

THE MISSING ECONOMICS OF RURAL CIRCULARITY: A COMPARATIVE BIBLIOMETRIC ANALYSIS OF CIRCULAR ECONOMY AND SUSTAINABLE RURAL DEVELOPMENT RESEARCH

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Abstract:

The circular economy (CE) in rural environments is a growing area of research, but its links to sustainable rural development literature are still being explored. This paper will utilize comparative science mapping methods to analyze three Web of Science corpora comprising 11,196 records retrieved for the 2000–2025 period on the topic of: circular economy and rural contexts (CE+R), sustainable development and rural contexts (SD+R), and their intersection (SD+CE+R). This study uses performance metrics and science mapping techniques to examine items such as publication trends, citation patterns, geographic distributions, international collaborations, and thematic developments. The SD+R corpus appears to be a well-established and internationally connected field of research; the CE+R corpus demonstrates rapid growth and has established itself primarily as a technical/environmental research area; and SD+CE+R corpus is relatively small and growing in its theme-based focus. Overall, the findings suggest that the integration of sustainable rural development and the circular economy is developing thematically more quickly than its collaborative and disciplinary research infrastructure. In comparing adjacent and overlapping research areas, this study identifies a long-standing economics gap in circular economy studies and emphasizes the importance of incorporating more business/economic/rural development related aspects in future circular economy studies.

Keywords: circular economy, sustainable development, rural areas, bibliometric analysis, research trends

JEL Classification: Q01, R11, O13

Received 30 March 2026; Accepted 17 June 2026

1. INTRODUCTION

Rural regions control an important amount of globally available natural resources and house 42.3% of the world's population (World Bank, 2024); in the EU, these regions are responsible for approximately 80% of the area and 30% of the population (Ciervo, 2024). As such, rural economic systems are heavily reliant upon traditional linear production methods, specifically within agriculture and extraction, that contribute to both environment degradation and social economic marginalization (Mihai, 2023). Circular Economy (CE) and Sustainable Development (SD) are therefore key drivers for reviving rural economies as the focus continues to expand on them as part of rural development strategies (Dabija, 2024). However, despite an increased EU policy attention to green diversification and bioeconomy (Münch et al., 2024; Ciervo, 2024), fragmented governance and technical capacity continue to hinder implementation, while rural SMEs continue to suffer from limited access to capital, infrastructure gaps and weak institutional support (Uvarova et al., 2020).

Our knowledge of the economic aspects of rural circularity is still far from complete. Despite the fact that many studies have described the application of circular technology, for instance, they have not explained how rural businesses can adapt their value proposition and create new revenue streams in response to pressures from the Circular Economy-Sustainable Development (CE-SD). Nevertheless, it remains unclear whether an inadequate economic dimension specifically limits rural circular economy research or if the limitations reflect a greater trend throughout Sustainable Rural Development scholarship. Existing bibliometric studies generally compare circular economy, sustainability, and/or rural development independently as separate areas of study and do not provide comparative information regarding the differences among discipline structure, geographic

distribution, and thematic structure of each area. Therefore, a comparative study is necessary to establish where rural circularity research fits into the larger body of work related to sustainable development as well as to identify those dimensions that currently remain inadequately covered by their intersection.

Within the context of the aforementioned considerations, the present research project seeks to answer the following research question: how are studies on rural circular economies different from other literature on sustainable rural development, with respect to the degree of scientific maturity, disciplinary position, geographic as well as collaborative configuration, and thematical expansion? To address this question, we have compared three overlapping Web of Science databases concerning studies about CE in rural areas (CE + R), SD in rural areas (SD + R) and the overlap of both fields (SD + CE + R).

This research makes two contributions. Firstly, to move beyond single-field bibliometric analyses through a comparative design which contrasts between a research area with high levels of maturity, a rapidly developing circular economy strand, and their emerging overlap. Secondly, through an analysis of the economic thematic gaps in rural CE-SD studies, the study will demonstrate the existence of persistent differences in the relative visibility of business, entrepreneurship, finance, ownership and value distribution throughout all the scholarly studies concerning the intellectual structure of the CE-SD field. In doing so, the study provides an evidence-based foundation for a more economically grounded research agenda on rural circularity.

2. MATERIAL-METHOD

This study employs a comparative bibliometric research design to identify the trends of circular economy and sustainable development studies in rural areas. In order to quantify scientific output and visualize interrelations within publication, country, and thematic research aspects bibliometric analysis will be employed. The methodology of this research is developed according to well-established methods for bibliometric analyses (Donthu et al., 2021) as well as previous examples of similar applications of this method in different types of sustainability research (Duarte & Carvalho, 2025).

3. BIBLIOMETRIC ANALYSIS

The data was collected from the Web of Science Core Collection (WoS), which is a multidisciplinary citation database with high quality indexing and wide range of disciplines (Clarivate, 2025; Duarte & Carvalho, 2025). Additionally, three search queries were created to cover all aspects of research at three different intersections of research as shown in Table 1.

Table 1. WoS Topic Search Queries

Query abbreviation	Search String	Results	Refined Results
CE+R	(TS=("circular economy")) AND TS=("rural" OR "rural development" OR "rural area*" OR "rural region*")	606	533
SD+R	(TS=("sustainable development")) AND TS=("rural" OR "rural development" OR "rural area*" OR "rural region*")	12,246	10,552
SD +CE +R	(TS=("sustainable development")) AND (TS=("circular economy")) AND		

Source: Own elaboration

Three separate data sets were built together into an overlapping analytical corpora rather than individual sample groups. As a result, the SD+CE+R dataset includes the overlap of the two search domain groupings: CE+R and SD+R. Thus, it will be included within each of these larger corpora. A correlation between data sets will not be assumed; instead, this analysis uses the three search levels to illustrate how the organization of the literature evolves from large-scale sustainable rural development research to more narrow research on the Rural Circular Economy, and then to the literature specifically addressing their intersection.

The time period covered in all searches includes articles from January 1st, 2000 through December 31st, 2025. The reason for choosing such a wide time span is to capture not only the initial theoretical debates as the field of CE emerged but also some of the most recent trends in the literature as CE has become more relevant to policymakers. In developing our search strings, we followed standard bibliometric best practices in terms of achieving semantic variations while maintaining lexical consistency. To achieve this balance, we employed truncation (*), to allow us to find variations of words, and TS (Topic Search) tags to allow us to find titles, abstracts and keywords. We also filtered by article and review type and language, English.

3.1 ANALYSIS TOOLS AND PROCEDURES

Two interlinked stages of analysis took place. In stage one, a bibliometric analysis based on the use of the RStudio software and the bibliography metric tool called "bibliometrix" was used to analyze the development of the corpus size, the sources that have contributed citations to the publications in this study, the collaborative links that are present in the studies represented by the publications included, and the overall level of scientific activity from countries participating as authors in publications. In stage two, a Science Mapping approach was used with the VOSviewer 1.6.20 software (Van Eck et al., 2005), to explore how countries are cited when referencing their research work, the levels at which researchers collaborate internationally, and the relationships among keywords and authors. Using full counting for all VOSviewer analyses provided each publication's contributions and each link in collaborations, because all three data sets are relatively small, i.e., CE+R and SD+CE+R. Therefore, using identical methods of analysis for each of these data sets enabled comparisons to be made regarding any potential structural differences between them.

4. RESULTS

The three databases exhibit different maturity characteristics (Table 2), namely that SD+R represents a fully developed global market (10,552 articles; 42 for h-index; 17.2 citations per article on average), whereas CE+R represents a rapidly growing technological sub-market (533 articles; h-index of 48; 16.9 citations per article on average) and finally SD+CE+R represents a new developing integrated sub-market (111 articles; h-index of 25; 16.8 citations per article on average).

Despite substantial differences in corpus size and average document age, the three research streams display remarkably similar average citation rates, indicating comparable citation visibility at the aggregate level.

Table 2. Comparative bibliometric characteristics of the three corpora

Description	CE+R	SD+R	SD+CE+R
CORE DATA			
Timespan	2011-2025	2000-2025	2011-2025
Sources	276	2445	79
Documents	533	10,552	111
Annual Growth Rate %	36.9%	18.3%	21.3%
Doc Avg Age	2.3 y	4.7 y	2.5 y
Avg citations per doc	16.88	17.22	16.81
Total References	37,154	615,852	8,469
Avg References per doc	69.7	58.4	76.3
KEYWORD INFORMATION			
Keywords Plus (ID)	1,336	9,248	370
Author's Keywords (DE)	1,915	23,145	430
AUTHORS			
Authors	2,212	30,821	466
Single authors	26	1,116	6
AUTHORS COLLABORATION			

Single-authored docs	29	1,193	7
Co-authors per doc	4.44	3.97	4.27
International co-authorships %	34.5%	31.7%	30.6%
DOCUMENT TYPES			
Article	528	10,383	111
Review	5	169	-

Source: Own elaboration using data from Web of Science Core Collection

The country-level distribution of scientific production reveals three geographic patterns across the corpora (Table 3). First, CE+R is mainly European-concentrated (China 14.1%, Italy 13.3%, Spain 12.2%- together 39.6%), with strong alignment to EU circular economy policy frameworks and limited representation from low-income and post-socialist contexts. Second, SD+R is genuinely global (180 countries, China 29.7%, USA 10.4%, India 7.4%), reflecting the broader institutional reach of the SDG framework. Third, SD+CE+R spans only 45 countries- with Italy, Spain, and China again leading, confirming that the integrated CE-SD research community remains geographically closer to CE+R than to the broader SD+R field. Overall, the geographic structure indicates that evidence at the CE–SD–rural intersection remains concentrated in a limited number of predominantly European and Asian research contexts.

Table 3. Comparative country-level scientific production across the three corpora

Dimension	Query		
	CE+R	SD+R	SD+CE+R
Total Countries	97	180	45
Top contributors	China (14.1%) Italy (13.3%) Spain (12.2%)	China (29.7%) USA (10.4%) India (7.4%)	China (17.1%) Italy (13.5%) Spain (12.6%)
Share of top 3 countries	39.6%	47.5%	43.2%

Source: Own elaboration using data from Web of Science Core Collection

4.1 KEYWORD CO-OCCURRENCE ANALYSIS

Keyword co-occurrence analysis mapped the thematic evolution of each corpus using author-keyword co-occurrence, with minimum frequency thresholds adapted to corpus size (CE+R = 4; SD+R = 30; SD+CE+R = 2). Synonyms were normalised and search-defining terms excluded. Major policy milestones, including the 2015 SDG adoption, the 2015 and 2020 EU Circular Economy Action Plans, and the 2019 European Green Deal, were used solely as interpretive context for temporal boundaries and not as evidence of causal influence.

The temporal evolution of keyword co-occurrence reveals distinct thematic trajectories across the three corpora. CE+R develops from a sparse conceptual structure in 2011–2018, centred primarily on the circular economy–sustainability relationship, toward an operational vocabulary of waste management, recycling, biogas, and life-cycle assessment in 2019–2022. By 2023–2025 these themes have converged into a wider biocircular cluster that includes bioeconomy; anaerobic digestion, composting and waste valorisation. The link between CE and sustainability becomes more prominent than the earlier linkage between CE and waste management. This indicates extension of rural CE research beyond waste-oriented applications to a broader sustainability framing. SD + R follows a different trajectory: governance, agriculture, poverty, food security and ecosystem services remain stable theme hubs, while the SDGs and laterally rural revitalization increased the field's vocabulary of interdisciplinary frameworks. At the CE+SD+R interface, the keyword structures combine with CE-derived themes including waste management, bioeconomy and life cycle assessment with SD-oriented themes including the SDGs, food security and agriculture. The emergence after 2021 of a distinguished bioeconomy-food security-agriculture cluster indicates increasing thematical

integration however the vocabulary is mainly sectoral/environmental rather than explicitly economic. These temporal pattern provide the theme context for subsequent network analysis which will analyse how intellectual influence and international collaboration are distributed across three research streams.

4.2 NETWORK ANALYSIS

Country-Level Citation Network

Through country-level citation networks, a comparison of the total link strengths for the three databases reveals a significant difference in the amount of intellectual integration in their respective citation structures (see Table 4, Figures 1–3). Total Link Strength (TLS) is an indicator of how much citation activity occurs among all citations originating from one or multiple authors. The TLS values for these three citation systems vary significantly. For example, Spain is the best-connected country in CE+R (with a TLS value of 80) while Italy has a TLS value of 48 and China a TLS value of 32. Despite China's larger number of publications relative to the other two countries, the TLS values indicate that Spain and Italy are better connected to other researchers than China. Therefore, although China publishes the most on CE+R, it does not hold as strong of a central position as Spain or Italy in the citation structure of CE+R. Poland, Romania, Germany, France, Portugal and Greece are also visible within this citation structure, supporting the notion that European researchers have a stronger connection to the intellectual structure represented by CE+R than Chinese researchers.

Table 4. Top five countries by total link strength in country-level citation networks

Ranking	Country (TLS)		
	CE+R	SD+R	SD+CE+R
1	Spain (80)	China (4564)	Italy (4)
2	Italy (48)	USA (2677)	Spain (4)
3	China (32)	UK (2387)	USA (2)
4	UK (29)	Australia (1599)	China (1)
5	Finland (27)	India (1101)	India (1)

Source: Own elaboration using data from Web of Science Core Collection

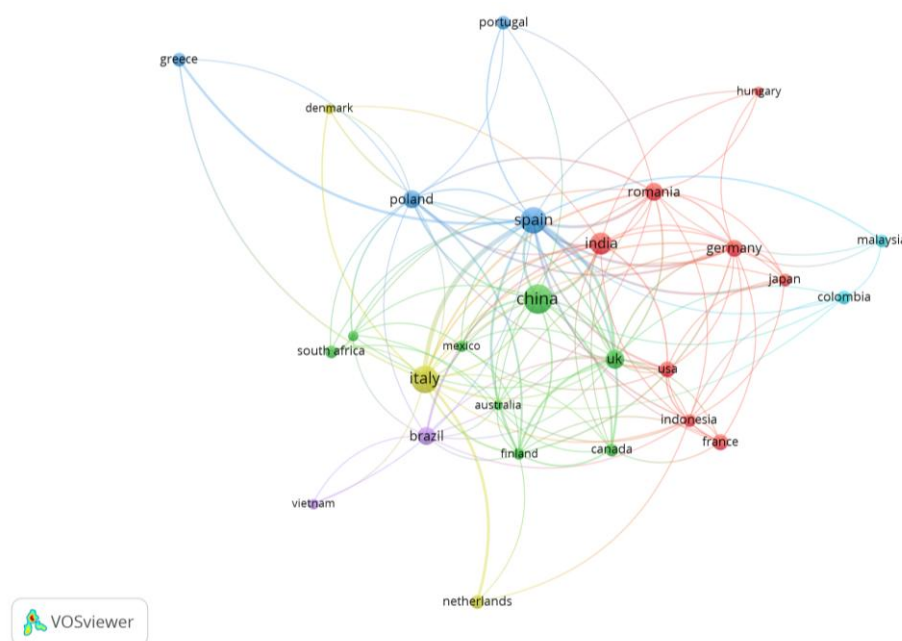


Figure 1. Country-level citation network: CE and Rural

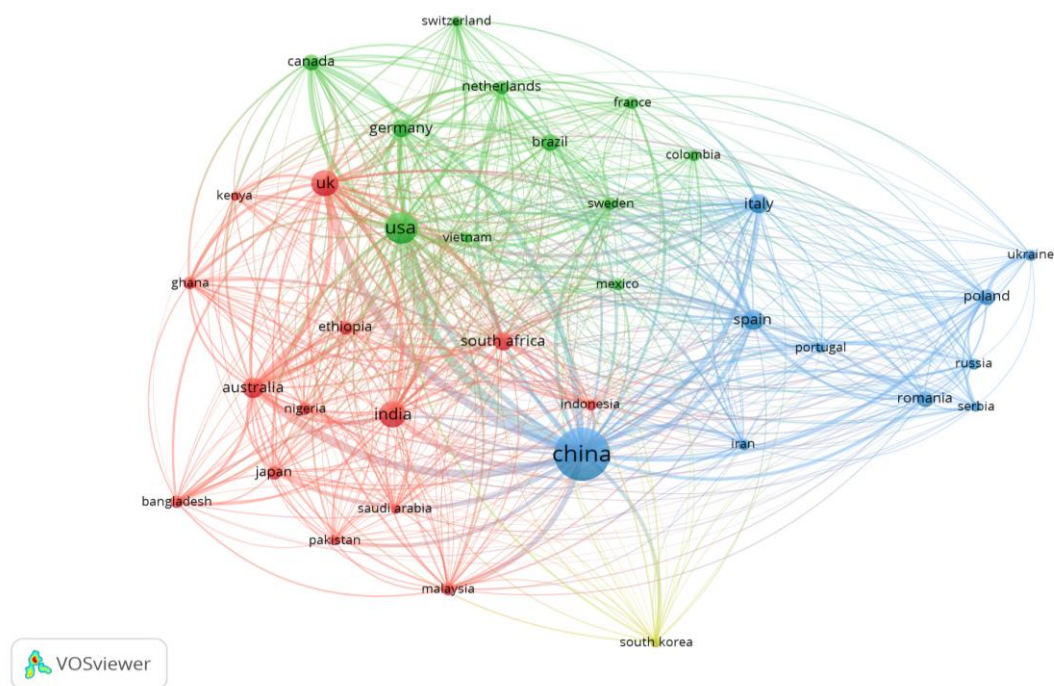


Figure 2. Country-level citation network: SD and Rural



Figure 3. Country-level citation network: CE-SD-Rural Intersection

Source: Own elaboration using data from Web of Science Core Collection

The SD+R network is much more dense and is also far more internationalized. Of the five nations identified in this study, China reports the highest number of TLS (4,564) followed by the United States (2,677), the UK (2,387), Australia (1,599), and India (1,101). These numbers represent many orders of magnitude greater than the TLS reported for the CE+R and SD+R networks and indicate strong linkages across research systems on every continent. Given that sustainable rural development represents a mature field of international research with multiple centers of innovation, it would be expected that the internationalization of this field would result in a similarly complex citation structure. It should be noted that the Chinese presence within the SD+R network does not appear to be limited to acting as a single high output node, and rather appears to have been actively engaged in creating a more integrated global knowledge structure than what might be suggested solely based upon publication counts.

In contrast to the SD+R network, the SD+CE+R network continues to exhibit sparsity. Among the countries included in the study, Italy and Spain report the largest TLS values at four each, while the U.S.A., China, and India all report one. While the reduction in overall citations is a notable aspect of these results, so too is the sharp decline in interconnectivity. This is important because there exists a large body of literature referencing the international nature of citation relationships among the components of the larger SD+R corpus. Rather than being associated with the wide geographic dispersion of researchers represented by the SD+R framework, the citation structure displayed by the SD+CE+R network is much closer to that of the small geographic concentration of researchers working within the CE+R framework. Thus, taken collectively, these findings suggest that although a considerable amount of research has been conducted at or near the intersection of CE and SD-rural development, it has not yet resulted in either intellectual or structural convergence between the two. Consequently, these data provide further evidence supporting the papers central assertion that

although CE is becoming increasingly embedded within rural development research, its incorporation into this research area is highly selective and is still largely driven by the technological/environmental roots out of which rural-based CE research originated.

4.3 INTERNATIONAL CO-AUTHORSHIP NETWORK ANALYSIS

International co-authorship patterns provide a complementary measure of field consolidation (Table 5). The mature SD+R corpus is characterised by extensive cross-border collaboration, with the USA recording the highest co-authorship TLS (1,057), followed by China (866), the UK (807), Australia (483), and India (389). CE+R presents a smaller but identifiable international collaboration core centred on Spain (TLS = 50), Italy (47), and China (44), with France (30) and the UK (28) occupying additional connecting positions. The correspondence between countries with high citation connectivity and those with strong co-authorship links suggests that the intellectual influence of CE+R is partly embedded in established international research relationships, particularly within European research networks. The coexistence of relatively high rates of international co-authorship and weak network connectivity suggests that collaboration is occurring, but has not yet generated the cumulative knowledge structures characteristic of more mature research fields.

Table 5. Top five countries by total link strength in international co-authorship networks

Ranking	Country (TLS)		
	CE+R	SD+R	SD+CE+R
1	Spain (50)	USA (1057)	China (5)
2	Italy (47)	China (866)	USA (4)
3	China (44)	UK (807)	India (3)
4	France (30)	Australia (483)	Romania (1)
5	UK (28)	India (389)	Spain (1)

Source: Own elaboration using data from Web of Science Core Collection

The pattern changes substantially in SD+CE+R. China records the highest co-authorship TLS at only 5, followed by the USA (4) and India (3), while Romania and Spain each record a TLS of 1. Although international co-authorship represents 30.6% of publications in this corpus, close to the shares observed in CE+R (34.5%) and SD+R (31.7%), the very low network connectivity indicates that these collaborations have not yet developed into a stable, interconnected research community. This distinction between the share of internationally co-authored publications and the structural strength of the collaboration network is important: international collaboration is present, but remains dispersed across weakly connected partnerships. Taken together with the citation evidence, the findings suggest that thematic integration between circular economy and sustainable rural development has advanced more rapidly than the formation of a consolidated international research community capable of sustaining cumulative and comparative inquiry.

4.4 INTEGRATED KEYWORD NETWORK ANALYSIS

The keyword co-occurrence network (Figure 4) provides a structural view of the conceptual relationships underpinning the integrated research landscape. The network is organised around two dominant hubs, circular economy and sustainable development, but their positions and surrounding clusters indicate that the relationship between the two concepts remains mediated primarily through technical and sectoral themes rather than through an established business or economics vocabulary. The largest hub seen in Figure 4, circular economy, connects strongly with sustainable development goals, sustainability, solid waste, recycling, resource efficiency, and rural communities. This cluster reflects a resource-management and environmental-efficiency framing of rural circularity. The strong visual links between circular economy, the SDGs and resource-efficiency concepts indicate that CE is increasingly positioned as an implementation pathway for sustainability objectives. However,

terms directly associated with value capture, ownership, financing or business models do not occupy comparable central positions in the network.

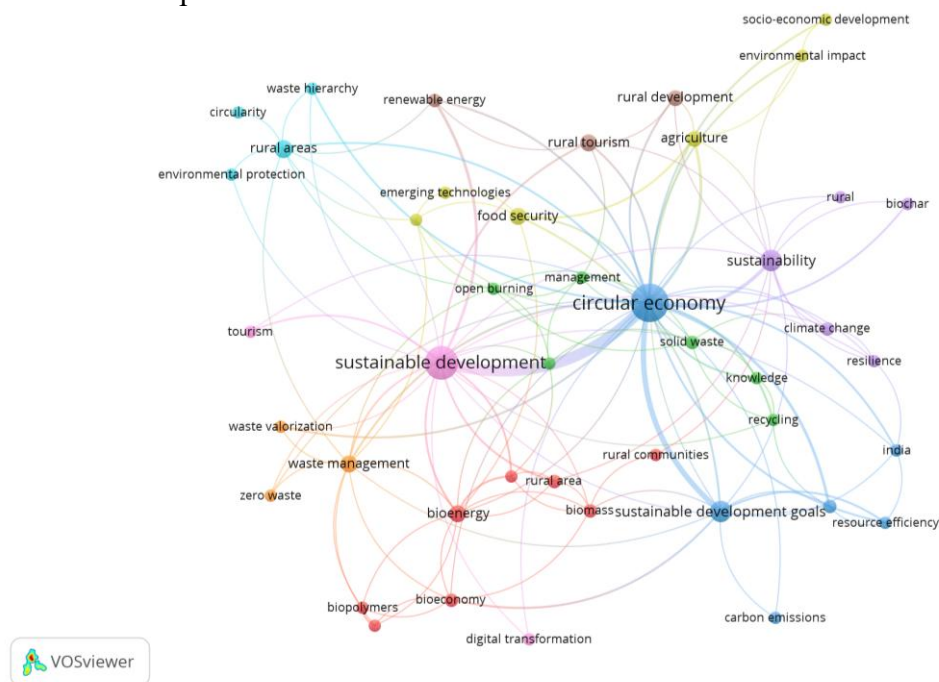


Figure 4. Keywords co-occurrence using VOSviewer

Source: Own elaboration using data from Web of Science Core Collection

A second major structure is organised around sustainable development, with connections to bioenergy, biomass, waste management, waste valorization, rural area, and digital transformation. This cluster reflects the growing integration of rural resource conversion and development-oriented research. The proximity of bioenergy and biomass to both sustainable development and circular economy confirms that biocircular resource conversion constitutes one of the principal conceptual bridges between the two research streams.

A further cluster links agriculture, food security, rural development, and rural tourism. Its position between the circular economy and sustainable development hubs suggests that agri-food and territorial development themes provide a second pathway through which CE and SD are integrated in rural research. Nevertheless, the network remains conceptually anchored in sectoral terms such as agriculture and food security rather than in explicit economic concepts such as bargaining power, market-making or value distribution.

Overall, the keyword network reinforces the comparative evidence of an economics gap in rural circularity research. The dominant conceptual bridges between circular economy and sustainable development are bioenergy, biomass, waste valorisation, agriculture, and food security. By contrast, ownership, financing, transaction costs, bargaining power, intermediation, and value distribution do not emerge as central nodes. These omissions show that economic processes have not yet become structurally visible within the field's dominant vocabulary, not that they are trivial to rural circularity.

5. DISCUSSIONS

It can be shown from comparative analyses that limited visibility of economics in rural circularity research does not result solely due to a lack of size in the SD + CE + R Corpus. As evidence will show from publication outlets, research areas, citation patterns, and keyword networks there is a greater structural issue of discipline. CE + R has grown very quickly; however, its intellectual growth continues to be highly linked with environmental sciences, environmental engineering, waste management, the bioeconomy and efficiency of resources. In contrast, the SD + R research area is significantly more developed and has international connections, yet business models,

entrepreneurship and explicit economic mechanisms continue to be poorly represented in the thematic structure of the most dominant themes in SD + R.

Therefore, when developing a new niche (SD + CE + R) it takes on attributes from both established research areas, but does so without having integrated their economic aspects. Citations indicate that the niche draws more heavily upon CE research than upon the larger and more mature SD + R knowledge base. Keywords provide further support for this finding by showing that the circular economy and sustainable development are becoming more closely tied through agricultural, bioeconomic, waste, and resource management concepts. However, keywords related to ownership, finance, capturing value, market organization, and business models continue to be peripheral. Therefore, the missing economics of rural circularity is apparent at multiple levels of bibliometrics, rather than being confined to one level.

Consequently, these findings present challenges and opportunities regarding the continued development of the field. An economics-focused research stream that builds upon the technical and environmental foundations of rural CE research could enhance understanding of how circular solutions are organized, funded, adopted and converted to locally retained economic value. Also, increased collaboration between rural economics/entrepreneurship/business/innovation researchers could increase the diversity of publications and collaborations within the SD + CE + R niche. Comparative empirical studies across various rural settings would help to identify if the currently preferred themes represent universal features of rural circular transitions or merely geographic concentrations of current literature.

Moreover, the comparative design clearly illustrates the benefits of analysing neighbouring research corpora (i.e., studying an emerging research area in conjunction with other research areas). If only SD + CE + R were analysed independently, then the technical focus of this research area may have been attributed solely to immaturity of the literature. Rather than viewing SD + CE + R in isolation, comparison with CE + R and SD + R indicates that the gap in economics is part of broader disciplinary trajectories and becomes evident at intersections where circular economy meets sustainable rural development.

Limitations

The results of this study are subject to several limiting factors that will have to be taken into consideration when they are interpreted. Firstly, the research is restricted to the Web of Science Core Collection (WoS) and excludes other databases such as Scopus, EBSCO, as well as practitioner-oriented research and non-English language research. Secondly, since the three analytical datasets were developed from each other, comparisons made between the datasets are at best structural and descriptive, rather than based on statistically independent samples. Thirdly, bibliometrics and keyword co-occurrences can show how researchers perceive an area of knowledge through their published papers, but they do not measure the actual performance of economic practices of circular businesses nor assess the efficiency of particular policies and funding mechanisms. Finally, as most of the studies included in the datasets come from European and some Asian countries (research communities), the themes identified in these studies may not apply to lower income and less represented rural areas.

6. CONCLUSIONS

This study compared three overlapping Web of Science corpora comprising 11,196 retrieved records to examine how rural circular economy scholarship is positioned within the broader sustainable rural development literature. The results identify three distinct maturity profiles: a mature and globally distributed SD+R field, a rapidly expanding but predominantly technical CE+R stream, and a small emerging SD+CE+R intersection.

While all three of the distinct structural forms of transition research contained some level of commonality across the different types of scholarly work that each represent, there was also a clear gap in the field of economics observable when comparing publications by type of outlet and thematic network structure. Environmental science, engineering, sustainability and technical resource

management perspectives have dominated both the journals publishing these studies and the thematic networks connecting them together, while business model innovation, entrepreneurial processes, financial mechanisms, ownership structures and value distributions remain underdeveloped. In addition, the SD+CE+R intersectional niche appears to be drawing upon Circular Economy scholarship more than the established Sustainable Rural Development body of knowledge and developing thematic interlinkages more quickly than it is creating stable international collaborative structures.

Thus, the evidence suggests that the next phase of research will require greater collaboration between Economics/Business/Rural Development scholars and researchers examining rural circular transitions. It is impossible to understand why or how circular practices are being implemented financially/organisationally/economically in rural communities based on technical feasibility alone. As such, by using comparative performance analysis and science mapping to locate this gap in the published literature, this study provides a basis for future research on the economic organization of rural circular transitions.

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