P., Gregori, F., & Morosini, F. M. (2026). *Affrontare la povertà dei trasporti in Italia: Evidenze, mappatura e opzioni di policy* [Technical report]. TESSA Analytics, Transport & Environment, University of Tuscia.

Carpentieri G., Guida C., Masoumi H. E. (2020). Multimodal Accessibility to Primary Health Services for the Elderly: A Case Study of Naples, Italy *Sustainability* 12(3), 781. DOI: 10.3390/su12030781

Cerioli A., Zani S. (1990). A fuzzy approach to the measurement of poverty *Income and Wealth Distribution, Inequality and Poverty: Proceedings of the Second International Conference on Income Distribution by Size: Generation, Distribution, Measurement and Applications* pp. 272–284. Springer Berlin Heidelberg, Berlin, Heidelberg.

Conigliani C., Addis M., Spinesi L. (2025). Assessing the impact of essential service locations on social hardship: Evidence from Rome *Cities* 167. DOI: 10.1016/j.cities.2025.106349

Dabagh S., Ministice L. M. B., Gentile G. (2024). Accessibility Via Public Transport Through Gravity Models Based on Open Data *Transport and Telecommunication Journal* 25(4), pp. 359–369. DOI: 10.2478/ttj-2024-0026

European Commission. (2025). *Transport Poverty Dashboard – Guide*.

European Parliament. (n.d.). *Understanding transport poverty*.
Eurostat. (2026). *Modal split of air, sea and inland passenger transport*. Accessed: 2026-07-15. URL: ec.europa.eu/eurostat/databrowser/view/tran_hv_ms_psmod/default/table
Gambacurta V. (2026). Multimodal accessibility, territorial inequalities, and transport dependence: The Sicily case study *European Transport Studies* 3, 100068.
Istat. (2023a). *Accessibility of municipalities to major transport infrastructures*. URL: istat.it/wp-content/uploads/2023/12/Stat_Focus_Accessibilità.pdf
Istat. (2023b). *L'accessibilità dei comuni alle principali infrastrutture di trasporto – Note metodologiche*. URL: istat.it/wp-content/uploads/2023/12/Nota-Informativa-Accessibilita2022.pdf
Licio V., Pinna A. M. (2026). Measuring Accessibility Within Islands *Island Studies Journal*.
Loonis V., de Bellefon M. P. (2018). *Handbook of spatial analysis: theory and application with R* Eurostat, INSEE, Paris, p. 394.
Lucas K., Mattioli G., Verlinghieri E., Guzman A. (2016). Transport poverty and its adverse social consequences *Proceedings of the Institution of Civil Engineers – Transport* 169(6), pp. 353–365. DOI: 10.1680/jtran.15.00073
Mejía Dorantes L., Murauskaite-Bull I. (2022). *Transport poverty: a systematic literature review in Europe* Publications Office of the European Union, Luxembourg.
Mejía Dorantes L., Murauskaite-Bull I. (2023). Revisiting transport poverty in Europe through a systematic review *Transportation Research Procedia* 72, pp. 3861–3868.
Moran P. A. (1950). Notes on continuous stochastic phenomena *Biometrika* 37(1/2), pp. 17–23.
Perucca G., Piacenza M., Turati G. (2019). Spatial inequality in access to healthcare: evidence from an Italian Alpine region *Regional Studies* 53(4), pp. 478–489. DOI: 10.1080/00343404.2018.1462481
Social Exclusion Unit. (2003). *Making the Connections: Final Report on Transport and Social Exclusion* Office of the Deputy Prime Minister, London, UK.
Sokal R. R., Oden N. L., Thomson B. A. (1998). Local spatial autocorrelation in a biological model *Geographical Analysis* 30(4), pp. 331–354.
Transport Poverty Hub. (2025). *Transport Poverty Hub*. URL: regions-and-cities.ec.europa.eu/cities-portal/eu-initiatives-cities/transport-poverty-hub_

Educational poverty and digital divide from a multidimensional perspective: theoretical framework and evidence from the Italian context

Matteo Stampella[1], *Ilaria Benedetti*[2], *Tiziana Laureti*[3]

Abstract

Educational poverty is a multidimensional phenomenon shaped by the interaction of economic, family, educational and contextual disadvantages. In contemporary societies, digital inequalities represent an increasingly relevant dimension of this process, as access to devices, internet connectivity and digital skills affects individuals' opportunities for learning, participation and social inclusion. This paper analyses the overlap between educational disadvantage and digital vulnerability in Italian households. Using microdata from the 2023 ISTAT Aspects of Daily Life Survey, the study constructs three household-level indicators of educational-digital poverty, based respectively on lack of full digital access, low digital skills among key adults, and the simultaneous presence of both conditions in households with low educational capital. Survey-weighted logistic regression models are then estimated to assess the association between family educational capital and different dimensions of digital inclusion, controlling for geographical area, household composition and age. The findings provide evidence on the coexistence of educational and digital deprivation and highlight the role of family educational capital, territorial inequalities and generational factors in shaping digital inclusion. The paper contributes to the multidimensional measurement of educational poverty by interpreting digital vulnerability not only as a technological issue, but as a family-level condition linked to unequal educational resources and opportunities.

Keywords: Educational poverty, Digital poverty, Multidimensional poverty, Digital divide, Poverty indicators.

1. Introduction

This study analyses the relationship between educational poverty and digital poverty from a multidimensional perspective, focusing on their overlap within Italian households. Drawing on Sen's capability approach, poverty is understood not only as economic deprivation, but as a limitation of the substantive freedoms and capabilities that allow individuals to pursue valuable life trajectories (Sen, 1999). From this perspective, educational poverty refers to the deprivation of opportunities to learn, develop skills, cultivate talents and participate fully in social life.

In contemporary societies, digital technologies have become increasingly central to accessing educational, informational, administrative and social opportunities. As a result, digital inequalities represent a relevant dimension of educational disadvantage. The literature usually distinguishes three levels of the digital divide: access to devices and infrastructure, digital skills and patterns of use, and the ability to transform digital resources into educational, social and economic benefits (Balbi, 2018). The concept of digital educational poverty captures this intersection, referring to the deprivation of

[1] Student of the PhD Program in Economics, Management and Quantitative Methods, University of Tuscia, matteo.stampella@unitus.it.

[2] Associate Professor of Economic Statistics, University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, i.benedetti@unitus.it.

[3] Rector of the University of Tuscia, Full Professor of Economic Statistics, University of Tuscia, Department of Economics, Engineering, Society, and Business Organization, laureti@unitus.it.

opportunities to learn and develop capabilities through the responsible, critical and creative use of digital tools (Save the Children Italia, 2021).
In Italy, the relationship between educational and digital inequalities is particularly relevant. Although internet access has become widespread, important differences persist by educational background, age and geographical area. Recent ISTAT (2026) evidence shows that households with higher educational levels are substantially more likely to have a home internet connection than households whose members have lower qualifications; at the same time, digital skills remain below European targets and are unevenly distributed across the population. These patterns suggest that the digital divide cannot be interpreted only as a matter of infrastructure, but should also be analysed in relation to family educational resources and the capacity to use digital tools effectively.
While educational poverty and digital inequalities are increasingly recognised as multidimensional and interconnected phenomena, less attention has been paid to their coexistence within households. In particular, it remains important to assess whether combined educational and digital deprivation varies according to the specific dimension of digital vulnerability considered: lack of full digital access, low digital skills, or the simultaneous presence of both conditions. It is also necessary to examine whether family educational capital remains associated with different dimensions of digital inclusion after accounting for territorial, family and generational characteristics.
This study addresses these issues using microdata from the 2023 ISTAT Aspects of Daily Life Survey. The analysis constructs three household-level indicators of combined educational and digital deprivation: a baseline indicator based on low family educational capital and lack of full digital access; a skills-based indicator combining low family educational capital and low digital skills among key adults; and a strong indicator identifying households where low educational capital, lack of full digital access and low digital skills are simultaneously present. In a second step, survey-weighted logistic regression models are estimated to assess the association between family educational capital and three dimensions of digital inclusion: individual internet use, lack of full digital access and low household digital skills.
The paper therefore aims to answer three research questions: first, to what extent do educational and digital deprivation overlap within Italian households, and how does their prevalence vary across different definitions of digital vulnerability? Second, is family educational capital associated with internet use, lack of full digital access and low household digital skills after controlling for geographical area, household composition and age? Third, how do territorial, family and generational inequalities differ across the various dimensions of digital inclusion?

2. Data and methodology

2.1 *Data sources and variables analysed*

The analysis is based on microdata from the 2023 Italian Multipurpose Survey on Aspects of Daily Life (AVQ), conducted by ISTAT. The survey collects nationally representative information on individuals and households, including socio-demographic characteristics, access to digital technologies, internet use and selected digital skills. Population estimates were obtained using the survey weight "*COEFIN*", appropriately re-scaled in accordance with the survey's methodological guidelines ("*COEFIN"/10000*). The study combines individual and household level information. Household variables were constructed using the family identifier "*PROFAM*", retaining one observation for each household.
Educational attainment was classified according to ISCED 2011 into three groups: low education (ISCED 0-2), corresponding to lower-secondary education or below; medium education (ISCED 3-4), including upper-secondary and post-secondary non-tertiary qualifications; and high education (ISCED 5-8), covering tertiary and postgraduate education (UNESCO Institute for Statistics, 2012). Family educational capital was then derived from the qualifications held by the household reference person (HRP) and any spouse or cohabiting partner. Households were classified according to whether

none, one, or two or more of these adults held at least an upper-secondary qualification. The first category was treated as low family educational capital.
Digital access was measured through the availability of a personal computer and a home internet connection. Households with both resources were classified as having “full digital access”. Digital skills were based on three activities reported for the HRP and any spouse or partner: using word-processing software, using spreadsheets and changing device settings or configurations.
The remaining variables include geographical area, the presence of children and age. Residence was grouped into North, Centre, and South and Islands. In the individual model, age was divided into six groups, while the household models distinguish between households whose HRP was aged under 60 and those whose HRP was aged 60 or over.

2.2 Analytical strategy

The empirical strategy was developed in two stages. The first stage focuses on the construction of three household-level indicators designed to capture the joint occurrence of educational and digital deprivation. The main indicator, referred to as the baseline indicator in Table 1, identifies households characterised by both low family educational capital and lack of full digital access. Low family educational capital refers to households in which neither the HRP nor any spouse or cohabiting partner holds at least an upper-secondary qualification, while lack of full digital access indicates the absence of either a personal computer, a home internet connection, or both. Two alternative specifications were then constructed to account for the skills dimension of the digital divide. The skills-based indicator refers to the second level of the digital divide (Balbi, 2018) and identifies households combining low family educational capital with low household digital skills. This condition occurs when none of the key adults in the household possesses at least two of the three skills considered: using word-processing software, using spreadsheets and changing device settings or configurations. The "strong indicator" adopts a more restrictive definition and identifies households in which low family educational capital, lack of full digital access and low household digital skills are simultaneously present.
The second stage examines whether family educational capital remains associated with different dimensions of digital inclusion after accounting for household composition, geographical area and age. Three survey-weighted binary logistic regression models were estimated. Logistic regression is appropriate when the dependent variable is dichotomous and allows the association between a set of explanatory variables and the log-odds of the outcome to be modelled (Peng et al., 2002). Since the AVQ survey provides survey weights, the models were estimated using the svyglm() function of the R survey package, with the quasibinomial() family, following the approach proposed for the analysis of survey samples (Lumley, 2004). The general form of the estimated models can be expressed as:

$$log\left(\frac{P(Y_i = 1)}{1 - P(Y_i = 1)}\right) = \beta_0 + \beta_1 EduCap_i + \beta_2 HHComp_i + \beta_3 Area_i + \beta_4 Age_i + \varepsilon_i$$

where Y_i represents the outcome of interest: internet use in the first model, lack of full digital access in the second, and low household digital skills in the third. $EduCap_i$ denotes family educational capital, $HHComp_i$ denotes household composition, $Area_i$ refers to the geographical area of residence, and Age_i age-related characteristics. In the individual-level model, age was included through six age groups, while the household-level models include a dichotomous indicator identifying households whose reference person is aged 60 or over. The left-hand side of the model represents the log-odds of observing the outcome:

$$LO_i = log\left(\frac{P(Y_i = 1)}{1 - P(Y_i = 1)}\right)$$

where LO_i denotes the log-odds. Therefore, each coefficient β_j expresses the change in the log-odds of the outcome with the corresponding explanatory variable, holding the other covariates constant. For ease of interpretation, coefficients were exponentiated and reported as odds ratios:

$$OR_j = \exp(\beta_j)$$

An odds ratio above one indicates higher odds of the coded outcome relative to the reference category, while a value below one indicates lower odds.

3. Empirical results

3.1 *Dual educational-digital poverty*

Table 1 reports the survey-weighted prevalence of dual educational-digital poverty across the three indicators and by household characteristics. The first indicator identifies households characterised simultaneously by low educational capital with the lower secondary school certificate adopted as the critical threshold (Morabito et al., 2022; Battilocchi, 2020) and a lack of full digital access. This is based on the idea of a close interconnection between the two dimensions, which tend to co-occur in the same family contexts. The results show that approximately 38.8% of Italian households have low educational capital, whilst 32.8% lack full digital access at home. When both dimensions are considered together, the proportion of households experiencing dual deprivation reaches 22.7%, indicating that more than one in five households simultaneously face educational and digital vulnerability. The comparison between the three indicators shows that educational-digital poverty changes substantially depending on the dimension of digital vulnerability considered. The baseline and skills-based indicators have similar overall prevalence, but they identify partially different forms of disadvantage: the former is more closely related to material access, while the latter captures limitations in adult digital capabilities. The "strong" indicator, by contrast, isolates a smaller but more severely deprived group of households in which educational and digital vulnerabilities accumulate across both access and skills.

Table 1. Survey-weighted prevalence of dual educational-digital poverty by household characteristics (%).

Household characteristics	Baseline indicator	Skills-based indicator	Strong indicator
All households	22.7	22.3	9.4
Geographical area			
North	19.9	20.9	7.8
Centre	18.9	18.4	7.3
South and Islands	29.2	27.4	13.6
Household composition			
Households without children	25.9	24.6	11.9
Households with children	8.5	19.0	4.7

Age of the HRP			
Households with HRP aged under 60	9.6	17.1	7.2
Households with HRP aged 60 or over	37.0	32.0	13.4

These indicators are unevenly distributed across household characteristics. The highest values are recorded in the South and Islands, where the baseline indicator reaches 29.2%, compared with 19.9% in the North and 18.9% in the Centre. A similar territorial pattern emerges for the skills-based and strong indicators, confirming that the overlap between educational and digital disadvantage is more pronounced in the southern areas of the country. Household composition also matters, although the pattern differs across the three measures. Households with children show a much lower prevalence of the baseline indicator than households without children. However, the gap is narrower when digital vulnerability is measured through skills, suggesting that the presence of children is more clearly associated with access to digital resources than with the possession of digital skills among key adults. The age of the household reference person further differentiates the results. Households with an HRP aged 60 or over display higher levels of dual deprivation across all three indicators. Nevertheless, the presence of non-negligible values among households with a younger HRP indicates that dual educational-digital poverty cannot be interpreted solely as an age-related phenomenon. Rather, the results suggest that educational capital and digital inclusion remain closely associated across different household profiles.

3.2 *Logistic regression models*

Table 2 reports the results of the survey-weighted logistic regression models. The first model analyses internet use at the individual level, while the second and third models examine, at household level, lack of full digital access and low household digital skills.

The results show a clear educational gradient across all three outcomes. Compared with households in which none of the considered adults holds at least an upper-secondary qualification, the presence of one qualified adult is associated with higher odds of internet use and lower odds of digital deprivation. The association becomes stronger when two or more adults hold at least an upper-secondary qualification. In this case, the odds of internet use are almost ten times those of the reference category ($OR = 9.953$), while the odds of lacking full digital access and of having low household digital skills are substantially lower ($OR = 0.102$ and $OR = 0.061$, respectively).

Territorial differences also remain relevant after accounting for the other covariates. Compared with the South and Islands, individuals living in the North and Centre have higher odds of internet use. At the household level, residence in the North and Centre is associated with lower odds of both lack of full digital access and low household digital skills. This evidence is consistent with literature highlighting the persistence of territorial disparities in digital inclusion (ISTAT, 2026).

Age-related differences are particularly evident in the model on internet use. All younger age groups show higher odds of using the internet than individuals aged 60 or over, with the strongest association observed among those aged 18-24. In the household-level models, having an HRP aged 60 or over is associated with higher odds of lacking full digital access ($OR = 1.260$) and, more markedly, with higher odds of low household digital skills ($OR = 2.464$). These results are consistent with Van Dijk and Van Deursen (2014), who show that digital access, use and skills tend to decline with increasing age, making older individuals more exposed to digital exclusion.

The role of household composition is more nuanced. Households with children are associated with higher odds of individual internet use and lower odds of lacking full digital access. However, the

association with low household digital skills is not statistically significant. This suggests that the presence of children may be more closely related to the availability of digital resources than to the skills possessed by the key adults in the household. The results should be read as associations rather than causal effects, given the cross-sectional nature of the data.

Table 2. Survey-weighted logistic regression estimates for internet use, lack of full digital access and low household digital skills.

	Internet use			**Lack of full digital access**			**Low household digital skills**		
	(1) Coeff.	**(2) S.E.**	**(3) O.R.**	**(4) Coeff.**	**(5) S.E.**	**(6) O.R.**	**(7) Coeff.**	**(8) S.E.**	**(9) O.R.**
Intercept	-0.649***	0.047	0.522	0.722***	0.085	2.060	2.034***	0.102	7.645
Family educational capital (ref. = none)									
One adult with at least an upper-secondary qualification	1.229***	0.056	3.418	-1.269***	0.070	0.281	-1.638***	0.086	0.194
Two or more adults with at least an upper-secondary qualification	2.298***	0.070	9.953	-2.285***	0.085	0.102	-2.798***	0.086	0.061
Household composition (ref. = no children)									
Household with children	0.313***	0.050	1.368	-1.260***	0.064	0.284	-0.093	0.066	0.911
Geographical area (ref. = South and Islands)									
North	0.518***	0.052	1.679	-0.687***	0.065	0.503	-0.659***	0.063	0.517
Centre	0.418***	0.064	1.519	-0.672***	0.088	0.510	-0.617***	0.080	0.539
Model 1: Age group (ref. = 60+) | Model 2-3: HRP aged 60+ (ref. = HRP aged <60 years)									
Age 18-24	4.285***	0.299	72.609						
Age 25-34	2.816***	0.134	16.706						
Age 35-44	2.442***	0.117	11.485						
Age 45-54	2.178***	0.085	8.832						
Age 55-59	1.828***	0.088	6.220						
HRP aged 60+				0.231***	0.064	1.260	0.902***	0.064	2.464

Notes: ***denotes statistical significance at 1% level; **denotes statistical significance at 5% level; *denotes statistical significance at 10% level.

4. Discussion and conclusions

This study is positioned within the body of literature that interprets the digital divide as a multidimensional phenomenon, comprising three distinct levels: access, skills, and the ability to transform digital resources into educational, social and economic opportunities (Balbi, 2018). The specific contribution of this analysis therefore does not lie in moving beyond a dichotomous view of the digital divide - an aspect already widely acknowledged in the literature - but in measuring how family educational capital interacts with the various dimensions of digital vulnerability.

With regard to the research questions, the results indicate that the co-occurrence of educational deprivation and digital vulnerability is a significant condition in the Italian context, but does not take a single form. The baseline indicator captures a dimension more directly linked to the physical availability of devices and internet connection; the skills-based indicator, on the other hand, captures a less visible form of vulnerability, concerning the ability of key adults in the household to independently use certain basic digital functions; finally, the "strong" indicator identifies the segment in which these two forms of digital vulnerability are compounded by low educational capital. The distinction between these three measures is an important step because it allows us to view educational-digital poverty not as a homogeneous condition, but as a configurational vulnerability; that is, different families may find themselves at a disadvantage for different reasons and, consequently, require different responses. The results confirm that family educational capital is systematically associated with the different dimensions of digital inclusion considered in the study.

Territorial, family and generational factors also contribute to differentiating these forms of vulnerability. The higher prevalence of all three indicators in the South and Islands confirms the territorial concentration of educational-digital deprivation. The age of the household reference person is particularly relevant for skills-related vulnerability, while the presence of children appears more strongly associated with access to digital resources than with adult digital skills. These results indicate that the different dimensions of digital inclusion should be analysed separately, rather than assuming that access, skills and use follow the same social pattern.

In the logistic regression models, the presence of one or more adults with at least an upper-secondary qualification is associated with higher odds of individual internet use and with lower odds of both lack of full digital access and low household digital skills. This pattern remains after controlling for geographical area, household composition and age, suggesting that family educational capital represents a relevant stratification factor across both access and skills-related dimensions of the digital divide.

A first policy implication arises from these findings: measures to tackle educational-digital poverty should be designed in a diagnostic manner, distinguishing the prevailing type of deprivation. Families falling into the baseline category require interventions focused primarily on ensuring the availability of suitable devices and stable internet connections. Families characterised by the skills-based category, on the other hand, require training programmes for adults, centred on practical skills, the use of online services, the independent management of digital tools, and the ability to use digital technology for educational, informational and administrative purposes. For households falling into the "strong" category - where low educational capital, lack of access and low skills are concentrated within the same household - integrated interventions appear necessary, capable of combining material support, training and local support services. The point, therefore, is not merely to identify how many households are excluded, but to understand what type of exclusion they face and, consequently, what needs they have.

A second implication concerns the relationship between digital policies and education policies. Digitalisation policies cannot be viewed as a sphere separate from education and lifelong learning policies. Schools, libraries, adult education centres, local authority services and community-based support centres can play an important role not only for pupils, but also for parents and other adult caregivers. In particular, within households with low educational capital, support for adult digital literacy can represent a decisive step in ensuring that technical access to tools does not remain

devoid of any real transformative power. These findings suggest that the school-family relationship may be a relevant setting for adult digital literacy interventions, especially in households where children's educational needs already generate demand for digital access.

A third implication concerns the local dimension. National digitalisation policies risk producing unequal outcomes if they do not take into account the local conditions in which they are implemented. In the most vulnerable areas, and particularly in Southern Italy, bridging the educational-digital divide requires interventions that simultaneously address infrastructure, skills, educational services and local institutional capacity. The point is not merely to guarantee access to technology, but to build local ecosystems capable of supporting families in their use of digital tools.

These findings also suggest implications for statistical measurement. Traditional indicators of access risk overestimating digital inclusion if they are not interpreted alongside skills and family educational capital. From this perspective, the development of family-based indicators of educational and digital vulnerability can make measurement not merely descriptive but diagnostic: it does not merely record the presence of a disadvantage, but helps to identify the nature of the need and the most appropriate type of intervention.

The study has certain limitations. The cross-sectional nature of the AVQ data does not allow causal relationships to be established between family educational capital and digital inclusion. The observed associations therefore do not allow us to determine the direction of the relationship between educational disadvantage and digital vulnerability, nor to reconstruct the processes through which these conditions may reinforce each other over time. Furthermore, digital skills are measured using the indicators available in the survey, which capture relevant operational aspects but do not cover the entire spectrum of digital competence, particularly its critical, creative and evaluative components. Despite these limitations, the analysis allows us to view the digital divide not as a phenomenon external to educational poverty, but as one of the areas through which educational inequalities can take on specific forms in a society increasingly mediated by technology. Not all vulnerable families face the same type of disadvantage and, for this very reason, not all require the same policy.

References

Balbi G. (a cura di) (2018). *Critical turn nel digitale* Morlacchi Editore.

Battilocchi G. L. (2020). Educational poverty in Italy: Concepts, measures and policies *Central European Journal of Educational Research* 2(1), pp. 1–10. DOI: 10.37441/CEJER/2020/2/1/5753

ISTAT - Istituto Nazionale di Statistica. (2026). *Cittadini e ICT. Anno 2025: Aumentano le competenze digitali* Roma.

Lumley T. (2004). Analysis of complex survey samples *Journal of Statistical Software* 9(8), pp. 1–19. DOI: 10.18637/jss.v009.i08

Morabito C. et al. (2022). *Alla ricerca del tempo perduto. Un'analisi delle disuguaglianze nell'offerta di tempi e spazi educativi nella scuola italiana* Save the Children Italia, Roma.

Peng C.-Y. J., Lee K. L., Ingersoll G. M. (2002). An introduction to logistic regression analysis and reporting *The Journal of Educational Research* 96(1), pp. 3–14. DOI: 10.1080/00220670209598786

Save the Children Italia. (2021). *Riscriviamo il Futuro: una rilevazione sulla povertà educativa digitale* Save the Children Italia, Roma.

Sen A. (1999). *Development as Freedom* Oxford University Press, Oxford.

UNESCO Institute for Statistics. (2012). *International Standard Classification of Education: ISCED 2011* UNESCO Institute for Statistics, Montreal.

Van Dijk J. A. G. M., Van Deursen A. J. A. M. (2014). *Digital skills: Unlocking the information society* Palgrave Macmillan, New York. DOI: 10.1057/9781137437037