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ORIGINAL PAPER

# Revisiting cluster organizations as drivers of public-private cooperation in Central and Eastern Europe

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**Abstract** Central and Eastern Europe continue to generate incremental innovations, slow rates of technology commercialization, and exhibit limited public-private collaboration in research and development. This paper examines the role of cluster organizations as intermediaries, particularly in bridging the knowledge transfer gap between industry and research. Employing qualitative comparative analysis methodology, this exploratory paper highlights the conditions that foster industry-driven collaboration. As a mixed research method that is novel to cluster research, it provides a fresh perspective on how companies establish and maintain connections with research centers. The analysis investigates the associations between the hindering and facilitating factors of cooperation within cluster organizations (conditions) and the prevalence of business-initiated collaboration with research organizations (outcome). The results indicate that structural, socio-behavioral and power dynamics factors influence the patterns of cooperation between these two types of actors. However, to contribute to the advancement and continuity of these relationships, intermediary actors should prioritize addressing the power imbalances to secure strategic cooper-

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ation that can lead to regional structural and systemic transformations. The results provide evidence for policy implications, emphasizing the importance of simplifying early-stage technology transfer procedures and reducing administrative obstacles to enhance clusters' mediator role in an innovation system.

**Keywords** Cluster organizations · Industry · Research organizations · Fuzzy set Qualitative Comparative Analysis · Innovation collaboration

## 1 Introduction

Intersectoral cooperation between public agents and private companies is a widely discussed topic in numerous fields. Recognizing this phenomenon's importance, interest in understanding its conditions and aspects of public and private cooperation has risen (Stojčić 2021; Vivona et al. 2023). This is especially the case for developing regions in Europe, which suffer from underdeveloped and lacking regional innovation systems (RIS). These regions, primarily in Central and Eastern Europe (CEE), face numerous structural shortcomings and collaborative weaknesses (Radosevic 1999; Kravtsova and Radosevic 2012), which could be addressed through increased efforts in public-private collaboration and joint innovation. Countries in CEE have increasingly adopted policies that promote research and development (R&D), technology transfer, and cooperation between public and private sectors through intermediary organizations. Despite some successes in developing RIS, the CEE macro-region faces unique challenges, including historical legacies of centralized planning, lower levels of R&D investment in comparison to Western Europe, and gaps in innovation systems (Radosevic 1999). Thus, cluster organizations (CO) became platforms to address some of the key challenges to innovation, such as fragmented industries, insufficient linkages between academia and industry, and others (Pavelková et al. 2019).

It is worth noting that CO represent unique settings where both types of actors meet and interact. Their management is typically responsible for promoting and helping maintain not only business-to-business relationships but also partnerships with other public organizations whose primary concern is producing relevant knowledge and technology with commercialization potential. This research addresses them as research organizations (RO), encompassing public and private entities oriented at providing research services and collaborations (e.g., universities, academies, laboratories, research centers). Although there have been several studies on CO in CEE (Coletti and Di Maria 2015; Pavelková et al. 2019; Mackiewicz and Pavelkova 2022), we identify a need for additional systemic exploratory studies on how companies establish and maintain links with ROs. Hence, the paper formulates the underlying assumption that CO could contribute to enhancing the levels of innovativeness in regions with constrained innovation potential by being an intermediary between industry and RO in less innovative countries.

Consequently, we aim to understand the role of COs as actors in contributing to industry engagement with RO for collaboration (industry-research cooperation). We focus on the context of CEE specifically due to the role of clusters and CO in

national and regional innovation policies (Pavelková et al. 2019) and their practical need to address these problems to mitigate RIS shortcomings. Furthermore, their economic and cultural backgrounds do not deviate critically, discouraging concerns for contextual bias regarding public-private partnerships in CEE. The study revisits the relevant conditions for configurations within CO that affect industry-initiated cooperation with research organizations and performs a systemic analysis to understand whether these conditions can explain current engagement levels and which of these conditions stay relevant to promote further cooperation.

Despite investigating an acclaimed field, we offer a new perspective through the analytical framework. We expand the cluster research by providing an analysis using the qualitative comparative analysis (QCA). This methodology is increasingly relevant in managerial, entrepreneurial, and innovation research (see Olan et al. 2022; Gangaliuc 2022; Cunningham et al. 2023). To the best of our knowledge, QCA was not widely utilized in research on clusters and CO and still represents a fresh view on this phenomenon (Pickernell et al. 2019). This method provides evidence of causal interconnections of conditions without assuming a linear relationship between variables. It also complements traditional case studies by providing a more systematic way to analyze and compare multiple cases simultaneously, thus providing a robust framework for understanding complex phenomena such as industry-research cooperation dynamics.

In the upcoming sections, the paper presents the contextual background. It exemplifies the shortcomings of collaboration in CEE, establishing COs as platforms that can contribute to promoting cooperation between ROs and companies. We then develop the research questions, describing the conditions that act as facilitating and hindering factors within the CO context and affect the way businesses engage with ROs. Furthermore, we describe the methodology and discuss the results of the analysis, concluding that mediating power imbalances between the two sectors is relevant to contributing to more frequent and effective cooperation.

## 2 Theoretical framework

### 2.1 The relevance of public-private cooperation

It is undeniable that public-private cooperation receives significant academic attention and is considered an important driver of innovation systems. From the early research on RIS, the theory emphasized the importance of the voluntary interaction of knowledge generation (i.e., public domain research) and knowledge application (industry) sectors (Asheim and Coenen 2005). The voluntary interaction of these subsystems is the cornerstone of RIS topology, in some of which the public domain plays a crucial role (Asheim and Coenen 2005; Gangaliuc 2022).

Recently, there has been increasing attention on involving other decision-making actors, such as governments, and highlighting the potential of RO's (e.g., universities) as a resource to promote RIS and create a framework for science-driven economic development. Industry-research cooperation is valued for its capacity to foster innovation, enhance educational outcomes, and drive economic growth (Figueiredo

and Ferreira 2022). This is particularly relevant in regions struggling to achieve greater innovation and competitive capabilities, such as CEE (Kravtsova and Radosevic 2012). In their case, public-private cooperation signifies a necessity in the race to catch up with the developments and demands in production chains (Besednjak Valič et al. 2023). Industry-research cooperation facilitates the engagement of additional innovative potential from university spin-off companies, collaborations for knowledge-based economic advancement, and strategic partnerships with firms of various technological capabilities (Figueiredo and Ferreira 2022), all contributing to increased rates of innovation commercialization (Stojčić 2021).

The intersectoral collaborative environment is frequently regarded as transient, which may impede the formation of enduring partnerships essential for sustained innovation (Baban et al. 2021). Furthermore, barriers prevent effective collaboration such as institutional inertia, divergent organizational cultures, and a deficiency of trust between ROs and industry (Fitjar and Gjelsvik 2018; Mirza et al. 2020; Vivona et al. 2023). This leads to piqued interest in the dynamics, obstacles, and enablers of effective collaboration between universities, research centres, etc. and industries. Therefore, it opened a research niche that examines the complexities and challenges intrinsic to industry-research collaboration (Mascarenhas et al. 2018; Nilsen and Lauvås 2018; Mirza et al. 2020; Baban et al. 2021). Some of these issues can be mediated by tertiary parties, such as COs, that act as agents to intervene and promote industry engagement with the RO.

### 2.2 Innovation and cooperation particularities in CEE

The macro-region's innovation practices are influenced by regional collaboration and knowledge exchange, with known gaps in the RIS performance, given resource scarcity, trust between stakeholders, and remaining transition path-dependencies (Radosevic 1999; Kravtsova and Radosevic 2012). CEE has improved its potential in human capital and technological capabilities over the years. Yet, the macro-region lags behind "Western Europe" due to its role as an innovation user rather than a producer (Shkolnykova et al. 2024). These countries face challenges in creating and commercializing innovation (Stojčić 2021). Another contextual feature is the inefficiency in transforming their innovation and production capabilities into higher productivity levels (Kravtsova and Radosevic 2012). According to Stojčić (2021), the reliance on R&D commercialization (from a diverse network of collaborators) leads to presenting to the market primarily incremental innovations when cooperating with domestic actors. The reasoning lies in a weak RIS coupled with low absorptive capacity and a lack of interest from value chain partners to share and contribute to the integration of foreign technologies.

As previously presented, public-private cooperation can help mitigate some of the RIS's failings (Stojčić 2021; Figueiredo and Ferreira 2022). However, in CEE, this cooperation pattern generally indicates a latent performance, as the primary focus is on a business-to-business approach (Stojčić 2021; Mackiewicz and Kuberska 2024). The industry-research partnerships are also characterized by businesses' predominant role in establishing innovation collaboration (Mascarenhas et al. 2018; Stojčić 2021; Besednjak Valič et al. 2023). As actors of knowledge commercial-

ization (Asheim and Coenen 2005), companies play a vital role in the success and application of the R&D outcomes generated after a successful joint innovation project. Due to the lack of intersectoral cooperation, the ROs' knowledge does not reach the joint pool of tacit knowledge established at the regional or other levels of innovation systems (Asheim and Coenen 2005). Similarly, a lack of experience in engaging with industries limits the potential of ROs to adjust to their needs and develop the necessary competencies, which can increase the likelihood of initiating or being invited into public-private cooperation (Mascarenhas et al. 2018; O'Connor et al. 2021). Ergo, this gap contributes to the underdeveloped RIS in CEE, further hindering cooperation in the macro-region. This is why there is a growing need to comprehend the way cooperation is established, how it functions, and what its outcomes are (Virag et al. 2015; Besednjak Valič et al. 2022, 2023) in order to facilitate more interactions and advance CEE RIS performance.

### 2.3 Cluster organizations as drivers of cooperation

Clusters are generally regarded as geographical concentrations of organizations where enough resources and competencies amass and reach a critical threshold of competitive advantage (Porter 1990). Hence, clusters form organically without any institutional interventions, and cooperation develops within the same sector and along the value chain (Ketels 2013). More importantly, sectoral clusters promote competition and cooperation simultaneously, as they stimulate favorable conditions for knowledge exchange and create a thick labor market on a regional scale (Audretsch and Aldridge 2008). Nonetheless, cluster effects are not permanent, as they might deteriorate (Menzel and Fornahl 2010) without a systematic approach to sustain the benefits of competition and cooperation (Eisingerich et al. 2010). Network strength and openness are crucial factors of regional cluster performance. Hence, clusters often develop into initiatives at the interplay between innovative entrepreneurship and place-based leadership, establishing cluster organizations—COs (Grillitsch and Sotarauta 2020).

Collaborative strategies can offer additional competitive breakthroughs in cases where the R&D resources are scarce. Research indicates that regional economic and business organizations, like collaborative platforms, can promote joint R&D to support innovation capacities in transitional countries (Amponsah Odei et al. 2024). In this context, COs serve as intermediaries between different entities, notably bridging the knowledge transfer gap to and from industry. COs act as crucial nodes for relational dynamics that boost capacities among member firms to effectively absorb innovation in CEE (Terstriep and Lüthje 2018). They offer a unique asset for exchanging tacit knowledge, which is critical for innovation in modern economies, underlining their role as mediators. Typically, COs serve as facilitators/intermediaries for collaboration among small and medium-sized enterprises (SMEs), nurturing regional strengths to enhance competitiveness by bridging stakeholders' interests. The interaction between firms within COs, particularly in knowledge-intensive industries, can lead to improved access to shared resources, including technology, expertise, and markets (Lis and Rozkwitalska 2020).

COs' essential function, as promoters of cooperation, contributes to acknowledging their role as agents of change. Establishing umbrella structures that support clustering and integrate various regional development activities leads to structural change promoted by CO (Ffowcs-Williams 2023). Acting as a networking platform, CO contribute to enriching the network with new connections which can overcome institutional thinness and fragmentation. These structures support the economic scaling of industries and act as agents of strategic collaboration that drive regional innovation through actors who combine their knowledge and networks in novel ways to pursue R&D initiatives (Kostadinović and Stanković 2020). In turn, this leads to the ability of CO to stimulate system-level transformative changes by promoting responsible actor-hood (Berkowitz and Gadille 2022), for example, by inspiring a proactive attitude towards industry-research cooperation. It marks a behavioral change lowering the barriers for engagement, leading actors to seek cross-sectoral cooperation, and generally being open to pursue joint projects. Consequently, their potential as agents of change unlocks their prospects as instruments in regional development strategies. Depending on their actual role and to varying degrees, CO can contribute to path creation in CEE RIS by navigating local actors to overcome structural constraints and seize opportunities to shape enduring collaboration.

Nevertheless, especially in deficient RIS, pursuing collaboration for the sake of collaboration is not advisable due to its high organizational costs (Vivona et al. 2023) and associated concerns, for example, in cases requiring sharing intellectual property ownership (Besednjak Valič et al. 2023). In this light, we opt to understand the conditions that drive businesses to initiate cooperation with RO, building upon established patterns of cooperation in CEE, and underline which of these factors can impact the transformation roles of CO, driving structural or systemic changes.

## 3 The factors contributing to public-private cooperation within cluster organizations

Researchers have scrutinized the issue of public-private collaboration for many decades. It is characterized by a wide range of particularities, including structural, behavioral, organizational, and motivational aspects that contribute to the initiation and success of these endeavors (Fitjar and Gjelsvik 2018; Mirza et al. 2020; Amponsah Odei et al. 2024). CO must create favorable conditions for members to deal with obstacles in R&D activities, with spillovers reaching beyond their borders (Mackiewicz and Kuberska 2024). Based on their nature, we group these factors into three groups: structural, socio-behavioral, and power dynamics.

The list starts with classical structural factors, such as the availability of funding, human resources (Roy 2018; Besednjak Valič et al. 2023), innovation constraints faced by SMEs (Mackiewicz and Kuberska, 2024), geographical proximity (Nilsen and Lauvås 2018; Atta-Owusu et al. 2021) and the area of research and collaboration. The rationale behind these factors is derived from the context of geographical and cognitive proximities (Boschma 2005) and the Resource-Based View (Madhani 2010), which complement a company's competitive interests and help it sustain learning and innovation. The lack of funds and human resources in the private sector

could be a significant motivator for industry to initiate cooperation (Ankrah and AL-Tabbaa 2015) as human capital builds from joint projects (Roy 2018; Marques et al. 2019). Contemporary practices have demonstrated that the presence of complementary funding, such as joint research, facilitates connections between different sectors. For example, the European Union's funding programmes require direct intersectoral interaction to strengthen such connections. In addition, collaboration with RO can significantly impact companies' innovation performance and absorptive capacity (Mackiewicz and Kuberska 2024), contributing to the development of employee skills. Simultaneously, a lack of human capital could become a barrier to it (Stojčić 2021). A common approach is seeing industries access specific infrastructure or scientific competencies (e.g., computational power Besednjak Valič et al. 2023). The significance of geography is under attention due to the expenses and benefits associated with knowledge transfer (Nilsen and Lauvås 2018) and the partnership search tactics (Boschma 2005; Atta-Owusu et al. 2021). The closeness between organizations can facilitate communication and collaboration due to reduced travel time and costs, positively influencing the efficiency of other types of proximities (Boschma 2005) and creating opportunities for informal interactions (Romero-Torres 2020). Structural factors are characterized by issues that the private and research sectors face in order to solve specific complex problems (e.g., production), advance competencies, and reduce costs, creating a positive impact on companies' competitive edge.

Socio-behavioral factors include interpersonal connections and communication, trust, and previous professional interactions (Mascarenhas et al. 2018; Mirza et al. 2020). These factors reflect the social and cognitive proximities (Boschma 2005) that act at the level of individual interactions. Cognitive proximity is significant in contexts where shared knowledge and mutual understanding are essential for effective communication and collaboration (Mackiewicz and Kuberska 2024). On the one hand, these reduce the complexity of innovation collaboration by ensuring that the actors share tacit knowledge. On the other hand, the overreliance of companies on cooperation with agents with a similar mindset can create lock-ins, in terms of shared knowledge (by not providing sufficient differentiated input, Boschma 2005), or in partnership preferences (usually with other businesses), in order not to break the cooperation routine. In this way, cognitive and social proximities can impact other types of factors that are bound to institutional or organizational proximities. Previous collaborative experience is essential, as contentment with prior interactions—whether personal, professional, or research-oriented— lowers individual and, therefore, institutional barriers to collaboration. Connections with prestigious stakeholders in industry-research cooperation can enhance the reputation and increase access to crucial sources (Mascarenhas et al. 2018) for both parties, as well as reduce collaboration complexity via mutual trust. Genuinely, this group reflects on building collaborations that last on the level of formal agreements and informal commitments through social ties, friendship, professional interactions and reciprocal trust (Ankrah and AL-Tabbaa 2015).

Finally, we focus on the relevant aspects mediating power dynamics within the RIS, such as the differences in organizational management, cooperation goals, and the like (Fitjar and Gjelsvik 2018; Vivona et al. 2023). This group of factors fo-

cuses on institutional and organizational proximities and refers to shared routines, visions (on an organizational level), and normative and legal frameworks (Boschma 2005). The business sector in CEE is primarily driven by short-term projects with flexible funding, whereas ROs seek long-term projects, institutional resources, and risk aversion (Kiselakova et al. 2018; Vivona et al. 2023). It is assumed that aligning economic interests is more likely to motivate actors to engage in productive collaborations, as they can effectively communicate and integrate new ideas into their existing frameworks (O'Connor et al. 2021). On the other hand, organizational differences in pursuing collaboration, such as the disparities in establishing collaboration goals and project management approaches, have been another aspect widely discussed in research and practice (Vivona et al. 2023). The conflicting attitudes between these entities frequently pose significant barriers to achieving productive partnerships (Lind et al. 2013; Nissen et al. 2014). In addition, the discrepancy between short-term and long-term initiatives highlights a lack of temporal proximity, as noted by Blanc and Sierra (1999). These conditions reflect the differences in the goals of industry and ROs regarding what to learn and what to protect in partnerships (Mirza et al. 2020; Kuberska and Mackiewicz 2024). In cases where such discrepancies exist, mediating power dynamics is relevant for facilitating the transfer of knowledge to achieve a win-win situation and ensuring the smoother commercialization of research outputs, particularly in CEE regions that encounter difficulties with efficiency (Stojčić 2021). For instance, companies functioning with similar institutional frameworks may experience enhanced communicative efficacy and collaborative synergy set up by CO, as they possess a mutual comprehension of the operational context. Extending this context to industry-research cooperation might contribute to alleviating tensions arising from the organizational gap and focusing on mutual interests.

We focus on these three groups to examine the internal cluster conditions that contribute to promoting industry-driven cooperation with RO. Thus, we formulate the first research question:

**RQ1:** What are the fostering and hindering factors to industry-research cooperation for R&D and innovation within COs' configuration in CEE?

Yet, understanding the status quo of industry research cooperation is insufficient for arguing the agency role of COs. To motivate businesses to be proactive and seek innovation cooperation with research centers, maintaining the same conditions might not indefinitely lead to an increase in private initiatives. Therefore, the second research question takes into account the parameters that can explain business-initiated cooperation advancing beyond the average performance, where actors seek sustainable and strategic partnerships.

**RQ2:** Will the same factors remain relevant when expecting businesses to play a more active role (a higher percentage) in initiating cooperation with ROs?

## 4 Methods and data

### 4.1 Data collection

To understand the impact of CO on industry-research cooperation, the paper conducts an exploratory study using the data collected in the period of 2022–2023. The data collection protocol considered engaging with cluster managers exclusively and followed the inclusion criteria in three steps: being operational and registered entities for at least five years, and having research organizations among members. The methodology was pretested in each country. In addition, the interviews were carried out by an interviewer face-to-face to ensure that the perception of the questions and answers would follow a standardized understanding of each issue by the CO management (Kuberska and Mackiewicz 2024). In this way, the respondents were offered the opportunity to answer open questions and assess their organization's potential while simultaneously having the freedom to comment on how to interpret their answers. These steps contributed to increasing the internal validity of the data and research.

After the data management phase (deleting missing data), the final sample for the analysis consists of 37 CO-13 from Poland; 10 from Hungary; 8 from Czech Republic; and 6 from Slovakia. The data also includes COs in distinct industrial fields, with 14 from mechanical engineering; 9 from information and communication technology (ICT), 6 from logistics; 4 from energy and construction; and 4 representing the CO in healthcare and medical science.

### 4.2 Research design

The study uses the Qualitative Comparative Analysis (QCA) framework (Ragin 2008, 2009, 2014; Duşa 2024), and particularly the fuzzy-set methodology (fsQCA) for the analysis. The QCA methodology is a mixed-methods research approach, utilizing a descriptive technique that focuses on establishing set-theoretical causation, even with a modest number of observations. Unlike symmetrical analyses (e.g., correlations, regression), which focus on measuring the reciprocal influence between variables (effects of causes), QCA uses an asymmetric approach to establish the cause of an effect (Rubinson et al. 2019), suited for testing hypothesized relationships for specific groups within an established theoretical consensus. It also allows distancing from the perspective of proportional influence (e.g., the more change in the independent variable, the more expected change in the dependent variable) and applies a rationale of condition causing an outcome (not sensitive to their mutual variability). In this line, instead of the independent and dependent variables, QCA operates with the terminology of "conditions" that are supposed to cause the "outcome". The methodology results in a series of rules of causation that present different conditions leading to the outcome, simultaneously and independently (defined as equifinality Ragin 2008; Mattke et al. 2022). The method uses Boolean algebra to provide condition complementarity (combinations of conditions), defining rules when single conditions are insufficient to produce the outcome but, combined in specific ways, can cause the desired effect. However, the methodology lacks any

inferential potential and relies on theoretical knowledge and qualitative examples to establish the mechanisms of causality (Ragin 2008; Rubinson et al. 2019).

The analysis identifies the set-subset relationship to underline the sufficient and necessary conditions (Ragin 2008). Therefore, sufficiency indicates a subset position of the condition for the outcome (C⊆O). This means that the condition is contained in the outcome, hence providing an explanation for some of the observations. The necessity corresponds to a reversed relationship (O⊆C), whereas the outcome is contained in the condition. This can be interpreted as the outcome being (almost) impossible if the condition is not met. By applying fsQCA, the analysis focuses on whether a specific CO condition contributes to the development of industry-driven cooperation with RO, omitting any assumptions that industry-research cooperation must continue rising if a benchmark is met.

QCA and fsQCA support context-orientedness, allowing for the verification of results by returning to the case studies (Ragin 2008; Rubinson 2013; Mattke et al. 2022; Cunningham et al. 2023), while performing a systematic comparison based on the operationalized scores. In QCA, the calibration process (score operationalization) is dichotomous, coding a true or false or present or absent situation into binary values of 0/1. Furthermore, the analysis is conducted by observing the patterns of associations through the creation of a truth table. It is a matrix identifying the joint presence or absence of the condition(s) and the outcome. To express the robustness of this analysis, QCA employs the inclusion index, which measures the ratio of coinciding observations (where both the condition and outcome are present) among all cases with a present condition. This indicator can be considered to estimate the strength of the condition to "cause" the outcome. Coverage is the second indicator that measures the proportion of coinciding cases relative to the number of cases with the presence of the outcome. It can be understood as the relevance of the condition for the outcome.

Instead of dichotomous operationalization (present/absent), the fsQCA accommodates fuzziness, expressed in the principle of set membership (0 to 1). The calibration process interprets the data relative to the analytical framework, theoretical models, or case-based empirical observations (Ragin 2009; Olan et al. 2022). Therefore, the analysis does not consider the variation of the condition but their closeness to three calibration anchors: full non-membership, the indecision point, and full membership. The "full non-membership" expresses the complete absence of the phenomenon, coinciding with the value 0. The "full membership" is the opposite of that, where the phenomena are entirely present (value = 1). In case of "indecision point," the values are precisely at the threshold of being neither present nor absent. This is not to be understood as the midpoint of impact, but rather as the situation where the condition has no causal effect, for example, neither positive nor negative. These three critical points explain the score membership in between: as being more out than in as a set member (values in the range $0 < 0.5$) and more in than out (range $0.5 < 1$, Ragin 2008; Mattke et al. 2022).

In the context of this research, we focus on explaining the association between the hindering-facilitating factors within cluster organizations (as conditions) and the prevalence of industry-driven cooperation with RO (as outcome). The operationalization of the condition used the answers to the question: "*What hinders*

*and what facilitates cooperation between business and research organizations within your cluster [CO]*?". The calibration of the conditions followed a straightforward logic of operationalizing a 5-step Likert scale (1-strongly hindering/2-hindering/3-neutral/4-facilitating/5-strongly facilitating) that includes the following fifteen factors, grouped into socio-behavioral, structural, and power dynamics factors (and their shortened, condition names used in the analysis, see Table 3):

**Structural factors**

- [availability of] Financial resources (Financial Resources);
- [availability of] Human resources (Human Resources/HR);
- [availability of] Research facility—i.e., equipment, technology (Research Facilities);
- Capacity constraints of R&D&I in SMEs (R&D Constraints);
- Geographic proximity between agents of cooperation (Geographic Proximity);
- Cross-sector differences—between the fields of technological application (Field Differences);
- Cross-sector similarities—indicating belonging to the same field of research (Field Similarities);

**Socio-behavioral factors**

- Communication between CO members (Communication);
- Mutual trust (and personal relationships) between CO members (Mutual Trust);
- Personnel exchange (Personnel Exchange);
- A positive image boost in reputation/prestige associated with cooperation (Reputation Gain).

**Power dynamics factors**

- Organization interests and culture—differences between the "world" of RO and industry (Organizational Culture);
- Organization structure—RO administrative structure contrasted to firm structure (Organizational Structure);
- Cost of collaboration due to administrative overheads (Collaboration Costs);
- Capacity and fields of research of RO in relation to the needs of firms in the cluster (Research Fit).

The set membership was easily computed, following Ragin's (2009) recommendations (see Table 2, condition), where the "strongly hindering" answer was calibrated as 0 (full non-membership), "strongly facilitating" as 1 (full membership), and the "neutral" effect was set as the indecision point.

Calibration of the outcome was based on a different principle. CO management was asked to divide 100% of private sector cooperation with RO into corresponding ratios of who initiated the collaboration between CO members (industry), ROs, and CO management. Therefore, the resulting scores do not describe the frequency of cooperation but express respondents' (subjective) perception of the initiation of the public-private collaboration by a specific type of member. The descriptive statistics for the outcome are presented in Table 1. As the aim dictates, we have focused on the performance of the companies in this measurement. The variable offers

**Table 1** The Perception of Business-Driven Cooperation Initiation (average)

| Industry | Average (%) | Country | Average (%) |
|---|---|---|---|
| *Energy and Construction (E&Co)* | 66.25 | *Czech Republic* | 44.38 |
| *Healthcare and Medical Science (Heal)* | 39.50 | *Hungary* | 38.10 |
| *Information and Communication Technology (ICT)* | 44.78 | *Poland* | 62.15 |
| *Logistics (Log)* | 29.67 | *Slovakia* | 31.67 |
| *Mechanical Engineering (McEng)* | 52.14 | | |

Source: IVF, project No. 22030333 (2022)
Calculations by the authors

the necessary perspective to understand the conditions under which companies are more eager (than other players) to initiate such a collaboration. Therefore, regardless of a CO's performance, the measurement can indicate the condition that prompts companies to begin a partnership with the RO, who is also a member.

To proceed with calibration, we set the non-membership at 0% cooperation being initiated (value was present in the data). The indecision point represents 33%, as it offers the ideal case when all three actors are equally active in starting such partnerships—presumably, the factors impact all actors equally. Further, to accommodate our research aims, we used fsQCA's flexibility to adjust two scenarios.

For Scenario A (Table 2, RQ1), we examined the descriptive statistics of the data to establish calibration thresholds. Most indicators showed that roughly half of the cooperation was initiated by companies, with a mode of 50%, a median of 50%, and an average of 46.86%. Therefore, we considered the full membership also at 50% cooperation initiated by companies to represent these trends. Finally, we calibrated the outcome required for a higher frequency of industry-driven cooperation with RO at 67% (Table 2, Scenario B, RQ2). This is set to represent two-thirds of all new engagements. We believe that this threshold is realistic for a CO configuration, while higher numbers (e.g., 75% or even 100%) represent a power imbalance among the three actors of collaboration. In other words, these CO environments are not

**Table 2** Calibration of Data Values into Set Membership

| Calibration target | Pre-calibration measurement scale | Membership anchors and corresponding values | | |
|---|---|---|---|---|
| | | Full non-membership (0) | Indecision point (0.5) | Full membership (1) |
| Conditions | Likert scale (1–5) | Strongly Hindering (1) | Neutral (3) | Strongly Facilitating (5) |
| Outcome Scenario A (RQ1) | Required respondents to split 100% of cooperation into percentages initiated by: CO members, RO, and CO management | 0% | 33% | 50% |
| Outcome Scenario B (RQ2) | | 0% | 33% | 67% |

Source: IVF, project No. 22030333 (2022)
Calculations by the authors

**Table 3** Sufficient Conditions for Scenario A and B

| | | Scenario A | | | Scenario B | | |
|---|---|---|---|---|---|---|---|
| | | Incl | Cov | PRI | Incl | Cov | PRI |
| *Socio-Behavioral* | *Communication* | 0.731 | 0.822 | 0.673 | Ø | Ø | Ø |
| | *Mutual Trust* | 0.719 | 0.869 | 0.663 | Ø | Ø | Ø |
| | *~Personnel Exchange* | Ø | Ø | Ø | 0.853 | 0.523 | 0.699 |
| | *Personnel Exchange* | 0.822 | 0.693 | 0.767 | 0.822 | 0.782 | 0.721 |
| | *Reputation Gain* | 0.766 | 0.746 | 0.706 | 0.758 | 0.833 | 0.643 |
| *Structural* | *Financial Resources* | 0.758 | 0.796 | 0.707 | 0.703 | 0.832 | 0.586 |
| | *Human Resources (HR)* | 0.716 | 0.732 | 0.651 | Ø | Ø | Ø |
| | *Research Facilities* | 0.751 | 0.795 | 0.693 | 0.713 | 0.851 | 0.592 |
| | *~R&D Constraints* | 0.833 | 0.617 | 0.793 | 0.797 | 0.666 | 0.695 |
| | *R&D Constraints* | 0.793 | 0.513 | 0.710 | 0.779 | 0.569 | 0.619 |
| | *Geographical Proximity* | 0.798 | 0.711 | 0.740 | 0.783 | 0.787 | 0.666 |
| | *Field Similarities* | 0.780 | 0.702 | 0.717 | 0.766 | 0.777 | 0.641 |
| | *~Field Differences* | 0.848 | 0.525 | 0.790 | 0.848 | 0.592 | 0.733 |
| | *Field Differences* | 0.820 | 0.630 | 0.764 | 0.796 | 0.690 | 0.669 |
| *Power Dynamics* | *~Organizational Culture* | 0.845 | 0.744 | 0.801 | 0.806 | 0.801 | 0.703 |
| | *~Organizational Structure* | 0.827 | 0.767 | 0.779 | 0.788 | 0.825 | 0.683 |
| | *~Collaboration Costs* | 0.848 | 0.732 | 0.803 | 0.823 | 0.800 | 0.725 |
| | *Research Fit* | 0.741 | 0.653 | 0.672 | 0.731 | 0.727 | 0.595 |

The symbol "~" expresses the negation of a condition, understood as a reversed score (1-C) for the condition
The "Ø" symbol indicates that the condition did not meet the validation benchmark for Sufficiency
Legend: Inc. Inclusion; Cov. Coverage; PRI Proportional Reduction of Inconsistency
Source: IVF, project No. 22030333 (2022)
Calculations by the authors

subjected to the factors we have considered in the same way, but more to the specific patterns in CO configuration.

## 5 Results and discussion

The research utilized the QCA package in "R" (Duşa 2024) for the analysis. We followed Mattke et al. (2022) benchmark for condition validation. Therefore, the association thresholds for sufficiency were selected as follows: Consistency/Inclusion (Incl) = 0.7, Coverage (Cov) = 0.5, and Proportional Reduction of Inconsistency (PRI) = 0.5. For necessity, the thresholds are: Incl = 0.9; Cov = 0.6; Relevance of Necessity (RoN) = 0.6. No condition reached the benchmarks for the necessity. This suggests that neither of the factors is essential and leads to the outcome within different cluster configurations. Analysis for the negated outcome yielded no significant results either. The list of suitable conditions to fulfil the benchmark is presented in Table 3, which contains only the conditions that met the analysis threshold and their dynamics between the two scenarios.

Before exploring the relevance of the results, we reemphasize that QCA promotes equifinality. It means that conditions can explain industry-driven cooperation as a facilitator or hindering ("~" in front of the condition, representing Boolean negation) factor independently of other conditions, varying in terms of strength (Incl) and relevance (Cov) for the outcome. The research did not consider the complementarity aspect of fsQCA due to insufficient analytical robustness. When the representation of the condition in the sampled cases is too low (ratio higher than 0.20 Mattke et al. 2022), the chances of encountering a type II error rise (in paper 15/37 = 0.4). We discovered one causal rule for Scenario B, the "HR*Communication", to satisfy the analysis thresholds (Incl = 0.726; Cov = 0.752; PRI = 0.595), which will not be further considered.

Both QCA and fsQCA are exploratory, and the results must be carefully considered. The analysis revealed that one socio-behavioral (Personnel Exchange) and two structural (R&D Constraints and Field Differences) conditions are simultaneously associated as facilitators and obstacles for industry-research cooperation. Such results are illogical and contradictory, necessitating an in-depth investigation of the ambiguous causality. Plotting these cases revealed their irrelevance (Fig. 1, focus on Scenario B). For example, in the case of SMEs' R&D constraints (Fig. 1a, b), the distribution of cases shows a wide dispersion in both directions (hindering and facilitating), primarily due to differences between industries. Similarly, the condition capturing previous personnel exchange between organizations (Fig. 1c, d) is heavily concentrated around the value 0.5—i.e., the indecision point. Therefore, empirically and through calibration, the fsQCA identifies their inconclusiveness or lack of impact.

The analysis following Scenario A (RQ1) highlighted numerous conditions as facilitators and obstacles. The structural (Financial Resources, HR, Research Facility, and Geographical Proximity) and socio-behavioral (Communication, Mutual Trust, Personnel Exchange, Reputation Gain) factors facilitate public-private cooperation. These conditions can be considered classical in cluster research, as these are usually

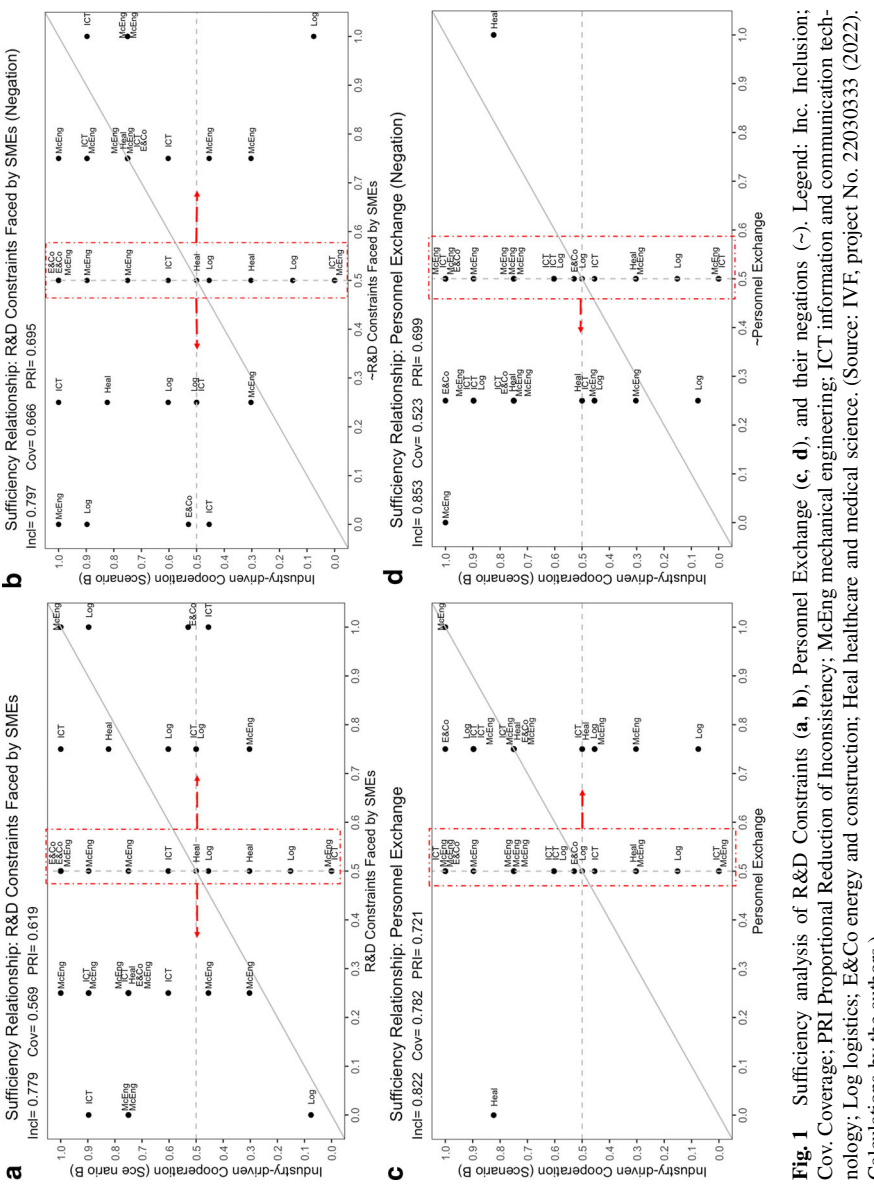


**Fig. 1** Sufficiency analysis of R&D Constraints (**a**, **b**), Personnel Exchange (**c**, **d**), and their negations (~). Legend: Inc. Inclusion; Cov. Coverage; PRI Proportional Reduction of Inconsistency; McEng mechanical engineering; ICT information and communication technology; Log logistics; E&Co energy and construction; Heal healthcare and medical science. (Source: IVF, project No. 22030333 (2022). Calculations by the authors.)

the ones with which clustering effects are associated. The results corroborate previous findings on the nature of cooperation (Lind et al. 2013; Morgulis-Yakushev and Sölvell 2017; Atta-Owusu et al. 2021) and offer additional evidence in this debate from the perspective of mixed-methods research.

To reiterate the previous argument, some conditions did not seem too impactful and are subject to industry patterns of cooperation. This is the case for the structural factors (conditions: R&D Constraints and Field Differences) in Scenario A, which highlight relevant differences between the industrial sectors. COs support

institutional cooperation, which often happens in similar research and application fields. Nevertheless, some relationships can consolidate around the need to engage with public organizations that offer a different knowledge base. The results may portray two parallel trends, whereas a) the companies seek superior competencies in their own field and b) pursue interdisciplinary knowledge from fields in which they have no competencies but would benefit to maximize R&D, innovation, and technology application (Amponsah Odei et al. 2024). The same can be said for the R&D constraints faced by SMEs, which may prompt some businesses to seek help in addressing their innovation gap, while others refrain from cooperation. It can be inferred from Fig. 1 that in service-oriented and manufacturing COs (e.g., ICT and mechanical engineering), companies seek cooperation with ROs. Still, in some industries (for example, in logistics), it demotivates engagement.

In contrast, the Power Dynamics factors (such as organisational culture and structure, and costs associated with collaboration) hinder cooperation. These parameters are known obstacles to public-private cooperation (Fitjar and Gjelsvik 2018; Amponsah Odei et al. 2024). The only exception in this group is the ability of ROs to meet SMEs' research needs, which promotes business-led collaboration. Its impact as a facilitator is intuitive and complements the previous argument. The assumption that companies seek to maximize their benefits by accessing the ROs' competencies (analytical and infrastructural) is self-explanatory (Besednjak Valič et al. 2023), regardless of their field of expertise. Therefore, Research Fit is a more effective causal condition for understanding industry-driven cooperation than any possible differences in the field of technological application (Field Differences).

The next step is to understand whether the same conditions hold if we perform an analysis expecting a higher industry-research cooperation initiation, as reflected in Scenario B (RQ2). The conditions in the socio-behavioral group appear to be eroding the most. The only factor that still positively impacts the establishment of partnerships with RO is the interest in gaining reputational and image benefits. The condition Personnel Exchange becomes inconsistent, while interpersonal trust and communication between actors no longer meet the sufficiency threshold of inclusion and coverage. It is premature to conclude that these characteristics become obsolete. The in-depth analysis provides a more nuanced understanding of the association (e.g., Mutual Trust, Fig. 2). In the first scenario (Scenario A; Fig. 2a), the majority of observations form two conglomerates in the upper-right corner, positioned close to or very close to the association's diagonal. When raising the outcome full-membership score (Scenario B; Fig. 2b), the agglomeration disperses, offering a better understanding that trust remains very relevant. Yet, some cases are not considered sufficient, mainly those involving COs in mechanical engineering. Their impact seems to erode as the public sector initiates more and more cooperation. These conclusions do not withstand the theoretical scrutiny of the relevance of social interactions (Ankrah and AL-Tabbaa 2015; Mascarenhas et al. 2018). A possible explanation is the "taken for granted" attitude in some industries, where the relevance of trust and communication remains present and of high significance, yet these conditions are seen as trivial. Consequently, trust and communication become less consciously acknowledged in later-stage collaboration compared to earlier interactions. The condition presents significant outliers in the ICT, logistics, mechanical

engineering, energy, and construction industries, which still exhibit low levels of business-led collaboration and high levels of trust simultaneously. Additional research on cases that contradict the findings or the inclusion of new conditions, such as cluster age and market competitiveness, may offer further insights.

The structural factors remain significant in Scenario B (namely, conditions Financial Resources, Research Facilities, Geographical Proximity), with the exception of the two inconclusive cases (R&D Constraints and Field Differences) and HR. The importance of managing human resources exhibits a similar pattern in the data, identical to that of Mutual Trust in Fig. 2. In the second iteration of the analysis, some of the observed cases fall short of meeting the fsQCA thresholds. Coupled with the findings concerning SMEs' R&D limitations, it is reasonable to assume that the relevance of HR deteriorates with continuous cooperation and an increase in collaboration rates. Public-private cooperation enhances internal competencies for innovation in SMEs (Ankrah and AL-Tabbaa 2015). Therefore, it won't act as a motivational factor once companies build human capital through previous collaborations.

The conditions reflecting power dynamics between CO members and ROs exhibited the most resilient association. In both scenarios, these factors demonstrate high causal potency in explaining the companies' engagement in public-private cooperation. The only condition that acts as a facilitator of industry-driven collaboration is the ability of ROs to provide valuable capabilities to SMEs (Research Fit), similar to Scenario A. The remaining factors (collaboration costs and differences in organizational culture and structure) present set-theoretical associations as conditions that hinder industry-research engagement. A deeper analysis revealed that for these conditions, a significant number of cases revolve around the indecision point (0.5) and the rest cluster towards a strong hindering effect (i.e., showing association with a negated condition).

The high costs of collaboration act as additional factors that widen the gap and discourage new industry-research cooperation in CEE (Shkolnykova et al. 2024). Considering the whole group of power dynamics conditions, the findings support previous conclusions (Nilsen and Lauvås 2018; Fitjar and Gjelsvik 2018), reassuring that the differences in motivation to pursue collaboration between firms (through short-term projects with preferably immediate impact) and research organizations (who seek long-term institutional financing) pose a significant threat to industry-to-research innovation partnerships. Balancing power relations by considering short-term and long-term collaboration yields advantages for enduring joint projects and research commercialization, as it streamlines change through institutional entrepreneurship (Fitjar and Gjelsvik 2018; Grillitsch and Sotarauta 2020; Amponsah Odei et al. 2024). Such shoulld be the role played by the COs in this context. It is also evident that cluster organizations are unable to transform these factors into enablers of cooperation and can only strive to prevent them from hindering new collaborations.

The analysis revealed that most of the conditions act as facilitators for the outcome. Most of these are relevant when explaining the current status quo in public-private cooperation in CEE cluster organizations, and only a few remain significant in expecting higher initiation rates. Nevertheless, this list includes multiple structural

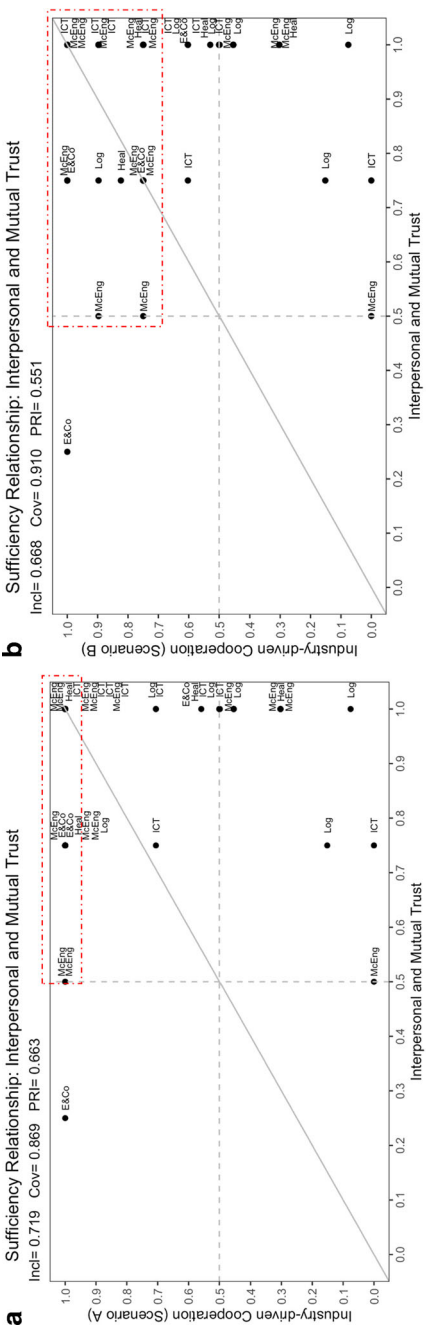


**Fig. 2** Sufficiency Analysis for Trust. Scenario A (**a**) and Scenario B (**b**). Legend: Inc. Inclusion; Cov. Coverage; PRI Proportional Reduction of Inconsistency; McEng mechanical engineering; ICT information and communication technology; Log logistics; E&Co energy and construction; Heal healthcare and medical science. (Source: IVF, project No. 22030333 (2022). Calculations by the authors.)

and socio-behavioral factors (e.g., Reputation Gain, Research Facilities, Geographical Proximity, Financial Resources) that are not always under the direct influence of the COs. In this light, a pressing need is to centralize their efforts around other forms of proximity (organizational, cognitive, etc.) and expand their membership by reducing the power dynamics obstacles, promoting structural changes and place-based leadership (Grillitsch and Sotarauta 2020).

## 6 Conclusions

The importance of regional cooperation and voluntary collaboration has generated significant interest among academics, particularly regarding intersectoral partnerships. Within this research, we focus on the CEE context, where innovation and public-private engagement encounter severe obstacles (Kravtsova and Radosevic 2012; Mackiewicz and Kuberska 2024; Shkolnykova et al. 2024). We operate under the assumption that promoting industry-research innovation partnerships is a path to facilitate technology transfer and commercialization (Besednjak Valič et al. 2023; Amponsah Odei et al. 2024), thereby helping to mitigate their RIS shortcomings. By addressing their internal condition for cooperation, COs can contribute to companies' engagement with RO. Therefore, they act as agents of change (Purkarthofer and Stead 2023) in their innovation systems, promoting localized (and collaboration-targeted) transformative and structural changes needed in CEE.

We applied the fsQCA methodology, which is novel to cluster research, to analyze whether structural, social, and power-dynamics conditions are relevant in explaining the current rates of industry-research cooperation (Scenario A) and the ones that boost cooperation initiation (Scenario B). Therefore, we corroborate previous findings on the nature of cooperation (Morgulis-Yakushev and Sölvell 2017; Atta-Owusu et al. 2021; Besednjak Valič et al. 2022, 2023) and offer additional evidence in this debate.

The study emphasizes that multiple structural and socio-behavioral conditions impact CO members' engagement with ROs as facilitators. Some might have inconclusive effects, depending on industry dynamics (e.g., capacity constraints in R&D in SMEs). Also, not all conditions remained relevant when transitioning to Scenario B. The causal potency of most social factors eroded to the point of not being sufficient. This leads to the assumption that we can observe two aspects: early (not temporal, but in terms of complexity and intensity) and later-stage cooperation initiation in COs. Therefore, trust and communication are seen as relevant in the early stages and then build up to become institutionalized, no longer being perceived as significant in later business-led partnerships. Based on this assumption and the analysis of the results, we consider that the main takeaway of the research is highlighting the relevance of CO's power-balancing role (Fitjar and Gjelsvik 2018; Amponsah Odei et al. 2024; Akpinar 2024), which maintained its impact. It requires acting as a mediator and balancing the hindering factors associated with the distribution of interest, as well as divergent organizational patterns established between public and private actors. This puts pressure on COs to contribute to bridging this gap and addressing the collaboration costs and goals continously.

The roadmap for CO's promotion of industry-research cooperation collaboration then considers sustaining social and locational proximity, but should center on addressing organizational and institutional ones (Nilsen and Lauvås 2018; Atta-Owusu et al. 2021). Balancing power dynamics is essential for enduring partnerships and research commercialization in CEE (Amponsah Odei et al. 2024). The change orchestrated by CO management provides a fertile ground for SMEs to maintain linkages with research infrastructure, shaping the direction of cooperation to transform innovation into higher productivity levels (Kravtsova and Radosevic 2012; Stojčić 2021). Through bridging socio-cultural and organizational divides and building sustainable, long-term, trust-based sectoral and intersectoral collaborations, COs can become harbingers of regional structural change, thereby enhancing the network of interconnections and advancing RIS. As a result, a region may experience systemic transformations, adopting new practices that lead to radical innovations, thus adjusting and evolving in response to global trends.

The conclusions provide relevant direction for practitioners, especially CO managers. The COs might take a proactive role by focusing on counterbalancing the hindering factors. The literature outlines mediating the costs and the steps of technology commercialization by RO (Mackiewicz and Kuberska and Mackiewicz 2024), assisting in consolidating intellectual property ownership and value recognition (Besednjak Valič et al. 2023), while simultaneously facilitating structural and social conditions. Despite the outlined limitations, the study highlights the strategic role of COs in power balancing, fostering resilient intersectoral ties and guiding CEE regions toward systemic innovation-led transformation.

At the same time, these findings should be interpreted with caution, given several limitations inherent to the study. The reliance on surveying and self-assessment tools increases the risk of wishful, trivial, or inaccurate answers, thereby introducing respondent bias. Similarly, case selection bias can also pose a problem, since the industrial affiliation appears to exert a greater influence on business-led cooperation than the national borders, questioning whether the trends are unique to CEE. Furthermore, the decision to focus the survey on CO managers excluded the perspectives of companies and ROs, creating space for an omission bias (Suchman 1962). The presented issues overlap with the manner in which researchers operationalized the outcome. Given the approximate perspective on industry-driven cooperation with RO from the CO managers, we had to consider the benchmarks dictated by the data collection protocol to construct the two scenarios rather than relying on any pre-existing statistics. To some extent, fsQCA mitigates such biases, as the methodology is not sensitive to data variability. The data remains applicable for set-theoretical associations, aiding in the understanding of the dynamics of companies' engagement with RO in CEE.

In light of the study's emphasis on fsQCA, it is necessary to acknowledge the methodological limitations inherent to this approach (Rubinson 2013). By utilizing the consistency scores, the methodology misses the opportunity to observe contradictory and inconsistent cases in truth tables that could highlight an oversight in the theoretical model, prompting further and deeper investigation. Additional in-depth analysis, exploring deviant cases, could complement the results of this research and provide new insights into why particular factors fail to cause industry-research co-

operation. Further research could also consider broadening the scope of analysis and engaging more actors. These steps will allow enriching the conclusions and help adjust for the expressed limitations. For example, considering the dynamics of business-initiated cooperation within CO and at the regional (or RIS) level can help in examining and assessing the impact of intermediary organizations. This opens up relevant research areas, including the potential to consider QCA's complementarity rules of causation, which will enable the extraction of pertinent observations for targeted policy actions, as well as mapping the role of other regional actors alongside cluster organizations.

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**Conflict of interest** C. Gangaliuc, L. Danko, and S.C.V. Husar declare that they have no competing interests.



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