JoRMA
JOURNAL OF RESEARCH MANAGEMENT AND ADMINISTRATION

EXPLORING THE DYNAMICS OF COLLABORATIVE RESEARCH: PUBLICATION TRENDS IN THE LUE IMPACT PROJECTS IN FRANCE

Angeliki Monnier | Université de Lorraine, Metz/Nancy, France | angeliki.monnier@univ-lorraine.fr

Centre for Research on Mediations (CREM)

0000-0002-1738-7091

ABSTRACT

What is new?	This study takes an interest in the dynamics of collaborative research as they materialize through publications conducted within the LUE IMPACT initiative at Lorraine University of Excellence, France, over the period 2016-2024.
What was the approach?	Using bibliometric data from HAL and OpenAlex databases, it studies publications in terms of co-authorship and with regard to their underlying organizational (cross-laboratory) and cognitive (cross-discipline) proximity.
What is the academic impact?	The study underscores the increasing number of multi-authored and multi-laboratory publications in the seven projects of the LUE IMPACT framework, as well as the diversity of the disciplinary fields involved. It also shows, however, that disciplinary proximity was by far the catalyst that underpinned co-publications. Narrow interdisciplinarity appeared to be the "optimal level" of disciplinary collaboration; but this equilibrium turned out to cover an underlying disequilibrium among discipline domains.
What is the wider impact?	This study offers key benefits to research management and administration by providing a data-driven understanding of collaborative research dynamics within institutional initiatives. It equips research administrators with evidence-based guidance to refine collaboration strategies, and maximize the outcomes of funded projects.
Keywords	Co-authorship, interdisciplinarity, cognitive proximity, organizational proximity, dynamics of team research.

INTRODUCTION

Over the last years, moonshots—targeted, high-stakes initiatives aimed at solving specific challenges—have gained traction, as governments and institutions seek rapid, transformative breakthroughs in areas like climate change, health, and digital transformation. Systems thinking and a certain injunction to interdisciplinarity have become increasingly prominent, emphasizing the interconnected nature of complex problems and the need for holistic, cross-sectoral approaches to innovation. While these evolutions pose challenges, they also seem to open new horizons for impact-driven research.

Collaborative research is believed to offer numerous benefits, enriching the research process and outcomes by bringing together diverse perspectives, expertise, and resources. By pooling knowledge and skills from different disciplines, collaborative teams may tackle complex problems more effectively, leading to innovative solutions that might not emerge in isolated efforts (Gibbons, et al. 1994; Miller, et al., 2008). Additionally, collaborative research enhances learning opportunities and knowledge spillovers, allowing team members to gain new insights and techniques from each other. This approach also facilitates the sharing of resources, such as funding and equipment, making ambitious projects more feasible. The collective efforts generally result in often co-authored publications which recognize the contributions of all participants (McNutt, et al., 2018). Currently, research grants and funding bodies tend to encourage or require collaboration, while universities and research institutions increasingly recognize and reward it.

Understanding the dynamics of collaborative research through publication offers valuable insights into how scientific knowledge is produced, shared, and advanced in the modern research landscape (Bozeman & Corley, 2004; Cummings & Kiesler, 2005; Condee, 2016). Publications serve as a tangible outcome of collaborative efforts, reflecting the complex interactions between researchers, institutions, and disciplines (Newman, 2001). By analysing co-authorship patterns, in particular, as well as the involvement of multiple institutions and the interdisciplinary nature of research papers, we can map the networks of collaboration and identify key contributors and hubs of knowledge exchange. Furthermore, understanding the dynamics of collaboration through publications helps to assess the impact and quality of research, as collaborative papers often have higher visibility and citation rates (Larivière, et al., 2015a). Even though co-authorship is certainly a partial indicator of collaboration (Katz & Martin, 1997), its analysis can inform strategies to foster more effective and inclusive research, ultimately leading to more innovative and impactful scientific outcomes (Larivière, et al., 2015b).

To this end, this study takes an interest in the dynamics of collaborative research as they materialize through publications conducted within the IMPACT initiative at Lorraine University of Excellence ("Lorraine Université d'Excellence", LUE), France, over the period 2016-2024. It is part of the activities of LUE's Centre for Interdisciplinary

Research and Expertise on Transitions (CELEST) which aspires to provide insights on—among others—the evolution of scientific practices within Lorraine University but also beyond. Using bibliometric data from HAL (Hyper Article en Ligne; Hyper Article Online) and OpenAlex databases, we seek to study publications in terms of their underlying organizational (cross-laboratory) and cognitive (cross-discipline) proximity, and assess the respective importance of the latter. The complete dataset is openly accessible in the French government's repository (Monnier, 2024: https://doi.org/10.57745/NNR7GP). Our study underscores the increasing number of multi-authored and multi-laboratory publications in the seven projects of the LUE IMPACT framework, as well as the diversity of the disciplinary fields involved. It also shows, however, that disciplinary proximity was by far the catalyst that underpinned co-publications. Narrow interdisciplinarity appeared to be the "optimal level" of disciplinary collaboration; but this equilibrium turned out to cover an underlying disequilibrium among discipline domains.

This study offers key benefits to research management and administration by providing a data-driven understanding of collaborative research dynamics within institutional initiatives. The findings on disciplinary proximity guiding co-publications can inform decisions on how to foster meaningful interdisciplinary engagement while ensuring balanced research development across fields. Insights into multi-laboratory and multi-authored publications can aid in optimizing resource allocation, enhancing the impact of collaborative research efforts. Contributing to the literature on multi- and interdisciplinarity, this study equips research administrators with evidence-based guidance to refine collaboration strategies, and maximize the outcomes of funded projects.

Collaborative Research as Proximity

The idea of research collaboration being influenced by proximity seems to be well-documented in the fields of scientometrics and sociology of science, but fewer are the contributions, as highlighted by Cannataro (2020: III), that closely investigate the role of proximity in research consortia. Nii and Dubé (2018: 23) also point to the lack of real-time data and the use of measures, such as publications. We could add that although a growing literature focuses on R&D and university-industry contacts (Broström, 2010), we know less about the dynamics that develop internally in laboratories and research teams.

Proximity influences the formation and dynamics of collaborative research relationships. According to Mattes (2012: 1086), "the transfer of knowledge deeply relies upon proximity, as the assimilation of the exchanged knowledge is not possible at all without it". In an often-cited paper, geographer Ron A. Boschma (2005) retraces the history of academic research on proximity and studies the concept in its different—evolving and sometimes overlapping—dimensions. Proximity can indeed take several forms, each of which plays a crucial role in shaping who collaborates with whom and how these collaborations unfold. Geographic proximity facilitates face-to-face interactions, while cognitive proximity (shared knowledge or expertise) and organizational proximity

(being part of the same institution or laboratory) can play a significant role in fostering collaboration and co-authorship. Other forms of proximity are social proximity, which reflects the strength of personal relationships among collaborators, virtual or technological proximity, which allows for distant exchanges and collaborations, as well as temporal proximity, which focuses on the synchronicity of career stages, but also on the role of opportunistic collaborations (be in the right place at the right time). For the purposes of this study and based on a first exploratory observation, we have isolated and worked with two widely-accepted forms of proximity that seemed to be the most relevant in our dataset: organizational and cognitive.

Organizational vs Cognitive Proximity

Organizational proximity refers to the closeness within or between organizations, such as shared institutional affiliations or collaborative partnerships. It can thus be inter-organizational or intra-organizational. Being part of the same organization or a close-knit network of organizations often leads to shared resources, goals, and communication norms and arrangements. Organizational proximity can enhance both formal communication channels (e.g. meetings, reports) and informal networks (e.g. social gatherings, inter-departmental interactions), which support knowledge sharing and collaboration. Intra-organizational proximity pertains to the explicit or implicit rules and routines of behaviour that are common to the members of a specific organization (Torre & Rallet, 2005). Researchers within the same research institute or laboratory often share similar resources, administrative support, and research priorities. This proximity can lead to more opportunities for interaction and collaboration, as well as a greater likelihood of co-authorship.

Inevitably, understanding and sharing common arrangements and modes of conduct is also a matter of subjective perception, and it comes as no surprise to find that, for some scholars, organizational proximity is treated as a broad category encompassing a cognitive dimension (Gilly & Torre, 2000). However, the subjective process of meaning-creation out of material or abstract structures could be applied to all forms of proximity. Hence our decision to align with Boschma (2005) and consider the cognitive proximity as a stand-alone concept.

Cognitive proximity generally refers to the closeness in knowledge, expertise, or intellectual approaches among individuals or groups. It enables them to have a common understanding of concepts, methodologies, and terminologies, which can facilitate clearer and more effective communication and collaboration. In research, sharing similar paradigms, approaches and methods generally tends to emanate from common disciplinary affiliation. The shared cognitive background reduces the likelihood of misunderstandings and increases the chances of producing innovative and well-integrated results. Moreover, the established social networks and platforms (scientific journals, conferences, etc.) within a discipline can provide the support needed to navigate the publication process, leading to greater visibility and impact of the research.

Research suggests that while both forms of proximity are important, cognitive proximity is a prerequisite for interactive learning processes to take place (Boschma, 2005: 71). Organizational proximity can enhance the collaboration process by providing necessary support and infrastructure, reducing barriers to interaction, but it is the cognitive alignment between scholars that ultimately seems to drive the quality and relevance of the research. Without cognitive proximity, researchers may struggle to find common ground (even though it is also true that too much proximity, particularly cognitive proximity, can limit the diversity of perspectives, leading to echo chambers).

Against this backdrop, we could assume that disciplinary proximity—certainly a form of cognitive proximity—is more critical for collaboration. Researchers within the same discipline or sub-discipline are more likely to work and co-author papers together. As our study will demonstrate though, this is not exactly the case, at least in regard to Lorraine's IMPACT projects. Interdisciplinarity does play an important role, but the difference between narrow and broad interdisciplinarity needs also to be taken into consideration.

Cognitive Proximity as Narrow Interdisciplinarity

Julie Thomson Klein (1990; 2005), a prominent scholar in the study of interdisciplinarity, discusses multidisciplinarity and interdisciplinarity in a nuanced way. Multidisciplinarity involves the juxtaposition of disciplines without necessarily integrating them. In a multidisciplinary approach, multiple disciplines work side by side on a common issue, but each remains within its own boundaries and methodologies. Interdisciplinarity, on the other hand, involves the integration of methods, theories, and concepts from multiple disciplines to create a unified approach to a problem. It goes beyond just using the tools of different disciplines; it seeks to merge them into a cohesive framework that can address complex issues in a more holistic way (Pohl & Hadorn, 2008; Frodeman, et al., 2010; Repko & Szostak, 2017; Schmitt, et al., 2023).

As Katri Huutoniemi, Julie Thomson Klein, Henrij Bruun and Janne Hukkinen (2010) have successfully highlighted, one of the most important dimensions of interdisciplinarity is its scope (or range (Porter & Rossini, 1984)), which can be narrow or broad (or, in other terms, narrow or wide (Kelly, 1996; Klein, 2005)). This conceptualization acknowledges that the cognitive distance between fields "is not a straightforward property and definitely not a binary variable" (Huutoniemi, et al.: 82).

Narrow interdisciplinarity refers to the collaboration between closely related disciplines that share similar methodologies, perspectives, and research questions. In such an approach, the integration of knowledge from different fields is relatively straightforward, as the disciplines involved often have overlapping concepts and terminologies. For example, the collaboration between biology and biochemistry is a form of narrow interdisciplinarity, where researchers can seamlessly combine insights to advance understanding in areas like molecular biology. This approach often leads to incremental advancements and specialized solutions within a confined area of study,

making it highly effective for addressing specific problems that require deep, technical expertise.

In contrast, broad interdisciplinarity involves the integration of knowledge from disciplines that are more distant from each other, often spanning different paradigms, methods, and epistemologies. This type of interdisciplinarity can include collaborations between the humanities and natural sciences, or between engineering and social sciences. The challenge here lies in bridging the gaps between these diverse fields, which may require the development of new frameworks or languages to facilitate communication and understanding. Broad interdisciplinarity can lead to innovative solutions and a more holistic understanding of complex issues, as it brings together diverse perspectives and expertise. However, it also requires a greater effort to synthesize and integrate knowledge across these broader disciplinary divides.

On the Empirical Study

The LUE IMPACT Projects as an Object of Research

Université de Lorraine is one of the largest universities in France, with ca 60,000 students and a wide range of programs. It offers undergraduate, graduate, and doctoral programs in various fields, including science, engineering, humanities, social sciences, health, and the arts. The University has several campuses across the Lorraine region, particularly in the cities of Nancy and Metz, in the North of France.

French universities are today "at the forefront in delivering their missions of education and research and innovation" (Zuolo et al., 2024: 670). The LUE IMPACT projects at the Université de Lorraine are a strategic initiative designed to strengthen and develop the University's research capabilities across various disciplines. These projects often involve collaborative efforts between the University, research institutions, and industry partners, aiming to tackle complex global challenges. They focus on multidisciplinary research, promoting innovation and technology transfer, which are crucial for addressing issues like sustainable development, energy transitions, and artificial intelligence.

The LUE initiative officially began in 2016. This was when the University started to implement the projects, following its recognition under the French government's "Initiatives of Excellence" (IDEX/I-SITE) program, which aimed to foster world-class research universities. The IMPACT projects were usually designed to be implemented over a probationary period of approximately 4 years, although, for some projects, data suggests that collaborations were already established beforehand. This is emblematic of the role played by existing (cognitive or organizational) connections in the design of the projects, even though our study cannot provide rigorous evidence on that matter. During this first (trial) period of the program, seven collaborative projects were funded (Table 1). As we currently write these lines, the second generation of the IMPACT projects is under way. According to the institutional framing provided, IMPACT projects aim to connect research teams, individuals, research and training activities.

Table 1. The 7 projects of the IMPACT-LUE Framework (first generation)

The BIOMOLECULES project studied the exploitation of biomolecules (initial production, elaboration, biological testing, final applications, etc.) with the goal of identifying novel compounds exhibiting anti-proliferative, antioxidant and/or anti-inflammatory activities. One of its initial objectives was to establish a collaborative network encompassing 17 laboratories within the Lorraine region, in close association with local, national and international industries spanning the entire value chain.
The DEEPSURF project concerned the observation of environmental systems, from underground geological environments to the critical zone, in order to optimize the uses of biomass and the subsoil for energy transition. It aimed to track the exchanges of mass and heat between the deep and the surface, and their consequences on the environment and the territories. The project was multidisciplinary by bringing together 12 research units from five scientific clusters of the University of Lorraine, 9 public institutions and 6 local companies.
The DIGITRUST project aimed to conduct research around IT security, related to, e.g. smart factories and cities, sensors, cameras, mobile phones, watches, home, car and health equipment. It encouraged interdisciplinary research based on the complementarity of expertise of its 13 members: laboratories at University of Lorraine and external partners. The overall scientific objective was the design, analysis and implementation of digital systems resisting attacks and protecting the assets contained in these systems.
GEENAGE, a translational health research project, brought together biologists, engineers, psychologists and physicians (10 partners in total) with the objective of preventing normal and pathological aging—focusing on the late repercussions of early events, such as in utero exposure to certain metabolic deficiencies, existence of cardiovascular risk factors or chronic inflammatory diseases—and strengthening links between health research and digital sciences, in particular to model certain biological processes and better exploit massive or complex data.
The N4S (Nanomaterials for sensors) project relied on the combination of skills of researchers from eight Lorraine laboratories from various disciplines. Based on research and innovation in the field of structured nanomaterials, N4S addressed the entire value chain: synthesis of materials, manufacturing of devices, transfer to industry, training of experts. The ambition was to create new families of sensors in applications in fields as varied as energy, data storage, health, the environment, and the entire industry 4.0 sector.
The OLKi (Open language and knowledge for citizens) project's mission was to design new machine-learning algorithms dedicated to extracting knowledge from language data, and to propose solutions that guarantee fair, open and shared control of data, as well as a use of this data which respects citizens and their privacy. The work, which solicited 5 laboratories, was carried out in an interdisciplinary manner by specialists in AI, NLP (natural language processing), mathematics, linguistics, philosophy, and information and communication sciences.
The ULHyS project, which stands for "*University of Lorraine Hydrogène Sciences and Technologies*", (i.e. University of Lorraine Hydrogen Sciences and Technologies), focused on research actions on hydrogen energy, and was part of the French strategy for the development of the hydrogen sector. Mobilizing 11 laboratories, it was organized into interconnected working groups covering the entire hydrogen sector: production, fuel cell, compression and storage, micro-grids, economy, ergonomics, end user.

Taking as an object of study these seven Lorraine's LUE IMPACT collective projects, and in the light of the aforementioned theoretical premises, our research built upon four major questions:

Q1: Did the dynamics of these collective projects enhance co-authorship in general?

Q2: What was the part of inter-organizational, i.e. inter-laboratory, proximity in the projects' publications?

Q3: What was the part of cognitive, i.e. interdisciplinary, proximity in the projects' publications?

Q4: What was the respective overall importance of inter-laboratory and interdisciplinary proximity in the projects' publications?

In the frame of extant research outcomes, we assumed that the answers to these questions would be the following, which also constituted the starting hypotheses of our study:

H1: Co-authorship was indeed developed in Lorraine's LUE IMPACT collaborative projects.

H2: Inter-organizational, i.e. inter-laboratory, proximity was important in Lorraine's LUE IMPACT publications.

H3: Cognitive, i.e. interdisciplinary, proximity was important in Lorraine's LUE IMPACT publications.

H4: Interdisciplinary proximity was more important than inter-laboratory proximity in the projects' published outcomes.

The bibliometric data necessary for this research were provided by the Research Data Support Service and the Bibliometrics Unit of Université de Lorraine (Bracco, 2022) during the first semester of 2024. An attributed analyst on indicators and ranking (Raty, 2024) collected this data, on our demand, using both HAL and OpenAlex databases.

HAL stands for Hyper Article Online (Hyper Article en Ligne). It is the French multidisciplinary platform for the deposit and consultation of writings, works and results of scientific research. HAL data is self-declarative data—and in this sense might induce errors. It is based on the principle of self-archiving and places no restrictions on access to documents distributed in full text. Administered by the Centre for Direct Scientific Communication, HAL is the most important open archive portal in France. Laboratory labels used in the present data collection corresponded to specific HAL collections, and were eventually completed by OpenAlex information. Laboratories were identified from the signatures and affiliation of the authors.

OpenAlex is a free and open database that provides a comprehensive and structured repository of scholarly information. It is designed to serve as an open alternative to proprietary databases like Scopus and Web of Science, offering access to a wide range of academic research data. Moreover, an algorithm assigns one or more disciplines to a publication based on the available information (abstract, title, review, citations). In our case, the OpenAlex corpus was constituted from a search of all the publications of the respective HAL collections containing a DOI. Its coverage rate was therefore lower, but

this database had the advantage of containing more precise information on publications.

The collected raw data were presented to us in the form of an 89-page internal report (Raty, 2024) comprising multiple tables which depicted, among others, the following features for each LUE IMPACT project ("collection"):

1. Number of single-authored and multi-authored papers per project and per year
2. Number of mono-laboratory and multi-laboratory papers per project and per year
3. Number of single-disciplinary field and multi-disciplinary field papers per project and per year (the hyphenated version of terms is occasionally used throughout the paper in order to create emphasis)
4. Number of single-disciplinary domain and multi-disciplinary domain papers per project and per year

The distinction between discipline field and discipline domain requires some further explanations.

Discipline Field vs Discipline Domain

Disciplines are the foundational categories that structure academic and professional fields, guiding research, education, and practice within a specific domain. Each discipline, regardless of a certain internal heterogeneity, is normally characterized by a set of theories, methods, concepts, and standards that shape how knowledge is generated, evaluated, and applied. However, over time, new disciplines have emerged as knowledge is expanding and new areas of inquiry develop. For instance, Data Science has become a recognized discipline in response to the growing importance of big data and computational analysis. Additionally, some modern research areas are inherently interdisciplinary, drawing from multiple traditional disciplines to address complex issues. For example, Sustainability Studies might integrate concepts from environmental science, economics, and sociology.

Over time, various systems have been developed to classify disciplines and subdisciplines, reflecting both historical developments in knowledge and the needs of academic institutions. The Dewey Decimal System is one of the oldest and most widely used library indexing protocols. Other key systems for the classification of disciplines include UNESCO's Fields of Science and Technology classification, but also field-specific classifications, like in Health and Biomedical Sciences, etc. More recently, the OpenAlex classification system has categorized and organized academic production within the OpenAlex database using a hierarchical and granular structure starting from 4516 topics, and moving to 252 subfields, 26 fields, and finally 4 domains (broad disciplines). An example provided by the platform's technical documentation is the following: The topic "Artificial Intelligence in Medicine" is part of the "Health informatics" subfield, which is part of the "Medicine" field, which belongs to the "Health Sciences" domain.

While this system offers many advantages for organizing and navigating academic knowledge, it can also lead to overly complex classifications that seem difficult to

navigate, because of the sheer number of topics and subfields, which sometimes overlap and make it challenging to identify relevant information. For this reason, we have focused our analysis only on the last two (broader) categories ("fields" and "domains"), which tend to align with the more traditional disciplinary categorization, compared to "subfields" and "topics", which are more thematic and cross-disciplinary. Examples of fields are: chemistry, computer science, engineering, arts and humanities, etc. The four OpenAlex domains are: life sciences, social sciences, physical sciences, health sciences.

Precaution: What about Integration?

From multidisciplinarity to interdisciplinarity, the process of synthesizing knowledge, methods, theories, and perspectives from different disciplines to address complex questions or solve multifaceted problems has brought researchers to use the term integration. This concept emphasizes the creation of new insights or solutions that cannot be achieved by relying on a single discipline alone. Bethany Laursen and Michael O'Rourke (2019) have examined integration in interdisciplinary and transdisciplinary research, drawing heavily on the work by Julie Thompson Klein. They insist on the importance of communication, and conceptualize integration as a process involving inputs, processing through integrative relations, and outputs, adaptable to various interdisciplinary contexts.

In the light of these elements, interdisciplinary integration does not necessarily entail multi-authorship. A single-authored paper can be interdisciplinary: the author may have expertise, training and background in multiple fields and incorporate methodologies, theories, or data from different disciplines to address a complex research question, and/or might have consulted or collaborated informally with experts from different disciplines, drawing on their input to enrich the paper's content. In this sense, the key is not the number of authors but the diversity of disciplines that contribute to the research question, approach, and analysis within the paper. However, the bibliometric data available for this study do not allow for assessing the degree of integration of different disciplines within the collective projects observed. Consequently, the degree of "real" interdisciplinarity as opposed to multidisciplinarity cannot be estimated. This precaution needs to be highlighted before we go any further.

Research Results

Co-Authorship

Co-authorship has become increasingly prevalent across disciplines, reflecting the collaborative nature of modern research. Research (Wagner & Leydesdorff, 2005; Wuchty, Jones & Uzzi, 2007) suggests that team-authored papers grow at a higher rate than single-authored papers across most scientific fields. Fields such as physics, biology, and environmental science often exhibit higher co-authorship rates due to the nature of the research requiring specialized equipment, large datasets, and interdisciplinary expertise. While traditionally having fewer co-authored papers, fields such as sociology and psychology have also seen an increase in co-authorship, driven by the growing

complexity of research questions and the need for diverse methodological approaches (Endersby, 1996), but also the role of funding regimes in supporting—and even mandating—engagement with these questions.

Co-authorship not only acknowledges the collective effort involved in research but also contributes to a more dynamic and interconnected academic environment. It fosters collaboration by allowing experts from different disciplines to share their insights and skills, leading to more comprehensive and innovative research outcomes. It provides opportunities for networking and professional growth, enabling researchers to establish and strengthen relationships with peers, which can lead to future collaborations. For early-career researchers, co-authorship with established scholars can be particularly valuable, offering mentorship and increasing their exposure in the field. Moreover, co-authorship seems to enhance the credibility, visibility and impact of the research, as mentioned before. Research scholars investigate patterns of co-authorship and features such as the role of the order of authors (Drongstrup, 2021) or the structure of co-authorship networks (Savić, et al., 2019). Needless to say, of course, that while multi-authored papers reflect positive trends in collaboration, they also present challenges, such as the complexity of coordinating work among multiple authors, managing differing opinions, and ensuring that all contributors receive appropriate credit.

Multi-authored publications were a dominant feature in the LUE IMPACT projects, indicating a growing trend towards collaboration among researchers. As Figure 1 clearly demonstrates, there has been a noticeable increase in multi-authored papers over the timeframe of the IMPACT framework, while single-authored papers have remained less frequent. This trend is consistent across all projects (for further details see dataset, Monnier, 2024). It suggests that research was less isolated, with fewer researchers working alone. The decline observed as of 2019 concerns both multi- and single-authored papers and is probably linked to the official termination of funding in 2020.

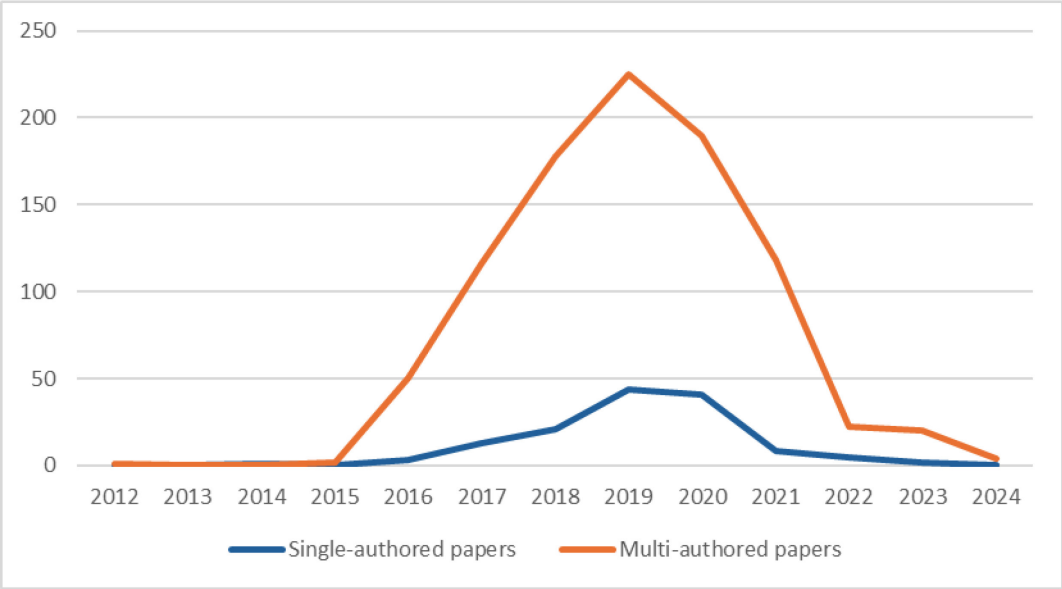

Figure 1. Evolution of LUE IMPACT multi-authored papers vs single-authored papers

The decision to co-author is influenced by various factors, including the desire to pool expertise, access resources, and increase the visibility and impact of research. However, co-authorship is not just a strategic choice; as mentioned above, it also represents a form of proximity between researchers: organizational, cognitive, etc. Could this dominance of multi-authored papers indicate cross-laboratory and interdisciplinary collaborations?

Organizational Proximity

Indeed, Figure 2 depicts the steady rise in cross-laboratory publications, which indicates a growing trend towards collaboration across different research units within the IMPACT projects. The laboratories involved are affiliated to the University of Lorraine or to other external institutions. This reflects the increasing complexity of research questions, which often require the expertise and resources of multiple laboratories but also the institution's strategic efforts to enhance research quality and innovation by fostering cooperation across different research units.

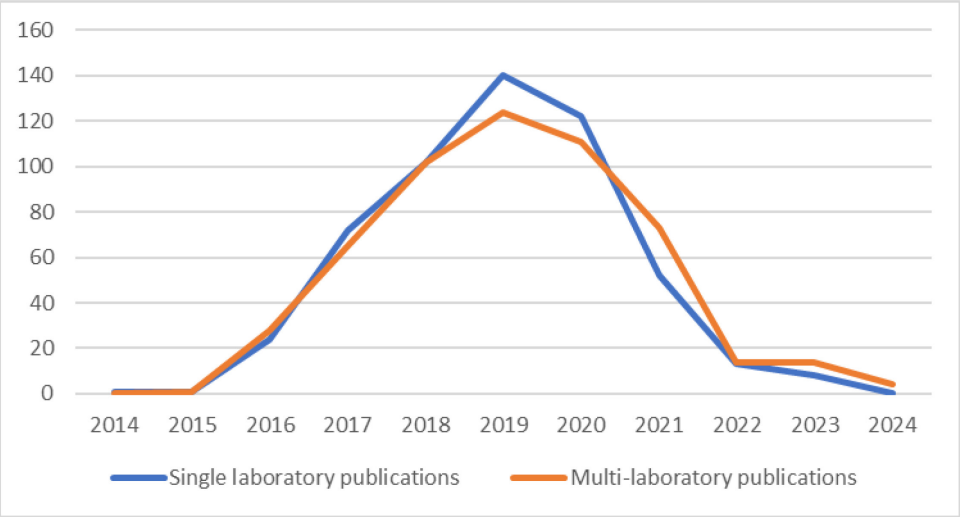

Figure 2. Plurilaboratory vs monolaboratory publications

However, monolaboratory publications have also risen during the same period following an almost identical curve. These publications typically indicate a focus on more specific or localized research goals that can be addressed within a single lab's resources and expertise, even if the latter involves multiple authors. In this sense, it is not possible to assert that organizational proximity or cross-laboratory publications prevailed across all IMPACT projects. Since the undeniable multi-authorship observed is neither totally intra- nor inter-laboratory, can interdisciplinarity shed light on this trend?

Cognitive Proximity in Terms of Disciplinary Field

Figure 3 depicts the overall evolution of multi-field versus mono-field publications within the seven projects of the LUE IMPACT program. We observe that monodisciplinary publications, while still present, are less dominant, with a noticeable importance of multidisciplinary research.

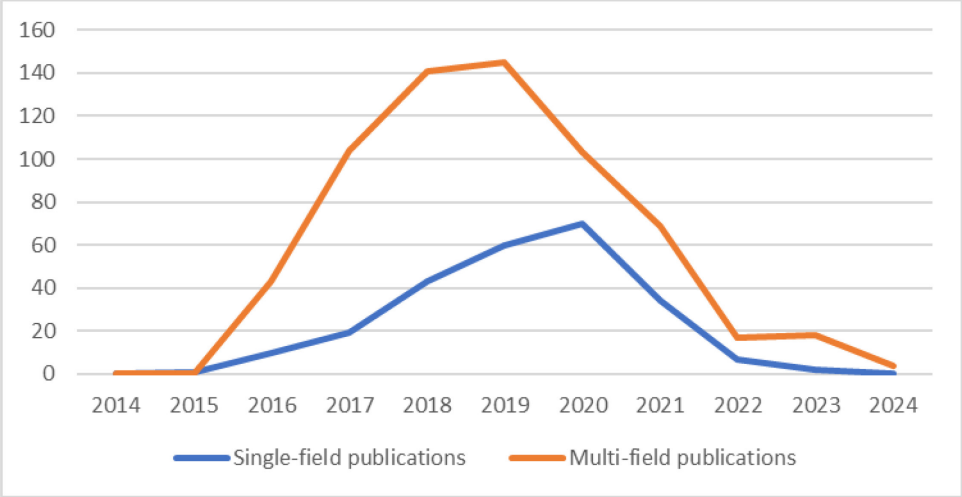

Figure 3. Multidisciplinary vs monodisciplinary publications in terms of field

This trend certainly suggests that researchers are recognizing the value of integrating knowledge from different fields to generate more comprehensive and innovative solutions. The shift towards multidisciplinary research probably also reflects institutional strategies aimed at promoting interdisciplinary collaboration. Universities such as Université de Lorraine are actively encouraging researchers to engage in projects that cross traditional disciplinary boundaries, in line with broader academic trends.

Cognitive Proximity in Terms of Disciplinary Domain

However, when we look into domain associations, the results bring us to a more nuanced conclusion. As Figure 4 illustrates, monodomain publications undoubtedly prevail. This pattern indicates that while researchers engaged with a range of disciplines, they tended to collaborate with peers whose expertise lied within a similar overarching domain.

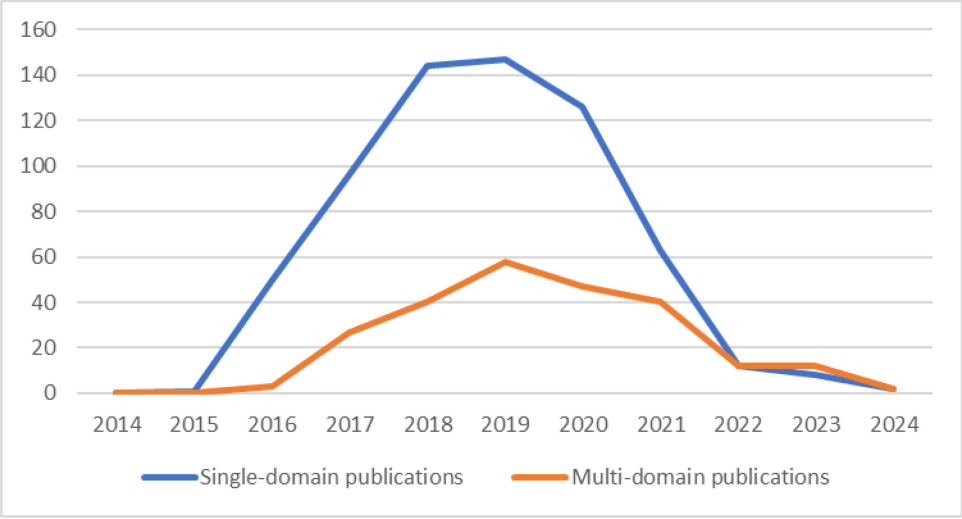

Figure 4. Multidisciplinary vs monodisciplinary publications in terms of domain

EXTENSIONS AND DISCUSSIONS: "OPTIMAL" INTERDISCIPLINARITY BETWEEN EQUILIBRIUM AND DISEQUILIBRIUM

Figure 5 illustrates the difference between the overall amount of multidimensional publications (multi-author, multi-laboratory, multi-disciplinary field, multi-disciplinary domain) and monodimensional publications (single-author, single-laboratory, single-disciplinary field, single-disciplinary domain, respectively). It reveals the dominance of the practice of multi-authorship in general, as well as, to a lesser extent, that of multi-disciplinarity in terms of fields: the difference between multi-author and mono-author papers is positive and significant, and so is the gap between multi-field and mono-field publications. On the contrary, the numeric difference between multi-laboratory and mono-laboratory publications is very small, as both practices are equally implemented. Finally, the distance is negative when it comes to comparing multi-disciplinary domain publications with single-disciplinary domain ones, confirming our results that disciplinary proximity limits the scope of multidisciplinarity.

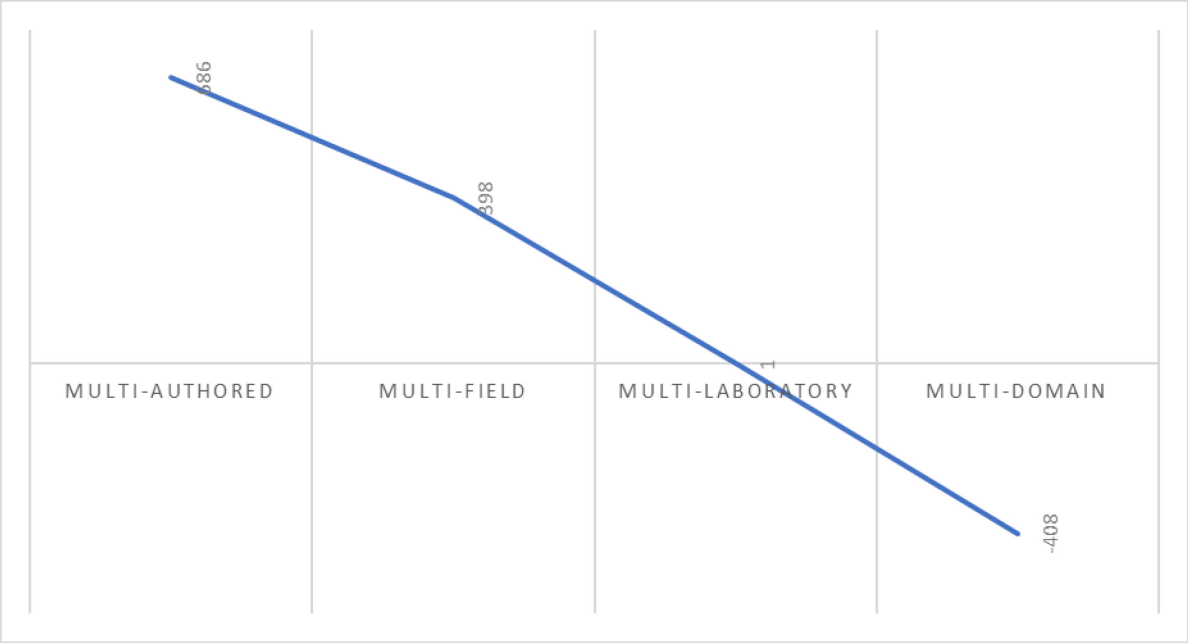

Figure 5. The dynamics of connectivity: difference between the "multi-" and the "mono-"

Table 2 presenting collaborative outputs in terms of percentages of overall production within each project generally consolidates these findings, even though divergences between the projects are observed, refining the research results.

Table 2. The place of multi-authored/laboratory/field/domain publications in each project (percentage of total output)

Name of Project	*Multiauthored p*	*Multilaboratory p*	*Multifield p*	*Multidomain p*
BIOMOLECULES	97,30%	50,89%	87,85%	71,03
DEEPSURF	87,76%	62,80%	82,67%	44,00
DIGITRUST	82,35%	85,06%	32,08%	13,21
GEENAGE	94,29%	34,17%	50,49%	47,09
N4S	90,14%	49,08%	84,23%	5,88
OLKi	60,15%	38,81%	52,17%	26,09
ULHyS	88,88%	61,11%	76,92%	0,00

This tendency to collaborate within broad domains reflects both the comfort and familiarity researchers have with their established networks and the structural barriers that may exist across different scientific cultures. As Cannataro has underscored (2020), the relevance of cognitive proximity lies in the ability to transfer and absorb knowledge. In order for two actors to learn from each other and absorb new knowledge, their cognitive bases and expertise should be close enough: there needs to be an optimal level of cognitive proximity between them (Boschma, 2005). The lack of overlap between knowledge bases hinders the ability of two actors to interact efficiently and meaningfully. Differences in terminology, methodologies, and research priorities, as well as the focus on "research performance" (Rafols, et al., 2012) can create challenges for cross-domain collaboration, leading to a preference for collaboration with colleagues who share a more similar epistemic background. As a result, while multidisciplinary publications may technically span multiple disciplines, they often do not necessarily reveal cross-domain innovation and knowledge exchange.

Moreover, a closer look into the specific disciplinary domains that were represented in our dataset reveals a clear imbalance between them. Figure 6 illustrates the weight of the disciplinary domains (social sciences/SS, physical sciences/PS, life sciences/LS, health sciences/HS) and the connections between them, measured in terms of co-occurrence in publications. Larger circles represent entities with higher significance, while the thickness of their links indicate the frequency of their co-occurrence. It becomes obvious that, within the LUE IMPACT initiative, physical sciences (chemistry, engineering, computer science, etc.) were globally prominent, whilst life sciences (neuroscience, biology, etc.) and health sciences (medicine, health professions, etc.) were strongly connected. On the contrary, the domain of social sciences (arts and humanities, psychology, economics, business management, etc.), hardly visible in the illustration, is marginal not only in terms of its weight but also in terms of its links to the other domains.

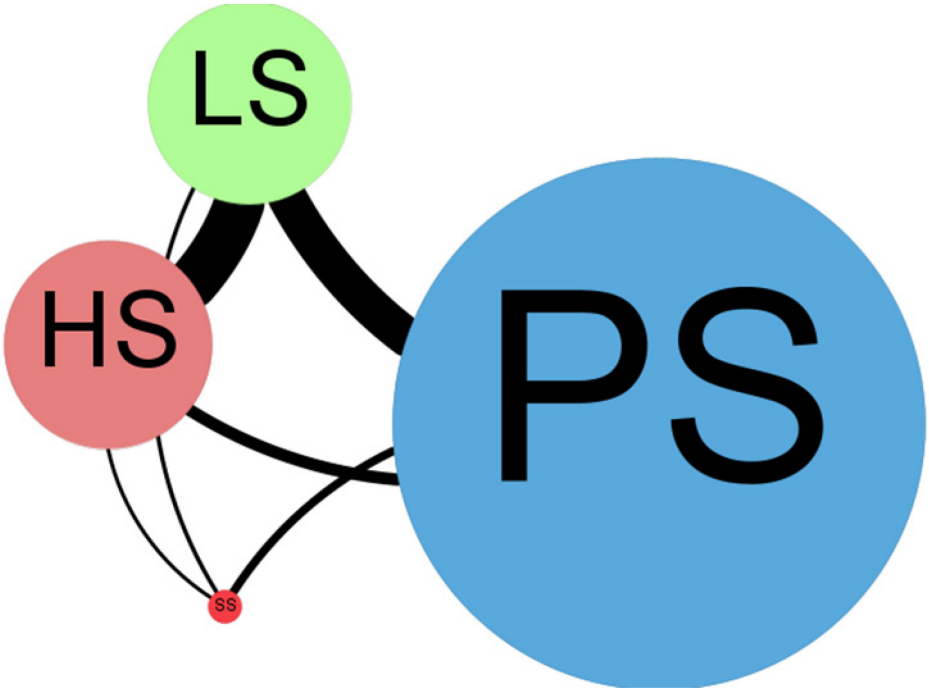

Figure 6. The weight of the disciplinary domains and their connections: Social Sciences (SS), Physical Sciences (PS), Life Sciences (LS), Health Sciences (HS)

One could argue, of course, that the design of a collaborative project, i.e. the disciplines, laboratories and researchers involved, predetermine, at least up to a certain extent, the scope of its collaboration dynamics and outcomes. This is true. We could reasonably also assume, however, that even these collaborations are also decided on the basis of existing affinities, defined, among others, by social, organizational and cognitive proximity. In other words, proximity remains an important factor, even though other parameters may intervene in the design of a research consortium. It has been demonstrated, for example, that the integration of humanities and social sciences (HSS) in funding for interdisciplinary research often confronts various barriers (Pedersen, 2016), institutional and political, but also psychological, among which is distrust. One reason for this seems to be a widely-held idea that HSS's public task is to unmask power structures, offering less "tangible" outcomes. Another reason would be the lack of institutional power to engage in practical discussions on policy problems (Brom, 2019).

Irrespective of the moment when interdisciplinary collaboration is designed or the reasons behind it, it seems that a certain search for an "optimal" level of proximity, in the name of diversity but also coherence (Rafols & Meyer, 2010), always takes place. However, optimal equilibrium still entails disequilibrium. This paradox reflects the complex and dynamic nature of interdisciplinary work, where balance and imbalance coexist.

CONCLUSION

Our research aimed to study collaboration dynamics within the LUE IMPACT projects at University of Lorraine, France, during their trial period (2014-2024). It focused on

publications indexed in HAL and OpenAlex, analysing them in terms of the number of authors and laboratories involved, as well as related disciplines. We have overall observed a general increase in cross-laboratory and multi-authored publications, along with a shift towards more multi-field research. The study highlights the general successful integration of multi-authored research within the LUE IMPACT projects, a key goal of the program. The shift from monodisciplinary, single-author papers to multidisciplinary, multi-author and cross-laboratory collaborations suggests a dynamic research environment that is increasingly focused on addressing complex, real-world problems through collective efforts across various fields and institutions. This increase aligns with the strategic goals of the Lorraine University of Excellence to foster interdisciplinary research and collaboration, and suggests that the University's initiatives to encourage inter-laboratory cooperation are yielding positive results.

However, and more particularly, our research has also shown that multi-authored, and—to a lesser degree—multi-field publications prevailed in the LUE IMPACT projects, much more than multi-laboratory publications. Multidisciplinarity often remained circumscribed within broad scientific domains. In this sense, narrow interdisciplinarity appeared to be the "optimal level" of disciplinary collaboration; but this equilibrium turned out to cover an underlying disequilibrium among discipline domains, with Social Sciences occupying a marginal place.

As mentioned before, the bibliometric data available for this study do not allow for assessing the degree of interdisciplinary integration of different disciplines within the collective projects observed, such as the role of spillovers and precise cognitive influences that may have occurred among researchers from different disciplines. Furthermore, other typologies of interdisciplinarity contest the simple distinction between narrow and broad interdisciplinarity, highlighting other modes of integration: integrative-synthesis, subordination-service, agonistic-antagonistic (Barry, Born & Weszkalnys, 2008). Even so, studying the dynamics of collaborative research through publications has provided insights into how knowledge is generated and disseminated, highlighting the synergies created when researchers collaborate. Understanding these dynamics can inform institutional policies and funding strategies, promoting more effective and impactful research partnerships. By further examining publication data, scholars and policymakers can also identify influential networks and collaborations, leading to better resource allocation and support for emerging research areas.

ACKNOWLEDGEMENTS

I am extremely grateful to the Research Data Support Service and the Bibliometrics Unit of Université de Lorraine, in particular Maxime Raty, who generously responded to my solicitations and provided the necessary data for this study. I would also like to thank the anonymous reviewers for their insightful feedback which has helped refine my arguments and strengthen the clarity of the findings.

REFERENCES

Barry, A., Born, G., & Weszkalnys, G. (2008). Logics of interdisciplinarity. *Economy and Society*, 37(1), 20–49. https://doi.org/10.1080/03085140701760841

Boschma, R. (2005). Proximity and innovation: A critical assessment. *Regional Studies*, 39(1), 61-74.

Bozeman, B. & Corley, E. (2004). Scientists' collaboration strategies: Implications for scientific and technical human capital. *Research Policy*, 33(4), 599–616. https://www.sciencedirect.com/science/article/abs/pii/S0048733304000162

Bracco, L. (2022). Mesurer l'ouverture de la science : le cas de l'Université de Lorraine. *Revue française des sciences de l'information et de la communication*, 24. https://doi.org/10.4000/rfsic.12474

Brom, F.W.A. (2019). Institutionalizing applied humanities: enabling a stronger role for the humanities in interdisciplinary research for public policy. *Palgrave Communications*, 5, 72. https://doi.org/10.1057/s41599-019-0281-2

Broström, A. (2010). Working with Distant Researchers—Distance and Content in University–Industry Interaction. *Research Policy*, 39(10), 1311-1320.

Cannataro, L. (2020). *Understanding proximity in research consortia*. Master's thesis, Uppsala Universitet. https://www.diva-portal.org/smash/get/diva2:1448601/FULLTEXT01.pdf

Condee, W. (2016). The Interdisciplinary turn in the Arts and Humanities. *Issues in Interdisciplinary Studies*, 34, 12–29. https://interdisciplinarystudies.org/wp-content/issues/vol34_2016/02_pp_12-29.pdf

Cummings, J. N., & Kiesler, S. (2005). Collaborative research across disciplinary and institutional boundaries. *Social Studies of Science*, 35(5), 703–722. https://journals.sagepub.com/doi/abs/10.1177/0306312705055535

Drongstrup, D. (2021). 5.9 Bibliometrics and Co-Authorship. In R. Ball (Ed.), *Handbook Bibliometrics* (pp. 397-406). Berlin, Boston: De Gruyter Saur. https://doi.org/10.1515/9783110646610-037

Endersby, J.W. (1996). Collaborative Research in the Social Science: Multiple Authorship and Publication Credit. *Social Science Quarterly*, 77(2), 375-392.

Frodeman, R., Klein, J. T., & Mitcham, C. (Eds.) (2010). *The Oxford Handbook of Interdisciplinarity*. Oxford University Press.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. Sage Publications.

Gilly, J. P. & Torre A. (2000). Proximity relations. Elements for an analytical framework. In M.B. Green, & R.B. McNaughton (Eds), *Industrial Networks and Proximity* (pp. 1–16). Ashgate, Aldershot.

Huutoniemi, K.I., Klein, J.T., Bruun, H., & Hukkinen, J.I. (2010). Analyzing interdisciplinarity: typology and indicators. *Research Policy*, 39(1), 79–88. https://doi.org/10.1016/j.respol.2009.09.011

Katz, J.S., & Martin, B.R. (1997). What is research collaboration? *Research Policy*, 26(1), 1-18. https://doi.org/10.1016/S0048-7333(96)00917-1

Kelly, J.S. (1996). Wide and narrow interdisciplinarity. *The Journal of Education*. 45, 95–113. https://www.jstor.org/stable/27797294

Klein, J.T. (1990). *Interdisciplinarity: History, Theory, and Practice*. Wayne State University Press.

Klein, J.T. (2005). *Humanities, Culture, and Interdisciplinarity: The Changing American Academy*. SUNY Press, Albany.

Larivière, V., Gingras, Y., Sugimoto, C. R. et Tsou, A. (2015a). Team size matters: Collaboration and scientific impact since 1900. *Journal of the Association for Information Science and Technology*, 66(7), 1323-1332. https://asistdl.onlinelibrary.wiley.com/doi/full/10.1002/asi.23266

Larivière V., Haustein S., & Börner K. (2015b). Long-distance interdisciplinarity leads to higher scientific impact. *PLoS One*, 10(3). https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0122565

Laursen, B.K., & O'Rourke, M. (2019). Thinking with Klein about Integration. *Issues in Interdisciplinary Studies*, 37(2): 33-61. https://interdisciplinarystudies.org/wp-content/issues/vol37_2019_No2/05_Vol.37_No.2_pp_33-61_Laursen_O'Rourke.pdf

Mattes, J. (2012). Dimensions of Proximity and Knowledge Bases: Innovation between Spatial and Non-spatial Factors. *Regional Studies*, 46(8), 1085-1099. https://doi.org/10.1080/00343404.2011.552493

McNutt, M.K., Bradford, M., Drazen, J.M., Hanson, B., Howard, B., Jamieson, K.H., Kiermer, V., Marcus, E., Pope, B.K., Schekman, R., Swaminathan, S., Stang, P.J. & Verma, I.M. (2018). Transparency in authors' contributions and responsibilities to promote integrity in scientific publication. *Proceedings of the National Academy of Science*, 115(11): 2557–2560. https://pubmed.ncbi.nlm.nih.gov/29487213/

Miller, T. R., Baird, T. D., Littlefield, C. M., Kofinas, G., Chapin, F. S., & Redman, C. L. (2008). Epistemological Pluralism: Reorganizing Interdisciplinary Research. *Ecology and Society*, 13(2), 46. https://www.ecologyandsociety.org/vol13/iss2/art46/

Monnier, A. (2024). *A Bibliometric Review of LUE IMPACT PROJECTS (1st generation)*, Recherche Data Gouv. https://doi.org/10.57745/NNR7GP

Newman, M.E.J. (2001). The structure of scientific collaboration networks. *Proceedings of the National Academy of Sciences*, 98(2), 404-409. https://doi.org/10.1073/pnas.98.2.404

Nii A.A., & Dubé, L. (2018). Addressing Complex Societal Problems: Enabling Multiple Dimensions of Proximity to Sustain Partnerships for Collective Impact in Quebec. *Sustainability*, 10(4), 980. https://doi.org/10.3390/su10040980

Pedersen, D. (2016). Integrating social sciences and humanities in interdisciplinary research. *Palgrave Communications*, 2, 16036. https://doi.org/10.1057/palcomms.2016.36

Pohl, C., & Hadorn, G.H. (2008). *Principles for designing transdisciplinary research*. Munich: Oekom Verlag.

Porter, A.L. & Rossini, F.A. (1984). Interdisciplinary research redefined: multi-skill, problem-focused research in the STRAP framework. *R&D Management*, 14, 105–111. https://onlinelibrary.wiley.com/doi/10.1111/j.1467-9310.1984.tb01149.x

Rafols, I., Meyer, M. (2010). Diversity and network coherence as indicators of interdisciplinarity: case studies in bionanoscience. *Scientometrics*, 82, 263–287 (2010). https://doi.org/10.1007/s11192-009-0041-y

Rafols, I., Leydesdorff, L., O'Hare, A., Nightingale, P., & Stirling, A. (2012). How journal rankings can suppress interdisciplinary research: A comparison between innovation studies and business & management. *Research Policy*, 41(7), 1262-1282.

Raty, M. (2024). *Rapport bibliométrique. L'interdisciplinarité dans les publications du programme IMPACT de Lorraine Université d'Excellence*. Service Bibliométrie, Université de Lorraine.

Repko, A. F., & Szostak, R. (2017). *Interdisciplinary Research: Process and Theory* (3rd ed.). Sage Publications.

Savić, M., Ivanović, M., Jain, L.C. (2019). Co-authorship Networks: An Introduction. In: *Complex Networks in Software, Knowledge, and Social Systems*. Intelligent Systems Reference Library, vol. 148. Springer, Cham. https://doi.org/10.1007/978-3-319-91196-0_5

Schmitt, J.B., Goldmann, A., Simon, S.T., & Bieber, C. (2023). Conception and Interpretation of Interdisciplinarity in Research Practice: Findings from Group Discussions in the Emerging Field of Digital Transformation. *Minerva*, 61, 199–220. https://doi.org/10.1007/s11024-023-09489-w

Torre, A. & Rallet, A. (2005). Proximity and Localization. *Regional Studies*, 47–59. https://www.tandfonline.com/doi/abs/10.1080/0034340052000320842

Wagner, C.S., & Leydesdorff, L. (2005). Network Structure, Self-Organization and the Growth of International Collaboration in Science. *Research Policy*, 34(10), 1608-1618.

Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science*, 316(5827), 1036–1039. https://pubmed.ncbi.nlm.nih.gov/17431139/

Zuolo, E., Sauty, G., & Mereu, S. (2024). The Profession of Research Management and Administration in France. In S. Kerridge, S. Poli, & M. Yang-Yoshihara (Eds), *The Emerald Handbook of Research Management and Administration Around the World* (pp. 669–677). Emerald Publishing Limited. https://www.emerald.com/insight/content/doi/10.1108/978-1-80382-701-820231064/full/html

BIOGRAPHY

Angeliki Monnier is professor in Information and Communication Sciences, director of the Centre for Research on Mediations (CREM), a multidisciplinary research unit of more than 200 members, at Université de Lorraine, France. She has held leadership positions in cross-disciplinary research projects (EU Connect/European Commission, Erasmus, French-German National Research Agencies), and is currently co-director of the Centre for Interdisciplinary Research and Expertise on Transitions (CELEST), Université de Lorraine, coordinator of Axis 1 which focuses on the evolution of scientific practices (interdisciplinarity, participative research).

Accepting Editor: Les Labuschagne | Received: 5 December 2025 | Accepted: 5 March 2025.
Cite as: Monnier, A. (2025). Exploring the dynamics of collaborative research: Publication trends in the LUE IMPACT projects in France. *Journal of Research Management and Administration, 4*(1), 2025031101. https://doi.org/10.18552/jorma.v4i1.1205