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EDITORIAL

Cross-border regional innovation systems: concepts, approaches and perspectives

Ben Derudder[a,b,c] and Xueqing Liu[b]

ABSTRACT

We present and review a collection of *Regional Studies* papers that jointly portray the evolving literature on cross-border regional innovation systems. We clarify the scope of this research agenda and then use it to reflect on possible future directions by specifying the main conceptual and empirical developments encapsulated by these papers. We argue that this literature has predominantly focused on three different dimensions: (1) the theoretical basis and conceptual specifics of cross-border regional innovation systems; (2) analytical approaches to examine the nature and dynamics of cross-regional innovation; and (3) geographical diversities and place-based contexts in cross-border innovation systems. Even though the literature has geographically diversified in empirical terms, theoretical contextualisation in varied socio-economic and geographical settings remains a work in progress.

KEYWORDS

cross-border; cross-border regional innovation system; dynamics

1. CROSS-BORDER REGIONAL INNOVATION SYSTEM (CBRIS): A DEVELOPING FIELD OF RESEARCH

Innovation research has received much attention in regional studies, not least in light of its growing importance for producing new knowledge and economic growth (Cooke, 2008). Much of this research has been conducted from the perspective of regional innovation systems (RISs), highlighting the crucial importance of spatial proximity and institutional structures for innovation, such as knowledge generation and diffusion (Trippl, 2010). Recognising that RISs often involve cross-border contexts spanning different nation-states (Lundquist & Trippl, 2013, in this collection; Trippl, 2010) or administrative territories (Chandra et al., 2023, in this collection; Wang et al., 2021) has led to the coining of the term 'cross-border regional innovation systems (CBRIS)' (Trippl, 2010).

The CBRIS concept has emerged in the literature through discourses highlighting the need for broadening and deepening our understanding of regional innovation dynamics across borders – whatever these 'borders' are or represent. CBRIS are not only a relevant topic of interest because they 'exist': it is suggested that they become increasingly salient due to the increasing dependencies of regions on their ability to foster cooperative linkages and economic interactions with neighbouring territories (Lundquist & Trippl, 2013, in this collection). The interdependence of innovation activities across borders is also commonly highlighted by policymakers (European Commission, 2017; Organisation for Economic Co-operation and Development (OECD), 2013), showing the critical role of CBRIS both as an analytical framework to capture empirical realities as well as their role as normative visions aimed at fostering innovation (Asheim & Coenen, 2006). In general terms, the development of CBRIS emphasises the potential of strengthening technology and innovation across borders by leveraging regional complementarities and integration efforts (Lundquist & Trippl, 2013, in this collection).

The emergence of CBRIS in academic publications and policy memoranda is summarised in this virtual collection: we selected 12 papers dealing with CBRIS research previously published in this journal. Our selection is based on a systematic search for *Regional Studies* articles related to the keyword (i.e., cross-border innovation), after which we applied several overlapping criteria for inclusion: influence in past scholarly discussions, recent advancements in the field, and geographical and

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methodological diversity. This collection of articles thus represents a cross-section of the state-of-the-art, including foundational texts such as Boschma's (2005, in this collection) discussion of the different dimensions of proximity and the seminal work by Lundquist and Trippl (2013, in this collection) on CBRIS themselves, alongside papers that represent theoretical, analytical and empirical developments. Collectively, these 12 articles provide a diverse array of perspectives crucial to understanding the concept's evolution.

The remainder of this accompanying editorial starts from the observation that CBRIS research has broadly centred on three topics: (1) the theoretical basis and conceptual specifics of CBRISs; (2) analytical approaches to examine the dynamics of cross-regional innovation; and (3) and geographical diversities and place-based contexts in cross-border innovation systems. Our references to these articles are organised around these themes, offering a synthesis from theoretical underpinnings and empirically grounded evidence to avenues for future research.

2. THEORETICAL ANTECEDENTS AND CONCEPTUAL DEVELOPMENT

The conceptual starting point of CBRIS research is itself rooted in the broader literature on 'proximity' (Boschma, 2005, in this collection). This literature explores how various forms of proximity – geographical and relational – explain regions' cooperation and innovation performance. Relational proximity serves as an umbrella term for a range of non-spatial proximities, including cognitive, cultural, institutional, social, organisational and technological proximity (Boschma, 2005, in this collection; Makkonen & Rohde, 2016). A second critical conceptual building block of the CBRIS literature is 'related variety' (Lundquist & Trippl, 2013, in this collection; Trippl, 2010), as it focuses on the 'optimal' amount of cognitive proximity between regions for fostering innovation and synergies (Makkonen & Rohde, 2016).

The term 'CBRIS' was initially coined by Trippl (2010), who proposed a research agenda focusing on cross-border regions' long-term innovative and competitive strength (Makkonen & Rohde, 2016). One of the key dimensions of CBRIS obviously involves clarifying the nature of a 'regional border'. This can obviously include adjacent territories, such as San Diego–Tijuana (Cappellano & Makkonen, 2020) and Lower Silesia–Saxony (Knippschild & Vock, 2017, in this collection), but also at much larger scales, encompassing transnational regions, such as the Northern periphery of Europe (Mikko et al., 2022, in this collection) and across EU-27 countries (Quatraro & Usai, 2017, in this collection). Importantly, borders are 'open and fuzzy' (Zhao et al., 2024, in this collection): they are not confined to political–administrative boundaries in the strict sense, but can also, in varying ways, have economic, cultural and social dimensions, as exemplified by the borders visible in economic and institutional structures within the Hong Kong–Shenzhen region (Chandra et al., 2023, in this collection).

The presence of different forms of borders implies differences, inequalities, and fragmentation in socio-economic dynamics and institutional set-ups across regions, highlighting the potential of CBRIS to dismantle the potential innovation barriers by enhancing the exchange of goods and knowledge, labour mobility and direct investments (Trippl, 2010).

Expanding the geographical scope of regional innovation dynamics, the conceptual underpinnings of the CBRIS are built on the theoretical work on RIS (Cooke, 2008; Trippl, 2010), where five critical constituent elements or subsystems (referred to as 'dimensions' by Trippl, 2010) are identified: (1) knowledge generation and diffusion, including research institutes, educational bodies and technology-transfer organisations; (2) knowledge application and exploitation comprising the companies and clusters within the region; (3) cross-regional linkages/flows of knowledge, resources and human capital; (4) regional policy, including public authorities and policies; and (5) socio-cultural and institutional settings. This conceptual model was further refined by Lundquist and Trippl (2013, in this collection) who added 'accessibility' to the typology of CBRIS to emphasise the degree of physical proximity and further discussed the different stages of CBRIS in terms of innovation-driven integration. More recent studies have expanded the framework to include 'resilience' and 'ecosystem' to reflect its evolving conceptual complexity: the ecological characteristics of openness, synergy and symbiosis in the process of innovation (Cappellano & Makkonen, 2020; Korhonen et al., 2021; Zhao et al., 2024). In essence, the emergence of CBRIS and the evaluation of cross-border innovation performance are primarily determined by specific 'dimensions' – either individually or through their interplay. For example, Quatraro and Usai (2017, in this collection) and Chandra et al. (2023, in this collection) analysed the development of CBRIS through knowledge diffusion and cross-regional collaboration linkages, respectively. Knippschild and Vock (2017, in this collection) and Rodríguez-García et al. (2024, in this collection) explored the role of cross-border cooperation in driving the emergence of CBRIS.

3. LEARNING FROM CBRIS STUDIES: ANALYTICAL INSIGHTS

Translating the conceptual frames of CBRIS into empirical evidence, the literature has seen the development of a range of analytical approaches. This virtual collection shows that empirical studies have used diverse datasets and a blend of qualitative and/or quantitative methods to offer empirical insights, particularly for the evaluation of the performance of cross-border innovation in terms of the key CBRI subsystem(s).

Several studies have employed qualitative methods to evaluate the performance and efficacy of projects or policies related to CBRIS. For example, Knippschild and Vock (2017, in this collection) evaluated the conformance and performance of cross-border cooperation projects by

giving equal weight to project achievements, activities and learning effects. Their impact analysis elucidated the cooperation mechanism through the transnational exchange of ideas and sharing of experiences, highlighting the potential of the collective innovation knowledge base in fostering cross-border cooperation. Similarly, Rodríguez-García et al. (2024, in this collection) conducted action research that combines systematic enquiry with practical action to evaluate start-up support policies of a cross-border pilot project. Their rich qualitative data, including direct observations and documentary evidence, revealed the practical challenges of implementing cross-border innovation policies. By actively involving practitioners and organisational members, their study enhances the understanding of how targeted entrepreneurship policies help leverage resources to foster cross-border collaborations.

Another strand of research has explored the dynamics of CBRIS through the lens of quantitative analysis using various methods and datasets. Employing patent-based datasets, for example, Quatraro and Usai (2017, in this collection) analysed the dynamics of co-inventorship, applicant–inventor relationships and citation flows. Their application of a gravity model revealed the impact of distance, contiguity and proximity on these different types of cross-regional knowledge flows. Similarly, Chandra et al. (2023, in this collection) employed data from university–industry co-publications, co-patents and investments to perform comparative statistical analyses. This study highlighted the potential of a diverse knowledge base in influencing the distribution of benefits from cross-border collaborations. Some studies performed research and development (R&D)-focused analyses to reveal cross-border innovation dynamics. For example, Rodríguez-Pose and Crescenzi (2008, in this collection) conducted a multiple regression analysis to demonstrate the importance of cross-border R&D investment and associated knowledge spillovers in driving economic growth. Using a related approach, Belderbos and Somers (2015, in this collection) examined the relationships between organisations and inward R&D investments in cross-border projects. Drawing on an unsupervised machine-learning technique, Mikko et al. (2022, in this collection) presented a text-mining method to identify similar topics in publications of universities and research institutes, which revealed the cross-border innovation performance and cooperation potential between knowledge producers.

By combining a survey, a pilot study and quantitative analysis, Huber (2003, in this collection) collected data from a questionnaire among Austrian firms about cooperation with their partners in the European Union (EU). They combined the data with a multinomial logit model and offered a comprehensive understanding of cross-border cooperation: the importance of distance, sizes and experiences in the forms of cooperation (e.g., ownership, incentive contract or business relations). Similarly, Chang (2009, in this collection) conducted a postal questionnaire survey of biotechnology firms and integrated

circuits firms across the UK and Taiwan, marshalling data on firms' knowledge links and innovative activities. Analysing the spatial knowledge flows between firms through logistic regression, this study revealed the relationship between cross-regional knowledge linkages and innovation performance that contributes to understanding CBRI subsystems. Similarly, Natalicchio et al. (2022, in this collection) proposed several indicators based on patent portfolio analysis, such as the weighted number of patents and their citations, to assess the technological innovation capabilities across EU regions. Complementary pilot studies were conducted in four EU regions, providing a practical evaluation of the feasibility and effectiveness of the indicators for explaining the knowledge generation and exploitation subsystem of CBRIS. These mixed-method approaches, integrating both qualitative and quantitative data collection and research methods, enhance the breadth of CBRIS analyses by synthesising case-oriented observations with statistical evidence. However, caution is required in employing mixed methods, as they may introduce additional complexity: qualitative and quantitative methods are sometimes 'conditionally' complementary (Maynard & Schaeffer, 2000) and may not always yield mutually informative results.

4. GEOGRAPHICAL DIVERSITIES AND PLACE-SPECIFIC CONTEXTS

The open and often fuzzy nature of 'regional borders' has introduced further diversity into CBRIS research, as evidenced by the variety of empirical contexts within/across different parts of the world. For example, recent evidence of cross-border innovation cooperation was observed in the binational San Diego–Tijuana region at the US–Mexico border region (Cappellano & Makkonen, 2020). Conducting a comparative case study of the knowledge links in the UK and Taiwan, Chang (2009, in this collection) found that cross-border knowledge linkages can improve firms' innovative performance and technological innovation potential, especially when regional and national innovation potential is relatively weak. Similarly, Chandra et al. (2023, in this collection) examined the cross-border collaboration and the associated asymmetric benefits of attracting technology and financial resources in the Hong Kong–Shenzhen region. Their analysis highlights the crucial role of universities in leveraging cross-border (asymmetric) knowledge and technology exchanges.

Scholarly attention to the growing importance of cross-border innovation also brought diverse empirical evidence on CBRIS in the (different parts of) European regions. This diversity is evident in this collection, where the geographical scopes range from specific cross-border regions to pan-European analyses. For example, Knippschild and Vock (2017, in this collection) analysed the performance of a territorial cooperation project in Borderland Lower Silesia–Saxony. Their results revealed that interactions of the societal culture, the planning system and the location-specific planning practice can influence the adoption of cross-border innovative approaches. Similarly,

Rodríguez-García et al. (2024, in this collection) examined business start-up support policies in the Galicia–Northern Portugal region. Their analysis identified potential challenges in applying these policies (e.g., culture, cooperation traditions and language) within European border areas.

In addition, several papers in this collection focus on the larger scale of transnational regions. For example, Mikko et al. (2022, in this collection) analysed the evolutions of CBRIS in the Northern periphery of Europe – more specifically, Arctic Scandinavia – through thematic cross-border research domains across space and disciplines. Meanwhile, Huber (2003, in this collection) examined the collaborative relations of Austrian firms with Central and Eastern European partners. These studies highlight how specific geographical areas and focused cross-regional collaborations play crucial roles in the development of CBRIS. More broadly, several studies analysed cross-border collaboration across various groups of European countries, such as the EU-15 countries (Belderbos & Somers, 2015, in this collection), the EU-25 countries (Rodríguez-Pose & Crescenzi, 2008, in this collection) and EU-27 countries, along with Norway and Switzerland (Quatraro & Usai, 2017, in this collection). These studies discussed the implications of integrating innovation efforts and facilitating the development of CBRIS on a larger scale and offered general strategies adaptable to various contexts.

Envisaged as a 'bottom-up' initiative, the Smart Specialisation Strategy (S3) has been recognised as part of the emerging agenda of identifying the potential for CBRIS in European regions (McCann & Ortega-Argilés, 2011). Mikko et al. (2022, in this collection), for example, analysed the S3 in Northern Europe to reflect cross-regional innovation initiatives and collaboration domains, thereby acting as decision support to facilitate the development of CBRIS. Similarly, Natalicchio et al. (2022, in this collection) identified technological competitive advantages in pilot regions, aiming to reveal the potential for knowledge exchange and recombination across European regions. These tailored strategies, focusing on region-specific contexts, represent prioritised agendas for supporting cross-border innovation and broad European Cohesion policy (McCann & Ortega-Argilés, 2011).

5. FUTURE DIRECTIONS OF CBRIS STUDIES

Collectively, the papers in this virtual collection demonstrate the ongoing value of exploring CBRIS and their dynamics, particularly their ability to create cooperative ties and economic interactions across borders (Lundquist & Trippl, 2013, in this collection). Nevertheless, much work remains to be done. Ongoing challenges are associated with the fuzziness of proximity and border definitions, as well as the complexity resulting from the multiple subsystems of CBRIS. In addition, comparing results across different contexts remains challenging because of the broad range of place-specific factors, including economic and institutional structures. The development of CBRIS is a prime example of 'no size fits all', as it is also determined by the stakeholders within their respective national and/or regional development priorities (Korhonen et al., 2021). There are, therefore, even more so than in other regional studies literatures, issues of generalisability, reproducibility and replicability in CBRIS studies (Brunsdon, 2016).

Future research could address some of these challenges. Based on this retrospective analysis, in our view there are at least three pertinent areas for further development: (1) advancing conceptual understanding of dynamics and integrated views on different proximities and border discourses; (2) translating the conceptual frames of CBRIS into a more diverse empirical exploration of different subsystems and their interplays; and (3) improving the presently limited levels of replicability of research. The proposed research agenda outlines the cornerstones of analytical lenses essential for the conceptual advancements and empirical validation of the CBRIS framework. It may also guide future research on mechanisms and processes underpinning the development of CBRIS through in-depth case studies to advance our understanding of the cross-border innovation dynamics.

One final reflection pertains to the 'geographies' of CBRIS dynamics. Although the CBRIS literature has geographically diversified, our review of earlier papers reveals that much of the empirical knowledge base is European. Echoing Roy's (2009) critique on the dominance of theoretical work in urban and regional studies rooted in Euro-American experiences, this empirical focus risks spilling over into the concept's theoretical and analytical remit. Crucially, then, calls to diversify the CBRIS empirical knowledge base are much more than that: exactly because CBRIS are so place and context specific, this empirical knowledge base risks shaping the theoretical and analytical scope of the research agendas (Lundquist & Trippl, 2013, in this collection). As a result, the increased use of the concept raises the stakes of properly contextualising CBRIS within varied socio-economic and geographical settings. Future dialogue could more explicitly focus on how comparative insights can enhance our understanding of cross-border 'regionalisation': understanding how cross-border regional innovation and cooperation evolve in response to internal (i.e., local and regional) and external (i.e., national and global) dynamics (Cruz & Teixeira, 2010; Scott, 1999).

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