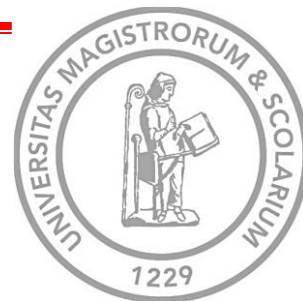




THÈSE de DOCTORAT

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Monsieur Carlos Alfredo PLATA JIMENEZ

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**Essays to better understand University-Industry
Collaborations**

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Thèse dirigée par :

Audrey Rouzies, Professeur des Universités, Université Toulouse Capitole

Eric Jolivet, Maître Conférences, Université Toulouse Capitole

Composition du jury

Rapporteur : Markus Perkmann, Professor, Imperial College London

Rapporteur : Caroline Hussler, Professeur des Universités, iaelyon School of Management

Examineur : Henry Etzkowitz, Professor, Stanford University, and Founder of the Triple Helix Society

Examineur : Quentin Plantec, Assistant Professor, TBS Education

Directeur de thèse : Audrey Rouzies, Professeur des Universités, Université Toulouse Capitole

Co-Directeur de thèse Eric Jolivet, Maître Conférences, Université Toulouse Capitole

*« L'université n'entend ni approuver ni désapprouver les
opinions particulières de l'auteur. »*

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This achievement has not as much individual merit as I once thought. While there is undoubtedly hard work at the individual level, the romanticized idea of a "Eureka moment" in my dorm room no longer holds true. Thankfully—or sadly—we are no longer in the 1900s, and this achievement would not have been possible without the support of many individuals.

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ABSTRACT

This dissertation explores the multifaceted dynamics of university-industry collaborations. Grounded in interdisciplinary theoretical frameworks, the research investigates how relational dynamics and institutional factors interact to shape the effectiveness of these collaborations across diverse geographical contexts: the United Kingdom, the European Union, and Latin America. Employing a mixed-methods approach that integrates qualitative insights from semi-structured interviews with quantitative analyses using advanced statistical methods and the development of a novel bibliometric tool (the Unity Index), the study uncovers that personal interactions and adaptations by academics are crucial for effective knowledge transfer. It also reveals that universities play a moderating role in enhancing innovation outcomes and that collaborations positively impact universities by strengthening internal capabilities, increasing financial support, and enhancing symbolic reputation. The findings offer valuable insights for academics, university administrators, industry practitioners, and policymakers, highlighting strategies to enhance collaboration effectiveness and foster innovation in an increasingly interconnected global landscape.

Keyword:

University-Industry Collaborations, Knowledge Transfer, Academics, Innovation

RESUME

Cette thèse explore les dynamiques complexes des collaborations entre universités et industries. S'appuyant sur des cadres théoriques interdisciplinaires, la recherche examine comment les dynamiques relationnelles et les facteurs institutionnels interagissent pour façonner l'efficacité de ces collaborations dans divers contextes géographiques : le Royaume-Uni, l'Union européenne et l'Amérique latine. En adoptant une méthodologie mixte intégrant des données qualitatives issues d'entretiens semi-structurés et des analyses quantitatives utilisant des méthodes statistiques avancées ainsi que le développement d'un outil bibliométrique novateur (Unity Index), cette thèse met en lumière l'importance des interactions personnelles et des adaptations des universitaires pour un transfert de connaissances efficace. Elle révèle également que les universités jouent un rôle modérateur en renforçant les résultats en matière d'innovation et que ces collaborations ont un impact positif sur les universités en renforçant leurs capacités internes, en augmentant les soutiens financiers et en améliorant leur réputation symbolique. Les résultats offrent des perspectives précieuses pour les universitaires, les administrateurs universitaires, les praticiens industriels et les décideurs politiques, en soulignant des stratégies pour améliorer l'efficacité des collaborations et favoriser l'innovation dans un paysage mondial de plus en plus interconnecté.

Mots-clés :

Collaboration Université-Industrie, Transfert de Connaissances, Universitaires, Innovation

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1. Research Context

1.1. Defining University-Industry Collaborations

University-industry collaborations refer to strategic partnerships between academic institutions and commercial enterprises to foster innovation, enhance research capabilities, and facilitate the transfer of knowledge and technology (Argote et al., 2000; Leischnig & Geigenmüller, 2020; Perkmann et al., 2013). These collaborations arise from mutual recognition of the complementary strengths of universities and industries: universities are centers of fundamental research and knowledge creation (Etzkowitz, 2004; Friedman & Silberman, 2003; Perkmann et al., 2011), while industries usually excel in applied research, development, and commercialization of new technologies and products (Colyvas & Powell, 2006; Friedman & Silberman, 2003; Penan, 1996).

At their essence, these collaborations are formal arrangements that enable the sharing of resources, expertise, and infrastructures to achieve common goals (Baglieri et al., 2018; Perkmann et al., 2013). They can take various forms, including joint research projects, consultancy services, technology licensing agreements, internships, and the establishment of research consortia or innovation hubs (Grimpe & Hussinger, 2013). Such partnerships are typically governed by agreements outlining each party's roles, responsibilities, intellectual property rights, and financial commitments, ensuring that the benefits and risks are equitably distributed (Neves & Brito, 2020).

A key objective of university-industry collaborations is the effective transfer of knowledge from the academic sphere to the industrial sector, this transfer involves the movement of ideas, research findings, and technical know-how, which can lead to the development of new products, processes, or services (Shane, 2002). The process is important because it bridges the gap between theoretical research and practical application, enabling innovations to reach the market more efficiently and benefiting society at large (Leischnig & Geigenmüller, 2020).

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These collaborations also enhance the relevance and impact of academic research by aligning it with real-world challenges and industrial needs, by engaging with industry partners, universities can tailor their research agendas to address pressing technological problems, thereby increasing the likelihood of their findings being adopted and implemented (Hagen, 2008). Conversely, industries gain access to cutting-edge research, specialized equipment, and a pool of talented researchers and students, which can drive their innovation processes and competitive advantage (Perkmann et al., 2013) .

Furthermore, collaborations between universities and industries contribute significantly to human capital development (Fromhold-Eisebith & Werker, 2013). They provide opportunities for students and academic staff to gain exposure to industrial practices, enhancing their skills and employability (Schartinger et al., 2002). Such interactions foster an exchange of ideas and perspectives, enriching educational experience and cultivating a workforce better equipped to meet the demands of a rapidly evolving economy.

1.2.Types of University-Industry Collaborations

University-industry collaborations can take various forms, each designed to leverage the unique strengths of academic institutions and industrial partners while achieving shared objectives. One common type is joint research projects, where universities and industry partners work together on research endeavors of mutual interest (Schartinger et al., 2002). These projects combine academic expertise in fundamental research with industry experience in practical applications, enabling them to tackle complex challenges more effectively than they could alone.

Sponsored research and contract research are also prevalent forms of collaboration. In sponsored research, an industry partner funds a university to investigate a specific topic, granting the sponsor certain rights to the results, such as early access to findings or licensing opportunities (Ankrah et al., 2013). Contract research involves the university conducting research services under the direct guidance and specifications

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of the industry partner (Lee & Win, 2004). Both models allow industries to utilize academic resources and expertise to advance their research and development goals.

Consultancy services represent another avenue of collaboration. University faculty and researchers provide expert advice to industry partners, offering solutions to specific problems without the need for long-term research projects (Grimpe & Hussinger, 2013). This arrangement benefits industries by granting access to cutting-edge academic knowledge, while universities strengthen industry ties and apply their expertise to real-world situations (Becerra et al., 2019).

Technology licensing and commercialization play a crucial role in transferring innovations from universities to the market. Universities license patented technologies or intellectual property developed through academic research to industry partners for commercialization (Chai & Shih, 2016). This process accelerates the transition of new technologies into commercially viable products, creating revenue streams for universities and competitive advantages for industries (Cesaroni & Piccaluga, 2016).

Internships and student placements are collaborations that provide practical experience for students within industry settings (Bercovitz & Feldman, 2006). These programs enhance students' skills and employability while offering industries fresh perspectives and access to emerging talent (Lin & Bozeman, 2006). Such collaborations also strengthen the connection between academic curricula and industry requirements.

Another significant form of collaboration is the creation of spin-offs and start-ups. Universities support forming new companies based on research outcomes or technologies developed within the institution (Crow et al., 2020). These ventures often involve partnerships with industry investors who provide capital, mentorship, and commercialization expertise. Collaborative consortia and research centers involve multiple universities and industry partners pooling resources to address broad research themes or sector-specific challenges (Mannak et al., 2019). Establishing

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dedicated research centers or institutes fosters long-term collaboration, interdisciplinary research, and shared use of specialized facilities, enhancing the participants' overall research capabilities.

Knowledge Transfer Partnerships are programs where a university and an industry partner collaborate on strategic projects. These partnerships typically involve a recent graduate working within the company under academic supervision (Rossi et al., 2017). They aim to improve business performance through innovation while providing practical experience for graduates and strengthening university-industry links (Perkmann et al., 2013).

Industrial chairs and fellowships involve industry partners funding academic positions within universities. Holders of these positions focus on research areas of mutual interest, fostering sustained collaboration and aligning academic research with industry priorities (Perkmann et al., 2011). This arrangement enhances the university's research capabilities and offers industries direct access to specialized expertise.

Sharing facilities and resources is another collaborative approach. Universities and industry partners may share facilities, equipment, or laboratories, allowing both parties to access advanced technologies and infrastructure that might be cost-prohibitive independently (Fromhold-Eisebith & Werker, 2013). This promotes efficient asset use and can accelerate research and development activities.

Continuing education and training programs are collaborations in which universities offer tailored education to meet the specific needs of industry partners (Jonbekova et al., 2020). These programs help companies improve their workforce with the latest knowledge and techniques while universities expand their educational impact.

The diversity of university-industry collaborations reflects the multifaceted nature of partnerships between academia and industry. By understanding and selecting the appropriate collaboration model, universities and industry partners can effectively address shared challenges, drive innovation, and contribute significantly to economic

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and societal advancement. These collaborations leverage collective strengths, fostering productive relationships that benefit all stakeholders involved.

1.3. Platforms of Exchange in University-Industry Collaborations

In the context of university-industry collaborations, platforms of exchange are the mechanisms and environments that facilitate interaction, communication, and collaboration between academic institutions and commercial enterprises (Perkmann et al., 2013). These platforms as the types of exchanges serve as essential bridges that connect the theoretical and research-oriented world of universities with the practical and application-driven sphere of industry (D'Este & Perkmann, 2011). By providing structured avenues for engagement, they enable the seamless transfer of knowledge, expertise, and technology, fostering innovation and mutual growth.

One of the most important exchange platforms is the establishment of technology transfer offices within universities, such as Toulouse Tech Transfer, these offices specialize in identifying research with commercial potential and managing the processes involved in protecting intellectual property, such as patenting and licensing (Baglieri et al., 2018). They act as intermediaries between university researchers and industry partners, helping to translate academic discoveries into marketable products and services (Berbegal-Mirabent et al., 2012). This structured approach ensures that valuable innovations do not remain confined within academic circles but are brought into the commercial domain where they can have a tangible impact. This platform also serves as the first proof of the university's commitment to the exchange of IP since the implementation of such an office often demands the use of resources in an exclusive way (Belitski et al., 2019).

Research parks and innovation hubs, such as Sophia Antipolis in the southeast of France, are physical platforms that co-locate university research facilities with industry offices and laboratories (Ng et al., 2019). By bringing together academics and industry professionals in a shared space, these environments encourage daily interactions, collaborative projects, and the spontaneous exchange of ideas. This proximity fosters

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a culture of innovation, where theoretical research can be rapidly aligned with practical applications, and industry challenges can directly inform academic inquiry (Barbini et al., 2021).

Digital platforms have also become increasingly significant as tools for exchange. Online portals, databases, and collaborative software allow for the sharing of research findings, data sets, and expertise across geographical boundaries (Albats et al., 2022). These digital environments facilitate open innovation, where universities and industries can co-create solutions to complex problems by leveraging a diverse pool of knowledge and perspectives (Gustina et al., 2024). Such platforms make it easier for small and medium-sized enterprises to access academic resources, democratizing the benefits of university-industry collaborations.

Conferences, seminars, business events, professional networks, and advisory board workshops serve as temporal platforms of exchange. These events bring together researchers, industry experts, policymakers, and other stakeholders to discuss recent developments, share insights, and explore opportunities for collaboration (Hughes & Kitson, 2012). They provide a forum for networking and can spark partnerships that extend beyond the event itself (Schaeffer et al., 2021). By facilitating face-to-face interactions, these gatherings help build the trust and understanding necessary for successful long-term collaborations.

Joint research centers represent one of the most formalized platforms where universities and industry partners commit to collaborative research agendas. These centers pool resources, share risks and align their strategic objectives to tackle specific scientific or technological challenges (Branson et al., 2002). These platforms often focus on long-term projects with significant potential for societal impact, such as sustainable energy solutions or advanced healthcare technologies (Moncada-Paternò-Castello et al., 2003), some examples founded by the European Union include the joint research center in Geel (Belgium) doing research on food safety or the joint research center in Karlsruhe (Germany) focusing on nuclear safety and security.

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In essence, platforms of exchange are vital for overcoming the barriers that traditionally separate academia and industry. They provide the infrastructure—both physical and virtual—that enables effective collaboration. By facilitating the flow of knowledge and resources, these platforms enhance the capacity of both universities and industries to innovate, adapt, and contribute meaningfully to economic development and societal well-being. They embody the recognition that complex challenges require cooperative efforts and that the synergy between theoretical research and practical application is essential for progress.

1.4. Knowledge Transfer Distinguishing Between Technology Transfer and Knowledge Transfer

When discussing university-industry collaborations, both technology transfer and knowledge transfer are crucial mechanisms that facilitate innovation and economic development (Perkmann & Walsh, 2007). While they are interconnected and sometimes used interchangeably, they represent distinct processes with different focuses and implications. Understanding the difference between them is essential to fully understand the dynamics of collaborative efforts between academic institutions and industry partners.

Technology transfer refers to the formal process of transferring tangible and codified technological innovations from universities to industry (Competence Centre on Technology Transfer, 2022). This typically involves the movement of physical assets or legally protected intellectual property, such as patents, prototypes, or specific technological solutions. The process is often transactional, governed by legal agreements defining ownership rights, licensing terms, and commercialization responsibilities (Sadaghiani & Jamali, 2012). Universities may license a patent to a company, for instance, allowing the company to develop and market a product based on university research. Technology transfer is asset-based; it deals with identifiable products or inventions that can be owned, sold, or licensed (Belitski et al., 2019).

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On the other hand, knowledge transfer encompasses the broader, more informal exchange of ideas, expertise, skills, and know-how between universities and industry. It involves the sharing of uncodified, tacit knowledge that resides within individuals or is embedded in organizational practices (Lockett, 2006; Lockett et al., 2008). Knowledge transfer can occur through various interactions, such as collaborative research projects, consulting engagements, workshops, conferences, internships, and informal networks (Fromhold-Eisebith & Werker, 2013; Hagen, 2008; Leischnig & Geigenmüller, 2020). Unlike technology transfer, knowledge transfer is not centered around specific assets or legal transactions. Instead, it focuses on the fluid movement of intellectual capital that enhances the capabilities and competencies of the receiving party (Bozeman, 2000).

The non-asset nature of knowledge transfer means that it does not involve the ownership or exchange of physical objects or legally defined intellectual property (Sung & Gibson, 2000). Rather, it is about disseminating understanding, insights, and skills that can inform decision-making, improve processes, and stimulate innovation within organizations. For example, when university researchers share their latest theoretical developments with industry professionals or when academic experts advise companies on best practices, they engage in knowledge transfer (Perkmann & Walsh, 2007). This process enriches the industry's knowledge base without the need for the transfer of tangible assets.

Moreover, knowledge transfer is often reciprocal and ongoing, fostering long-term relationships between universities and industry partners (Philbin, 2008). It contributes to capacity building, continuous learning, and the development of human capital. By emphasizing collaboration and the sharing of intellectual resources, knowledge transfer supports adaptability and innovation in a rapidly changing economic landscape.

In a nutshell, while technology transfer deals with the formal, asset-based movement of specific technologies and intellectual property from universities to industry,

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knowledge transfer involves the more fluid, non-asset-based exchange of expertise and understanding.

2. Research Object

University-industry collaborations have become increasingly significant in fostering innovation, driving economic growth, and solving complex societal challenges (Perkmann & Walsh, 2007). These partnerships leverage the unique strengths of each participant—academics, companies, and universities—to create a synergistic environment where theoretical knowledge meets practical application. Understanding the distinct roles and contributions of these key stakeholders is essential for maximizing the effectiveness of such collaborations. This section provides a comprehensive overview of the roles played by academics, companies, and universities, highlighting how their combined efforts facilitate collaborations, spur innovation, and contribute to mutual advancement.

2.1.1. *Companies*

Companies, as one of the major organizational actors in this partnership, play a significant role in these partnerships by providing practical insights, resources, and a market-oriented perspective that complements the theoretical and research-focused approach of universities (Etzkowitz & Leydesdorff, 2000). Their understanding of market needs, customer preferences, and industry trends enables them to identify practical applications for academic research (Hagen, 2008). By articulating real-world problems and technological gaps, companies guide academics toward research areas with high potential for commercial success and societal impact (Bercovitz & Feldman, 2006). This market-driven perspective ensures that collaborative projects remain relevant and aligned with current industry demands.

A key role of companies is to provide funding and resources necessary for conducting advanced research and development (Evans et al., 2023). Collaborations often require significant investment in equipment, materials, and personnel. Companies may offer

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financial support, access to specialized facilities, or in-kind contributions such as proprietary data and technologies (Perkmann & Walsh, 2007). This support not only accelerates the research process but also allows universities to undertake projects that might be beyond their budgetary constraints.

Companies also play a significant role in defining project objectives and outcomes within collaborations. Their input helps shape research agendas to address specific industry challenges and opportunities (Perkmann et al., 2013). By setting clear goals and deliverables, companies ensure that collaborative efforts are goal-oriented and result in tangible benefits. This alignment of expectations fosters a more productive partnership, where both academia and industry are working toward common objectives.

Through knowledge transfer platforms, companies facilitate the flow of information and expertise between industry and academia (Rybníček & Königsgreber, 2019). They may participate in joint research projects, workshops, and conferences, sharing proprietary knowledge that can enhance academic research (Grimpe & Hussinger, 2013). Companies also engage in collaborative publications and presentations, contributing to the broader dissemination of knowledge (Hagen, 2008). In some cases, they may license university-developed technologies, fostering innovation within their own organizations.

Strategic partnerships and networking are another area where companies play a crucial role. By connecting universities with other industry players, government agencies, and international partners, companies help expand the scope and impact of collaborative projects (Etzkowitz & Leydesdorff, 2000). These networks can lead to multidisciplinary and cross-sector initiatives that address complex global challenges (Guerrero & Urbano, 2012). They may also advocate for supportive policies and funding programs that facilitate university-industry collaborations.

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Despite the numerous benefits, companies navigate some challenges in these partnerships. Like academics, cultural differences between the corporate environment and academia can lead to misunderstandings and misaligned priorities, also they often operate under tight deadlines and competitive pressures, seeking immediate results, whereas academic research may have longer timelines (Hughes & Kitson, 2012; Miller et al., 2016; Siegel et al., 2003).

Moreover, companies need to address ethical considerations and regulatory compliance within collaborations. This includes adhering to research ethics, data protection laws, and industry-specific regulations, ensuring that collaborative activities meet all legal requirements and uphold high ethical standards to maintain trust and credibility (Kumar, 2010).

In conclusion, companies are indispensable partners in university-industry collaborations, bringing practical expertise, resources, and a market-oriented approach that enhances the relevance and impact of academic research. Their roles in funding, guiding research objectives, facilitating commercialization, and developing talent are crucial for the success of these partnerships. By effectively collaborating with universities, companies can drive innovation, gain a competitive edge, and contribute to societal advancement. Navigating the challenges inherent in these collaborations requires clear communication, mutual respect, and well-defined agreements, but the potential benefits for all parties involved are substantial.

2.1.1. Universities

Universities, as the second major organizational actor in this partnership, play a central and transformative role in university-industry collaborations, serving as hubs of knowledge creation, innovation, and talent development (D'Este & Patel, 2007; Etzkowitz & Leydesdorff, 2000). These institutions provide a vital foundation for advancing research that meets the demands of both academia and industry, fostering mutually beneficial partnerships that drive economic and societal progress (Perkmann et al., 2013).

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One of the primary roles of universities in these collaborations is as centers of knowledge creation. Through their rigorous academic research, universities generate knowledge that serves as the bedrock for industry innovation (Scott, 2006). This commitment to exploring and validating new ideas positions universities as indispensable contributors to the research and development efforts of their industry partners, allowing for a steady flow of cutting-edge findings and intellectual property (D'Este & Perkmann, 2011).

Universities are also instrumental in facilitating innovation and interdisciplinary research. By fostering an academic environment that values cross-disciplinary inquiry, universities encourage collaboration across various fields (Etzkowitz & Leydesdorff, 2000). This interdisciplinary approach enriches university-industry partnerships, as it enables industries to access diverse perspectives and novel solutions that it would be challenging to achieve within a single discipline. Universities often serve as conveners of knowledge, bringing together experts, researchers, and industry professionals to address multifaceted issues with comprehensive solutions (Hughes & Kitson, 2012).

Universities also play a significant role in facilitating knowledge transfer between academia and industry. Through joint research projects, publications, patenting, and licensing, universities enable industry partners to access and apply academic discoveries (Hagen, 2008; Heinzl et al., 2013; Schartinger et al., 2002). Many universities have established technology transfer offices or innovation hubs to support these efforts, helping to manage intellectual property, negotiate licensing agreements, and guide research with commercialization potential (Baglieri et al., 2018). These dedicated offices act as intermediaries, translating academic findings into market-ready technologies and supporting the creation of spin-offs and start-ups to bring research outcomes to the market.

Moreover, universities contribute to university-industry partnerships by offering research infrastructure and resources that may not be readily available in industry settings. Universities house specialized laboratories, equipment, and research facilities

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that are essential for conducting advanced research (Dias & Selan, 2023). In collaborative projects, industry partners can leverage this infrastructure to explore solutions without the need to invest in costly equipment or facilities of their own; accessing state-of-the-art resources allows industry partners to engage in high-risk, high-reward research that might otherwise be prohibitive (Bozeman et al., 2013).

In addition to these tangible contributions, universities bring a culture of inquiry and ethical responsibility to collaborations (Kumar, 2010). The academic commitment to critical thinking, peer review, and ethical standards ensures that research conducted within university-industry partnerships is rigorously evaluated and aligned with societal values.

However, universities face several challenges in navigating collaborations with industry. Differences in timelines and objectives can create tension; while industry may prioritize rapid, market-driven results, academic research often operates on longer cycles and focuses on fundamental questions. Intellectual property management is another critical area, requiring clear agreements to balance the academic emphasis on open knowledge dissemination with the industry's need for proprietary advantages. Addressing these challenges necessitates transparent communication, flexible frameworks, and a shared understanding of both parties' goals.

In conclusion, universities serve as foundational partners in university-industry collaborations, bringing knowledge creation, research infrastructure, and talent development to the partnership. Their roles in facilitating innovation, enabling knowledge transfer, and upholding ethical standards are essential for creating impactful and sustainable collaborations. By providing the resources, expertise, and environment needed to address complex problems, universities help drive progress and create lasting value for both industry and society. Through these partnerships, universities fulfill their mission to advance knowledge, enrich education, and contribute to the public good.

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2.1.2. *Academics*

University-industry collaborations have become important in fostering innovation, driving economic growth, and addressing complex societal challenges (Carayannis & Campbell, 2009). Central to these collaborations are academics, whose roles are multifaceted and instrumental in bridging the gap between theoretical research and practical application (Berbegal-Mirabent et al., 2013).

Academics serve as the primary creators and custodians of knowledge within universities. Through rigorous research and scholarly activities, they generate new insights, theories, and technologies that form the foundation for innovation (Hoc & Trong, 2019). In university-industry collaborations, academics leverage this expertise to address real-world problems faced by industry partners (Shane, 2002). Their deep understanding of fundamental principles allows them to contribute novel solutions and advance technological frontiers.

Innovation and problem-solving are central to the academic role in these partnerships. Academics approach challenges from a theoretical perspective, offering fresh viewpoints and alternative solutions that may not be immediately apparent to industry practitioners (Jonbekova et al., 2020). This intellectual diversity fosters a creative environment where innovative ideas can flourish. Moreover, academics can identify emerging trends and technologies, guiding industry partners toward future opportunities and helping them stay competitive in rapidly evolving markets (Rybníček & Königgruber, 2019).

In addition to research activities, academics play a significant role in teaching and training. They are responsible for educating the next generation of professionals and equipping students with the knowledge and skills required by industry (Scott, 2006). Through collaborations, academics can align curricula with industry needs, ensuring that graduates are prepared to contribute effectively to their careers (Jones & Coates, 2020). Also, they often facilitate internships, co-op programs, and project-based

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learning opportunities, providing students with practical experience while supplying industry with fresh talent (Bercovitz & Feldman, 2006; Lin & Bozeman, 2006).

However, challenges exist in these collaborations. Cultural differences between academia and industry can lead to misaligned expectations and communication difficulties. Academics may prioritize knowledge dissemination and theoretical advancement, while industry partners focus on practical applications and confidentiality (Baldini, 2009). Intellectual property issues can pose significant barriers, requiring careful negotiation to balance the interests of both parties (Perkmann et al., 2013). Time constraints and differing project timelines can further complicate collaborations, as academic research may not align with industry deadlines.

Accordingly, academics play a pivotal role in university-industry collaborations by acting as conduits of knowledge transfer. Their contributions to research, innovation, teaching, and problem-solving are essential in translating academic discoveries into practical applications that drive economic and societal progress. By navigating the challenges and leveraging the strengths of these partnerships, academics help forge a synergistic relationship between universities and industry, fostering an environment where knowledge and innovation thrive.

2.2. Research Questions

Many scholars have called for an in-depth investigation of university-industry collaboration processes and the development of integrative models that capture the complexities of knowledge transfer and innovation (Perkmann et al., 2013, 2021; Schaeffer et al., 2021; Van Rijnsoever & Hessels, 2021). Despite extensive studies on the antecedents and outcomes of these collaborations, the roles of academics and the multifaceted dynamics involving intangible knowledge and institutional factors remain underexplored. This gap in the literature highlights the need to examine how individual and organizational elements interact within university-industry partnerships to influence knowledge transfer effectiveness and innovation outcomes.

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The baseline research question of this dissertation is: How do the relational dynamics involving academics and firms, on the one hand, and the institutional and structural factors influencing university-industry collaborations shape the processes and outcomes of U-I Collaborations and innovation?

Acknowledging the critical role of academics in university-industry collaborations (D'Este & Perkmann, 2011; Perkmann & Walsh, 2007), this research seeks to explore the relational dynamics that shape these partnerships. The traditional focus on institutional and organizational levels often overlooks the individual agency of academics, who are pivotal in bridging theoretical research and practical application. Hence, the first sub-question in chapter 3 is: How do the adaptations and approaches employed by academics, particularly in managing intangible knowledge, influence the effectiveness of university-industry collaborations?

This inquiry is justified because academics often need to adapt their communication styles, negotiation strategies, and engagement methods to align with industry practices (Tartari & Breschi, 2012). Intangible knowledge, such as tacit expertise and know-how, plays a significant role in knowledge transfer but is challenging to codify and transmit (Nonaka & Teece, 2001). Understanding how academics navigate these challenges and facilitate the transfer of intangible knowledge is crucial for enhancing collaboration effectiveness and innovation outcomes.

In terms of relational dynamics, this dissertation aims to focus on the interactions between academics and industry partners, the mechanisms of intangible knowledge transfer, and the adaptations academics make to bridge cultural and organizational gaps. All these relationships may be active before, during, and after collaboration initiatives. By examining these relationships, the study seeks to identify the factors that facilitate or impede effective knowledge exchange and how individual agency contributes to successful collaborations.

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Recognizing that university-industry collaborations are influenced by a myriad of institutional and structural factors (Perkmann et al., 2021), the research in chapter 6 addresses the second sub-question: How do institutional dynamics, such as financial resources, internal capabilities, and symbolic reputation, interact with university-industry collaborations to impact innovation processes and outcomes?

This perspective is essential because collaborations do not occur in isolation but are embedded within broader institutional contexts that shape their effectiveness (Etzkowitz & Leydesdorff, 2000; Perkmann et al., 2011). Factors like financial support, organizational capabilities, and institutional prestige can significantly influence the ability of universities and industries to engage in productive partnerships (Hazelkorn, 2015). Moreover, the non-linear relationships among these factors can create complex dynamics that affect innovation outcomes in unpredictable ways.

In terms of institutional dynamics, this dissertation's objective is to focus on how collaborations influence and are influenced by factors such as innovation expenditure, the internal capabilities of universities, access to financial support, and the symbolic reputation of institutions. By exploring these interactions, the study aims to understand how institutional resources and constraints shape the processes and outcomes of university-industry collaborations.

By integrating the examination of relational dynamics involving academics and the institutional factors affecting collaborations, this research provides a comprehensive view of the mechanisms that shape knowledge transfer and innovation processes. The extended view accounting for both relational and institutional dynamics allows for a global understanding of how university-industry collaborations function and evolve. Understanding both the individual and institutional levels is crucial for developing effective strategies to enhance collaboration effectiveness, drive innovation, and contribute to economic and societal advancement.

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2.3.Epistemological Positioning

Positivism and interpretivism are the most used paradigms in organizational and management scholarship (Creswell & Plano Clark, 2018), but this dissertation adopts a pragmatist epistemological stance, reflecting a commitment to practical outcomes and the applicability of knowledge to real-world challenges. Pragmatism, as an epistemology, emphasizes that the value of ideas and theories lies in their usefulness and practical consequences (Easterby-Smith et al., 2015). It moves beyond the dichotomy of positivism and interpretivism by focusing on the problem at hand and selecting methodologies best suited to address it, regardless of traditional philosophical boundaries (Johnson & Onwuegbuzie, 2004).

In the context of this research, pragmatism provides a flexible and integrative framework that accommodates both quantitative and qualitative methodologies (Creswell & Creswell, 2013). The complex nature of university-industry collaborations, knowledge transfer mechanisms, and innovation processes necessitates a multifaceted approach (Schaeffer et al., 2021). By embracing pragmatism, the dissertation leverages the strengths of different research methods to gain a comprehensive understanding of these phenomena and to develop actionable insights.

The mixed-methods approach employed in this dissertation is a direct reflection of its pragmatist approach. Quantitative methods present in chapters 1 and chapters 4 to 6 are utilized to identify patterns, test hypotheses, and establish generalizable findings across large datasets. These methods align with positivist traditions by seeking objective measurements and causal relationships, and simultaneously, qualitative methods, present in Chapter 3, provide rich, contextual insights into the experiences, motivations, and strategies of individuals involved in university-industry collaborations (Johannesson & Perjons. This interpretivist element recognizes the subjective and socially constructed aspects of human behavior and organizational dynamics (Leitch et al., 2010). By understanding the nuanced roles and adaptations of

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academics, the research uncovers practical ways to enhance collaboration effectiveness.

The pragmatist epistemology prioritizes the research questions and their practical implications over strict adherence to a single methodological paradigm. It allows for methodological pluralism, selecting tools and techniques based on their efficacy in addressing specific aspects of the problem (Creswell & Plano Clark, 2018). This flexibility is essential when exploring the multifaceted and interconnected factors influencing university-industry collaborations, such as academic workload, administrative support, institutional reputation, and regional innovation dynamics.

Moreover, this dissertation's pragmatism is evident in its focus on generating tangible benefits for stakeholders. The findings are not merely theoretical contributions but are intended to inform policies, strategies, and practices that can enhance the effectiveness of collaborations between academia and industry. For example, the insights gained from analyzing the moderating role of university cooperation on innovation outcomes in Latin America offer practical guidance for policymakers and business leaders seeking to maximize the impact of innovation expenditures through strategic partnerships.

The theoretical frameworks employed—Evolutionary Economic Theory (Nelson, 1987), Resource-Based Theory (Barney et al., 2021), and Actor-Network Theory (Callon, 1984; Latour, 2007) under the umbrella of the Triple Helix model (Etzkowitz & Leydesdorff, 2000)—are applied pragmatically to interpret empirical findings and to understand the mechanisms driving innovation and collaboration. Rather than being the sole focus, these theories serve as lenses through which practical solutions can be developed and implemented. This application-oriented use of theory aligns with the pragmatist emphasis on the utility of knowledge.

Additionally, the pragmatist stance supports the consideration of context-specific factors, recognizing that the applicability of findings may vary across different settings

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(Creswell & Creswell, 2018). The regional analysis of Latin American innovation dynamics, for instance, considers the unique socio-economic conditions, institutional structures, and cultural factors that influence university-industry collaborations in that context. This sensitivity to context enhances the relevance and applicability of the research outcomes.

By adopting a pragmatist approach, the dissertation also acknowledges the evolving nature of knowledge and the importance of adaptability. It recognizes that university-industry collaborations and innovation processes are dynamic and influenced by technological advancements, economic shifts, and changing societal needs. The research is, therefore, designed to be responsive to these changes, offering insights and recommendations that can be adapted as circumstances evolve.

3. Methodological Choices

This dissertation adopts a mixed-methods research design that integrates both qualitative and quantitative methodologies. The selection of these methodological approaches, as said in section 2.3, is grounded in the pragmatist epistemological stance. By combining qualitative and quantitative methods, the study captures both the depth of individual experiences and the breadth of generalizable patterns.

3.1. Qualitative Approach

The choice of qualitative methods is driven by the need to gain deep, contextualized insights into the complex phenomena of university-industry collaborations, knowledge transfer mechanisms, and the roles of individual actors within these processes.

The primary qualitative methods utilized in this research are the conduct of semi-structured interviews with full-time management academics across various universities in Europe. These interviews are designed to explore the experiences, perceptions, and strategies of academics who engage in collaborations with industry partners. The semi-structured format allows for flexibility in questioning, enabling

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respondents to share their insights freely while ensuring that key topics are systematically addressed (Flick, 2023). This method facilitates the exploration of themes such as the adaptations academics make to foster effective collaborations, the challenges they face, and the influence of institutional factors like university prestige (Schaeffer et al., 2021).

The decision to employ qualitative interviews is rooted in the interpretivist paradigm, which emphasizes the importance of understanding the subjective meanings and social constructions that individuals attach to their experiences (Denzin & Lincoln, 2011). By capturing the perspectives of academics directly involved in knowledge transfer activities, the research delves into the human elements that drive collaboration practices. This approach acknowledges that university-industry collaborations are not solely governed by structural and institutional factors but are also shaped by personal motivations, relationships, and individual agency (Perkmann & Walsh, 2007).

Furthermore, the qualitative methodology aligns with the Actor-Network Theory (ANT) framework applied in the dissertation. ANT posits that social, technological, and organizational elements form networks where human and non-human actors interact to shape outcomes (Latour, 2007). Through qualitative interviews, the research examines how academics navigate these networks, negotiate roles, and mobilize resources to facilitate knowledge transfer. The rich, descriptive data gathered provides insights into the relational dynamics and networked interactions that are central to the ANT (Callon, 1994).

The qualitative methodological choice is further justified by the nature of the research questions posed in the dissertation, specifically in chapter 3, where the research question looks into the adaptations and approaches employed by academics, influence the effectiveness of university-industry collaborations. Qualitative methods are well-suited to capturing the complexities and subtleties inherent in these inquiries.

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Moreover, the qualitative approach contributes to the pragmatist epistemological stance of the dissertation by focusing on practical implications and real-world applications of the research findings. By understanding the lived experiences of academics and the intricacies of collaboration dynamics, the research generates actionable insights that can inform strategies for enhancing university-industry partnerships. It provides a basis for recommendations aimed at academics, university administrators, and policymakers, emphasizing the practical utility of the knowledge produced.

3.2. Quantitative Approach

This dissertation also employs a quantitative methodological approach as a component of its mixed-methods research design. The choice of quantitative methods is driven by the need to analyze large datasets, test hypotheses, identify patterns, and establish generalizable findings related to university-industry collaborations, innovation processes, and the factors influencing these phenomena. Quantitative methods complement qualitative insights by providing empirical evidence that can validate theories, support conclusions, and inform practical recommendations (Creswell & Creswell, 2018).

One of the quantitative methods employed is the use of neural network modeling to analyze complex relationships among variables influencing university-industry collaborations. Specifically, the research utilizes neural networks to examine factors such as academic workload, administrative support, scientific output, and university ranking impact collaboration dynamics. Neural networks are advanced computational models capable of identifying nonlinear and non-monotonic relationships within data, making them suitable for exploring intricate patterns that traditional linear statistical methods might overlook (Choudhury et al., 2021; Helfat et al., 2023; Kingma & Ba, 2014). By applying neural network analysis to datasets sourced from the HESA, SCIMAGO Rankings, and Clarivate Publications, the research uncovers important insights into the factors that facilitate or hinder effective collaborations.

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The choice of these quantitative methods is grounded in the positivist tradition, which emphasizes objectivity, measurement, and the testing of hypotheses through empirical observation (Kaplan, 2004). Quantitative methods are particularly well-suited for addressing research questions that seek to quantify relationships, assess the significance of effects, and generalize findings across populations. They enable the researcher to handle large datasets efficiently, apply rigorous statistical techniques, and derive conclusions that have a high degree of reliability and validity (Creswell & Creswell, 2018).

Data collection for quantitative analyses involves sourcing secondary data from reputable and comprehensive databases. For this case, I used HESA UK to provide detailed information on university performance metrics, including staffing levels, financial resources, and student enrollments (Sengupta & Ray, 2017). The SCIMAGO Rankings offer data on research output, citation impact, and institutional prestige (Hazelkorn, 2015) and the Clarivate Publications supplies extensive bibliometric information. The Latin American Innovation Survey captures firm-level data on innovation activities, expenditures, outcomes, and collaboration practices across several Latin American countries (Crespi et al., 2022).

The use of secondary data from these sources ensures that the research is based on accurate, up-to-date, and representative information. It allows for the analysis of large samples, enhancing the generalizability of the findings. Moreover, the diversity of data sources enables the examination of variables across different contexts and levels of analysis, from individual academics and universities to firms and national innovation systems.

In terms of data analysis techniques, the research employs a variety of statistical methods appropriate for the research questions and the nature of the data. Descriptive statistics are used to summarize and explore the data distributions (Kaplan, 2004). Inferential statistics, such as regression analysis, are applied to test hypotheses about relationships between variables (Saunders et al., 2019). Neural network models

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provide a sophisticated means of capturing complex, nonlinear interactions (Kingma & Ba, 2014). Moderation analysis with the PROCESS macro facilitates the examination of conditional effects and interactions between variables allowing researchers to explore whether the effect of an independent variable on a dependent variable changes at different levels of a third variable (the moderator) (Hayes, 2022).

The quantitative methodological choice is a fundamental aspect of this dissertation's research design. It enables the rigorous examination of relationships among key variables, the testing of theoretical propositions, and the derivation of generalizable findings. By employing advanced quantitative techniques and leveraging extensive datasets, the research provides robust empirical evidence that complements the qualitative insights, contributing to a comprehensive understanding of university-industry collaborations and innovation processes.

3.3. Empirical Context

3.3.1. United Kingdom

One of this dissertation's empirical investigations, in chapters 4 and 6 are rooted in the context of the United Kingdom (UK), a nation renowned for its robust higher education system and dynamic industrial landscape. The UK serves as an ideal setting for studying university-industry collaborations due to its well-established universities, diverse range of industries, and supportive governmental policies that foster innovation and partnerships between academia and the private sector (Hewitt-Dundas, 2012).

The UK's higher education sector is characterized by a rich diversity of institutions, ranging from ancient universities with centuries of tradition to modern institutions at the forefront of technological advancements (Focacci & Perez, 2022). This diversity provides a fertile ground for examining how varying institutional characteristics—such as size, research focus, funding structures, and prestige—influence the nature and effectiveness of collaborations with industry partners. Universities in the UK are

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known for their high-quality research output, international outlook, and significant contributions to global scholarship (Taylor, 2011), making them attractive collaborators for industries seeking innovation and expertise.

Data from this context was sourced from the reputable and comprehensive database compiled by the Higher Education Statistics Agency (HESA). The HESA provides detailed and standardized data on university performance metrics, staff and student demographics, financial information, and research activities (Sengupta & Ray, 2017) allowing an in-depth analysis of factors such as academic workload, administrative support structures, and institutional resources.

The UK's industrial sector is equally diverse and innovative, encompassing traditional industries like manufacturing, engineering, and agriculture, as well as cutting-edge sectors such as biotechnology, information technology, renewable energy, and creative industries (Becker et al., 2023). This industrial diversity facilitates an exploration of university-industry collaborations across various fields. The presence of technology clusters and innovation hubs, such as the "Golden Triangle" of London, Oxford, and Cambridge, further enhances opportunities for collaboration by bringing together leading universities and high-tech industries in proximity (Nature, 2005).

Additionally, governmental initiatives and policies in the UK actively promote university-industry engagement as a catalyst for innovation and economic growth (Bertoletti & Johnes, 2021). Programs like Innovate UK, Research Councils UK, and Knowledge Transfer Partnerships (KTP) provide funding, support, and incentives for collaborative projects between academia and industry. These initiatives aim to bridge the gap between research and application, encouraging universities to commercialize research findings and industries to invest in R&D activities (Vick & Robertson, 2018). The supportive policy environment creates an ideal context for studying the impact of administrative support and external incentives on the success of university-industry collaborations.

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Moreover, the UK context allows for an examination of the influence of institutional reputation and ranking on collaboration dynamics. With several UK universities consistently ranked among the top institutions globally (Scimago Institutions Rankings, 2024), the dissertation investigates how institutional factors affects the ability to attract and sustain partnerships with industry.

The UK's emphasis on research excellence, innovation, and knowledge transfer makes it a compelling empirical context for this dissertation. The combination of high-quality data sources, diverse institutional settings, and active policy support provides a comprehensive environment to explore the multifaceted factors influencing university-industry collaborations. Studying these dynamics within the UK not only yields insights pertinent to the national context but also contributes to the broader understanding of collaboration practices in developed economies.

3.3.2. European Union

This dissertation extends its empirical investigations in chapter 3 to include, to some extent, the broader context of the European Union (EU), a region characterized by its diverse array of higher education systems, industrial landscapes, and collaborative innovation initiatives (European Commission, 2024). The EU provides a compelling setting for studying university-industry collaborations due to its emphasis on fostering a knowledge-based economy, its commitment to research and development, and the implementation of policies designed to enhance cross-border cooperation among member states (Zabala-Iturriagoitia, 2022).

The EU comprises 27 member countries, each with its unique cultural, economic, and educational characteristics (European Union, 2024a). This diversity offers a rich tapestry of institutional environments and practices, enabling a comprehensive examination of how varying national policies, academic traditions, and industrial sectors influence university-industry collaborations (Cai, 2023). The EU's commitment to the free movement of people, goods, services, and capital facilitates cross-border

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collaborations, creating a dynamic environment for innovation and knowledge exchange (European Union, 2024b).

Data for this research incorporate insights from universities across multiple EU countries, including Germany, France, the Netherlands, Bulgaria, Austria, Norway, and Italy. These countries represent a mix of established and emerging economies within the EU, each contributing unique perspectives to the study. The inclusion of diverse educational institutions allows for an exploration of different collaboration models and strategies employed across Europe.

European universities are known for their strong emphasis on research excellence, internationalization, and collaboration. Many institutions participate actively in EU-funded research programs, such as Horizon 2020 and its successor Horizon Europe, which are designed to promote research and innovation across the continent (Ferrer-Serrano et al., 2021). These programs encourage universities to engage with industry partners and other stakeholders to address societal challenges and enhance Europe's global competitiveness (Perkmann et al., 2021). The availability of such funding mechanisms and collaborative platforms provides fertile ground for examining the impact of external support and policy incentives on innovative partnerships (Bertello et al., 2022).

Governmental policies at both the EU and national levels play a significant role in shaping the environment for university-industry collaborations. The European Commission promotes initiatives aimed at strengthening the European Research Area (ERA), fostering open science, and enhancing innovative ecosystems (European Commission. Directorate General for Research and Innovation., 2024). Policies such as the European Innovation Council (EIC) and the Strategic Energy Technology Plan (SET-Plan) are examples of efforts to integrate research, innovation, and industrial competitiveness. These policy frameworks provide context for analyzing how regulatory environments and strategic priorities influence collaboration practices.

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Furthermore, the EU's focus on addressing grand societal challenges — such as climate change, digital transformation, and health crises — encourages collaborative efforts that bring together academia, industry, government, and society (Branson et al., 2002). The Quadruple Helix Model (Carayannis & Campbell, 2009), an extension of the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), is increasingly relevant in the European context, emphasizing the inclusion of civil society in innovative processes. This broader approach underscores the importance of multi-stakeholder collaborations and provides an expanded framework for analyzing university-industry partnerships.

The empirical context within the EU also highlights the role of cultural factors in shaping collaboration dynamics. Differences in organizational cultures, communication styles, and expectations can impact the effectiveness of partnerships. By examining collaborations across various European countries, the research captures the specifics of how cultural diversity influences knowledge transfer mechanisms and the strategies employed by academics and industry professionals.

3.3.3. *Latin America*

This dissertation extends its empirical investigations in chapter 5 to Latin America, a region characterized by its vibrant economies, rich cultural diversity, and unique challenges and opportunities in innovation and university-industry collaborations (Miranda et al., 2020). Latin America provides a compelling and insightful setting for studying the dynamics of innovation processes, particularly in the context of developing economies striving to enhance their competitiveness in the global market.

Latin America encompasses a diverse group of countries, including Brazil, Mexico, Argentina, Colombia, Chile, and Peru, among others. These nations exhibit varying levels of economic development, industrialization, and technological advancement (Olavarrieta & Villena, 2014). Despite differences, they share common traits such as emerging markets, youthful populations, and a growing emphasis on education and innovation as drivers of economic growth (Lamy et al., 2021; Miranda et al., 2020). The region's socio-economic landscape offers a rich empirical context for analyzing how

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universities and industries collaborate to foster innovation and address developmental challenges.

Data for this research were sourced from the Latin American Innovation Survey (LAIS), a comprehensive database that captures detailed information on innovation activities within firms across several Latin American countries (Crespi et al., 2022). The LAIS provides insights into firms' innovation expenditures, outcomes, collaborative practices, and interactions with various stakeholders, including universities and research institutions.

Latin America's industrial sector is diverse, encompassing traditional industries such as agriculture, mining, and manufacturing, as well as emerging sectors like information technology, biotechnology, renewable energy, and services (Lall et al., 2004). Many firms in the region are small and medium-sized enterprises (SMEs), which are crucial for job creation and economic development but often face resource constraints that impact their innovation capacities (OECD et al., 2024). The presence of multinational corporations operating alongside local firms adds complexity to the industrial landscape, influencing collaboration patterns and technology transfer mechanisms.

Universities in Latin America are increasingly recognized as key players in national innovation systems, many institutions are enhancing their research capabilities, expanding graduate programs, and seeking greater engagement with industry and society (Olavarrieta & Villena, 2014). However, universities often find challenges such as limited funding, infrastructural constraints, and bureaucratic hurdles that can impede effective collaboration with industry partners (Sierra-González et al., 2021). The varying levels of institutional development across countries and regions within Latin America provide a rich context for exploring how internal capabilities and external collaborations influence innovation outcomes (Cardoza et al., 2016).

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Governmental policies and initiatives play a significant role in shaping the innovative ecosystem in Latin America. Many countries have implemented national innovation strategies aimed at promoting research and development, supporting technological innovation, and fostering university-industry collaborations (OECD & Inter-American Development Bank, 2022). For example, Brazil's National Innovation System and Chile's CORFO (Corporación de Fomento de la Producción) programs are designed to stimulate innovation through funding, incentives, and support services. These policy frameworks provide a backdrop for analyzing how governmental support influences firms' innovative activities and their engagement with academic institutions (Fischer et al., 2019).

Cultural factors and socio-economic conditions unique to Latin America also impact the dynamics of university-industry collaborations (Mazouz et al., 2021), trust, personal relationships, and informal networks often play a significant role in business dealings and partnerships. These cultural dimensions can influence how collaborations are initiated, negotiated, and sustained. Additionally, issues such as income inequality, educational disparities, and regional development imbalances pose challenges that can affect the accessibility and effectiveness of innovation initiatives (Ketelhöhn & Ogliastri, 2013).

By incorporating data from Latin America, the dissertation addresses the need for more empirical studies focusing on developing economies, which are often underrepresented in academic research. This inclusion enhances the generalizability of the findings and provides valuable insights into how university-industry collaborations can be leveraged to promote innovation and economic development in emerging markets.

4. Dissertation Overview

This dissertation presents a comprehensive exploration of the multifaceted dynamics underpinning university-industry collaborations, with a particular emphasis on knowledge transfer mechanisms, innovation processes, and the development of novel

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analytical tools for assessing scientific production. Grounded in theoretical frameworks such as Evolutionary Economic Theory (Nelson, 1987), Resource-Based Theory (Barney et al., 2021), and Actor-Network Theory (Callon, 1984) under the umbrella of the Triple Helix model (Etzkowitz & Leydesdorff, 2000), the research traverses both theoretical explorations and empirical investigations, offering valuable insights and practical implications for enhancing collaborative efforts between academia and industry.

The initial chapter introduces the Unity Index, a novel metric designed to address the limitations inherent in traditional univariate indicators used for assessing scientific production, such as the number of publications, citations, and the H-Index. This new metric was later used in chapter 2 of the dissertation and helped shed light to better insights on the bibliometric analysis. Recognizing that these conventional metrics often provide a fragmented view of a researcher's impact, the Unity Index integrates these existing measurements into a multivariate framework. This index operates through a three-part point system where points are assigned to authors based on their rankings across the three traditional indicators. Specifically, the author with the most published articles receives one point, and subsequent authors receive incrementally higher points. The same point attribution is applied to the number of citations and the H-Index rankings. The index is calculated using three different methods, each providing a nuanced perspective on scientific output.

This chapter introduces the index and validates its effectiveness through empirical analysis. Different ways to interpret the results and generate meaningful insights are suggested, particularly in bibliometric studies, where a holistic assessment of scientific production is crucial. By providing a more comprehensive evaluation, the Unity Index facilitates a better understanding of researchers' contributions and promotes a more equitable recognition of scientific achievements.

Building on the theme of knowledge assessment, the second chapter delves into the intricate processes of intangible knowledge transfer within university-industry

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relationships. Acknowledging that intangible knowledge—such as skills, expertise, and know-how—is a critical component of innovation, this chapter conducts a meticulous bibliometric and systematic literature review. Utilizing the standard methodology, a dataset of 1,496 articles for the bibliometric analysis and systematic literature review of 20 selected studies, the research identifies pivotal trends and patterns within the field.

The findings reveal that effective university-industry collaborations are often facilitated by informal networking and personal interactions rather than being significantly constrained by factors such as industry type, firm size, or academic specialization. This shows the importance of interpersonal relationships and the role of informal networks in fostering knowledge exchange. The chapter also highlights the emergence of mutually beneficial partnerships that transcend traditional constraints, emphasizing that the most successful collaborations are those built on trust and mutual understanding.

Transitioning from literature analysis to empirical research, the third chapter explores the adaptations and approaches employed by management academics when engaging in industry-university collaborations. Through semi-structured interviews with 22 full-time academics from universities across Europe, the study uncovers three primary approaches to participating in knowledge transfer: academic that do consultancy, consultants that do academic work, and support roles.

In the academic that do consultancy approach, academics have as a priority their academic work, while in the consultants that do academic work, the priority can be shifted from the university work to the industrial project. The support roles refer to academics facilitating collaborations without direct involvement in the negotiation process.

The findings also reveal common adaptations that academics make to foster effective collaborations. These include using lay language to communicate complex academic

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concepts in more accessible terms, enabling better understanding and engagement from industry partners. Time allocation emerges as a critical factor, with academics needing to balance their teaching, research, and collaboration commitments effectively. Negotiation tactics are also highlighted, emphasizing the need for clear communication of expectations, deliverables, and resource allocation.

The study also emphasizes the significant influence of the university's prestige as a facilitator in these collaborations. Institutions with strong reputations tend to attract more opportunities for engagement, as their brand adds credibility and appeal to potential industry partners. This underscores the importance of institutional support and recognition in promoting and sustaining collaborative efforts.

Moving into the quantitative section, the fourth chapter investigates the factors influencing university-industry collaborations using advanced analytical methods. Employing a neural network model to analyze data sourced from the HESA, SCIMAGO Rankings, and Clarivate Publications, the research examines variables such as academic workload, administrative support, scientific output, and university ranking impact collaboration dynamics.

The findings reveal that reducing academic workload and enhancing administrative support substantially improve the effectiveness of university-industry collaborations. When academics have manageable workloads and strong administrative backing, they are better positioned to engage with industry partners, dedicate time to collaborative projects, and navigate the logistical complexities of such partnerships.

Interestingly, the roles of scientific output and university ranking are found to be more complex, challenging straightforward assumptions. High scientific output, while indicative of expertise, does not always align with industry objectives, which may prioritize practical applications over theoretical advancements. Similarly, although top-ranked universities are often perceived as more attractive partners, the advantages

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are not guaranteed. The success of collaborations depends on the alignment of goals, mutual benefits, and the ability to translate academic research into industry-relevant solutions.

The fifth chapter extends the exploration to a regional context, analyzing innovation dynamics in Latin America. Utilizing data from the Latin American Innovation Survey, the study examines the moderating influence of university cooperation on the relationship between innovation expenditures and innovation results.

The research suggests that while firms invest significantly in innovation, the outcomes are not always aligned with the expenditure. The findings show that collaborative partnerships with universities amplify the impact of innovation spending on results. Firms that engage in university cooperation experience a stronger positive relationship between their innovation expenditure and the successful development of new products, processes, or services.

The chapter underscores the importance of fostering strong partnerships between firms and universities in Latin America to drive innovation and economic growth. It offers valuable insights for policymakers and business leaders and advocates for policies and initiatives that encourage and support university-industry collaborations.

The final chapter, Chapter Six, examines the intricate relationships among internal capabilities, university-industry collaboration, financial resources, and symbolic reputation within organizations, using university-industry collaboration not as the consequence or the result of a process but as the trigger. Employing a parallel mediation analysis, the study uncovers how these variables interact to influence organizational performance and reputation management.

The findings reveal that universities with robust internal capabilities—such as skilled personnel, effective processes, and technological resources—are more inclined to collaborate effectively with industry partners. Financial resources play a pivotal role

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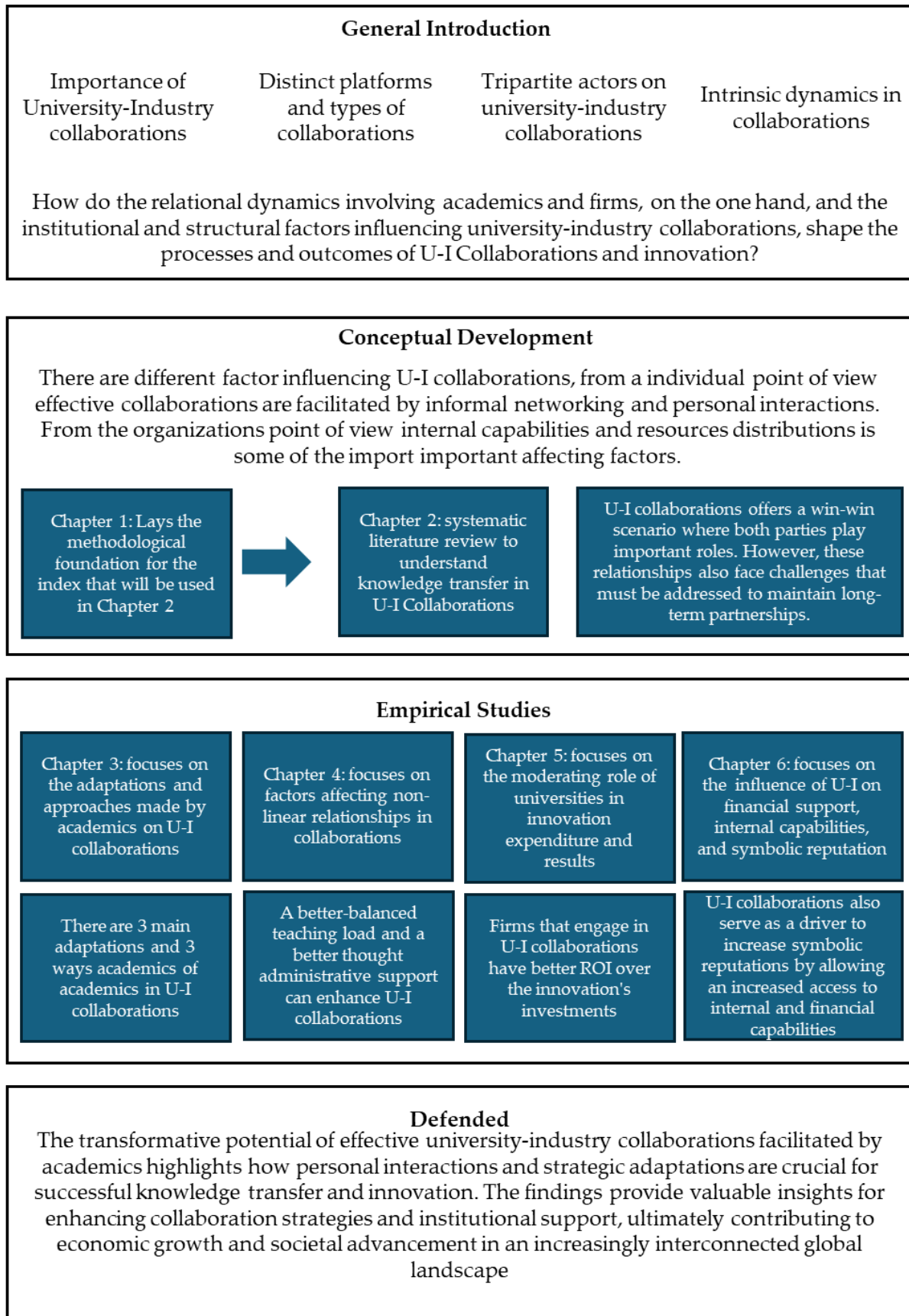
in enabling organizations to invest in their internal capacities and foster fruitful partnerships.

Notably, symbolic reputation exhibits complex dynamics with the other variables. Organizations with a strong reputation may rely less on internal capabilities and financial resources when engaging in collaborations, as their established prestige can more readily attract partners and opportunities. This suggests that a strong symbolic reputation, defined as the extent of favorable evaluation from the public, can, to some extent, substitute for other resources in facilitating collaborations.

Overall, this dissertation tent to advance the dialogue on university-industry collaborations, offering a comprehensive understanding of the factors that facilitate or hinder successful partnerships. By bridging theoretical concepts with empirical evidence and practical applications, the dissertation contributes valuable knowledge to the field and lays the groundwork for future research and policy development aimed at strengthening the synergy between academia and industry. It highlights the potential for such collaborations to drive innovation, economic growth, and societal advancement, emphasizing that the collective efforts of universities and industries are crucial in addressing the complex challenges of the modern world.

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FIGURE 0.1: DISSERTATION ABSTRACT



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TOWARDS CHAPTER 1

This dissertation begins by introducing a new tool essential for the analysis presented in the subsequent chapter: the Unity Index. Chapter 1 focuses on the creation, rationale, and methodological explanations of this index, addressing the limitations of traditional bibliometric measures such as publication counts, citation numbers, and the H-Index. The Unity Index offers a more holistic assessment of academic contributions, integrating multiple dimensions of scholarly performance to provide a more comprehensive evaluation of scientific impact. By explaining the index's development, structure, and validation, this chapter establishes a clear conceptual and methodological foundation, ensuring clarity on how the index functions as both a measurement tool and an analytical lens.

The importance of this chapter becomes evident in Chapter 2, where the Unity Index is employed to assess academic contributions in the context of intangible knowledge transfer. Understanding its creation and underlying logic is crucial for interpreting the findings.

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MORE THAN JUST A NUMBER OF PUBLICATIONS: UNITY INDEX, AN ALTERNATIVE "RANKING" FOR BIBLIOMETRIC ANALYSES.

Carlos Plata

TSM-Research, University of Toulouse Capitole, CNRS UMR 5303

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<https://doi.org/10.1016/j.mex.2022.101878>

Prior versions of this project have been presented at the EIBA Annual Conference in
2022

1. Abstract

This paper presents the unity index- an index designed in response to the call to find a more holistic way to assess scientific production. In this case, the scientific production is understood from a multivariate perspective using existing measurements, such as the number of publications, the number of citations, and the H-Index. It can be used especially when generating or assessing production in bibliometric studies. The index consists of a 3-part point system where points are assigned to the authors based on their position in the rank of the 3 traditional indicators for production, acceptance and impact. The index is calculated by attributing 1 point to the author with most published articles and increasing the number of points attributed by 1 to all the subsequent authors. The same point attribution is done to the remaining 2 indicators, acceptance -citations- and impact -h-index-. In the presented method, 3 different means of calculation are shared. Finally, the method is validated and different ways to analyze the results and generate insights are suggested.

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2. Method details

A bibliometric study is part of the scientometrics field and is known for using statistical methods to analyze bibliographical data from a quantitative perspective (Broadus, 1987; Naseer & Mahmood, 2009). It is mostly based on how authors cite and get cited, and on scientific production based on the number of publications. Therefore, it provides important criteria to select, evaluate, and monitor published research (Moed et al., 1995). While these methods are not new, they have gained popularity among scholars with the rise of comprehensive bibliographic databases such as Clarivate Analytics' WoS database and Elsevier's Scopus database. In addition to the development open software tools (Bengoa et al., 2021), software tools for analyzing, such as Bibliometrix (Aria & Cuccurullo, 2017) or VOSViewer (van Eck & Waltman, 2010; Waltman et al., 2010) were also developed.

Traditionally, the indicators to rank and position authors within bibliometric analyses are linear and show a lack of interaction between them. The standard way to assess the production is the number of publications, while acceptance is by the number of citations, and the impact measurement is by the H-Index (Ding et al., 2014). When studied, these linear indicators can be merely informative and might present an incomplete picture of the authors, adding little value to the results and the understanding of the field.

Assessing researchers based on their production or linear indicators has created a publish or perish culture, where authors are pushed to publish in quantity and not in quality (De Rond & Miller, 2005; Parchomovsky, 2000). This is counterproductive for research development due to the increase in the number of available papers, which can negatively affect the quality of the scientific production (van Dalen, 2021). This culture is not new, and existing proposals have attempted to change it. The Leiden Manifesto is one of the most prominent initiatives and promises a revised assessment of the scientific production based on the utility and the push of scientific cooperation (Hicks & Wouters, 2015). Yet, this and other similar initiatives look for a systematic change.

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A change proposed by initiatives like the Leiden Manifesto is desired, but a change of that magnitude will take generations to happen. As a short-term response, I propose a new way to assess scientific production using the existing indicators for production, acceptance, and impact, but breaking the aforementioned linearity and generating relationships between them.

This response is called the unity index and is a 3-part point system in which the authors are assigned points based on their position in the rank on the 3 traditional indicators for production. The index is calculated by attributing 1 point to the author with most published articles and increasing the number of points attributed by 1 to all the following authors according to their rank. As such, the author with the second highest number of publications gets 2 points, the author with the third highest number of publications gets 3 points, etc. The same point attribution is done for the remaining 2 indicators: acceptance -citations- and impact -h-index-. After the point attribution, the unity index is calculated by adding the 3 components, as shown in equation 1.

EQUATION 1: UNITY INDEX

$$\uparrow \text{Unity Index} = \downarrow \text{PointsPublication} + \downarrow \text{PointsCitations} + \downarrow \text{PointsH}_{\text{Index}}$$

It is important to note that the Unity Index is initially designed with bibliometrics studies in mind. By that, the position of a specific author depends on the data set, and not on the overall production, which means that a specific author can lose or gain notoriety depending on the field or query used to retrieve the data set. This variability is a strength of the index because it gives the researcher the possibility to assess the authors based on specific cases, and gives the opportunity for niche authors to find their way up in terms of assessment. An example of this change of position is shown in the method validation section, along with an example of the different types of analysis that this type of relationship can bring.

The process of calculating the Unity index consists of 2 major parts: the generation of the input and the calculation of the Index. The first part, which is also the standard for

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all bibliometric analyses, is the search and the compilation of the bibliometric data. In this step, the researcher can choose any bibliometric database available, two of which are Clarivate Analytics' WoS database and Elsevier's Scopus. After choosing the fitting database, the researcher will have to run and define a search query that satisfies the needs of the study. While there is no good or bad query, it is crucial that the query responds to the needs of the project in terms of limitations and expansion in order to ensure the quality of the input.

Once the data is retrieved, a database including all the bibliometric data is downloaded. For the unity index, the basic information required is the name of the author and the citation map, which is usually downloaded by default from any of the major databases. After downloading the data, the researcher will treat the data using a bibliometric tool- in this case, I recommend Biblioshiny, a web service from the Bibliometrix¹ library running in R (Aria & Cuccurullo, 2017), because of its user-friendly scheme for non-coder researchers. In figure 1.1, the basic script to access Biblioshiny in R is displayed. These 2 lines of code are sufficient to access the platform and explore it at its full potential.

¹ <https://www.bibliometrix.org/home/>

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FIGURE 1.1: BIBLIOSHINY BASIC SCRIPT IN R

```
> library (bibliometrix)

To cite bibliometrix in publications, please use:

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

https://www.bibliometrix.org

For information and bug reports:

Send an email to info@bibliometrix.org

Write a post on https://github.com/massimoaria/bibliometrix/issues

Help us to keep Bibliometrix free to download and use by contributing with
a small donation to support our research team
(https://bibliometrix.org/donate.html)

To start with the shiny web-interface, please digit:

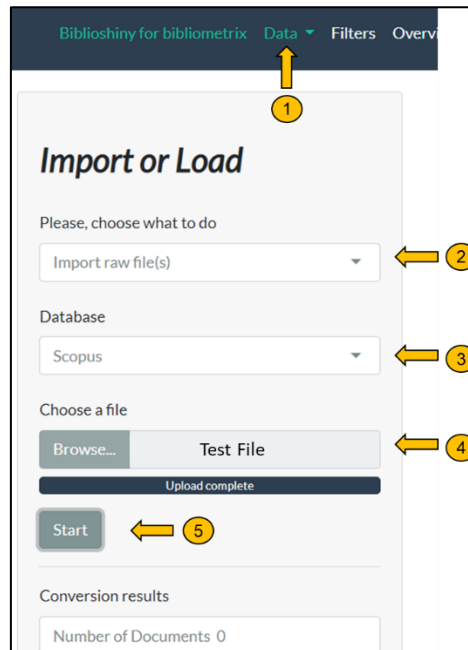
biblioshiny()

> biblioshiny()
```

Once Biblioshiny is loaded, a web browser tab will open, and the researcher can upload the database downloaded from the bibliometric software. With this step, shown in figure 1.2, the researcher will be able to manipulate the data and generate multiple classic bibliometric analyses.

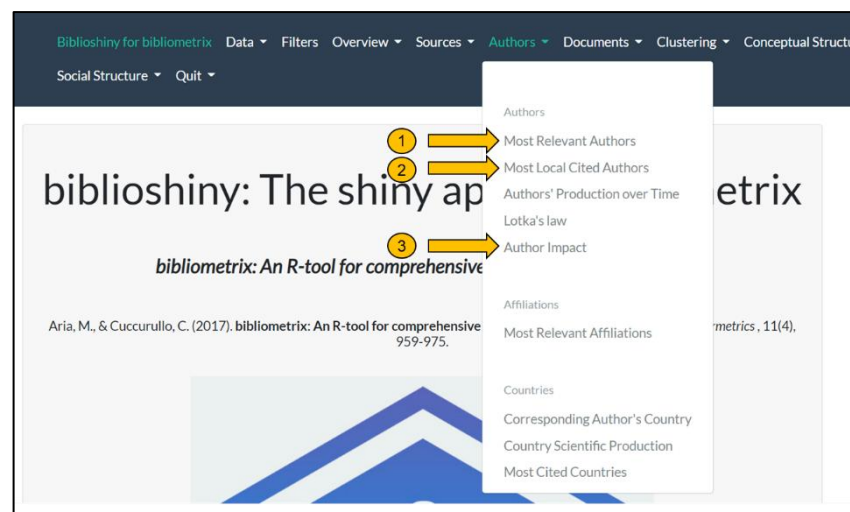
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FIGURE 1.2: UPLOAD THE BIBLIOMETRIC DATASET



After the dataset is properly loaded onto the tool, the generation of the dataset commences by downloading 3 documents: most relevant authors, most locally cited authors, and author impact. In order to do that, it is important that the researcher makes sure that all the authors of the database are selected, the number of documents (Authors > Most Relevant Authors), the number of local citations (Authors > Most Local Cited Authors), and the H-index (Authors > Authors Impact). In figure 1.3, the sequence of clicks to access and download the data is shown.

FIGURE 1.3: GENERATING INPUT DATASET



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After downloading these 3 documents, the researcher will create a newly compiled document in which all the information will be available comprehensively. A suggested method to compile this document is using MS Excel function VLOOKUP², with the author's name as the lookup value. After the compilation of the information, the researcher will have a 4-column matrix including Authors, Articles, LocalCitations, and h_index. Here, it is important to respect the names and order of columns if the researcher is planning to calculate the index automatically using the python repository or the MS Excel macro available in GitHub³.

The previous steps conclude the first part, by the end of which the data set would be ready to use. Now, the calculation of the index begins, following either of the three methods mentioned next. The first, is using MS Excel functions, the second using an MS Excel macro, and the third using a Python script running in a Jupyter Notebook.

2.1.Calculation of the Unity Index using MS Excel functions

To calculate the Unity Index using MS Excel function, the input needed is the dataset retrieved before, and the correct use of the functions RANK.EQ⁴, and SUM. Assuming that columns A, B, C, and D are labeled, Authors, Articles, LocalCitations, and h_index respectively, the researcher should then label the columns E to J as follows: PointsPublication, PointsCitations, PointsH-Index, UnityIndex, UnityRank, and RaiseInRank.

² <https://support.microsoft.com/en-us/office/vlookup-function-0bbc8083-26fe-4963-8ab8-93a18ad188a1>

³ <https://github.com/cplata21210/UnityIndex>

⁴ <https://support.microsoft.com/en-us/office/rank-eq-function-284858ce-8ef6-450e-b662-26245be04a40>

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FIGURE 1.4: COLUMNS SET UP

	A	B	C	D	E	F	G	H	I	J
1	Authors	Articles	LocalCitation	h_index	PointsPublic	PointsCitatic	PointsH-Inde	UnityIndex	UnityRank	RaiseInRank
2	Author 1	21	9	14						
3	Author 2	11	5	10						
4	Author 3	8	9	4						
5	Author 4	7	2	6						
6	Author 5	7	1	6						
7	Author 6	6	1	4						
8	Author 7	6	36	5						
9	Author 8	6	3	3						
10	Author 9	6	0	5						
11	Author 10	5	2	4						
12	Author 11	5	1	3						
13	Author 12	5	5	4						
14	Author 13	5	32	4						
15	Author 14	5	0	5						
16	Author 15	5	0	3						
17	Author 16	5	3	2						
18	Author 17	4	0	4						
19	Author 18	4	10	2						
20	Author 19	4	4	2						
21	Author 20	4	8	3						

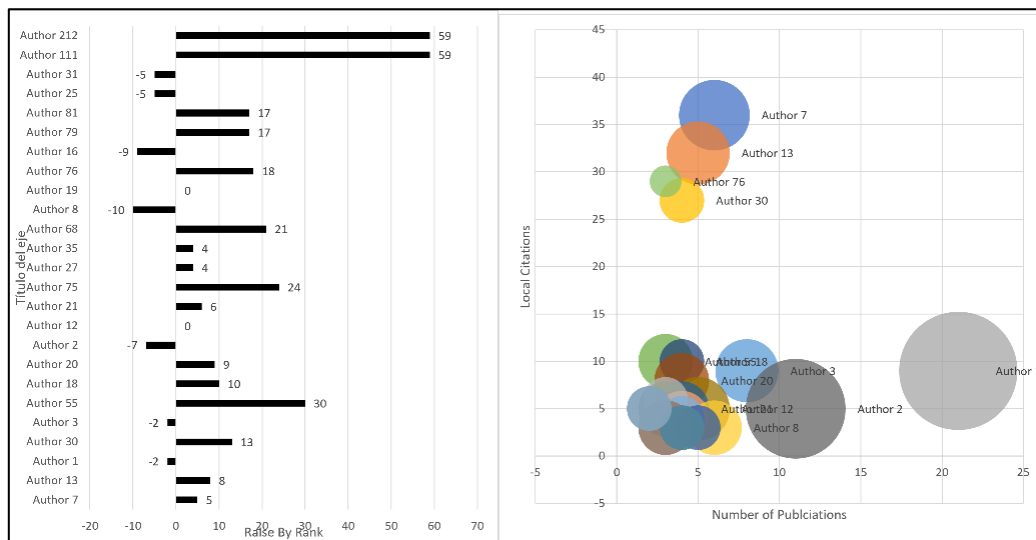
In column E (PointsPublication), the point awarding function will be generated using the MS Excel function RANK.EQ. This function will give the author with the most published articles a total point of 1 and will add 1 point to each subsequent author. In the case that multiple authors share the same amount of publications, the function will attribute the same amount of points to all these authors. For columns F (PointsCitations) and G (PointsH-Index), the researcher will use the same function RANK.EQ and change the input values for the corresponding column.

The UnityIndex is calculated in column H by adding the points gained by each author in columns E, F, and G, which will give the researcher a combined view of the author's production, acceptance by the community, and impact. Hereby, it is important to note that, counterintuitively, the author with the best performance is the author with the least points in the Unity Index. Additionally, in column I, the rank based on the Unity Index will be calculated by using again the function RANK.EQ. However, unlike columns E through G where the points are attributed in a descending order -the author with the most publications will get the least number of points- here, the researcher will change the parameters to organize the data in ascending order, giving the highest rank position (1) to the author with the lowest Unity Index.

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Additionally, and to understand the rise in rank or the change of the positions when compared linearly from publication output and the unity index, a subtraction between the column E -PointsPublications- and column I -UnityRank- is done in the column J -RaiseInRank-. As a final step to present the data in a more aesthetic way, column J can be formatted to graphically show the rise in rank, and a bubble chart as well as a bar chart can be plotted. It is recommended to choose the first 25 authors with the best performance in the Unity Index and plot a bubble chart with the x-axis showing the number of publications and the y-axis showing the number of local citations, with the size of the bubble representing the H-Index. As for the bar chart, the same 25 authors will be plotted, but in this case, the Raise in Rank column will be the input, as shown in the example used in figure 1.5.

FIGURE 1.5: EXAMPLE OF PLOTTING



2.2. Calculation of the Unity Index using MS Excel macro

Another way to more automatically calculate the index is using the excel macro, Macro_Unity_Index, available on the Github repository. When downloading the macro, the researcher will find 3 sheets: the read-me sheet with some basic information and instructions, the Unity Index sheet where all the calculations are done, and the graph sheet where some key information gets plotted automatically.

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After reading the information in the read me sheet, the researcher will proceed by pasting the information of the authors in the first 4 columns, as shown in figure 1.6.

FIGURE 1.6:UNITY INDEX MACRO SET-UP

	A	B	C	D	E	F	G	H	I	J
1	Authors	Articles	LocalCitation	h_index	PointsPublic	PointsCitation	PointsH-Index	UnityIndex	UnityRank	RaiseInRank
2	Author 1	21	9	14						
3	Author 2	11	5	10						
4	Author 3	8	9	4						
5	Author 4	7	2	6						
6	Author 5	7	1	6						
7	Author 6	6	1	4						
8	Author 7	6	36	5						
9	Author 8	6	3	3						
10	Author 9	6	0	5						
11	Author 10	5	2	4						
12	Author 11	5	1	3						
13	Author 12	5	5	4						
14	Author 13	5	32	4						
15	Author 14	5	0	5						
16	Author 15	5	0	3						
17	Author 16	5	3	2						
18	Author 17	4	0	4						
19	Author 18	4	10	2						
20	Author 19	4	4	2						
21	Author 20	4	8	3						

After all the information is pasted on the correct columns, the researcher will proceed to run the macro by pressing *CTRL+h*, or by the route View > Macro >See Macro > Execute. Afterwards, the macro does the necessary calculations and displays the compiled information when done, as presented in figure 1.7.

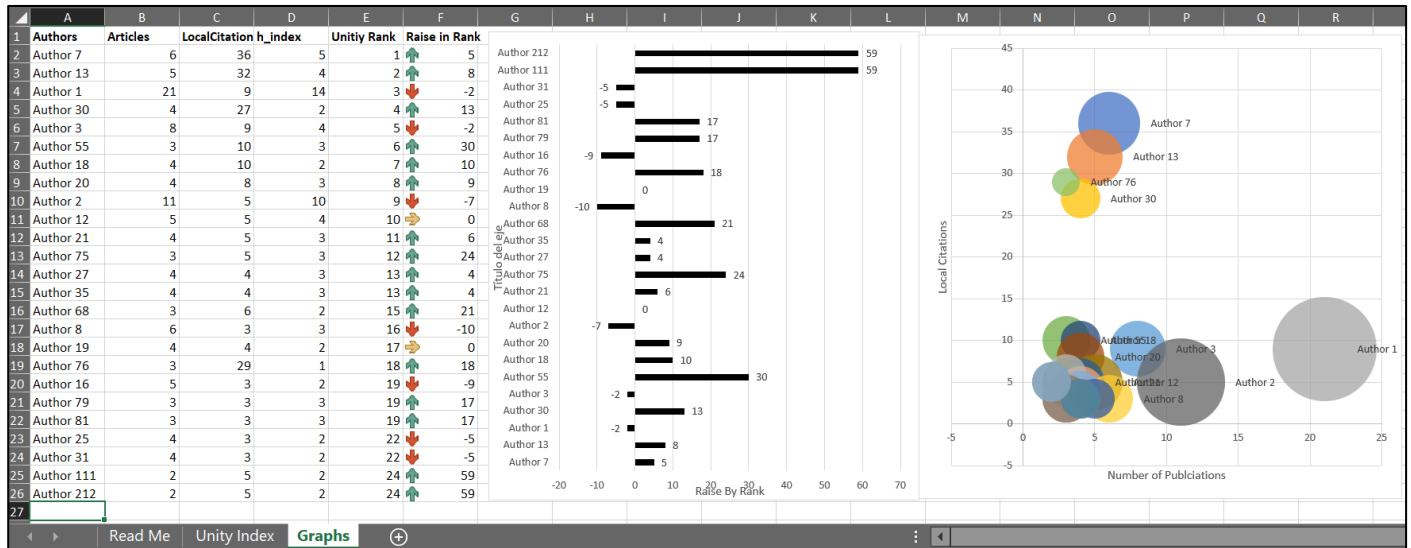
FIGURE 1.7: OUTPUT OF THE UNITY INDEX MACRO

	A	B	C	D	E	F	G	H	I	J
1	Authors	Articles	LocalCitation	h_index	PointsPub	PointsCita	PointsH-Index	UnityIndex	UnityRank	RaiseInRank
2	Author 7	6	36	5	6	5	5	16	1	5
3	Author 13	5	32	4	10	6	8	24	2	8
4	Author 1	21	9	14	1	64	1	66	3	-2
5	Author 30	4	27	2	17	8	42	67	4	13
6	Author 3	8	9	4	3	64	8	75	5	-2
7	Author 55	3	10	3	36	33	16	85	6	30
8	Author 18	4	10	2	17	33	42	92	7	10
9	Author 20	4	8	3	17	74	16	107	8	9
10	Author 2	11	5	10	2	104	2	108	9	-7
11	Author 12	5	5	4	10	104	8	122	10	0
12	Author 21	4	5	3	17	104	16	137	11	6
13	Author 75	3	5	3	36	104	16	156	12	24
14	Author 27	4	4	3	17	126	16	159	13	4
15	Author 35	4	4	3	17	126	16	159	13	4
16	Author 68	3	6	2	36	90	42	168	15	21
17	Author 8	6	3	3	6	162	16	184	16	-10
18	Author 19	4	4	2	17	126	42	185	17	0
19	Author 76	3	29	1	36	7	156	199	18	18
20	Author 16	5	3	2	10	162	42	214	19	-9
21	Author 79	3	3	3	36	162	16	214	19	17

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On the Graphs sheet, a graphical representation of the information displayed in the matrix is delivered. This representation is set for the first 25 authors, yet it can be easily changed by adding or subtracting of the number of authors the researcher would like to present.

FIGURE 1.8: GRAPHICAL REPRESENTATION OF THE UNITY INDEX



2.3.Calculation of the Unity Index using Python Script

An additional automatic way to calculate the index while reducing the human error to a minimum is using the Python Script, *Unity_Index_Github*, available on the Github repository. It is important to note that for this method to be successful, the dataset file must respect the titles of the columns expressed earlier and should be saved as a *TopUnity_Data.CSV*.

When downloading the python script, the researcher will open it using Jupyter Notebook, which is easily available via Anaconda Navigator ⁵. For a less experienced researcher in terms of coding, it is recommended that all the files (dataset, python script) be saved in the same folder. With this, the probability of encountering an error from the code is reduced.

⁵ <https://www.anaconda.com/>

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After opening the Jupyter notebook, the only action needed to run the code is clicking the run button at the top of the page, as shown in figure 1.9. The run button should be clicked once for every cell. It is important to note that the code is very efficiently crafted, and does not necessarily need high-end hardware, but can run on almost every system in a very efficient way and without having any compatibility problems.

FIGURE 1.9: RUNNING THE PYTHON SCRIPT



The script used to calculate Unity in an automatic way is found below. It is important to note that in the available GitHub there is no need to write any code, since this is already parametered correctly

```
def TopUnity(df,cr_file):
    top = np.ones([len(df.columns), len(df)])

    for i,col in enumerate(df.columns[1:]):
        top[i,:] = df[col].rank(method='min', ascending = False)

    unity = top[0,:] + top[1,:] + top[2,:]

    TopU = pd.DataFrame(np.column_stack((df['Authors'],unity)), columns =
['Authors','Unity'])

    uni_sort = TopU['Unity'].rank(method='min', ascending = True)

    TopUni =
pd.DataFrame(np.column_stack((df['Authors'],df['Articles'],df['LocalCitatio
ns'],df['h_index'],top[0,:], top[1,:],top[2:],unity,uni_sort,top[0,:]-
uni_sort)), columns =
['Authors','Articles','LocalCitations','h_index',
'PointsPublications','PointsCitations','PointsH-
Index','UnityIndex','UnityRank','RaiseInRank'])

    TopUni = TopUni.sort_values(by=['UnityRank'],ascending=True)

    if cr_file == True:
        TopUni.to_csv('TopUnity_file.csv', index=False)

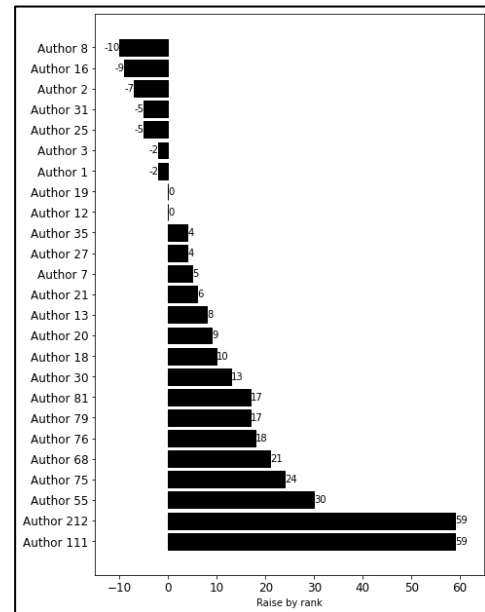
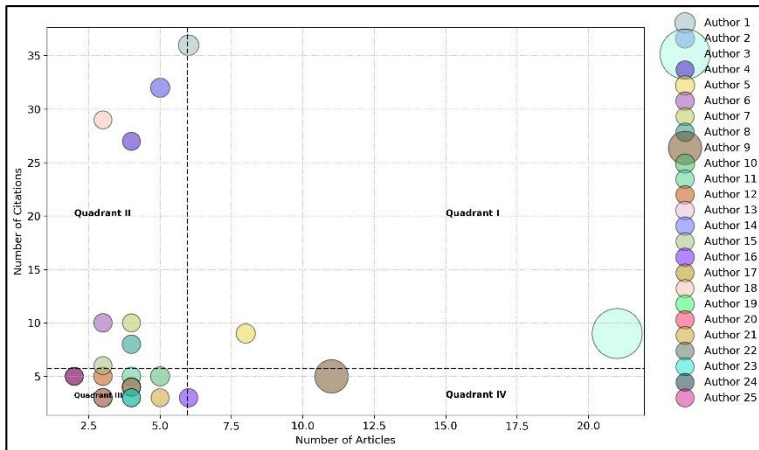
    return(TopUni)
```

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When the running process is finished, the researcher will find that the code generates and saves 3 files: the TopUnity_file, where all the results of the calculations are compiled, the cross analysis file (figure 1.10), and the raise by rank graph file (figure 1.11).

FIGURE 1.10: RAISED BY RANK PYTHON OUTPUT

FIGURE 1.11: MULTIVARIABLE ANALYSIS



Finally, as already mentioned, the code is set to plot the first 25 authors, yet, this could be changed. However, it is recommended that it is only changed by researchers that have some experience with python scripts, and if this is not the case, the researcher can contact the corresponding author via mail.

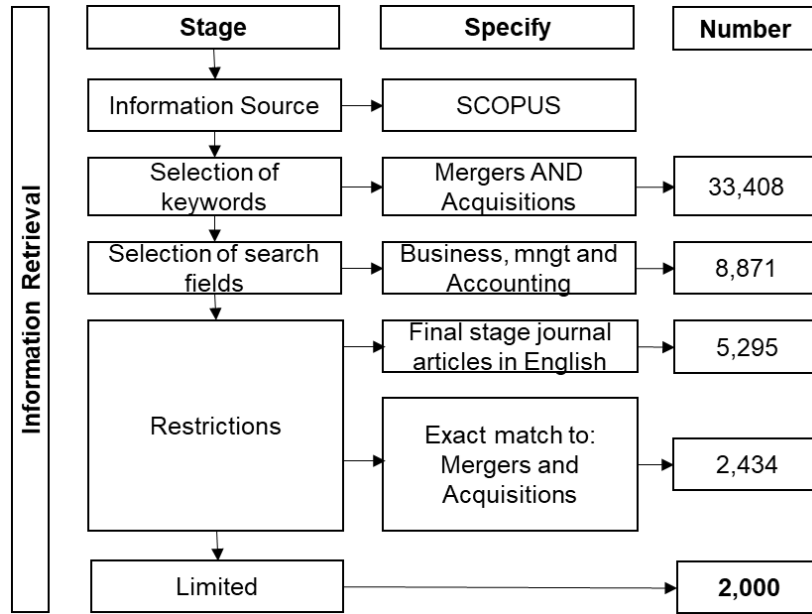
3. Method Validation

To validate the mentioned model, the first step is to retrieve the information as shown in figure 1.12. The information retrieval section starts by choosing the information source. In this case, Elsevier's Scopus database was chosen based on the broad inclusion of journals and the detailed information it provides. After searching the abstract, title, and keywords of the Boolean words Mergers AND Acquisitions, a preliminary number of 33.408 hits was obtained. To limit the search, only articles

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inside the business, management, and accounting fields were considered, resulting in 8.871 hits.

FIGURE 1.12: BIBLIOMETRIC FLOW



To further refine the search, only journal articles written in English and in their final stage of the publication process were taken into account, which also lowered the number to 5.295. Furthermore, in order to focus the search, only articles with an exact match of the keywords Mergers and Acquisitions were considered, which brought down the count to 2.434⁶ articles. Since this is a method validation, the final dataset was limited to 2.000 entries.

To begin, the software tools used to perform the analysis are the Bibliometrix pack (Aria & Cuccurullo, 2017) running in the R 4.2.2 version, and the Unity_Index_Github script, explained in the *Calculation of the Unity Index Python script* section, including the

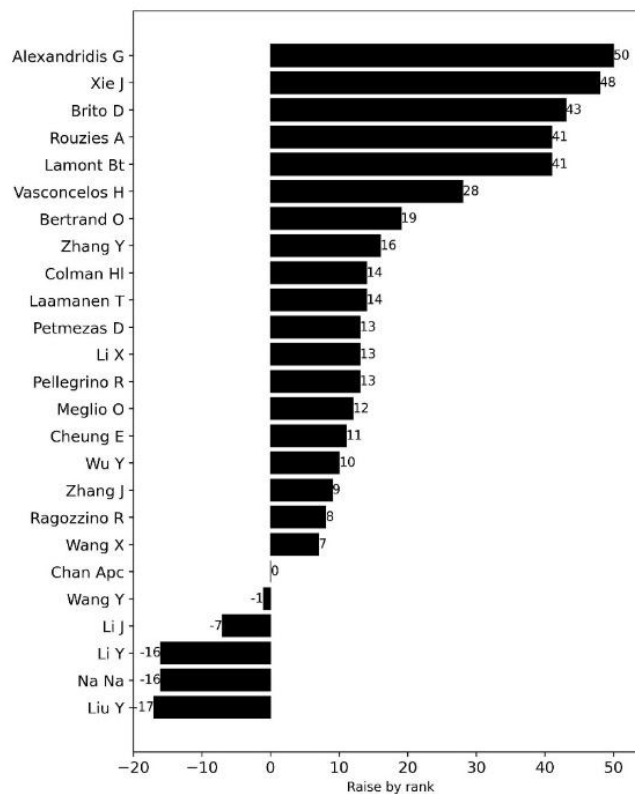
⁶Elsevier's Scopus database final query: TITLE-ABS-KEY (mergers AND acquisitions) AND (LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Mergers And Acquisitions"))

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use of the matplotlib libraries in the version 3.5.2 python for the correct plotting of the information.

The first analysis, displayed in figure 1.13 shows how the different authors shift positions in the “ranking” when the position in the Unity index and the publications are compared.

FIGURE 1.13: RAISE BY RANK VALIDATION



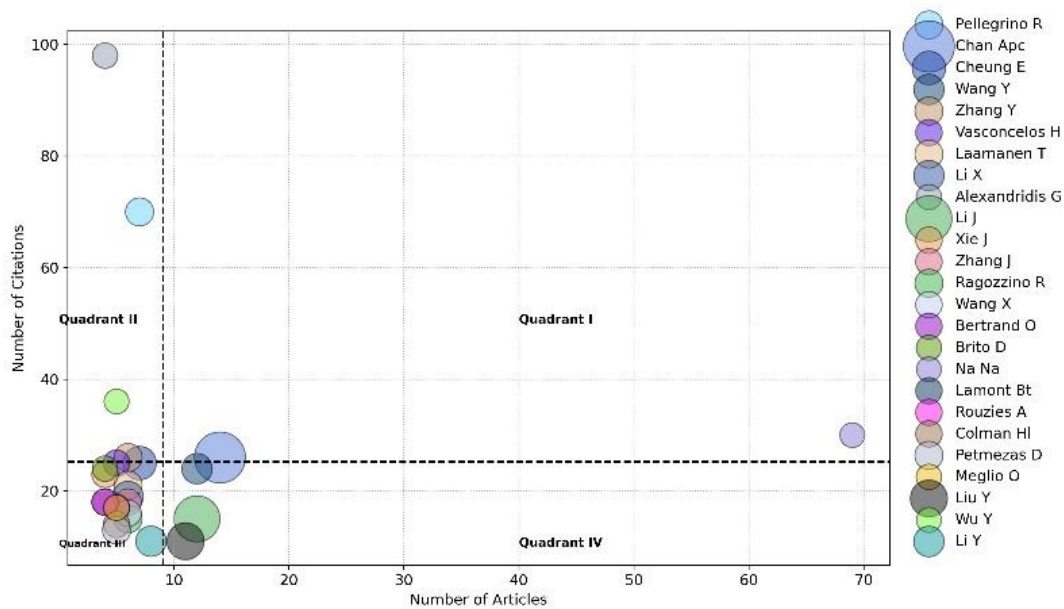
Comparing the first 25 authors with the best Unity Indexs hows that, on average, each author gained 15 positions. Only 4 authors lost positions, while 19 authors gained positions, with Alexandridis G, Xie J, Brito D, Lamont Bt, and Rouzies A being the authors with most positions gained. This could be attributed to the fact that position-gaining authors are not as consistent in their productivity, so their position in the publication rank is not secure; however, their publications are quite accepted and have a higher impact, as measured by the number of publications and the H-Index- a trend in line with the Leiden Manifesto proposals (Hicks & Wouters, 2015). This shows that the Unity Index is complying with its purpose to serve as a normalizing measure when

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compared to the linear traditional measures, and to give the opportunity of having a more complete view when assessing scientific production.

In figure 1.14, the unity index multivariable analysis is presented. Following the method explained before, the x-axis shows the number of publications, whereas the y-axis represents the number of local citations followed by the size of the bubble representing the H-Index. Additionally, the average line for each axis was presented to create 4 quadrants that will help understand how the pool of authors can be characterized.

FIGURE 1.14: UNITY INDEX MULTIVARIABLE ANALYSIS



An example of how productivity does not necessarily translate to impact or acceptance within a specific part of a field is the case of Na Na. With 69 publications, more than double the average publications of the 25 authors with a better position in the Unity Index Ranking, Na Na falls behind the average in terms of the number of citations and the H-Index. In a traditional bibliometric analysis, this author would have been given the most credit, leaving behind authors like Rouzies A, who has a modest number of publications, right at the average, and yet, her publications are consistently being cited and have an impact.

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Another example is Lui Y, an author with both the production and citations right above the average, yet with an under-average H-Index. This results in a position sharing with Alexandridis G, an author that has a low number of publications compared to the average yet has a number of citations 4 times above average. Both examples show how the Unity Index allows consistent authors to gain notoriety, and especially in bibliometric studies where the quantity measured is important to have alternative measures to unveil gem authors.

Additionally, the graph shows 4 quadrants which are based on the average citations and publications of the studied authors. In quadrant I, authors like Na Na, with publications and citations over the average, can be characterized as authors with a consistent publication rate and publication acceptance in the field. In quadrant II, authors like Pellegrino R have a high number of citations but an under-the-average productivity yet are authors that have well-accepted research.

Furthermore, in quadrant IV, authors like Li J, with over the average publications yet under the average citations are ones that still lack some acceptance from the community. This is not a weakness from the author's point of view, because not all the scientific production of the authors is assessed, just the portion that fits inside the query. It can be the case that the author is more prominent in other fields. Additionally, a deeper understanding of the literature using other types of research approaches such as Systematic Literature Reviews could help to understand these phenomena.

In the quadrant III, homogenous authors are found. There are authors that do not necessarily stand out in terms of production or acceptance, yet their contributions to the field is not assessed with the unity index. As the index is a calculated amount, this data closes the door to have external comparison. However, with that being said, it can be the case that an author with a low Unity Index in a certain dataset can be a top ranked author in a different data set.

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Finally, the Unity Index could serve as a response to the publish or perish culture in the short term by using the available indicators to assess the researcher's productivity from a multivariate point of view, especially in highly quantitative studies such as the bibliometric studies.

4. Conclusion

The general motivation of this paper stems from the need to answer past calls for action such as the Leiden manifesto, that request the finding of easily implemented alternatives to measure and assess scientific production (Hicks & Wouters, 2015). However, the motivation to add his paper in the dissertation is rooted in need of explaining how this new index was developed and with this give a support to its use in the chapter 2.

Unity combines the three more traditional scientific production measures such as production, acceptance, and impact measured by the number of publications, citations, and the h-Index respectively. The index is calculated by adding the points assigned to each of the variables. The points are attributed by giving 1 point to the author with the most published articles and increasing the number of points attributed by 1 to all the subsequent authors. The same point attribution is done to the remaining 2 indicators acceptance -citations- and impact -h-index-.

This paper does not aim to add a new measurement of the researcher's work which would feed the publish or perish culture, but rather, to create a leeway measurement that could be useful while desired structural changes that are expected to take more time and require more extended discussions take place. In the meantime, the evolution of the linear measurements to a multivariate measure can serve a temporary solution.

With regards to policy, an index such as unity can serve as a "middle" man for extended structural changes, by giving the opportunity to slowly evolve the mindset of linear measures. The calculation of unity was thought of as a simple option that

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could be applied using one of the several previously mentioned techniques, and with this, it extends the opportunity to perform more robust bibliometric analyses.

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TOWARDS CHAPTER 2

In the preceding chapter, I laid the first approach into a new way to assess academic work with the idea of finding a middle ground in the publish-or perish culture and systematic reform, this proposed index serves as both a conceptual foundation and a methodological guide for the bibliometric study presented in Chapter 2.

Transitioning into Chapter 2, I shift the focus to the critical role of intangible knowledge in knowledge transfer processes within these collaborations. In this chapter I observed the macro-level perspective but also the micro-level dynamics of how tacit expertise and non-codified knowledge are exchanged between academics and industry partners. By investigating the mechanisms that enable or hinder the transfer of intangible knowledge.

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UNIVERSITY-INDUSTRY RELATIONSHIPS BEYOND TECHNOLOGY TRANSFER: THE ROLE OF INTANGIBLE KNOWLEDGE

Carlos Plata

TSM-Research, University of Toulouse Capitole, CNRS UMR 5303

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Prior versions of this project have been presented at the EIBA Annual Conference in
2022

1. Abstract

This paper meticulously examines the intricacies of intangible knowledge transfer within university-industry relationships, aiming to provide an all-encompassing understanding of the present landscape and its future trajectory. Through the implementation of a rigorous bibliometric and systematic literature review methodology, encompassing a substantial dataset of 1496 articles and a meticulous analysis of 20 selected studies, the research identifies pivotal trends and patterns within the field. Notably, despite the apparent discrepancy between academic and practical domains, the study reveals the emergence of mutually beneficial partnerships facilitated by informal networking and personal interactions, rather than the constraints of industry typology, firm scale, or academic specialization. Significantly, the analysis underscores the pivotal role of intangible knowledge transfer platforms, emphasizing their significance in fostering effective university-industry collaborations. To harness the full potential of such partnerships, the paper advocates for the adoption of streamlined protocols and procedures, advocating for a more efficient exchange of intangible knowledge between academia and businesses. Moreover, the introduction of the innovative Unity Index serves as a novel analytical tool, shedding light on key authors and elucidating the intricate relationships between

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variables, thereby offering novel insights and opportunities for future research. In its comprehensive approach, this study underscores the critical significance of intangible knowledge transfer within the context of university-industry relationships, offering crucial insights often overlooked in conventional analyses of technology transfer and business-to-business knowledge exchange.

Keywords:

Knowledge Transfer, University-industry Collaboration, Intangible Knowledge, Systematic Literature Review, Bibliometric Analysis.

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2. Introduction

Social development and economic growth are grounded on the relations of three major actors: governments, society, and higher-education institutions. When they work in synergy, they can raise the standard of living and improve the overall well-being of its citizens (Corpuz, 2021). However, this synergy is not usual in modern society, as multiple agendas exist with different interests, which are not usually aligned (Rykun et al., 2015).

On the one hand, universities typically focus on teaching future generations, task that is complemented by creating knowledge through research processes (Sam & Van der Sijde, 2014; Scott, 2006). Originally, this creation of knowledge does not directly seek direct financial benefits, as governments or universities themselves commonly fund these processes. Nonetheless, the practice of researching has evolved and some universities have found different mechanisms to commercialize their results and innovations (Etzkowitz, 2004; Friedman & Silberman, 2003; Perkmann et al., 2011), in order to sustain their endeavors and improve research facilities and other necessary assets.

On the other hand, companies usually focus on profit maximization, and their innovation and research usually seek profitability and commercialization (Weersink & Fulton, 2020). Consequently, the business world has different time frames and objectives in terms of product launches, and research and development processes (Searls, 2009).

There has been a long-standing and active relationship between companies and universities, as the latter trains the current and future workforce, delivering the knowledge and skills needed by the former (Scott, 2006). This relationship has certainly evolved throughout the years. Initially, universities traded technologies and innovations resulting from hard sciences (Etzkowitz, 2004; Friedman & Silberman, 2003; Penan, 1996; Perkmann et al., 2011). Thereafter, universities started to create technological centers in charge of providing technical services and technology

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developed within institutions (Chilana et al., 2015). Likewise, technology transferring offices were created, to be in charge of this technology transfer business model, shaping, and pushing from within towards, a close relationship with industries (Baglieri et al., 2018).

The next step in this fast-changing era was the aspiration of universities to create new value for society (Chunoo & Osteen, 2016). One way of achieving this, developing further the industry-university relationship, was through the creation of university-supported ventures, generally labeled academic entrepreneurship (Crow et al., 2020). These start-ups were one step forward compared to business incubators, since the university shared part of the financial risk and, in some cases, scholars started to be part of managerial or advisor boards (Neves & Brito, 2020).

The most recent development in the university-industry relationship is the knowledge-transferring process, where universities teach the next generation of workers (Good et al., 2019). In its most basic form, this knowledge-transferring process could be simply regarded as “teaching and preparing” the workforce (Scott, 2006). Nevertheless, it has evolved into a more complex and intricate relationship consisting of consultancy, joint research, co-publication, design of professional training or student placement, among others (Hagen, 2008). These relations have become critical, as they aid in the development and sustenance of the skills of managers within the company (Leischnig & Geigenmüller, 2020).

These knowledge-transferring processes are more aligned and, at their best, create a more synergic relationship, in accordance to the so-called four-helix model, where innovations come from the meeting point of needs and capabilities of governments, businesses, universities, and society in general (Carayannis & Campbell, 2009).

It is important to review and evaluate literature on university-industry relations regarding the exchange and transfer of intangible knowledge, as there is a lack of research for this specific kind of skill. The literature has typically focused on

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technology transfer (Sanchez & López, 2018), since it can be accurately measured and, when studying knowledge transfer, researchers tend to mix both intangible and tangible results (Agrawal, 2001). This mixture has resulted in intangible knowledge transferring to be mainly studied between companies or inside corporations (Anand et al., 2021; Minbaeva, 2007). However, the transfer of intangible knowledge is one of the most relevant relationships between universities and businesses. Thus, understanding these relations as substantially different from their hard skill counterparts can avoid misguided policies, improving them and bringing the business and academic worlds closer.

The systematic literature review and the bibliometric analysis pursue complementary objectives. First, the bibliometric analysis gives an overview of the field, by providing quantitative information on scientific production. The systematic literature review, on its part, seeks a deep understanding of the literature through a qualitative approach, i.e., a detailed analysis and synthesis of the existing research on university-industry relations related to intangible knowledge transferring.

3. Literature Review

Knowledge can be quite difficult to understand due to its non-tangible nature and its close relation with concepts like data and information. To clarify, data can be defined as the most basic form of events, while information is defined as the relationship between data points (Ackoff, 1989). Likewise, from an organizational standpoint, information represents the union between systems and the people required to carry out any work activity (Braganza, 2004). Knowledge, on the other hand, is a broader and deeper concept, defined by Davenport & Prusak, (1998, p. 5) as “a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information”.

One of the main sources of knowledge are universities through their research process, which nowadays is usual among universities worldwide (Stich & Reeves, 2016). Nonetheless, research-focused institutions have existed since pre-industrial Germany

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in the 1800s, starting with the University of Berlin, with its primary goal of conducting strong innovative research, instead of simply teaching (Scott, 2006).

Universities are “factories” of knowledge (Heinzl et al., 2013), historically transferred only through teaching or training, providing the next generation the skills necessary to perform and be an active part of society (Scott, 2006). However, this idea has evolved with the increase of the volume and complexity of the intellectual results universities can deliver. Today, these products can be intangible or tangible. Some examples of the former are joint research, contract research, consulting, student mobility, and employee training (Hagen, 2008; Heinzl et al., 2013; Schartinger et al., 2002); while the latter consists of, e.g., patents, software, and industrial designs (Sadaghiani & Jamali, 2012).

Tangible asset transferring is easier to understand and track because the use of a tangible asset in a transaction gives both parties the possibility of accurately following its impact. This “hard science” transferring is commonly known as technology transfer and is defined by the (Competence Centre on Technology Transfer, 2022) of the European Commission as the process of transferring results of technological research, alongside complementary skills and procedures, to the marketplace and society at large.

On the other hand, intangible asset transfer is also known as knowledge transferring and is generally defined as a process where a body of knowledge used and organized in one setting is exchanged with other organizations (Bloedon & Stokes, 1994). This type of transferring process is harder to understand due to its very nature (no tangibility). Hence the resulting transaction is harder to follow (Sung & Gibson, 2000) and, in some cases, the accuracy when measuring its impact can be questioned.

Technology transfer usually comes with a financial benefit for the university (D’Este & Perkmann, 2011). This benefit undoubtedly fosters further research on similar or complementary topics/technologies, which could, in turn, change the research

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panorama and the internal structures of the university and its business partners (Pisano, 2006). As stated by Schaeffer et al., (2020) a linear model for understanding technology transfer is insufficient, as it reduces university objectives to the maximization of financial returns, based on the commercialization of property rights.

However, this reductionist conception ignores the relevance of universities to economic development. Indeed, one of its most reliable ways to contribute to economic development is by means of accompanying or coaching companies in their business path. This accompaniment usually comes in the form of consultancies, defined by Landry et al. (2010) as companion activities that are commissioned by industrial partners or governments to bring the research expertise into the field. It is important to note that Grimpe & Heusinger, (2013) found that both formal and informal consultancy are the most utilized form of transfer, through collaborative research, contract research, and licensing/technology acquisition.

The process of hard-skill transferring has been studied extensively, from its conception to the process of seeking funding, and the impact of a constant flow of financial resources on the infrastructure of the company and the university. Nevertheless, the study of the process of intangible knowledge transferring is still in its infancy. Consequently, this paper seeks to contribute to the discussion of the latter.

4. Methodology

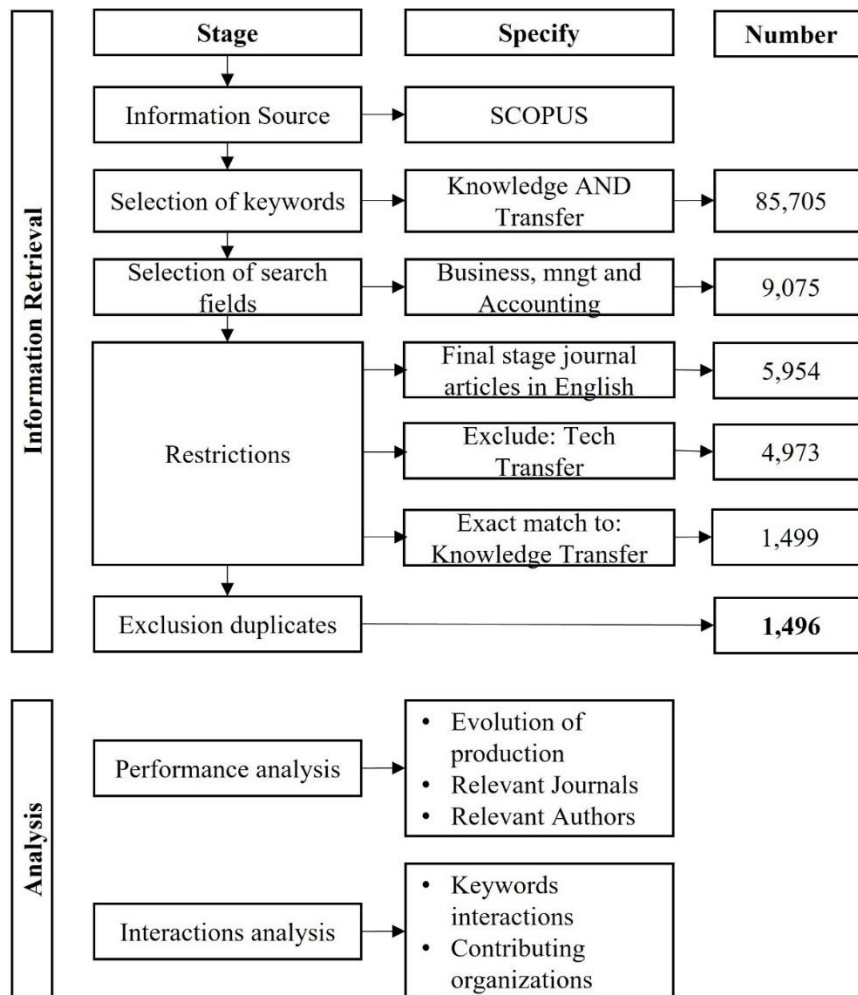
4.1. Bibliometric Analysis

A bibliometric study, part of scientometrics, is known for using statistical methods to quantitatively analyze bibliographical data (Broadus, 1987; Naseer & Mahmood, 2009). It provides important criteria to select, evaluate and monitor published research (Moed et al., 1995). While these methods are not new, they have become popular among scholars with the rise of comprehensive bibliographic databases such as Clarivate Analytics', WoS database and Elsevier's Scopus database, and open software tools (Bengoa et al., 2021).

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Bibliometric studies are divided into 2 major sections: information retrieval and analysis, as shown in Figure 2.1. First, the retrieval of information starts with choosing the information source. In this case, Elsevier's Scopus database was chosen due to its wide inclusion of journals and the detailed information it provides (Harari et al., 2020). A preliminary number of 85,705 hits was obtained after a search of "knowledge AND transfer" (using Boolean operators) in the abstract, title, and keywords. To limit the search results, only articles inside the business, management, and accounting fields were considered, reducing the number of hits to 9,075.

FIGURE 2.1: BIBLIOMETRIC FLOW



Thereafter, to refine the search further, only journal articles written in English and in the final stage of their publication process were considered. This brought the number down to 5,954 hits. Likewise, to focus the search on knowledge transferring, all the

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papers with technology transferring as keyword were excluded, reducing the number of hits to 4.973. Finally, after limiting the search to an exact match of keywords and removing duplicates, the final data set has 1.496 papers.

In the phase of the bibliometric analysis, choosing the correct indicator is crucial (Ding et al., 2014). To achieve a broad understanding of the topic, while deep diving in the systematic literature review section of this paper, only five main analyses were made. In this regard, it is important to note that certain variables were added, such as H-Index, to break the usual linearity of the bibliometric studies. This brought some innovative ways to mix different variables when targeting the same issue and will help to bring to light different authors and journals, in order to make a more comprehensive analysis.

To perform the analysis, software tools as the bibliometrix pack (Aria & Cuccurullo, 2017) in the version running in R in the 4.2.2 version, and VOSViewer (van Eck & Waltman, 2010; Waltman et al., 2010) in the version 1.6.18 were used. Likewise, the matplotlib libraries in the version 3.5.2 python were used to correctly plot the information.

The first analysis consisted in the evolution of scientific production. To achieve this, the number of publications and the average citation per year were compared. In addition, a thematic evolution map was created to observe the evolution in terms of central topics, and not only in terms of publications. The next two analyses related to the relevant journals and relevant articles included in the study. These were chosen to have a more complete view of the production. This method is in line with the Leiden Manifesto (Hicks & Wouters, 2015), as it not only considers the number of publications (Merigó & Yang, 2017), but also adds the H-Index (Hirsch, 2005) and the number of citations, to attain a more holistic understanding of the subjects and the journal's performance.

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Additionally, to evaluate the authors, the Unity Index was used (Plata, 2022). This new index is a three-part point-based system, as shown in equation 1, where the points are assigned by granting 1 point to the author with the most published articles and increasing the number of points assigned by 1 to all subsequent authors. The same system is conducted in relation to the remaining 2 indicators: acceptance -citations- and impact -h-index- (Plata, 2022).

$$\uparrow \text{Unity Index} = \downarrow \text{PointsPublication} + \downarrow \text{PointsCitations} + \downarrow \text{PointsH_Index}$$

Moreover, the Unity Index serves as an additional form of observing scientific production from a more holistic approach, while still using traditional scientometrics. This helps more impactful authors, though not top producers, to share the spotlight with top producers in different bibliometric studies. As an example, from the pool of 3156 authors, Linda Argote, top author on both the number of publications and H-Index, is placed 91st in number of citations. As a result, she is in 5th place in the Unity index and shared the spotlight with Andrea Caputo (placed 9th in the Unity Index) placed 40th in publications, 79th in H-Index and 7th in citations. Using traditional linear ways of comparing scientific works can lessen the prominence of authors with a high impact, but not a substantial number of publications. A more complex form of this index could consider assigning different weights to the variables. However, considering the interdependency between the variables, this was not considered for this study.

To understand the use of keywords and their relations, a keyword interaction network was created using a co-occurrence analysis and generating clusters of affinity. Finally, to understand the affiliation interaction, a 3-field map was generated, which included authors, their affiliations, and the targeted journals.

4.2. Systematic Literature Review

To review the empirical literature regarding the process of transferring intangible knowledge and their possible impact on actors, the first step of the proposal, in line

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with the best practices of systematic literature reviews (Hiebl, 2021), is to conduct a comprehensive search on the databases available through the University's library services.

The preliminary databases chosen were EBSCO, with the market name Business Source Ultimate, and ScienceDirect, based on their comprehensiveness across journals and disciplines. The preliminary keywords proposed for this search are "Knowledge transfer" and "Process". It is essential to note that the search does not have any time restrictions but may be limited to articles that had both of the keywords in their abstract, keywords, or title in the case of ScienceDirect. Likewise, since there is no equivalent option regarding Business Source, and following the advice of a librarian from the University Toulouse Capitole, the search is limited to the abstract only.

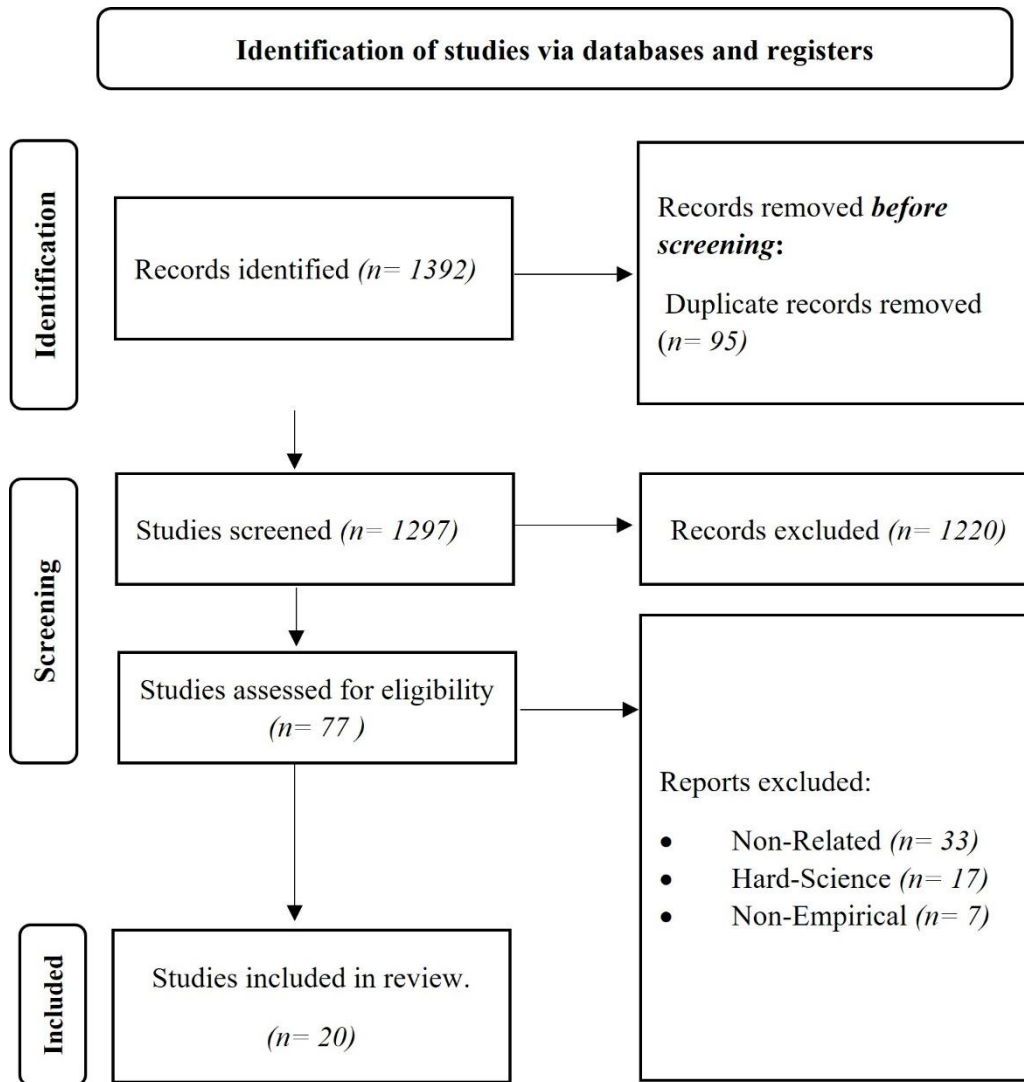
Every search is limited to academic journals and peer-reviewed publications, excluding dissertations, books, book chapters, conferences, or any other "grey" literature study (Harari et al., 2020). Additionally, since the ScienceDirect database has multiple disciplines outside the focus of the study, the search is expected to include only articles from the following subjects: economics, econometrics and finance, psychology, business management and accounting, and social sciences. On the other hand, for the case of Business Source Ultimate, as there is no discipline filter, the area was slightly delimited by excluding those topics that are evidently not related to the subjects of the study, for example, urban ecology.

The first number of hits in both databases was screened using the technological platform COVIDENCE, tool that addresses the pertinence of the title and the abstract and decides to either include or exclude it of the full-text reading and categorization phase. Only articles in English researching the intangible knowledge transfer between the Higher Education Institutions (HEI) and the companies were considered.

The Figure 2.2, based on Page et al (2021), details the methodology process and the workflow until the coding process.

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FIGURE 2.2: PRISMA FLOWCHART



The coding process will begin with the full-text reading of the final included articles and the information recording was done with Microsoft Excel. In addition to this extraction and organization of the information related to knowledge-transferring processes, descriptive information from the paper, such as sample, year, journal, country, and sector, was also recorded. To assess the different fields of journals, this study used the Chartered Association of Business Schools Academic Journal Guide (AJG guide). Finally, after gathering all the information, it was analyzed and presented, to conclude with recommendations and a research agenda.

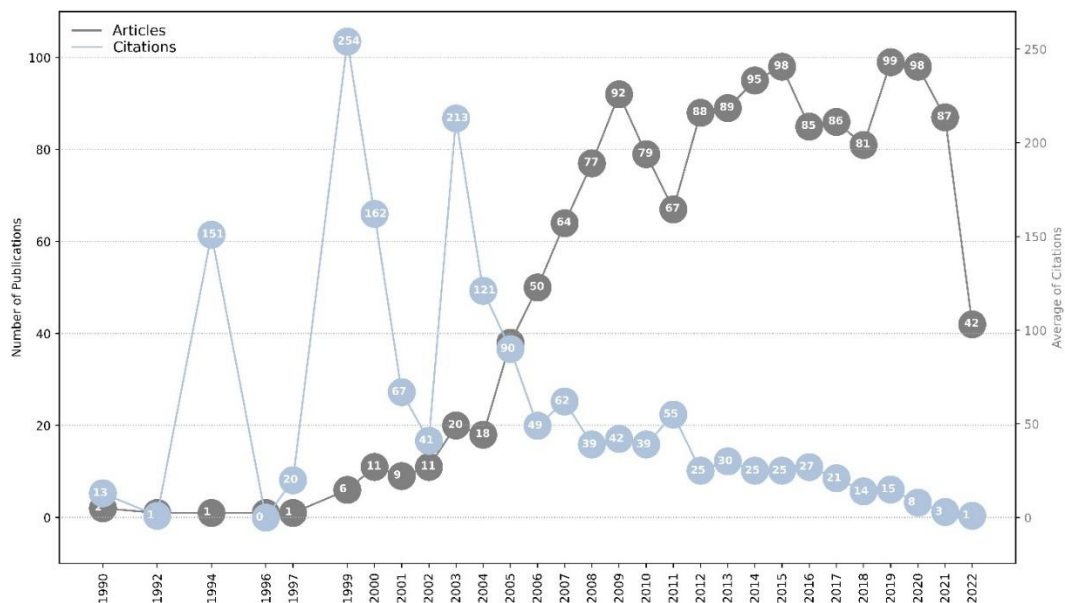
5. Results

5.1. Bibliometric Analysis

5.1.1. Evolution of the scientific production

The number of scientific publications, often in peer-reviewed journals, are a tangible measurement of the scientific output and the interest of the community in a specific field or topic. The 1496 articles published during over more than 30 years in Figure 2.3 reflect a clear trend in this regard. The first article was published in 1990 and, since then, the field of knowledge transferring has continued in an upward trend. This trend is certainly consistent with the research interest in the sister topic of technology transferring (Bengoa et al., 2021). When analyzing the publication distribution per decade, there is an initial phase from 1990 to 2000 with an average of 2 publications per year, followed by an expansion phase between 2001 and 2010 with an average of 46 publications per year, and a final phase between the 2011 and 2020 with an average of 89 publications per year. The most rapid growth period was between 2005 and 2009 and, in the following years, there was an average of 83 publications per year. 2014, 2015, 2019, and 2020, on their part, were above the average.

FIGURE 2.3: COMPARISON OF THE EVOLUTION OF SCIENTIFIC PRODUCTION AND CITATIONS

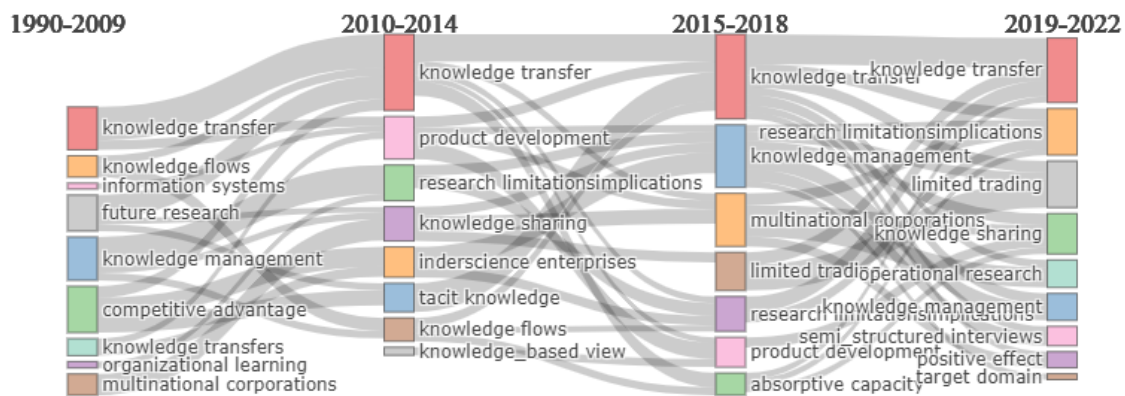


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In addition to the number of publications, and their evolution, an analysis of the number of average citations per article per year was conducted. It is important to note that this study did not include the graphical representation of this evolution as presented by Szulanski, (1996), which has 4915 citations. The average citation per article per year was 58, and the years 1999, 2000, 2003, and 2004 were at least 3 times above the average. In contrast, during the last decade, no year surpassed this average, with the years 2013 to 2016 having the best citations rate.

To qualitatively understand the evolution of the topic, a thematic evolution representation using the bibliometrix (Aria & Cuccurullo, 2017) was plotted and presented in Figure 2.4. This map was created using bigrams. Its inputs are the abstracts of the papers and three time slices in 2009, 2014, and 2018. This map aims to show how different themes have evolved and how they influence each other over time.

FIGURE 2.4: THEMATIC EVOLUTION



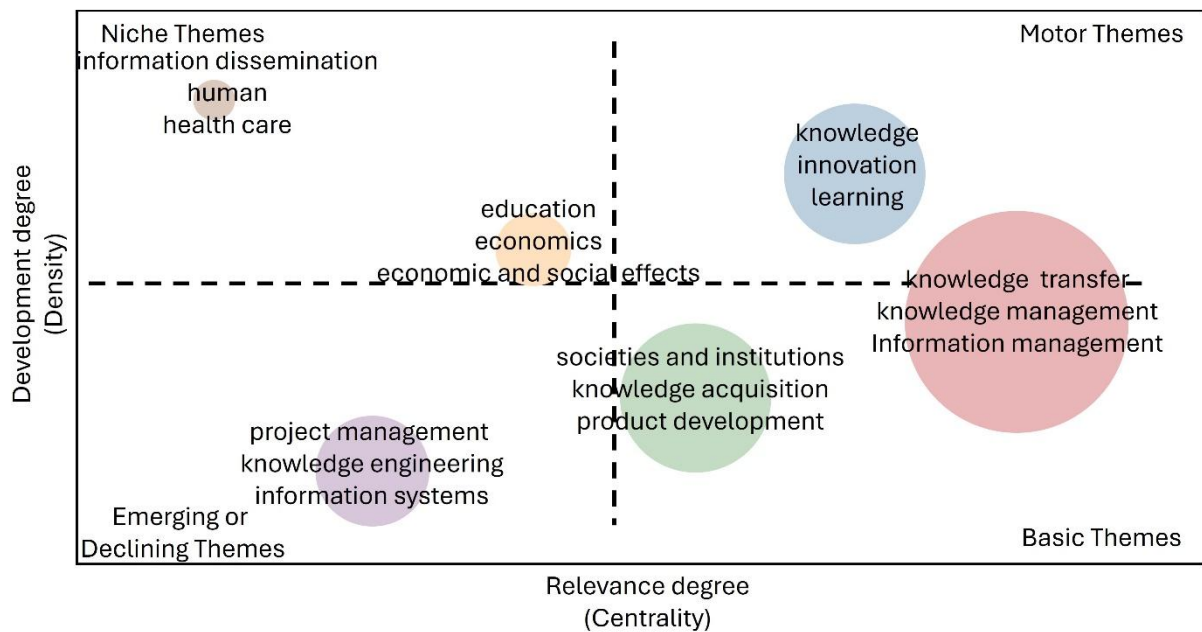
Figure, 4, shows that knowledge transfer has been present during this period, and that it has been influenced by topics such as competitive advantage and multinational corporations, during the period of 2010-2014. Likewise, from 2015 to 2018, knowledge transfer influenced fields such as knowledge management, product development, and

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absorptive capacities. Regarding the final period, from 2019-2022, knowledge transfer influenced topics such as knowledge management and limited trading. The aforementioned shows that even when maintaining a constant trend, the field of knowledge transfer has been influenced by, and has influenced, key important fields in research, aiding in the development of various fields of research, and positively impacting the scientific community.

Additionally, and continuing the qualitative analysis, a thematic map, using the bibliometrix (Aria & Cuccurullo, 2017) and Keywords Plus parameter, was plotted and presented in Figure 2.5. This map aims to understand each theme and its classification. Basic themes are part of the usual mainstream research, while motor themes foster the most production. Additionally, emerging themes are the ones rising in importance in the fields and have the potential to become motors in the future.

FIGURE 2.5: THEMATIC MAP



The analysis found that knowledge transfer and knowledge and information management were the most persisting topics, and they are in-between basic and motor themes. Knowledge innovation is a motor theme, which is in line with the analysis of topic evolution. These results show that knowledge transfer and management are

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some of the driving topics of the field and, while still new, researchers have found ways to keep them prominent and influential over time.

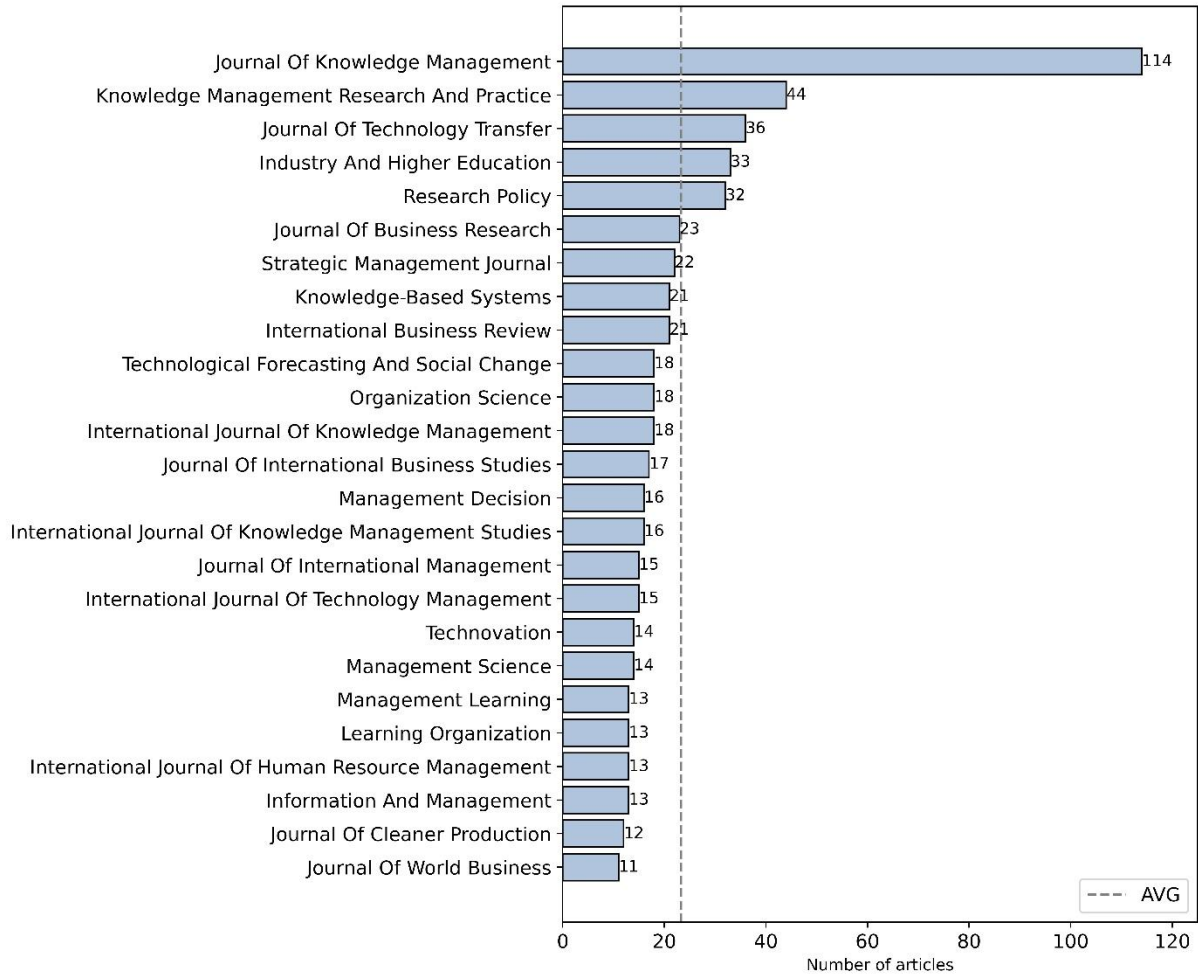
Knowledge engineering is one of the emerging themes and it can be regarded as the natural evolution of the knowledge management and knowledge acquisition themes, since it may entail an organized and standard form of handling knowledge, utilizing the engineering mindset to the generation of knowledge and common problems. However, as it is an emerging topic, it is best to wait and observe how the field is developed in the future.

5.1.2. Most Relevant Journals

The relevance of sources and to what extent they influence the knowledge transfer field initially was measured by the function that correlated the number of articles published, the number of citations and the H-index. Figure 2.6 shows the 25 most relevant journals in knowledge transfer. In the list, we can find journals such as the Journal of Technology Transfer, Research Policy, and Technovation journals traditionally linked to the technology transfer field, showing the interest of traditional journals in adopting a new stream of research.

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FIGURE 2.6: MOST RELEVANT SOURCES



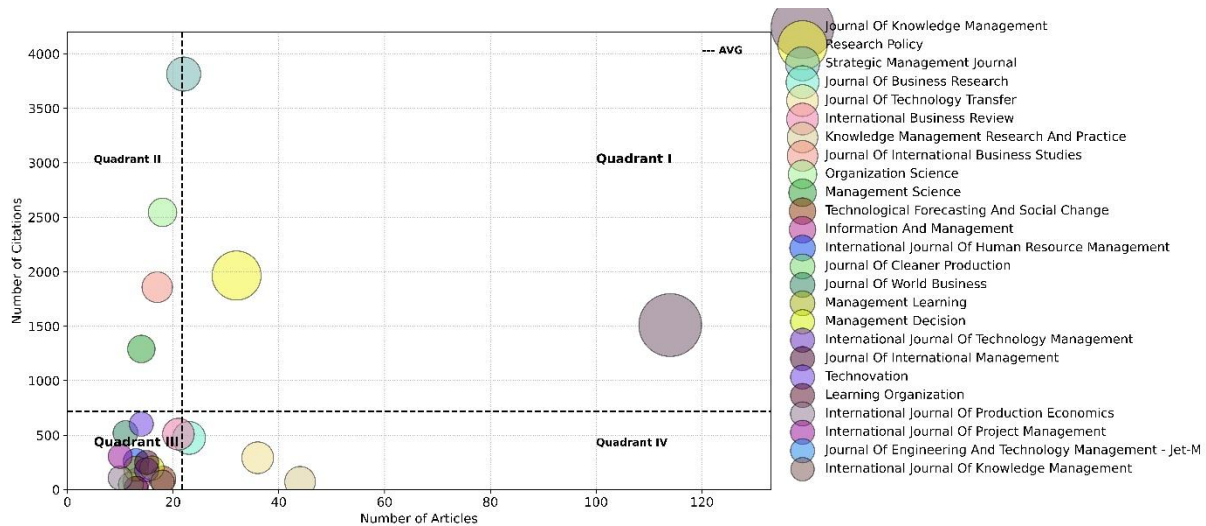
In terms of citations, the most relevant journal is the Strategic Management Journal with more than 3500 citations, followed by Organization Science, Research Policy, and the Journal of International Business Studies with more than 2000 citations each. In terms of H-Index, the most prominent journals are the Journal of Knowledge Management and Research Policy with an impact of 39 and 30 respectively, followed by the Strategic Management Journal, the Journal of Business Research, and the Journal of Technology Transfer, with an impact of close to 20.

Most of these journals do not specifically focus on knowledge transfer, but the high number of publications and citations could be due to a rising interest in the topic, in areas traditionally focused on technology transfer and strategic management. In Figure 7, the relationship between the number of citations, publications, and the H-

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Index can be observed. The x-axis shows the number of publications, whereas the y-axis presents the number of citations, followed by the size of the bubble representing the H-Index. Additionally, the average line for each axis was presented to create four quadrants, which helps to understand the state of the journals.

FIGURE 2.7: MULTIVARIATE ANALYSIS MOST RELEVANT JOURNALS



The top 25 journals in terms of number of H-Index are presented in the graph above. As observed, the resulting quadrants are not balanced, which may imply that most journals are quite similar, but there are some that are stronger on the subject in question. Quadrant I shows the three stars journals, the Journal of Knowledge Management, the Strategic Management Journal, and Research Policy, both excelling in the indicators of publications, citations, and H-Index. This may be the result of their specialty on the subject of knowledge transfer and of their new policy proposals regarding knowledge management.

In quadrant II, journals like Organization Science, Management Science, and the Journal of International Business Studies show an above-average number of citations, but a below-average number of publications. Thus, their “limited” number of published papers are well received by the community.

In quadrant III, journals such as the Journal of Business Research or International Business Review show a close-to-average number of publications and number of

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citations. This presents them as journals with a possibility of moving into a more “impactful” quadrant.

Furthermore, in quadrant IV, journals like *Industry and Higher Education*, *Knowledge Management Research and Practice*, and the *Journal of Technology Transfer* have a below-average number of citations, but an average number of publications. This may be due to various reasons such as their non-specific focus on the topic of study.

In addition to the relevant sources, in terms of number of publications, the quality of the journal can be analyzed. Following the Chartered Associations Of Business schools journal ranking (AJG) (Laing et al., 2018), from the 1198 articles published in ranked journals (80% of the total articles), 126 articles were published in 4* journals, followed by 83 and 279 in journals ranked 4 and 3 respectively. In the lower end, in journals ranked 2, there are 352 papers, and 358 in journals ranked 1. Thus, 41% of the papers published in ranked journals are located in the upper end of the ranking, showing the quality and innovation achieved by scholars in a non-mainstream field.

In the same vein, in the AJG ranking, 50% of the articles published in ranked journals are published in the disciplines of Organizational Studies, Innovation, Information Systems, and International Business and Area Studies. This shows that knowledge transfer studies can target different disciplines and could serve as an interdisciplinary field of study. In addition, in the lower end of the number of publications, there are articles published in various disciplines such as Human Resource Management development and Education (77 publications), Management and Employment Studies (48 publications), and Operations Research and Management Science (25 publications). In the supplemental material A, the 50 most cited articles are listed for the reader to consult.

5.1.3. Most Relevant Authors

As with the most relevant journals, the analysis of the most relevant authors was based on the number of articles published, local citations and the H-index. Nonetheless, it is

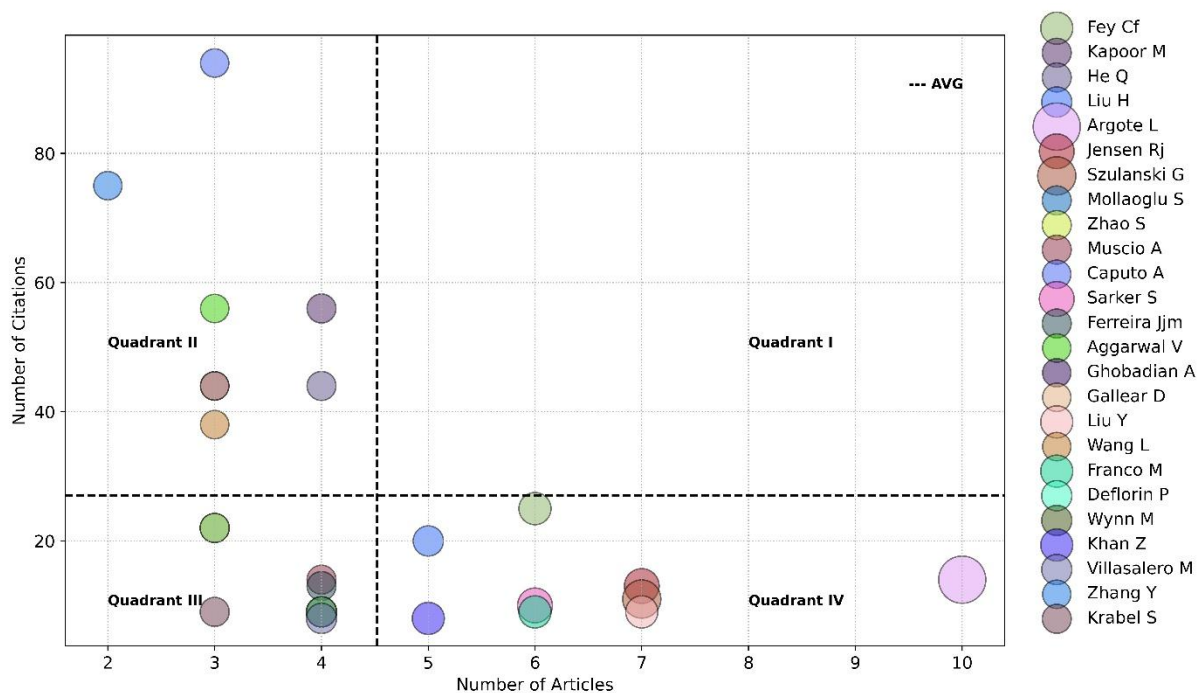
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important to note that there are 3156 authors, which shows a high tendency toward co-authorship. In terms of publications, the most prominent author is Linda Argolote with 10 articles, followed by Robert J. Jensen, Gabriel Szulanski, Yang Liu, and Sajjad Jasimuddin with 7 articles each.

Concerning local citations, authors Ivo Tafkov, Kristy Towry, and Flora Hailan Zhou are an exceptional case, as they have one article with 323 local citations. When analyzing the H-Index, the most impactful authors are Linda Argolote, Gabriel Szulanski, Robert J. Jensen, Suprateek Sarker, and Daniel Z. Levin with an H-Index above 5.

Figure 2.8 shows the top authors of the unity index, a relation between the number of local citations, publications, and the H-Index. The x-axis shows the number of publications, whereas the y-axis shows the number of local citations, followed by the size of the bubble representing the H-Index. Additionally, the average line for each axis creates four quadrants that will help to understand how the characterization of the pool of authors.

FIGURE 2.8: MULTIVARIATE ANALYSIS MOST RELEVANT AUTHORS



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The authors listed in the graph are the 25 more prominent authors in the Unity Index. The four quadrants are not “balanced”, i.e., the average is not near the middle and the normal curve is out of phase. This creates bigger and smaller quadrants depending on how far the authors are from the middle. In quadrant I, there are no authors. Hence, no authors are above average in terms of citations and number of articles. This shows that, in this specific dataset, there are no “star” authors.

Furthermore, quadrant IV presents authors like Argote L, with above-average number of publications and H-index, but below-average number of citations. This mixture may imply that she is an influential author, but only in certain impactful publications. Additionally, Deflorin P is above average in terms of number of publications, and is close to being above average in number of citations, thus, her publications have good acceptance.

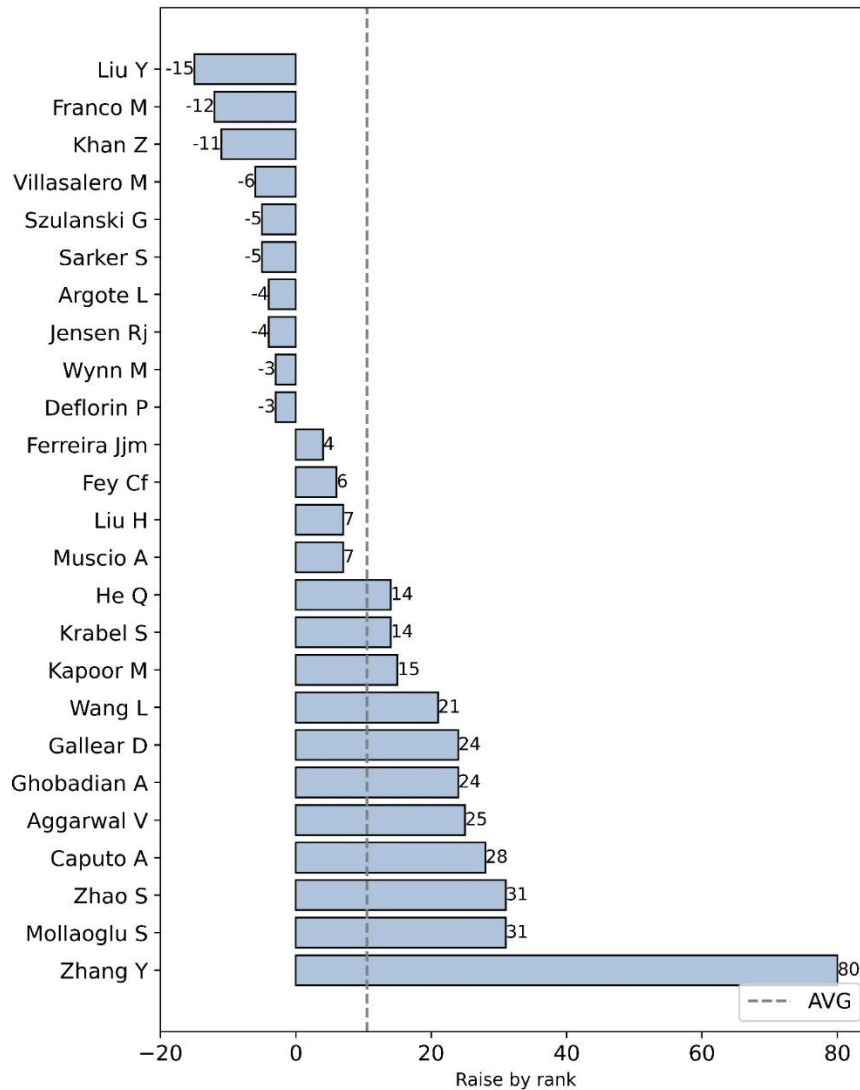
Quadrant II presents authors like Caputo A, Zhang Y, and Aggarwal V with three, two, and three publications, respectively. Nevertheless, their number of citations is above average. This shows that the acceptance of those publications is extensive. These results may imply the existence of a seminal paper that started to change the way a line of research was conducted.

In quadrant III, homogenous authors such as Krabel S and Muscio A are at the top in the Unity Index, but the number of publications or citations are not above average. This does not imply that their contributions are negligible, since the index is calculated with a specific data set coming from a query based on a research question. It may be the case that the author is more prominent in other fields or specialties.

A follow-up analysis, displayed in Figure 2.9, shows how different authors shift places in the “ranking” when their place in the Unity index and their publications are compared.

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FIGURE 2.9: RAISE IN RANK AUTHORS



Comparing the first 25 authors with the best Unity Index shows that, on average, each author scaled higher by 11 places. 10 authors were placed lower, while 15 authors scaled higher. Moreover, Zhang Y, Mollaoglu S, Zhao S, Caputo A, and Aggarwal V were the authors who scaled the most: 80, 31, 31, 28, and 25 places higher, respectively. These shifts can come from an over- or under-indexation. The over-indexed authors that scaled places were Zhang Y, Caputo A, or Aggarwal V, thanks to the high number of citations per paper. Additionally, Kapoor M or He Q scaled one place higher based on their high H-Index.

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Subsequently, the under-indexed authors were Liu Y or Franco M, placed lower, due to a strong number of publications but a lower citation number compared to other authors from the data set.

5.1.4. Popular Keywords

In Figure 2.10, a network map of keywords is presented. This network map was made with the VOSViewer software (van Eck & Waltman, 2010; Waltman et al., 2010) and was generated by fully counting the co-occurrences, using every keyword as a unit. The minimum occurrence was set to 25 and every keyword that met the threshold was graphed.

FIGURE 2.10: KEYWORD NETWORK

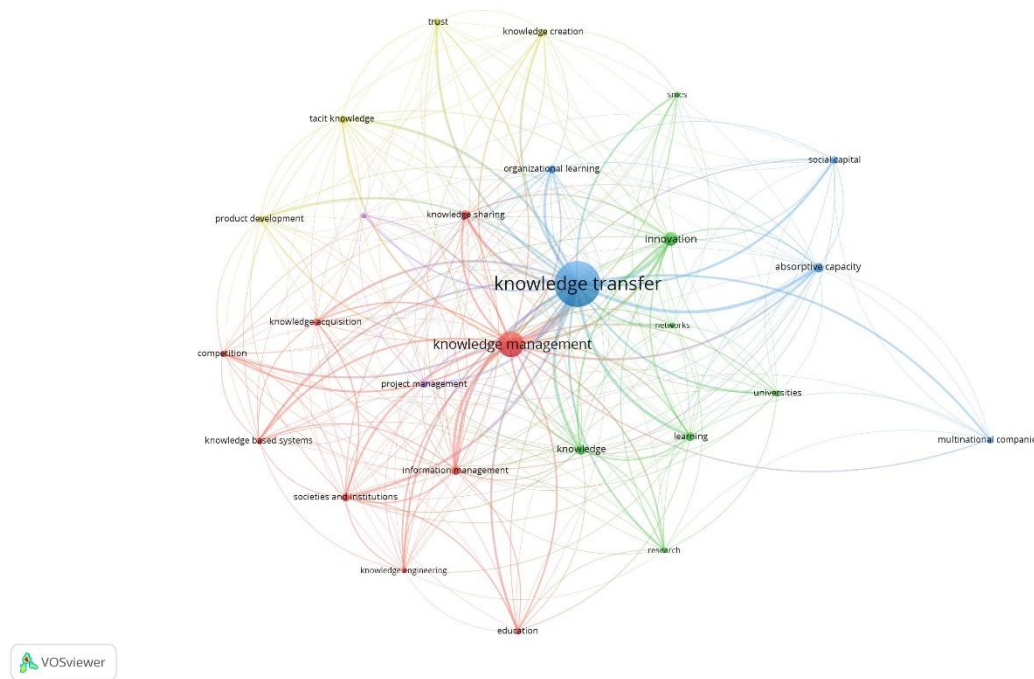


Figure 2.10 presents 5 clusters, the first cluster - in blue - has as central node “knowledge transfer”, the stronger node of the network. This cluster includes words such as absorptive capacity, organizational learning, multinational companies, and social capital. This cluster shows the importance of knowledge inside organizations, its effect in their internal relationships and in their social tissue.

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A second cluster - in red -, with “knowledge management” as a central node, includes words as knowledge sharing, knowledge-based systems, knowledge engineering, knowledge sharing, and knowledge acquisitions. This cluster presents the importance of knowledge management inside institutions and for future endeavors.

A third cluster - in green -, with “innovation” as the central node, shows a relationship with universities, research, and learning. It presents how knowledge can be created inside universities through research and innovation processes.

A fourth cluster - in yellow -, with “knowledge creation and trust” as a central node, shows that the relevance of trust is in the process of knowledge creation and of transferring tacit knowledge. In the last cluster - in purple -, the relation between human resource management and project management can be found.

When holistically analyzing the network, one can find a relation in knowledge-transferring processes between its generation (universities, innovation and research), management (knowledge-based systems, knowledge engineering), its impact on the processes inside the company (product development, absorptive capacities) and how institutions achieve successful transferring (tacit knowledge, organizational learning). This shows the central and important role of a proper and structured transfer of knowledge.

5.1.5. Contributing Organizations

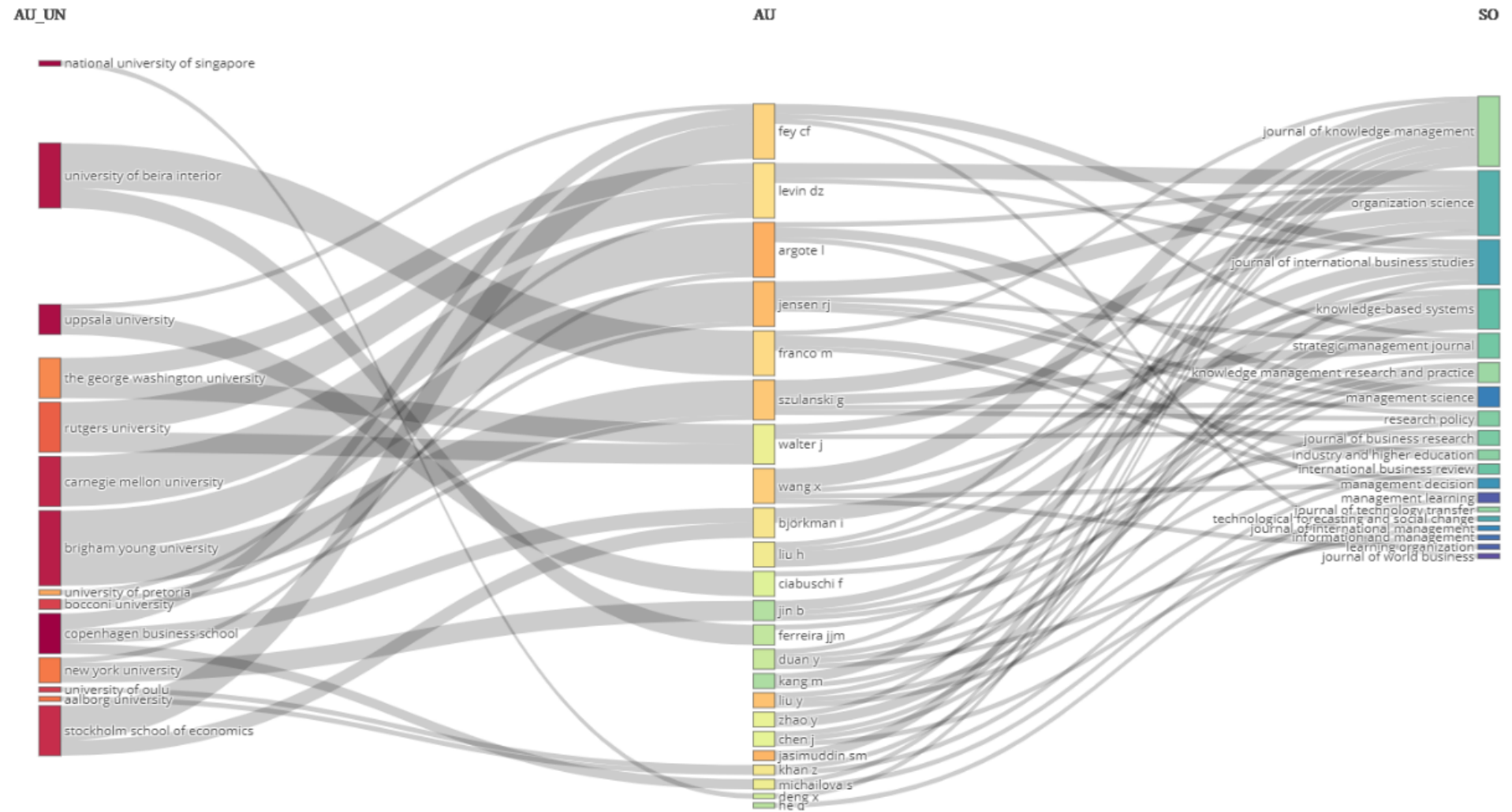
In order to understand the ways authors work when researching and their affiliations, a 3-field map was generated using bibliometrix (Aria & Cuccurullo, 2017), as presented in Figure 2.11. This 3-field map has in its center the author, accompanied by the journal on the left and the affiliation of the authors on the right. Likewise, the maximum number of iterations for each field was set to 25. This 3-field plot shows the affiliation the author declares at the time of the publication, and the journal where the work was published. This is important to find the affiliations that most support research in the topic, and the journals that most authors target.

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In terms of most relevant affiliations, the Copenhagen Business School was at the top, with 3 main authors declaring it as their affiliation at a point in time. Every other institution has a maximum of 2 authors affiliated. Following previous results, Robert J. Jensen and Linda Argote are central authors with 3 and 4 papers, and 2 different affiliations respectively. Additionally, the most receiving journals were the Journal of Knowledge Management with 9 authors publishing, or aiming to publish, in it, and Organizational Science, on its part, with 6. This shows that authors contribute with each other and that is common for a scholar to change institutions. Moreover, it shows that authors target multiple journals, which can be the result of aiming to find the journal that better fits their research and influences the community the most.

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FIGURE 2.11: 3-FIELD MAP



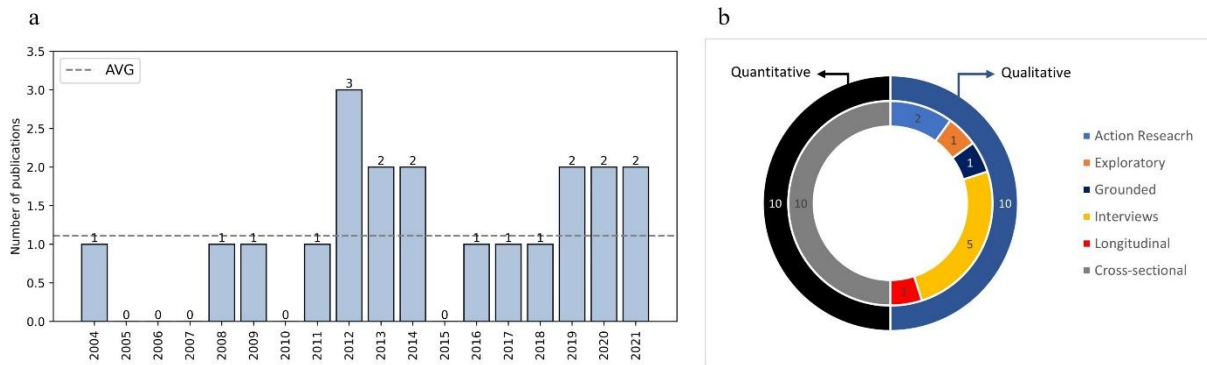
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5.2. Systematic Literature Review

5.2.1. Descriptive Information

The descriptive results from the articles included in the review show a spike in publications in the past decade, with 60% of the publications made between 2012 and 2019. In this period, the year with most publications is 2012, and there are between 1 or 2 publications for each of the other years. In Figure 2.12 (a), detailed information regarding this evolution can be found.

FIGURE 2.12: (A) PUBLICATION PER YEAR - (B) METHODS

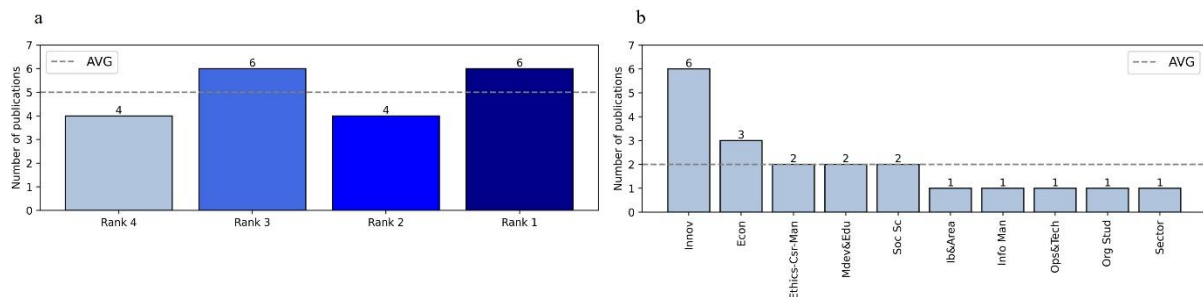


As shown in Figure 2.12 (b), and considering the type of study -in the outer ring -, 50% (n=10) of the articles have a quantitative method, with only cross-sectional research designs (Andersen & Rossi, 2011; Arvanitis & Woerter, 2009; Berbegal-Mirabent et al., 2012; Bodas Freitas et al., 2013; Govender et al., 2018; Handoko et al., 2014; Hewitt-Dundas, 2012; Hughes & Kitson, 2012; Martinelli et al., 2008; Olmos-Peñuela et al., 2014). The remaining 50% (n=10) presented a qualitative design. Indeed, these articles presented a more varied methodology, with 5 publications using interviews (Becerra et al., 2019; Canonico et al., 2020; Dee & Leisyte, 2017; Siegel et al., 2003; Thomas, 2012), 2 publications using action research (Jones & Coates, 2020; White et al., 2019) and 1 publication using grounded theory (Elliot, 2013), longitudinal studies (Miller et al., 2016) and exploratory approaches (P. R. Schaeffer et al., 2021).

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According to the fields listed in the AJG guide (Laing et al., 2018), and as shown in Figure 2.13 (b), the subject with more publications is innovation with 6. Moreover, there are 3 publications in the field of Economics, Econometrics, and Statistics. Additionally, 2 publications were found in the field of General Management, Ethics, Gender; and Social Responsibility, Management Development, and Education and Social Sciences, respectively. Finally, the fields of International Business and Area Studies, Information Systems, Operations Research, Management Science, Organizational Studies and Sports, Leisure, Tourism, and Sector Studies only have 1 publication each.

FIGURE 2.13: (A) PUBLICATION BY RANK - (B) PUBLICATION BY FIELDS



Additionally, Figure 2.13 (a) shows the rank of the journal, with four papers published in rank 4 journals, followed by 6 papers in rank 3 journals, and 4 papers in rank 2 journals. Likewise, in ranked 1 journals, 6 papers were published. It is important to note that there are no publications in rank 4* journals. This statistic may be explained by the limited number of papers targeting academic and non-academic participants in the knowledge transfer process. It is important to note that the lack of interest in high ranked journals seems an unlikely explanation, given the data coming from the aforementioned bibliometric analysis.

5.2.2. Relations between academic sectors and non-academic sectors

Unexpectedly, the active sectors in intangible knowledge transferring are diverse, and not necessarily linked to services. There are companies related to hard-sciences products, such as gas separation and compressed air (Jones & Coates, 2020), computer

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science (Elliot, 2013), manufacturing (Bodas Freitas et al., 2013) and automobiles (Canonico et al., 2020). Additionally, there are studies that include multiple companies from different sectors (Andersen & Rossi, 2011; Berbegal-Mirabent et al., 2012; Hewitt-Dundas, 2012; Hughes & Kitson, 2012; Martinelli et al., 2008). This suggests that all types of business can engage with, and use, knowledge-transferring platforms. Consequently, scholars could choose a niche sector that could better use their knowledge and approach. However, this may lead to an excessive specialization of academic-industry relations, and may be an inflection point in terms of innovative research.

In terms of disciplines and fields, there were also knowledge-transferring processes in projects related to corporate social responsibility and environmental sustainability (Elliot, 2013), marketing (Jones & Coates, 2020), tourism management (Thomas, 2012), business management (Miller et al., 2016), product management (Canonico et al., 2020) and human resources management (Govender et al., 2018). Additionally, there were some mixed publications where the study was within the field of social sciences and, specifically, management (Hewitt-Dundas, 2012; Hughes & Kitson, 2012; Olmos-Peñuela et al., 2014). This diversity of disciplines suggests that multiple scholars from multiple disciplines are willing to engage in knowledge transferring, which may serve as a means to reduce the gap between management practitioners and scholars.

In contrast to the sectors and fields, the platforms through which knowledge transferring occurs are not as varied. The most used platform by scholars and practitioners to share different expertise is consultancy (Becerra et al., 2019; Hewitt-Dundas, 2012; Olmos-Peñuela et al., 2014). This may be because, although consultancy is a formal transferring platform, it opens the door for a substantial number of informal encounters. Hence, it may be an avenue to balance the transfer of tacit knowledge. Another platform used is action research (Jones & Coates, 2020; White et al., 2019). In contrast to a more standard consultancy process, in this platform, research has a more active part in the process and is a more “hands-on” initiative.

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There are other platforms used for processes of industry-university knowledge transferring such as joint research (Elliot, 2013; Olmos-Peñuela et al., 2014) and collaborative projects (Berbegal-Mirabent et al., 2012). These types of relations are more formal and, in general, less flexible in terms of the outputs and the objectives.

5.2.3. Impact of knowledge-transferring relations

Knowledge-transferring processes affect both the offering (universities) and the receiving parties (companies). This impact, regardless of the platform, may be positive in terms of external credibility, which can accentuate even more in universities with a high research intensity (Hewitt-Dundas, 2012; Jones & Coates, 2020). Also, knowledge transfer can be a route for companies to bring a new vision when understanding certain problems, and to generate more complex and accurate models (Elliot, 2013), in order to more effectively invest their resources into solutions.

Financial benefits are also part of the transactional results of the use of transferring platforms. The spillover of financial resources in this exchange can bring funding to the university, to support additional research endeavors that do not necessarily end with a product that can be commercialized. Hence, it can be a tool to support a wider research agenda (Berbegal-Mirabent et al., 2012). However, this commercialization of knowledge may have disadvantages, specially where there is an imbalance of power within different stakeholders (Miller et al., 2016). In these cases, university governing bodies would tend to support only research projects that could be commercialized. Thus, the diversity and the emergence of new topics of research could be jeopardized (Jones and Coates 2020).

Additionally, university-industry relations can serve as an avenue to increase and improve innovation processes and the economic performance of firms (Arvanitis & Woerter, 2009). This can be achieved by coming up with new meanings and solutions to problems during the transferring process (Canonico et al., 2020), and by including innovations and expertise that the company lacks and that would be expensive to acquire (Jones & Coates, 2020).

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The generation of knowledge transfer relations is crucial to avoid the perception of academic research as tangential, and unnecessarily complex for practitioners (Thomas, 2012). A way of generating long-lasting relationships would be the creation of knowledge transfer offices, centralized bodies in charge of ensuring a proper flow of information. These offices would certainly influence the university, as they would be a new body with a new hierarchy and governance structures. Thus, they would need to fit in the university structure and, in some cases, these offices would become a priority within strategic plans (Becerra et al., 2019).

Likewise, the impact of knowledge transferring on universities is not only financial, in terms of additional funding for new research and incentives towards engaging in more knowledge transfer contracts (Berbegal-Mirabent et al., 2012). It can also help in their main missions of education and research. Regarding education, industry knowledge fed to universities can help guide the creation and adaptation of curriculums for better educated future generations (Jones & Coates, 2020). In terms of research quality, knowledge-transferring processes and working closely with the industry would increase the likelihood of producing better and more impactful research (Hewitt-Dundas, 2012), through different points of view and new data.

5.2.4. Knowledge transfer and small companies (SMEs)

The idea of generating knowledge transfer relations with universities as something exclusive to large companies is untrue. There are relations between universities and SMEs, which often do not rely on any institutionalized infrastructures, as there is a stronger presence of personal relations and interactions between researchers and practitioners (Bodas Freitas et al., 2013). This is also the case for entrepreneurs and technology managers, which are more used to informal relationships (Siegel et al., 2003). These relations can positively impact the receiving party, as this type of company frequently encourages the design of more innovative programs and platforms, in order to achieve a sustainable advantage in a highly competitive scenario (Handoko et al., 2014).

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Regarding structural or organizational changes inside SMEs, knowledge transfer partnerships can serve a particular role and have been successful in delivering significant and sustainable changes (White et al., 2019). In addition to the important economic contribution that SMEs can bring to a region where they are established, they can create opportunities to graduates of local universities, providing them with a space to stay and contribute with their skills in less developed regions (Hewitt-Dundas, 2012).

5.2.5. Creation and maintenance of relationships

The creation of knowledge transfer relations with the industry is usually initiated through a personal contact between the researcher and people from the industry. This personal contact may be created by to past experiences such as participating in business events, professional networks, advisory boards, conferences organized by non-academic external organizations, professional fairs, lectures or providing employee training (Hughes & Kitson, 2012; P. R. Schaeffer et al., 2021; Thomas, 2012).

These contacts can allow businesses to gain the necessary trust to build communication channels, to set up a well-supported relationship (Jones & Coates, 2020; Thomas, 2012). This is especially critical, as most of the knowledge transferred from the social sciences to companies is not protected through intellectual property mechanisms such as patents. Hence, there may be a lack of transparency in the knowledge-transferring process and contract negotiations may be hard, due to certain difficulties when assessing the economic value of the contributions (Andersen & Rossi, 2011)

Even though most of knowledge-transferring processes seem positive for companies, some practitioners see academic research as tangential, unnecessarily complex, and inaccessible. Thus, sometimes they are unwilling to engage in long-lasting relationships with universities (Thomas, 2012). Scholars and universities must certainly correct these issues through proper science communication. Additionally, to achieve better results, it is important engage with knowledge-transferring processes that have more than one transferor, for instance, the government. Hence, the impact of

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the transfer can be more significant (Handoko et al., 2014) and overcome some of the usual bureaucratic barriers such as legislations, licenses, and permits. Moreover, the use of intermediaries for multiple stakeholders can aid further in the exploitation and commercialization of the knowledge (Miller et al., 2016).

Finally, in addition to the expected barriers when finding a non-academic partner and a correct platform of knowledge transferring, inside universities, scholars also find barriers to knowledge transferring, such as lack of flexibility of boards, insufficient resources devoted to external relations, and deficient incentives for researchers (Hughes & Kitson, 2012; Siegel et al., 2003).

6. Discussion

University-industry relationships are a major opportunity to transfer knowledge generated inside research processes of higher education institutions directly to the business world. This process has been widely used in the technology transfer field, where the relationship between scholars and practitioners has been tight and fruitful for years. This is not the case when it comes to intangible knowledge/social sciences (management) transferring. This could be explained by the fact that business problems have no unique answer and this diversity opens the door for trial and error on behalf of practitioners, without the need of including an academic expert as mentor or consultant. In addition, when the opportunity arises to solve a business problem, the tendency has been to choose other business practitioners or companies to help.

It would be unfair to unload the responsibility of the lack of this knowledge transferring solely onto the practitioners. While positive in terms of scientific rigor, the fact that scholars choose to publicize their knowledge in journal publications or academic conferences limits the possibility of implementing their results. This creates a sort of bubble where scholars and practitioners follow different paths, with a growing disconnection between them.

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After understanding the existing disconnections between both worlds, it is time to start a new chapter in the university-industry organizations. This has certainly begun with some scholar and practitioners. Knowledge-transferring processes can be an opportunity to gain experience, both in terms of academia and practice. On the one hand, businesses could change the trial-and-error culture to a knowledgeable culture, where decisions are based, not only on experiences and material conditions, but also on theoretical knowledge coming from schools. It is important to note that not all managerial decisions need to include a theoretical understanding of the matter, but key strategic decisions could profit more from them.

On the other hand, the academia can profit from this type of engagement to change the idea of companies as data machine generators toward conceiving them as an important stakeholder. This can lead to the generation of more impactful and useful research projects for companies. In short, knowledge-transferring processes have a double impact, where both the giving and the receiving party can profit from the exchange and generate expertise and experience, which will help in future endeavors.

Furthermore, in terms of knowledge-transferring platforms, choosing the correct platform is a key factor for success, as the correct implementation of the platform will greatly affect the accomplishment of the endeavor. In this sense, there is no “best platform” and is up to the parties to choose the most convenient, based on the type of project and the expected results.

Moreover, it is important to highlight that these relations must be profitable for the companies to be interested in them. As with any other process, profitability cannot be ensured. This can affect the willingness of companies to engage in knowledge-transferring activities. Therefore, it is important to reduce uncertainty. A way to encourage companies to engage in this type of exchange is by the government, venture capitalists, or non-governmental organizations creating incentives. These incentives can initiate these kinds of relations by distributing the risk between actors. Thereafter,

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when the incentives are over, the role of the university and the company would be to generate more relationships, from which they can profit.

Understanding the common benefits that a fluent university-industry relationship can bring may be an incentive for scholars to open more communication spaces to a non-academic public, and for companies to approach universities with business problems. These common spaces will serve as an avenue for the alignment of both worlds. With it, the bubble of scholars could be burst and, simultaneously, the trial-and-error culture could come into question. Moreover, additional profits for both parties could aid universities in their commercial endeavors in a way that does not force them to engage in enterprises not related to their core objectives. Rather, they can do business with what they know best: transferring knowledge through teaching and researching.

Finally, as a suggested research agenda, it is important to generate additional research projects that include both sides of the exchange, to understand from both perspectives how to address these projects and their different motivations. Additionally, from an individual standpoint, it is relevant to understand the different barriers that particular scholars/practitioners can encounter when trying to engage with such types of processes.

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TOWARDS CHAPTER 3

Building upon the exploration of the literature of knowledge transfer in university-industry collaborations discussed in Chapter 2, I now turn our attention to the individuals who are central to these processes—the academics themselves. While the previous chapter delved into the challenges of transmitting tacit knowledge and the mechanisms that facilitate or hinder its transfer, Chapter 3 focuses on the different adaptations and approaches that management academics employ when engaging with industry partners. This shift highlights how academics actively navigate and bridge the cultural and organizational gaps between academia and industry to enhance collaboration effectiveness.

In contrast to the emphasis on intangible knowledge itself, this chapter examines the proactive strategies academics use, such as adjusting communication styles, negotiating expectations, and managing their roles within collaborations. By understanding these personal adaptations, we gain insight into how individual agency contributes to successful knowledge transfer and innovation. This focus on the human element of collaborations provides a deeper understanding of the dynamics at play and sets the stage for subsequent discussions on the broader factors affecting university-industry partnerships.

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CHAPTER 3

EXPLORING ADAPTATIONS AND APPROACHES IN MANAGEMENT ACADEMICS' INDUSTRY-UNIVERSITY COLLABORATIONS

Carlos Plata

TSM-Research, University of Toulouse Capitole, CNRS UMR 5303

Prior versions of this project have been presented at the EURAM conference in 2023
and the TSM-LUMS-WHU PhD workshop in 2023

Abstract

This study explores the dynamic interactions between management academics and industry-university collaborations, highlighting the adaptations and approaches used to foster these relationships. Through semi-structured interviews with 22 full-time academics, it unveils three primary approaches to participating in knowledge transfer: academic consultancy, consultant academic work, and support roles. The findings reveal common adaptations such as the use of lay language, time allocation, and negotiation tactics, emphasizing the university's prestige as a significant facilitator. This research contributes to understanding the nuanced roles and strategies management academics employ in industry-university collaborations, offering insights into enhancing these partnerships' effectiveness.

Keywords

Knowledge Transfer, University-industry Collaboration, Adaptation, Actor Network Theory.

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1. Introduction

In the dynamic of knowledge creation and dissemination, the collaborative link between universities and industries emerges as a pillar of innovation, economic growth, and societal advancement (Etzkowitz & Leydesdorff, 2000). This intricate relationship, characterized by the exchange of expertise, resources, and ideas, serves as a bridge between academic research and practical applications in real-world contexts (Grimpe & Hussinger, 2013; Heinzl et al., 2013; Perkmann et al., 2013; Shane, 2002). Over the years, university-industry collaborations have evolved from traditional boundaries, into multifaceted partnerships that span a spectrum of activities, from research collaborations and consultancy to technology transfer agreements and joint ventures (Heinzl et al., 2013; Perkmann, Neely, et al., 2011; Schartinger et al., 2002; Van Rijnsoever & Hessels, 2021).

At the center of these collaborations lie the collective aspirations of academia and industry to address pressing challenges, capitalize on emerging opportunities, and push the frontiers of knowledge forward. Universities, driven by their missions of research, education, and societal impact (Scott, 2006), recognize the intrinsic value of engaging with industry partners to enhance their research capabilities, foster innovation, and provide students with immersive learning experiences (Baltaru et al., 2022). By leveraging their intellectual capital, state-of-the-art infrastructure, and interdisciplinary expertise, academic institutions serve as engines of innovation, generating novel insights and solutions to complex problems that resonate beyond the confines of academia (Leischnig & Geigenmüller, 2020a).

Conversely, industries harness the knowledge, creativity, and technical prowess embedded within academic institutions to drive their innovation agendas, gain competitive advantages, and navigate the intricacies of global markets (Cesaroni & Piccaluga, 2016; Handoko et al., 2014). Businesses seek to tap into the rich reservoir of academic research and talent to accelerate product development, explore new markets, and stay ahead of the curve in an increasingly competitive landscape (Aksoy &

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Beaudry, 2021; Leischnig & Geigenmüller, 2020a). By forging strategic partnerships with universities, industries gain access to cutting-edge research, novel technologies, and a pipeline of skilled graduates, positioning themselves at the forefront of innovation and market disruption.

However, amidst the promise of collaborative synergy, university-industry partnerships also encounter an array of challenges. From reconciling divergent priorities and navigating regulatory frameworks to addressing concerns about intellectual property rights and fostering effective communication, stakeholders must navigate a complex web of considerations to ensure the success of collaborative endeavors (V. Schaeffer et al., 2020a; Weersink & Fulton, 2020; Woltmann & Alkærsig, 2018). Moreover, the evolving nature of industry-academic relationships underscores the need for adaptable strategies, proactive engagement, and a deep understanding of the changing dynamics shaping collaborative innovation ecosystems.

In this context, and in line with the triple helix model (Leydesdorff & Etzkowitz, 1996) and the actor-network theory (Latour, 1987) this study seeks to delve into the multifaceted nature of university-industry collaborations, with a particular focus on the perspectives of management academics engaged in knowledge transfer processes. By exploring the lived experiences, adaptive strategies, and enduring impacts of university-industry collaborations from the academic viewpoint, this research aims to illuminate the intricate dynamics of collaborative relationships between academia and industry by answering the What are the different adaptations and approaches that management academics employ when engaging in Industry-University collaborations? Through qualitative analysis of interviews conducted with full-time management academics from universities across Europe, this study endeavors to uncover the facilitators, methods, and impacts of university-industry collaborations, offering nuanced insights into the role of academics in bridging industrial relationships.

CHAPTER 3

1.1.Literature Review

1.1.1. Typology history and development

The trajectory of university-industry collaborations has undergone a nuanced evolution, initially rooted in the hard sciences and technology sectors, before progressively embracing a broader spectrum of disciplines within the social sciences (Kalar & Antoncic, 2015). In the early stages, university-industry partnerships were predominantly concentrated within the hard sciences and technology (Etzkowitz, 2004; Friedman & Silberman, 2003; Penan, 1996; Perkmann, Neely, et al., 2011). This focus was driven by the clear applicability of scientific research and technological innovations to industrial processes and products. Industries sought access to cutting-edge research and breakthrough technologies emanating from universities to enhance their competitive edge, drive innovation, and solve complex technical challenges (Carayannis & Campbell, 2009).

However, as the global economic landscape evolved, there was a marked shift towards recognizing the value of knowledge in all forms, not just the tangible outputs of hard sciences (Cesaroni & Piccaluga, 2016). This realization heralded a more inclusive approach to university-industry collaborations, extending beyond traditional research and development to encompass consultancy in social sciences, business, and other disciplines (Hagen, 2008; Leischnig & Geigenmüller, 2020a). Universities began to offer not only technological innovations but also expert advice, strategic insights, consultancy services to industry partners (Olmos-Penuela et al., 2014) and design of professional training or student placement (Hagen, 2008). This shift reflected a broader understanding of innovation as a multifaceted concept that includes business models, organizational strategies, and human resources, in addition to technological advancements (Bercovitz & Feldman, 2006; Heinzl et al., 2013) .

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TABLE 3.1: SUMMARY MAIN INSTITUTIONAL VEHICLES THROUGH WHICH TRANSFER OCCUR

Type	Description	Belongs To
Internships/Student Placment	Students work at companies, gaining practical experience.	Know-How
Consulting Services	University experts provide advisory services to companies.	Knowledge/Know-How
Data Sharing	Universities share data sets with companies for analysis and research.	Information
Professional Training	Educational events where industry professionals learn from academia.	Knowledge

This transformation in the scope of collaborations has been characterized by a more bi-directional exchange (Philbin, 2008), where industries not only consume academic knowledge but also contribute real-world challenges and insights, fostering a rich environment for co-creation and mutual learning (Lockett et al., 2008). The platforms through which collaborations are done include consultancy, being popular, where academics and professionals contribute their many areas of expertise (Becerra et al., 2019; Hewitt-Dundas, 2012; Olmos-Penuela et al., 2014). This might be the case because, despite being a formal venue for transfer, consulting also provides a significant number of opportunities for casual interactions. Consequently, it might be a way to balance the dissemination of tacit information. Other methods of collaboration between industry and universities include joint research (Elliot, 2013; Olmos-Penuela et al., 2014) and collaborative initiatives (Berbegal-Mirabent et al., 2012). These relationships are more formal and typically less flexible in terms of goals and results.

The interactions between universities and businesses can be understood under the Triple Helix model (Leydesdorff & Etzkowitz, 1996), which later evolved into the Four-Helix model (Carayannis & Campbell, 2009). In this model, innovations originate from the meeting point of needs and capabilities of governments, businesses, universities,

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and society at large. These knowledge-transferring processes are more aligned and, at their best, create a more synergistic relationship. This is an ideal model that encourages all actors of society to play a part in the process of generating interactions with a common goal. Additionally, it is important to note that this type of model also encourages governments to generate and encourage industrial relations.

Following this rationale, from an individual standpoint, the process of exchanging a body of information that is used and arranged in one context with other organizations is known as knowledge transfer (Bloedon & Stokes, 1994). Vehicles like the ones presented before fall into that category. Due to the nature of this type of transferring process, understanding it might be challenging, yet the Actor-Network Theory (ANT) offers a valuable framework for tracing knowledge production, dissemination, and transformation in complex networks. By emphasizing the co-production of knowledge and the dynamic relationships among actors, ANT captures the multifaceted nature of knowledge transfer and highlights the importance of the social context in shaping scientific and technological innovations (Callon, 1984, 1994; Latour, 1987), proposing that the actors need to adapt their behaviors and language in order to generate a proper relationship and fruitful exchange of knowledge. This is critical given the latent differences between the interlocutor and the receiving end of a university-industry relationship.

1.1.2. Adaptations

Barriers in the collaborations between universities and industries are multifaceted, often rooted in the intrinsic differences in the operational cultures, motivations, and communication styles of the participants involved. These barriers can significantly impede the flow of knowledge and innovation, despite the potential benefits of such collaborations.

One of the primary challenges at the is the difference in motivation and reward systems between academia and industry. Academics are primarily motivated by pursuits such as discovery, publication in prestigious journals, and contributions to

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theoretical knowledge, with their career advancements often tied to these achievements (Leischnig & Geigenmüller, 2020a; Perkmann et al., 2013). In contrast, professionals in the industry are driven by market success, product development, and financial returns. This divergence can lead to misaligned goals in collaborative projects, where an academic's interest in thorough, exploratory research may clash with an industry partner's need for quick, application-ready results (D'Este & Perkmann, 2011; Perkmann & Walsh, 2007).

Communication barriers further exacerbate the challenges in university-industry collaborations (Canonico et al., 2020). Academics often use highly specialized language and methodologies that, while rigorous and precise, may not be easily accessible or relevant to industry partners (Thomas, 2012). This can result in misunderstandings or underutilization of research findings, as industry participants may struggle to translate academic insights into actionable business strategies (Berbegal-Mirabent et al., 2012; Siegel et al., 2004). Conversely, the industry's emphasis on confidentiality and proprietary knowledge can hinder open communication, limiting academics' ability to fully engage with and contribute to collaborative projects (Heinzl et al., 2013).

Additionally, the fear of intellectual property (IP) entanglement presents a significant barrier. Academics and industry partners may have differing views on IP rights and usage, with academics concerned about open dissemination of research findings and industry partners focused on protecting innovations for commercial advantage (Barbini et al., 2021; Hausberg & Korreck, 2020). Navigating these IP concerns requires careful negotiation and clear agreements to ensure that both parties feel their contributions and interests are adequately protected.

1.1.3. Impacts

Both the offering party (universities) and the receiving party (companies) are impacted by knowledge-transfer procedures. No matter the platform, this impact may be favorable in terms of external credibility, which can be amplified even more in academic institutions with a high research intensity (Hewitt-Dundas, 2012; Jones &

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Coates, 2020). Additionally, knowledge transfer can be a way for businesses to develop more complicated and accurate models to better understand certain challenges and allocate their resources to finding solutions (Elliot, 2013).

The transactional outcomes of using transferring platforms also include financial gains. The spillover of financial resources from this exchange may provide money to the university for additional research projects that may not ultimately result in a marketable product. It can therefore be a tool to support a larger research program (Berbegal-Mirabent et al., 2012). However, there may be drawbacks to this commercialization of information, particularly when there is a power imbalance among many players (Miller et al., 2016a). In these circumstances, university governing bodies would often only finance research initiatives that could be turned into products. As a result, it is possible to endanger diversity and the formation of new research themes (Jones & Coates, 2020).

Relations between universities and industry can also be a way to boost and enhance innovation processes and business performance (Arvanitis et al., 2008). This can be accomplished through creating novel interpretations of and responses to issues during the transfer process (Canonico et al., 2020), as well as by incorporating technologies and know-how that the company lacks and would be expensive to acquire (Jones & Coates, 2020).

Similarly, knowledge transfer has an impact on universities in ways other than just money (Berbegal-Mirabent et al., 2012), it can support their primary purposes of research and education. When it comes to education, providing universities with industry expertise can assist them to create and modify curricula for future generations that will be better prepared (Jones & Coates, 2020). Through new data and diverse points of view, knowledge-transfer mechanisms and close collaboration with the industry would boost the possibility of creating better, more significant research (Hewitt-Dundas, 2012).

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However, it is crucial to highlight that managerial scholars themselves are often not studied within the scope of these knowledge-transfer processes (Ankrah & AL-Tabbaa, 2015). Despite their significant role in bridging the gap between academic research and practical application, there is a conspicuous absence of research focusing on how these scholars navigate the complexities of knowledge transfer, their contributions to the process, and the challenges they face (Bruneel et al., 2010). This oversight limits our understanding of the full spectrum of knowledge transfer dynamics and potentially overlooks valuable insights that managerial scholars can provide in enhancing the effectiveness of these exchanges.

The purpose of this study is to investigate the relationships between academic and non-academic parties, from the academic point of view in order to understand their approach and the different adaptations to maintain a fruitful relationship by answering the following research question: What are the different adaptations and approaches that management academics employ when engaging in Industry-University collaborations?

2. Method

2.1.Sampling

This paper is based on qualitative, semi-structured interviews (V. Schaeffer et al., 2020a) collected from full-time academics from universities in eight European countries participating in the ENGAGE.EU alliance and a total of 11 higher education institutions, all this academics works in management sciences, this decision was made under the assumption that management experts will provide the organizations with intangible knowledge expertise. It is also crucial to clarify that following the exploratory rationale key criteria such as a minimum number of contract/interactions or institution and cultural characteristics, were not taken into consideration when choosing the subjects. The sample size followed the rationale of saturation (Glaser & Strauss, 2017; Guest et al., 2006) where the researcher compares the new data in the ongoing data collection with previous analysis. The sampling was done following

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purpose sampling (Marshall, 1996) and with a high information power (Malterud et al., 2016) to achieve saturation with a smaller sample.

The foregoing qualitative studies in knowledge transfer show the sample size of this study is very much in line with available empirical studies (Canonico et al., 2020; P. R. Schaeffer et al., 2021; Thomas, 2012) giving the overall 22 interviews representative, Table 3.2. The subjects were selected based on their participation in the intangible knowledge transfer process and their permanent affiliation with a university. Given the exploratory state of the project, no criteria regardless of the number of processes they had participated, their expertise, or their position inside the university were given. From the total pool of participants (N=22), there are full professors (N=8), associate professors (N=8), assistant professors (N=3), and Ph.D. graduates (N=3).

The field of expertise also varied including cost and finances (N=4), human resources management and organizational behavior (N=5), operations and strategy (N=3), and marketing (N=10). Additionally, the geographical position also varies including France (N=4), Netherlands (N=4), Austria (N=3), Bulgaria (N=1), Italy (N=4), Germany (N=2), Finland (N=3), and Norway (N=1).

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TABLE 3.2: SUBJECTS DESCRIPTIVES

Subject	Institution/country	Position	Expertise	Experience	Duration
Subject 1	MinesParisTech/France	PhD Graduate	Costs	CIFRE PhD	56 Mins
Subject 2	UniMannheim/Germany	Full professor	Procurement	Chair of board/Consultancy	44 Mins
Subject 3	University of National and World Economy/Bulgaria	Associate professor	FIN	Consultancy/Business owner related to the research	38 Mins
Subject 4	WU Vienna/Austria	Assistant Professor	STRAT	Chair of board/Consultancy	33 Mins
Subject 5	Radboud University/Netherlands	Assistant Professor	HRM	Consultancy	42 Mins
Subject 6	Norwegian School of Economics/Norway	Associate professor	FIN-ECON	Consultancy/Legal Concepts	38 Mins
Subject 7	Toulouse Capitole University/France	Full professor	ACC	Consultancy	42 Mins
Subject 8	MinesParisTech/France	PhD Graduate	OPE	CIFRE PhD	41 Mins
Subject 9	LUISS/Italy	Associate professor	HRM	Consultancy	47 Mins
Subject 10	Radboud University/Netherlands	Associate professor	HRM	Consultancy	46 Mins
Subject 11	Tilburg University/Netherlands	Full professor	STRAT	Consultancy	44 Mins
Subject 12	UniMannheim/Germany	Full time Researcher	STRAT	Consultancy/ PhD	35 Mins
Subject 13	LUISS/Italy	Associate Professor	OB	Consultancy/Director Program	39 Mins
Subject 14	Hanken School of Economics/Finland	Full professor/Dean	MKT	Consultancy	37 Mins
Subject 15	LUISS/Italy	Associate professor	HRM	Consultancy	45 Mins
Subject 16	Hanken School of Economics/Finland	Full professor/Dean	STRAT	Consultancy/Business owner	37 Mins

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Subject	Institution/country	Position	Expertise	Experience	Duration
Subject 17	TBS Education/France	Full professor	MKT	Consultancy	39 Mins
Subject 18	Tilburg University/Netherlands	Tenured Assistant Professor	STRAT	Consultancy	37 Mins
Subject 19	LUISS/Italy	Full professor	MKT	Consultancy	34 Mins
Subject 20	Hanken School of Economics/Finland	Associate professor	STRAT	Consultancy	43 Mins
Subject 21	WU Vienna/Austria	Full professor	STRAT	Consultancy/Director Department	46 Mins
Subject 22	WU Vienna/Austria	Associate professor	STRAT	Consultancy	42 Mins

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2.2.Data collection

General contact with potential respondents is the first step in the data collection process, which is followed by an evaluation of whether the requirements are met before conducting the interview (Canonico et al., 2020; Dee & Leisyte, 2017; V. Schaeffer et al., 2020a).

The collection of data began with a search for suitable subjects within the university alliance ENGAGE.EU⁷. Once the potential subjects were identified, an introductory email was sent to confirm their fit for the research and their willingness to participate. After the agreement a set time slot, a semi-structured interview was done, this type of interview was chosen to provide a general direction but also permit a thorough comprehension and examination of the subjects. Additionally, questions will be utilized, the interviewee will have more freedom and autonomy to direct the dialogue, allowing for a more fluid exchange with the interviewer.

This interview was conducted online or in person, depending on the subject's availability, and it lasted on average 45 minutes. The interviewees were presented with informed consent, and after their agreement, the interviews were recorded to later be transcribed to a total of 187 pages single-spaced. The interview guide can be found in appendix A.

The transcribing process began using the AI-based program Otter.ai, followed by the author's hand correction and editing. The data was then made anonymous by randomly assigning pseudonyms to the participants.

2.3.Analysis

In analyzing the data, we employed open, axial and selective coding techniques as outlined by (Gioia et al., 2013) to generate first-order concepts, second-order themes, and aggregate dimensions, respectively, a method that has been used in university-

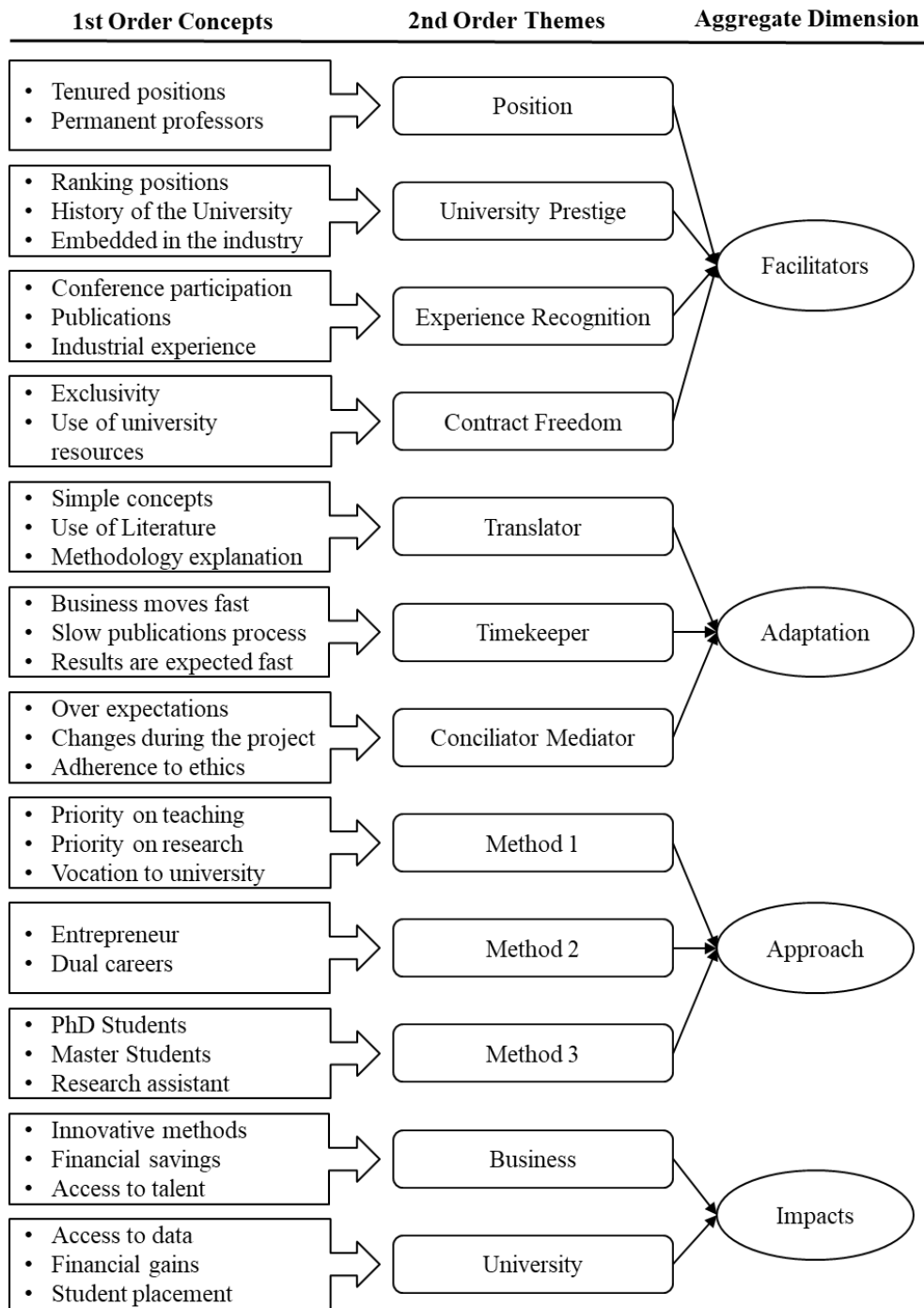
⁷ <https://engageuniversity.eu/>

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industry collaboration (Conlé et al., 2023; McCabe et al., 2023). The process unfolded in three primary phases. Initially, open coding was conducted on interview data, discerning preliminary concepts from participants' statements, which were then organized into first-order concepts, and refined to resolve overlaps and redundancies following the approach by (Gioia et al., 2013). Axial coding followed, where we compared first-order concepts with existing literature to unveil relationships among them, yielding second-order themes, conceptualized by the researchers, distinct from primary interview data (Nag & Gioia, 2012). Finally, during selective coding, we categorized theoretically relevant second-order themes into four aggregate dimensions. Concurrently, the iterative engagement with the work system framework and continual cross-referencing of qualitative data and literature facilitated the emergence of themes and dimensions (Gioia et al., 2013). Our data analysis employed NVivo version 14 to streamline coding processes, culminating in a three-layered framework, available in figure 3.1, of adaptation impacts and impacts of these types of collaboration.

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FIGURE 3.1: DATA STRUCTURE



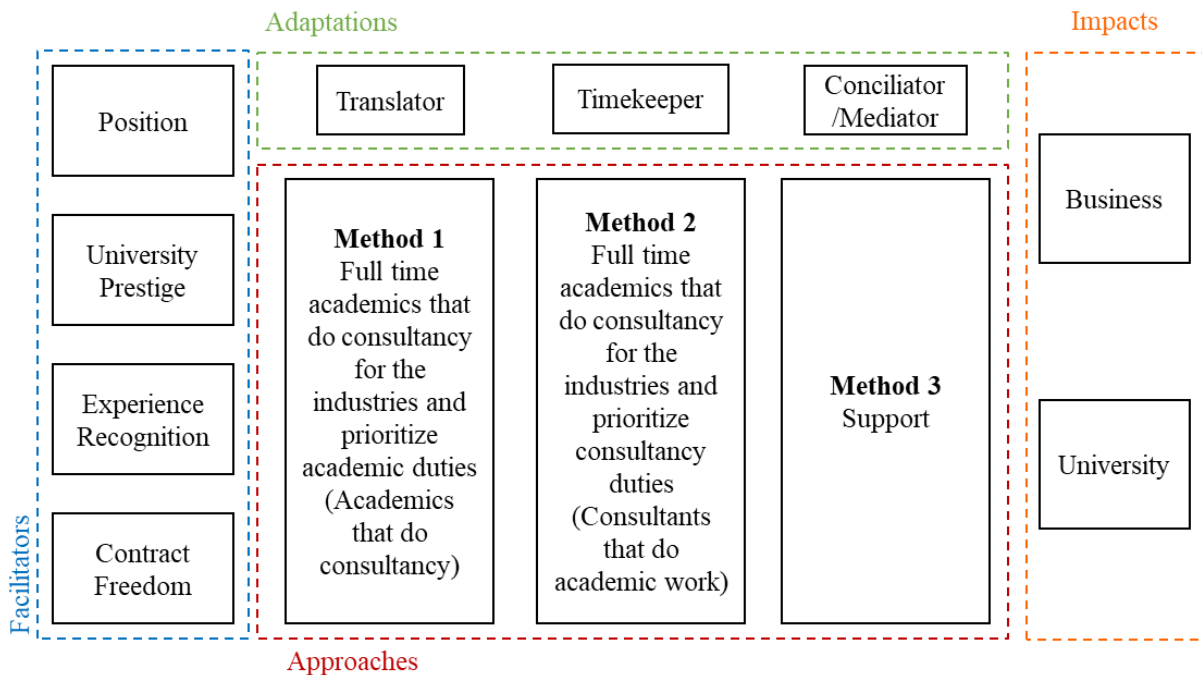
3. Results

In the dynamic interplay of university-industry collaborations, a tripartite model presented in figure 3.2 emerges. The starting point to this model is the facilitators—position, university prestige, experience recognition, and contract freedom—which collectively create a foundation for engagement between academics and industry.

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Central to the model are the three distinct methods illustrate the spectrum of engagement: Method 1 posits full-time academics who consult for industry while prioritizing academic duties, suggesting an academia-led approach; Method 2 reverses this priority, signalling a consultancy-led approach among full-time academics; and Method 3 encapsulates a supportive function, details of which remain to be expounded. Transversal to these methods there are the adaption required from academics to engage in collaborative work, translators, timekeepers, and conciliators/mediators. Finalizing the model is with the bidirectional impact that the collaborations have.

FIGURE 3.2: SUMMARY OF RESULTS



3.1.Facilitators

University-Industry collaborations are often enhanced by facilitators (Leischnig & Geigenmüller, 2020a; Miller et al., 2016a). It found that academic position, university prestige, experience and recognition, and contract freedom play instrumental roles. Each of these facilitators, while pivotal in forging strong links between academia and

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industry, is also accompanied by inherent challenges and barriers that can impede the process of effective knowledge transfer and collaboration.

The academic position within a university can serve as facilitator in establishing industry connections. The role and status of an individual in academia can significantly influence their ability to attract and retain industry partners. As subject 7 illustrates, holding a position such as a professor or a permanent faculty member infuse a sense of credibility and legitimacy among potential industry collaborators. This perception is often rooted in the assumption that higher academic ranks are associated with greater knowledge, expertise, and reliability.

"... So yes, I think this is there because all thanks to my status at university that's for sure. It helps because they can find More. Well, I mean, it's more than just because of what I am saying." Subject 7

However, this facilitator can also present a barrier, particularly for early-career researchers or those in temporary positions. This disparity can lead to missed opportunities for early career academics, who may possess innovative ideas and fresh perspectives but lack the institutional backing and title to gain the necessary recognition and trust from industry partners.

Also, the prestige of an academic institution acts as a powerful signal to potential industry collaborators (Houweling & Wolff, 2020) about the quality and reliability of its faculty and research outputs. Subjects 2 and 9 emphasize how the reputation of a university can serve as a seal of quality that automatically enhances the credibility of its researchers. This intangible asset facilitates easier access to industry partnerships, as the institution's name carries weight in negotiations and discussions.

"When we say we come from this university, we have more credibility."
Subject 2

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"...but I feel it. And in my previous experiences, you know, I have been through Latin countries that in Europe, via countries, it was the same."

Subject 9

However, the reliance on university prestige also introduces a significant barrier for researchers affiliated with less well-known or lower-ranked institutions. These individuals may face undue prejudice or scepticism from industry partners, regardless of their personal expertise or the quality of their research. The challenge here lies in overcoming entrenched biases and demonstrating value in a landscape where institutional reputation can overshadow individual merit.

Experience and recognition in one's field serve as testament to a researcher's capability and reliability, thereby facilitating smoother collaborations with industry. The cumulative effect of expertise, as noted by subject 5, enhances a researcher's attractiveness to industry partners. Publications, public outreach, and a visible presence in the academic community contribute to building a reputation that can open doors to new opportunities and collaborations yet the pathway to gaining such recognition is fraught with challenges. The competitive nature of academia, coupled with the pressure to publish and secure grants, can marginalize those who are unable to meet these demands quickly.

"And what I see is that our expertise as organizational psychologists, so that is my expertise, this expertise has become much more open through the internet and all organizations know a lot more, giving me more opportunities." Subject 5

Additionally, contractual arrangements that allow academics to engage in external activities, such as consultancy, offer the flexibility to explore industry collaborations without the constraints of strict employment obligations. Several interviewees describe the benefits of such arrangements, which enable them to utilize their expertise in varied contexts, fostering innovation and knowledge transfer. However, this freedom

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is not universally available across all institutions, as highlighted by subject 14. Restrictions on external engagements can stifle opportunities for collaboration, particularly in environments where institutional policies are rigid. Additionally, the balance between academic duties and external activities can be delicate, with the risk of overcommitting to industry projects potentially detracting from teaching and research responsibilities within the university. The challenge lies in navigating these contractual limitations and finding a harmonious balance that allows for impactful industry engagement without compromising academic obligations.

“This particular university and this are in England, we had two ways that an academic could go out and do these projects. The university will take an overhead X% And that’s to enable, you know, the academic to use their facilities and printers and all this stuff. And plus, provide some liability insurance in case you screw it up. The other alternative for academics they could go ahead and do a consultancy on their own in their name with no university affiliation. They didn’t have to pay x% overhead, but they couldn’t use the university’s facilities or printers or what have you. Now, you and I can figure out how well that can be pleased. But in any event, those were the two options for people to earn extra income by doing these kinds of things”.

Subject 14

In sum, while the facilitators of academic position, university prestige, experience and recognition, and contract freedom significantly contribute to the success of industry-business collaborations, they also present unique challenges. Overcoming these barriers requires a nuanced understanding of the academic-industry interface and a proactive approach to fostering environments that support equitable and productive collaborations.

3.2.Adaptations

Transversally adaptations by academic researchers play a crucial role in knowledge transfer processes (Latour, 2007), it was found that academics make adaptations

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during the collaboration and the identified adaptations are named: Translators, Timekeepers, and Conciliators/Mediators. Each adaptation encompasses a set of challenges and changes, vital for the successful university-industry collaborations.

The translator adaptation embodies an adaptation that academics undertake to bridge the complex divide between academic research and industry application. This role is not merely about the possible linguistic translation but encompasses a broader scope of converting academic knowledge into forms that are accessible, relevant, and actionable within industry contexts (Meyer, 2010; Wachelder, 2003). Academics in this capacity engage deeply with both the substance of their research and the practical needs of industry partners, necessitating a nuanced understanding of both domains to ensure that the essence of academic insights is effectively communicated and retained in the translation process.

At its core, the translation involves understanding difficult and puzzling words of academic research, which is steeped in discipline-specific terminologies and theoretical frameworks, into a language that industry experts easily understand and connect with. This task is exemplified in the insights shared by subject 4, who emphasize the importance of making scholarly work comprehensible and applicable to business practices. The challenge here is double: first, to distil complex concepts into digestible information without losing the depth and rigor that characterize academic research; and second, to ensure that this translated knowledge aligns with the operational realities and strategic objectives of industry partners.

“Since the academic world has very specific terminology. And when you interact with companies, then yeah. In business practice, I thought it was the insights are the same, but terminologies perhaps differ”. Subject 4

However, the translation process extends beyond mere simplification. It requires an empathetic and strategic engagement with both the content of the research and the context of its application. This involves identifying key insights that hold the most

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value for industry applications and recontextualizing academic findings in ways that illuminate their practical implications. For example, when academics design questionnaires based on scientific frameworks for industry assessments, as mentioned by subject 5, they are translating theoretical models into practical tools that can directly inform business decisions and strategies.

“Yes. Well, so, for example, in the quantity we use the questionnaire, or we designed a questionnaire to look into an assessment and there we the questionnaire was built on a scientific framework model if you like and that particular model to, to ask the right questions to and we also used questions taken from questionnaires that were that are accepted in our science...”

Subject 5

Moreover, translation is inherently iterative and collaborative, as expressed by subject 10. It involves ongoing dialogue with industry partners to refine the translation of academic knowledge, ensuring it addresses the specific challenges and opportunities faced by the industry. This iterative process can also lead to reciprocal learning, where academics may gain new insights into the applicability and relevance of their research, potentially guiding future academic inquiries.

“...So I think just doing it a lot and learning from interactions that you have to adapt your timelines to adapt your approach to see where you have to advocate more for your approach and where you’re maybe overselling things...” Subject 10

The inherent challenges of this role include the risk of oversimplification, where the nuanced complexities of academic research may be lost in translation, leading to misapplications or misunderstandings in industry contexts. Additionally, there exists the challenge of ensuring that the translation process is not unidirectional but fosters a mutual exchange of knowledge that respects and integrates the expertise and insights of both academic and industry stakeholders, as expressed by subject 12.

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"...So I, when I was basically thinking about, Okay, what kind of questions do we want to ask? How should the questionnaire look like, what we actually want to achieve with this program, I always was in touch with her." Subject

12

The next adaptation of academics is into timekeepers addressing the often overlooked but critical aspect of temporal alignment between these two spheres. Serving as a timekeeper requires academics to navigate and reconcile the inherently different paces and timelines that govern academic research and industrial innovation. This adaptation is pivotal in ensuring that the collaborative efforts not only yield fruitful outcomes but also do so within the time frames that align with the strategic and operational imperatives of industry partners.

Academic research is traditionally characterized by a more deliberate pace, governed by the rigors of methodological thoroughness, peer review, and publication cycles. This meticulous approach, while foundational to the integrity and advancement of scientific knowledge, operates on a temporal scale that can seem at odds with the faster, more immediate timelines driven by market demands, competitive pressures, and operational urgencies prevalent in the industrial sector. Subject 6 exemplifies the challenge this discrepancy presents, pointing to the necessity for academics to adapt their research processes and outputs to fit the more accelerated timelines of industry projects.

"So, you change the research because of different timeframes, perhaps more about, you know, the different perhaps logics that are involved in that..."

Subject 4

Acting as a Timekeeper, therefore, involves more than just speeding up academic work; it requires a strategic and nuanced understanding of both the academic and industrial timelines and finding a middle ground where the depth and rigor of research can be maintained without compromising the timeliness of deliverables. This

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might involve setting clear, mutually agreed-upon milestones, as suggested by subject 2, which serve as checkpoints to ensure that the collaboration is progressing in alignment with both academic and industry expectations. It also necessitates a flexible approach to research planning and execution, where academics may need to prioritize certain aspects of their work or adopt more efficient methodologies to meet industry deadlines.

"You're no good, I think, yeah, they are project milestones, obviously, which we also had, but that worked relatively well. I would say they probably both agreed on the timeline. The speed also worked. Okay. Well." Subject 2

However, this adaptation is not without its challenges. The pressure to conform to industry timelines can lead to tensions, particularly when it risks compromising the quality or integrity of academic research. There's a delicate balance to be struck between adhering to the scientific process and meeting the practical exigencies of industry collaborations. Academics must navigate this balance, ensuring that their work remains robust and credible while being responsive to the needs of their industry partners.

Moreover, the role of a Timekeeper extends into the realm of project management, requiring academics to develop skills in managing both the expectations and the dynamics of collaborative projects, as expressed by subjects 4, 5, and 6. This includes not only time management but also communication, negotiation, and adaptation skills, as they work to align the diverse and sometimes conflicting priorities and timelines of the various stakeholders involved in a project.

"Yeah. So that's very different because they have very short term." Subject 6

"So, you change the research because of different timeframes, perhaps more about, you know, the different perhaps logics that are involved in that..."

Subject 4

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“So, as in consultancy, we need to adapt, and I think also that often do we adapt to the client, the client’s timeframe, and rhythm...” Subject 5

The third adaptation is the academic as a Conciliator/Mediator is necessary for bridging the distinct cultures, expectations, and objectives that often separate these two realms. This adaptation is pivotal for fostering a collaborative environment where both parties can thrive, ensuring that the synergistic potential of these partnerships is fully realized. Through conciliation and mediation, academics facilitate a dialogue that harmonizes differing perspectives, aligns goals, and navigates the complex interplay of academic rigor and industrial pragmatism.

Conciliation and mediation include not just negotiating terms or mediating disputes; they require a deep understanding of the intrinsic values, operational norms, and strategic imperatives of both academia and industry. Academics in this role must possess the empathy to appreciate the pressures and constraints faced by industry partners, while also articulating and advocating for the fundamental principles and standards of academic research. This dual empathy is critical for ensuring that collaborations do not devolve into transactions but evolve into partnerships characterized by mutual respect and shared ambition.

The challenges inherent, academics must navigate the potential for conflict arising from misaligned expectations, such as the industry's demand for quick, actionable results versus academia's emphasis on thorough, peer-reviewed research. Subject 10 illuminates these tensions, highlighting difficulties in translating research insights into actionable strategies and the pitfalls of overpromising and underdelivering. Moreover, the involvement of industry practitioners in academic settings, introduces real-world perspectives into academic curricula, enriching student learning but also necessitating careful management to ensure the integrity of academic content.

“I think the part where you mentioned, like indeed being a translator, I think that’s definitely one of the roles that we see we translate all the literature that

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is out there into how we can now apply it to your case. Another role that I definitely see there is ensuring that it happens in an evidence-based way. So, if we try and only translate it, we still leave it up to them on how they're going to study it or they're going to investigate it and I think there we also have a big role to play to make sure that it happens" Subject 10

Effective conciliation and mediation also extend to the ethical and logistical dimensions of collaborations. For instance, navigating issues related to intellectual property rights, data privacy, and ethical considerations requires a mediator who can articulate these concerns and find common ground. The academic's role in ensuring that projects adhere to ethical standards, while also meeting the practical requirements of industry partners, exemplifies the delicate balance that must be struck in these collaborations.

Furthermore, this role demands a proactive approach to identifying and addressing potential barriers to collaboration. As subject 5 notes, bridging the gap between academic research and business practice involves overcoming significant barriers, such as regulatory compliance and privacy concerns. Academics must anticipate these challenges and work collaboratively with industry partners to devise solutions that respect both the spirit and the letter of regulatory frameworks, ensuring that the collaboration advances in a compliant and ethical manner.

"I don't know, to be honest, I think the barrier between academia and business practice it has become bigger or where there's a big gap. I do think there is there is still maybe the maybe I think the gap meaning, for example, the questionnaire today here to all kinds of ethical and privacy regulations..."
Subject 5

In conclusion, the adaptations of acting as a Translator, serving as a Timekeeper, and functioning as a Conciliator/Mediator are essential in facilitating effective industry-academia collaborations. Each adaptation addresses specific challenges inherent in

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bridging the gap between the theoretical and the practical, the methodical and the expedient, and the academic and the applied. By embracing these roles, academics can significantly enhance the value and impact of their collaborations with industry, contributing to a more seamless integration of research insights into practical applications and innovations.

3.3.Approaches

The Method 1 – Full time academics that do consultancy for the industries and prioritize academic duties (Academics that do consultancy) - encapsulates the segment of the academic community engaged in navigating both research and industry consultancy. This set of academics, by integrating consultancy projects into their professional repertoire, seeks to apply their specialized knowledge and research insights directly within industry settings, thereby fostering a practical impact beyond the traditional academic boundaries.

Academics in this category often view consultancy as an opportunity to enrich their research and teaching by incorporating real-world challenges and solutions into their academic work. This perspective is underscored by subjects who express a commitment to their roles within the university, emphasizing the primacy of their academic duties while acknowledging the value of consultancy in enhancing their professional practice. There is a clear preference for the academic over the consultancy role, highlighting the intrinsic satisfaction derived from teaching and the broader impact on students' professional development. This sentiment reflects a common theme among academics who venture into consultancy, where the pursuit of consultancy work is driven not by financial incentives but by the desire to apply and validate academic research in practical contexts, as stated by subject 10.

“I will continue being a professor because this is what I love the most. I love doing research, and I love the freedom of choosing every time what you want to do. And this is unbeatable.” Subject 10

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However, engaging in consultancy presents a set of challenges that stem from the potential conflict between the expectations and metrics of success in academia versus those in the industry. Academics as expressed by subject 2 must navigate the pressures of maintaining their scholarly productivity - often measured in terms of teaching quality, research output, and peer recognition- while also fulfilling the demands of consultancy projects, which require a focus on deliverables, timelines, and client satisfaction.

“... I usually only engage in projects, which are when my currency is publications, I need to do research, I need to publish, and this is also what I tell them upfront. I do this because I want to get the possibility to do a certain research project, which I can then also publish.” Subject 2

Moreover, the institutional and cultural frameworks within universities play a critical role in shaping academics' engagement with consultancy. The emphasis on autonomy and professional identity, as highlighted by the subjects 3, suggests that the decision to engage in consultancy is also influenced by how these activities align with individual and institutional values regarding the role of academia in society.

Because let's say the other job is just a job, you did something, and you earn money; you spend the money next month on something and nothing more. But when I work in the university, I believe that I help a lot of students to become better, better professionals in business in business tomorrow” Subject

3

While some universities are increasingly incentivizing faculty involvement as expressed by Subject 2, in industry collaborations, there remains a variability in how such engagements are recognized and rewarded within the academic career progression, leading to divergent views on the desirability and viability of consultancy as a complementary academic activity.

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“...I have no uncertainty regarding my existence in the university. However, I have much incentive (from the university). That kind of circle of companies continues to work with us, and I might probably I can say, most of the time, it's really when it works, really it, it works really, positively...” Subject 2

The Method 2 - Full time academics that do consultancy for the industries and prioritize consultancy duties (Consultants that do academic work) - represents a distinctive paradigm within the sphere of university-industry collaborations, this group consists of individuals who, while hold positions within universities, also maintain formal positions or ties with the business world, thereby acting as conduits between practical industry applications and academic theory. This dual engagement enables them to introduce real-world industry challenges into the academic setting, enriching the educational experience for students and fostering a practical understanding of theoretical concepts.

Individuals within this category often possess a unique blend of skills and knowledge that enable them to navigate both the academic and industry landscapes with ease. As exemplified by Subject 5, who describes themselves as an independent entrepreneur engaged in diverse sectors while maintaining a position at the university, these professionals embody the essence of ambidexterity in their careers. This dual role allows them to leverage their industry experience to inform their academic work, offering students and fellow academics invaluable insights into the application of research in practical settings. Furthermore, their involvement in academia serves to enhance their consultancy practice, as they remain at the forefront of academic advancements and research innovations, which can be directly applied to solving industry problems.

“It's my own company. So, I am an independent entrepreneur, if you like, and then I do assignments for clients in very different sectors, profit as well as nonprofit or not-for-profit organizations. But it's entirely independent of to the university” Subject 5

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However, the integration of consultancy into academia is not without challenges. the institutional recognition and support for this hybrid role vary across universities. While some institutions actively encourage and reward faculty engagement with industry, others may view such activities with skepticism, concerned about the potential dilution of academic focus or conflicts of interest, as shared by Subject 5. This variability underscores the need for clear policies and frameworks that facilitate the productive integration of consultancy into academic work, ensuring that such engagements are aligned with the institution's mission and values.

“...Well, it’s the two reasons that I don’t want this conflict of interest. Okay, that I use the university for the benefit of my consultant profile of I use students to be involved in my assignments that I think that’s a conflict of interest that I’m trying to avoid” Subject 5

The Method 3 – PhDs students or postdocs – ‘the support’ within the framework of university-industry collaborations highlights a pivotal role played by early-career researchers, such as PhD candidates, Master's students, and postdocs, in facilitating the transfer of intangible knowledge between academia and industry. This model of engagement leverages the expertise and labour of these individuals to execute projects and research endeavours that require collaboration with industry partners. Unlike their more experienced counterparts, these emerging scholars engage with industry under the auspices of existing academic contracts and projects, contributing their skills and knowledge without directly participating in the negotiation or strategic direction of these collaborations. This arrangement provides a vital support system that underpins the success of university-industry partnerships, offering tangible benefits to both the academic institution and the industry stakeholders involved.

The involvement of early-career researchers in these collaborations addresses several critical needs. Firstly, it allows for the efficient allocation of resources towards the achievement of project objectives, ensuring that the expertise available within the academic institution is fully utilized in pursuit of innovation and problem-solving. For

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instance, as highlighted by subjects 1, PhD students and postdocs often undertake significant portions of the work on industry-related projects, applying their academic training to real-world challenges. This not only accelerates the progress of projects but also provides these young researchers with invaluable exposure to industry practices, enhancing their professional development and employability.

“It’s a bit and it’s also quite specific how your collaborative PhD projects can be built. Personally, actually I applied for I sent an application for PhD... that was considered an industrial PhD and was inside a company” Subject 1

Moreover, this approach mitigates one of the fundamental challenges of academic-industry collaborations: the potential diversion of faculty time and attention away from core academic responsibilities. By involving early-career researchers in project execution, universities can maintain a balance between their educational and research missions and their commitment to contributing to industry innovation. This strategy also aligns with the increasing emphasis on experiential learning and the integration of practical experience into academic programs, as evidenced by initiatives like the Cifre⁸ PhD program in France, which formalizes the involvement of PhD students in industry-funded research projects.

Furthermore, the support approach also raises important considerations regarding the quality of the experience for the early-career researchers involved, as illustrated by Subject 10. Ensuring that these engagements offer meaningful learning opportunities and do not exploit the labour of these individuals requires careful oversight and mentorship. The academic institution must strive to create an environment where the contributions of these researchers are valued and where their involvement in industry projects advances their academic and professional goals.

⁸ A CIFRE contract (Convention Industrielle de Formation par la REcherche) is a French research partnership program that allows a PhD student to conduct their doctoral research while working within a company. The program is supported and partially funded by the French National Association for Research and Technology (ANRT).

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“You would often include PhD students or research master’s students. Either because they can use data if they’re allowed to for their thesis or dissertation. Or because they’re really interested in the practical side of our field as well. Or for research master’s because they get a small contract and you get a small fee in return.” Subject 10

In summary, the three methods represent distinct strategies for engaging with the complex landscape of university-industry collaborations. Each approach offers unique insights into how academics navigate the tensions between their professional identities, the demands of consultancy work, and the imperatives of academic research and teaching. By understanding these diverse strategies, we gain a deeper appreciation for the dynamic roles that academics play in bridging the gap between the ivory tower and the marketplace, contributing to the advancement of knowledge and its application in addressing real-world challenges.

3.4.Impacts

The final section of the model, figure 3.2, shows the mutual impacts on both universities and businesses when engaging in knowledge transfer processes. These impacts were found to be bidirectional extends beyond the conventional boundaries of financial support and resource allocation, embedding itself deeply within the core missions of research, teaching, and societal contribution (Jones & Coates, 2020).

Through these partnerships, universities experience a significant enhancement in their research capabilities, not only by securing additional funding, various interviews noted, which facilitates the engagement of more PhD students and researchers in cutting-edge projects but also by gaining access to invaluable industry data and contexts for research, as highlighted by subject 15. This access not only broadens the scope of academic inquiry but also elevates the potential for ground-breaking discoveries that can be translated into tangible societal benefits.

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“We usually try to negotiate maybe, like data access or access to do another survey for a research project. So, we can, we can collect interesting data rather than money”¹⁵

The collaborative projects also serve as a bridge for students to engage directly with the industry, offering them a platform to showcase their talents and potentially secure employment opportunities post-graduation. This direct involvement in industry-relevant projects, as subject 18 have pointed out, not only bolsters the students' resumes but also provides them with a sense of the professional expectations and dynamics they will encounter in their future careers. This practical exposure is invaluable in equipping students with the confidence and skills necessary to navigate the transition from academic settings to professional environments successfully.

“I involve a corporate partner is usually a large firm because of the nature of the cores I’m teaching is the large company and they usually come up with a challenge broadly related to innovation. And then my students will work on an assignment and then they will also present you know their proposed solutions to the company.” Subject 18

Moreover, the benefits of these collaborations extend to the faculty members, who find in these partnerships a means to apply their research in solving practical challenges, thereby fulfilling the university's mission of contributing to societal advancement. The reciprocal nature of these collaborations ensures that academic research is not conducted in isolation but is instead deeply integrated with industry needs, driving innovation and economic development. This alignment of academic research with industry challenges not only amplifies the impact of university research but also attracts further industry partnerships, creating a virtuous cycle of collaboration, innovation, and impact. By fostering a culture of collaboration, universities can navigate the challenges of the 21st century, leveraging their unique strengths to make significant contributions to society and the economy.

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The impact of bi-directional university-industry collaborations on businesses manifests beyond the traditional confines of research and development. Access to university expertise and resources presents a foundational benefit for businesses engaged in these collaborations, partnering with universities enables companies to tap into the reservoir of academic knowledge and research capabilities that are often beyond the reach of in-house R&D departments. This access can catalyse the development of novel products and services, driving innovation and offering companies a distinct edge in highly competitive markets. Moreover, the collaborative nature of these partnerships ensures that business needs guide academic research, leading to outcomes that are not only scientifically sound but also commercially viable.

Through collaborations, companies gain insights into the latest research developments that can be applied to improve their operations, enter new markets, or create new product lines, as. This benefit is particularly pronounced in industries where technological advancements rapidly transform the competitive landscape, making the timely application of research findings a crucial element of business strategy, as stated by subject 22.

“Where we look for alternative forms of application technology, but we also hosted summer schools, where we would invite the people from “the company” to participate into a course on business planning, business modeling” Subject 22

Furthermore, these partnerships offer businesses unique opportunities for employee training and development. By engaging with academic experts and participating in joint projects, employees can acquire new skills and knowledge, enhancing their ability to innovate and solve complex problems. This aspect of collaboration not only boosts the company's internal capabilities but could also foster a culture of continuous learning and adaptation, which is vital for sustaining competitiveness in an ever-evolving business environment, as expressed by Subject 16.

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"...where we could compare their capabilities with the average capabilities of these 21 companies, so they, they also got some direct feedback in terms of where they were strong and where they might be maybe weaker than the other..." Subject 16

Talent recruitment, as expressed by subject 11, also emerges as benefit from the collaborations with universities often enable companies to identify and attract top talent. This dynamic is particularly beneficial in sectors where skilled professionals are in high demand but short supply. By establishing strong ties with universities, businesses can gain early access to graduates who are not only highly qualified but also familiar with the company's operations and challenges, thereby easing the integration process and enhancing the effectiveness of new hires.

"... hiring our former students, that happens more often." Subject 11

Finally, the ability to share risks associated with research and development is a tangible benefit that underscores the strategic value of university-industry collaborations. Partnerships can also lead to significant cost savings and optimized outcomes through shared investment in R&D activities.

In conclusion, the impact of university-industry collaborations on businesses is profound, offering a suite of benefits that encompass innovation, talent development, and strategic risk management. By leveraging the expertise, resources, and networks available through academic partnerships, businesses can enhance their innovation capabilities, accelerate commercialization efforts, cultivate a skilled workforce, and navigate the complexities of modern markets with greater agility and insight. These collaborations not only bolster the immediate competitive stance of businesses but also lay the groundwork for sustained growth and success in the future.

4. Conclusion and contribution

In conclusion, the findings of this research helped to fulfill the objective of understating the different adaptations and approaches that management academics employ when

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engaging in Industry-University collaborations, figure 3.2, by offering both promising opportunities and daunting challenges for stakeholders involved. On one hand, the identified facilitators, including academic position, university prestige, and contractual flexibility, provide a solid foundation for fostering collaborative partnerships. These facilitators enhance the credibility of academic expertise, expand access to industry resources, and enable the seamless transfer of knowledge between academia and industry. Moreover, the adaptations undertaken by academics, such as serving as translators and timekeepers, demonstrate a commitment to bridging the gap between theoretical research and practical application, thereby enriching the collaborative process.

However, alongside these bright prospects, there exist significant barriers and complexities that can impede the success and sustainability of university-industry collaborations. Challenges such as conflicting timelines, institutional rigidities, and ethical dilemmas underscore the inherent tensions between academic and industry priorities. Moreover, the varying institutional recognition and support for collaborative activities highlight the need for greater alignment and coherence in incentivizing and rewarding collaborative engagement. Moving forward, addressing these challenges will require an understanding of the cultural, institutional, and economic factors that shape collaborative partnerships, as well as a proactive approach to fostering environments that support equitable and mutually beneficial collaborations. Ultimately, by navigating these complexities with sensitivity and foresight, stakeholders can unlock the full potential of university-industry collaborations in driving innovation, economic growth, and societal impact.

4.1.Theoretical contribution

This chapter provides a two-part theoretical contribution by using Actor-Network Theory (ANT) (Latour, 2007) and the Triple Helix Model (Leydesdorff & Etzkowitz, 1996) to examine university-industry collaborations from a socio-technical viewpoint. By drawing on ANT, the study goes beyond simply highlighting human and non-

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human actors (such as academics, contractual frameworks, and knowledge) and shows how these actors actively shape collaborative processes. Rather than acting as mere background details, non-human elements—like administrative policies and project requirements—can alter power relationships, generate strategic adaptations, and influence the outcomes of university-industry partnerships. In this way, the chapter extends ANT's emphasis on the agency of both human and non-human actors, demonstrating that these seemingly minor or peripheral artifacts can significantly impact the ways academics and industry partners work together.

Building on this, the Triple Helix Model is applied to illustrate that, while it envisions a cooperative relationship among academia, industry, and government, the reality can be more complex and often marked by conflicting objectives and professional identities. The data collected in this study reveal that academics frequently need to balance the demands of their scholarly roles with industry's goals, and these conflicting interests can lead to power struggles and resource constraints. As a result, this chapter calls for a more careful look at how the Triple Helix Model operates in contexts where multiple institutional logics collide. Rather than if universities, industries, and governments form a seamless, symbiotic system, the findings suggest that internal tensions can disrupt collaboration. By showing how these tensions can reshape the way academics and industry partners interact, the study offers a refined view of the Triple Helix framework, highlighting the need to address both organizational and personal factors when studying collaborative innovation.

4.2. Managerial contribution

The research findings offer valuable insights for managers seeking to enhance Industry-University collaborations. By identifying key facilitators such as academic position and contractual flexibility, managers can strategically leverage these factors to build and find collaborative partnerships. Additionally, understanding the challenges highlighted, such as conflicting timelines and institutional rigidities,

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enables managers to proactively address these issues, fostering environments conducive to effective collaboration.

4.3. Limitations

One limitation of this chapter lies in the geographical scope of the sample, which comprises management academics solely from European universities. While Europe provides a diverse higher education landscape, cultural and institutional differences coming from other regions may yield different strategies, adaptations, or challenges when engaging in university-industry collaborations. Consequently, the findings may not fully capture the range of academic experiences worldwide. Moreover, the sample size of 22 interviews, while researched saturation, also constrains the representativeness of the insights gathered. Although this number allowed for an in-depth exploration of personal narratives and perspectives, additional participants or contexts might uncover other variations in the results. Future studies can address this limitation by including different geographical regions and a wider sample.

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6. Appendix

6.1. Appendix A: Interview Guide

Good afternoon and thank you for accepting this interview. My name is Carlos PLATA, and I am in the first year of my Ph.D. thesis at the Toulouse School of Management, the management school of the University Toulouse 1 – Capitole. My research is under the supervision of Prof. Eric Jolivet and is on the topic of knowledge transfer. This questionnaire is for research purposes only. Your name will be known only to the researchers participating in this project.

This interview will be centered around your experience in the knowledge transfer process from the academy to the industry. As a general remark, the general research question is *How is the process of knowledge transfer (soft skills) deployed.*

This interview will be recorded and transcribed, and you can oppose this at any time, and you can ask for the transcription of the interview if you consider it necessary you could ask for the deletion of your interview. Before we continue, do you agree with what was mentioned?

The interview will be semi-structured with primarily open-ended questions. Please feel free to ask me to clarify anything if needed

Having said that, I would first like to start with

- *Can you present yourself and briefly explain your research?*
- *Can you say how you define knowledge in your research, what sort of knowledge do you have in mind?*
- *Can you recall one knowledge transfer process with a company in which you have been involved? Such as consultancy, and contracted research?*
- *Can you say what stages are involved in transferring knowledge?*
- *Can you recall some of the barriers you faced in the process?*
- *Since we are talking about barriers, did you feel like you had to convince/explain your objectives and/or project to multiple actors to let you carry on?*

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- *Can you say how you overcame these barriers? Maybe name some milestones or situations where you considered the barriers were overcome??*
- *Can you say in your case, when does the knowledge transfer process start and end?*
- *How do you move through the stages (if there are stages)?*
- *Who is involved in the process and what are their roles and what is the level of involvement?*
- *Does your position or status within the university benefit or influence your experience in knowledge transfer processes?*
- *Are there adaptations that you do to how things are done when you are part of a knowledge transfer process role versus an academic one? Such as changes in time frames for example.*
- *What is your institution's policy with regard to signing additional contracts? Could you please provide information on the current contractual situation within your institution?*
- *Does your role as a professor usually take priority in your line of work?*

*Sub-questions for elaboration will be asked as needed, depending on the answers of the participants

TOWARDS CHAPTER 4

Building upon the insights from Chapters 2 and 3, where I explored the role of intangible knowledge in knowledge transfer processes and examined the adaptations and approaches of academics in university-industry collaborations, I now broaden our focus to the complex interplay of factors that influence these partnerships at an organizational and institutional level. While the previous chapters delved into the micro-level dynamics and individual contributions to collaboration effectiveness, Chapter 4 investigates the different array of factors that affect the non-linear relationships within university-industry collaborations.

In contrast to the emphasis on intangible knowledge and individual agency, this chapter examines how organizational structures, resource availability, institutional support, cultural differences, and external environmental conditions interact in non-linear ways to shape the success of collaborations. Chapter 4 goes into the complexities of these interdependent variables, analyzing how they collectively influence the trajectory of collaborative efforts and innovation outcomes. By understanding these non-linear relationships, we aim to uncover the underlying mechanisms that either facilitate or hinder effective partnerships, providing a comprehensive perspective that bridges individual adaptations and broader institutional dynamics.

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A MACHINE LEARNING APPROACH FOR THE UNDERSTANDING OF FACTORS INFLUENCING UNIVERSITY-INDUSTRY COLLABORATIONS

Carlos Plata

TSM-Research, University of Toulouse Capitole, CNRS UMR 5303

Alejandro Casallas

Institute of Science and Technology Austria, Austria

Prior versions of this project have been presented at the EURAM conference 2024, the ENGAGE.EU PhD Workshop in 2024 and TSM-LUMS-WHU PhD workshop in 2023

Abstract

In the evolving landscape of innovation, the relationships between academia and industry serve as a pillar for breakthroughs and practical applications. However, the foundation of these University-Industry (U-I) partnerships is loaded with complexity. This paper explores these collaborations, highlighting what makes collaborations work well. Based on Resource-Based Theory, our study breaks new ground by employing a neural network model to analyze a comprehensive dataset from the UK's Higher Education Statistics Agency, SCIMAGO Rankings, and Clarivate Publications. This innovative approach clarifies how academic workload, administrative support, scientific output, and university ranking influence U-I collaboration dynamics. Our findings reveal that while reducing academic load and enhancing administrative support substantially improve U-I collaborations, the roles of scientific output and university ranking are more complex, challenging straightforward assumptions. High scientific output, though reflective of expertise, may not always meet industry objectives. Likewise, although top-ranked universities might seem more likely to attract collaborations, the advantages are not guaranteed. This paper not only deepens the understanding of U-I collaborations but also offers practical insights for university administrators, policymakers, and industry leaders.

Keywords: University-Industry Collaborations, Machine Learning, Neural Networks, Higher Education, Innovation

CHAPTER 4

1. Introduction

Universities and industries have long been pivotal players in the landscape of innovation and economic development (D'Este & Perkmann, 2011; Etzkowitz, 2004; V. Schaeffer et al., 2020b). Collaborations between these two entities, often termed University-Industry (U-I) collaborations, have become increasingly essential in driving research advancements and translating academic insights into practical applications (Perkmann & Walsh, 2008). However, the dynamics between these collaborations are complex and influenced by a multitude of factors.

This paper seeks to unravel the complexities of U-I collaborations by examining how various factors such as academic load, administrative support, scientific output, and university rank positioning impact the nature and success of these partnerships. Grounded in the Resource-Based Theory (RBT) (Penrose, 2009), the study offers a nuanced understanding of how universities' unique resources and capabilities influence their ability to engage effectively in collaborations with industry partners.

This research stems from a growing recognition of the critical role that U-I collaborations play in fostering innovation and addressing societal challenges (Carayannis & Campbell, 2009; Miller et al., 2018). Despite the acknowledged importance of these collaborations, there remains a gap in understanding the specific factors that facilitate or hinder their success (V. Schaeffer et al., 2020b). This study aims to fill this gap by providing empirical insights into the dynamics of U-I collaborations within the context of UK universities.

Our methodology involves an innovative approach, utilizing a neural network model to analyze a comprehensive dataset compiled from the Higher Education Statistics Agency (HESA UK), SCIMAGO Rankings, and Clarivate Publications. This methodological choice allows us to dive into the intricate relationships (non-linear or monotonic) between the variables of interest and to draw out patterns that might be obscured by more traditional analytical techniques.

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Following the introduction, we present a detailed literature review that sets the stage for our hypotheses. Next, our research methodology describes the data sources, manipulation techniques, and the neural network model used for the analysis. The subsequent sections present the results of our analysis, discuss their theoretical and managerial implications, and conclude with recommendations for future research and policy considerations.

This paper focuses into the factors that influence collaborations between universities and industries, providing a more complete view of these partnerships when compared to the existing cross sectional studies (Azagra-Caro et al., 2017; Perkmann et al., 2013). Our research introduces hypotheses that show the interactions in both sides of existing literature, revealing that the interactions between universities and industries involve more complexity than previously thought. We found that these relationships are governed by a variety of factors and their interactions are not straightforward, indicating a non-linear behavior. This insight is crucial to improve the effectiveness of these collaborations, such as university administrators, policymakers, and industry leaders. Our findings suggest that understanding these complexities is key to enhancing the success of university-industry collaborations, which are vital in the fast-paced world of research and innovation

2. Literature Review

University-industry collaborations, an integral component of the modern academic and industrial landscape (Scott, 2006), have evolved significantly over the years. These collaborations, which began as informal interactions between academia and industry, have transformed into structured, strategic partnerships (Etzkowitz, 2004; Perkmann et al., 2013; V. Schaeffer et al., 2020b). This transformation was catalyzed by legislative changes, notably in the United States with the Bayh-Dole Act of 1980, which actively encouraged universities to patent inventions and engage in technology transfer (Thursby & Thursby, 2003). Such collaborations manifest in diverse forms, ranging from joint research projects and technology transfer agreements to the establishment

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of corporate-sponsored research centers and faculty consulting roles (Grimpe & Hussinger, 2013; Hagen, 2008; Heinzl et al., 2013; Perkmann et al., 2013; Schartinger et al., 2002). These partnerships vary greatly in their scope, field, and objectives. For instance, in the field of biotechnology, collaborations often involve extensive joint research and development efforts; whereas, in engineering and technology fields, they might include cooperative education programs and industry placements (G. P. Pisano, 2006).

The importance of U-I collaborations is multifaceted. They serve as a bridge between theoretical research and practical application, facilitating the transfer of knowledge and technology between academia and industry (Etzkowitz, 2004; Perkmann, Neely, et al., 2011). This synergy is crucial for fostering innovation, driving economic growth, and addressing societal challenges (Heinzl et al., 2013). The impact of these collaborations is evident in the enhanced research productivity (Berbegal-Mirabent et al., 2013), increased patenting activity (Azagra-Caro et al., 2017), and the development of innovative new products and processes, which often result from these partnerships (Sadaghiani & Jamali, 2012). Recent trends in U-I collaborations have been influenced by the globalization of research activities, the increasing emphasis on interdisciplinary research, and the rapid advancement of digital technologies (Mauricio Sanchez & López Mendoza, 2018; van Rijnsoever & Hessels, 2021), including the rise of big data analytics and artificial intelligence that have opened new frontiers for collaborative research, expanding the potential for innovation across various fields.

Despite their numerous benefits, U-I collaborations also present significant challenges and concerning issues such as intellectual property rights, conflict of interest, and the commercialization of academic research (De Wit-de Vries et al., 2019). There is a growing concern that the pressure to generate commercially viable research outcomes may lead to the neglect of basic and fundamental research, essential for long-term scientific advancement (Anokhin et al., 2011; Perkmann et al., 2013). Additionally, the management of these collaborations often requires navigating complex administrative

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and bureaucratic landscapes, which can be a barrier to effective partnerships. Moreover, the success of U-I collaborations is not uniformly distributed across all academic institutions. Top-ranked universities often attract more industry collaborations due to their reputation, resources, and established networks, leading to a concentration of research partnerships with certain institutions (Altbach, 2021). This disparity raises questions about the accessibility and inclusivity of research opportunities, particularly for smaller or less-known academic institutions.

Balancing the commercial interests of the industry with the academic integrity and research freedoms of universities is essential for ensuring that these partnerships contribute positively to both sectors (Leischnig & Geigenmüller, 2020b). Understanding the dynamics of these collaborations, their benefits, challenges, and the factors influencing their success, is vital for any comprehensive analysis in this field.

The Resource-Based Theory (RBT) (Penrose, 2009) serves as a robust theoretical framework for examining U-I collaborations. At its core, RBT posits that the competitive advantage of an organization (or in this case, a university) lies in its unique resources and capabilities (Helfat & Peteraf, 2003). Within the context of U-I collaborations, these resources can be tangible, such as research infrastructure and financial assets, or intangible, like reputation, expertise, and institutional culture (Heinzl et al., 2013; Perkmann et al., 2013). RBT suggests that when universities leverage these unique resources in collaborations, they not only enhance their competitive standing but also contribute to the creation of valuable, innovative outputs in partnership with industry. Applying RBT to the realm of U-I collaborations offers a lens through which the impact of various factors –academic load, administrative support, scientific output, and rank positioning– can be critically examined. Each of these factors represents a resource or a capability that can potentially shape the nature and success of U-I collaborations. For instance, reduced academic load and increased administrative support can be viewed as organizational capabilities that enable faculty members to engage more effectively in collaborative research (Reymert & Thune,

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2023). Similarly, a university's scientific output and rank positioning can be considered unique resources that may attract industry partners and facilitate collaborative ventures (D'Este & Perkmann, 2011; Hazelkorn, 2015; Leischnig & Geigenmüller, 2020b).

2.1.The influence of academic load on University-Industry (U-I) collaborations

The academic load carried by university faculty, encompassing teaching responsibilities, research activities, and administrative duties, plays a pivotal role in shaping the landscape of U-I collaboration (Perkmann et al., 2013). The prevailing understanding in academia and industry alike is that a lighter academic load, particularly in teaching, can significantly enhance a faculty member's ability to engage in collaborative research with industry partners (Houston et al., 2006; Reymert & Thune, 2023). This notion stems from the idea that reduced teaching commitments provide more time and flexibility for research endeavors, which are central to effective U-I collaborations. Evidence from various studies suggests that faculty members burdened with heavy teaching loads often face challenges in allocating sufficient time for research, a critical component of U-I collaborations (Lyons & Ingersoll, 2010). This is especially pronounced in teaching-focused institutions (Scott, 2006), where faculty may have limited opportunities to engage with industry, thereby potentially restricting the number and scope of collaborative projects (Landry et al., 2010). Conversely, faculty at research-centric universities (Scott, 2006), where the teaching load is generally lighter, often have greater capacity to engage in extensive research collaborations with industry partners (Reymert & Thune, 2023). However, there are instances where teaching activities can also serve as a valuable platform for academics to initiate or sustain industry relationships (Gonzalez-Sanchez et al., 2022).

The impact of academic workload is not uniform across all disciplines, for example, in STEM -Science, Technology, Engineering, and Mathematics- fields where research often involves lab work and is integral to the discipline, a lighter teaching load can

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significantly increase a faculty member's ability to engage in industry collaborations; whereas, in disciplines where research is less dependent on lab-based or resource-intensive activities, the influence of teaching load on U-I collaborations may be less (Miller et al., 2018; Secundo et al., 2020). Moreover, the nature of the academic workload itself impacts the type and extent of U-I collaborations. Faculty with a higher proportion of their workload dedicated to research are more likely to engage in complex, long-term collaborative projects requiring sustained effort and substantial research output (Hoc & Trong, 2019). In contrast, those with heavier teaching commitments might be inclined towards shorter-term, less demanding collaborative endeavors (García-Gallego et al., 2015). Institutional policies and support systems also critically shape the relationship between academic load and U-I collaborations (Perkmann & Walsh, 2007). Universities that actively foster faculty engagement with industry, through measures such as offering research sabbaticals, granting research funds, or implementing policies for reduced teaching loads, often report stronger and more productive U-I collaborations (Heinzl et al., 2013). These policies not only free up time for faculty to engage in research but also demonstrate an institutional commitment to fostering industry partnerships, which can be a significant motivator for faculty.

Furthermore, the balance between teaching, research, and administrative responsibilities is not just a matter of time allocation; it also impacts faculty motivation and satisfaction (García-Gallego et al., 2015). Faculty who perceive a supportive environment that values and rewards research and collaboration with the industry may feel more motivated to pursue these activities. In contrast, a heavy teaching load with little recognition or support for research endeavors can lead to reduced motivation for engaging in U-I collaborations (Berbegal-Mirabent et al., 2013). Accordingly, hypothesis 1 is presented below:

Hypothesis 1: Less academic load positively affects U-I relations.

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2.2.The role of Administrative Support as an influencing factor in University-Industry (U-I) collaborations

Administrative support within universities plays a crucial role in shaping the dynamics and success of U-I collaborations. This support encompasses a range of services and structures, including grant management, legal and intellectual property advice, liaison offices, and collaborative research centers, all of which are essential for facilitating effective interactions between academic researchers and industry partners (Perkmann et al., 2013). The importance of strong administrative support is underscored by the complexity inherent in U-I collaborations. These partnerships often involve intricate negotiations over intellectual property rights, confidentiality agreements, and research funding. Effective administrative support structures provide the necessary expertise and resources to navigate these complexities (Leischnig & Geigenmüller, 2020b), ensuring that collaborations are not only productive but also compliant with legal and ethical standards. For instance, universities with dedicated technology transfer offices have been found to be more successful in patenting research outcomes and establishing commercial partnerships with industries (Cesaroni & Piccaluga, 2016). These offices play an essential role in bridging the gap between academic research and market application, helping to translate research discoveries into viable commercial products or services (Baglieri et al., 2018).

Furthermore, administrative support extends beyond transactional aspects to encompass strategic alignment and relationship building. Universities that prioritize U-I collaborations often have dedicated teams or offices responsible for fostering industry relationships, identifying potential collaboration opportunities, and facilitating the development of joint research projects (Rothaermel et al., 2007). These teams work closely with faculty members to understand their research interests and expertise, aligning them with industry needs and opportunities (De Wit-de Vries et al., 2019). This proactive approach not only increases the quantity and quality of U-I

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collaborations but also ensures that such partnerships are strategically aligned with the university's research goals and priorities (Baglieri et al., 2018).

The role of administrative support is also critical in managing the logistical and operational aspects of U-I collaborations. This includes coordinating research schedules, ensuring access to necessary resources and facilities, and managing project budgets and timelines (McCabe et al., 2023). Efficient handling of these logistical details is essential for the smooth functioning of collaborative projects (van Rijnsoever & Hessels, 2021), allowing researchers to focus on the scientific and technological aspects of their work without being bogged down by administrative burdens.

Additionally, in an era where interdisciplinary and cross-sectoral research is becoming increasingly important, administrative support structures must evolve to facilitate collaborations that span different disciplines and industries (Van Rijnsoever & Hessels, 2011; van Rijnsoever & Hessels, 2021). This requires a flexible and adaptive approach, as the needs and dynamics of collaborations in, say, biotechnology, might be quite different from those in information technology or renewable energy (Powell et al., 1996). Universities that invest in developing versatile and responsive administrative support systems are better positioned to capitalize on the diverse opportunities presented by U-I collaborations.

Moreover, effective administrative support also plays a vital role in creating an environment that fosters and encourages U-I collaborations. This includes developing policies that recognize and reward faculty engagement in collaborative research, providing professional development opportunities to enhance faculty's collaboration skills, and creating platforms for regular interaction and networking with industry partners (Bercovitz & Feldman, 2006; Van Rijnsoever & Hessels, 2021). Such an environment not only facilitates the initiation and management of U-I collaborations but also contributes to a culture where such partnerships are valued and pursued as a key aspect of academic research. Following that rationale, hypothesis 2 is presented below:

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Hypothesis 2: More administrative support positively affects U-I relations.

2.3.The influence of Scientific Output as an important factor affecting University-Industry (U-I) collaborations

Scientific output, typically measured in terms of publications, patents, and research findings is a crucial aspect that significantly influences U-I collaborations (Abramo & D'Angelo, 2014). Traditionally, one might assume that higher scientific output would naturally lead to increased U-I collaborations (D'Este & Perkmann, 2011), given that it reflects a strong research base and expertise. However, the relationship between scientific output and U-I collaborations is more nuanced and, in some instances, may present a complex, inverse correlation (Banal-Estañol et al., 2013).

The reasoning behind this paradoxical situation stems from several factors. Firstly, universities with high scientific output often prioritize fundamental, exploratory research which may not always align with the immediate, application-driven interests of the industry. Industry partners typically seek collaborations that can yield tangible and rapidly commercializable results; whereas, high-value academic research may be more theoretical and long-term in nature (Ćudić et al., 2022; Lai & Lu, 2016). This misalignment of goals can sometimes deter U-I collaborations, as industries may prefer to partner with institutions that offer more immediate and practical research outcomes (Rybnicek & Königsgruber, 2019).

Additionally, faculty members who are heavily involved in producing high-level scientific output may have less time or inclination to engage in industry collaborations (D'Este & Perkmann, 2011). The demands of conducting top-tier research, combined with the pressures of publishing in high-impact journals, can leave little room for the additional commitments that U-I collaborations entail (Hoc & Trong, 2019). This is particularly relevant in research-intensive universities, where the emphasis on publishing and securing research grants might overshadow the potential benefits of collaborating with industry partners (Leischnig et al., 2014).

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Another aspect to consider is the nature of the research itself. High scientific output in certain specialized or niche areas may not always translate to industry-relevant applications (Evans et al., 2023). Research that is highly specialized or theoretical may not find immediate resonance with industry needs, which tend to be more practical and application-focused (Thomas, 2012). Therefore, even if a university boasts significant scientific output, it may not necessarily be in areas that are conducive to productive U-I collaborations (McCabe et al., 2023).

Furthermore, the way scientific output is valued and rewarded within academic institutions can also impact U-I collaborations (Azagra-Caro et al., 2017). In university environments where the primary metrics of success are publications and citations, faculty members may be less motivated to engage in collaborative projects with industry, especially if these projects do not immediately contribute to their publication record (Lam, 2011). This dynamic can create an institutional culture that inadvertently discourages U-I collaborations, despite the potential benefits they may offer in terms of innovation and practical application.

It is also important to consider the role of intellectual property (IP) rights in the context of scientific output and U-I collaborations. Universities with high scientific output often have extensive portfolios of IP, which can be both an asset and a barrier to establishing industry collaborations (Azagra-Caro et al., 2017). Negotiating IP rights and licensing agreements can be a complex process, and industry partners may be hesitant to engage in collaborations that involve intricate or restrictive IP terms (Baglieri et al., 2018). Therefore, the management and negotiation of IP rights become crucial in facilitating U-I collaborations, particularly in cases where significant scientific output is involved (Aksoy & Beaudry, 2021; Bercovitz & Feldman, 2006).

Understanding these intricate relationships is essential for universities and industry partners alike, providing the base for the third hypothesis:

Hypothesis 3: More scientific output negatively affects U-I relations.

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2.4.Rank Positioning as an influencing factor in U-I collaborations

The Rank Positioning of universities, which is often reflected by the various academic and research rankings, plays a significant and multifaceted role in shaping U-I collaborations. The rank or perceived prestige of a university can have both direct and indirect effects on its ability to attract industry partners and engage in fruitful collaborations (Altbach, 2021).

At a fundamental level, higher-ranked universities are often perceived as more attractive partners by industry due to their reputation for research excellence and innovation (Altbach, 2015; Van Rijnsoever & Hessels, 2021). These institutions typically have a history of significant scientific contributions, cutting-edge research facilities, and a pool of renowned faculty members and researchers (Hazelkorn, 2015). This reputation can act as a powerful magnet for industry partners seeking to align themselves with prestigious institutions, hoping to leverage the associated brand value and advanced research capabilities these universities offer (Fumasoli et al., 2020). As a result, higher-ranked universities may find it easier to initiate and sustain U-I collaborations compared to their lower-ranked competitors.

Moreover, the prestige associated with high-ranking universities often translates into better access to funding and resources (Baltaru et al., 2022). Such institutions are more likely to receive substantial research grants, endowments, and donations, which can be channeled into further enhancing their research capabilities and infrastructure (Aksoy & Beaudry, 2021; Carayannis & Campbell, 2009). This financial advantage can be a crucial factor in supporting and expanding U-I collaborations, as it allows these universities to invest in state-of-the-art facilities and equipment, attract top talent, and conduct groundbreaking research, all of which are highly appealing to industry partners (Leischnig & Geigenmüller, 2020b; Perkmann, Neely, et al., 2011).

However, this dynamic creates a disparity in the U-I collaboration landscape. Lower-ranked or less prestigious universities may face challenges in attracting industry partnerships due to their relatively limited visibility and resources (R. Tijssen, 2021).

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This issue is further compounded by the fact that industry collaborations themselves might factor into university rankings, creating a cycle where high-ranking institutions continue to enhance their status through successful collaborations, while lower-ranked institutions find it difficult to break into this cycle (R. J. W. Tijssen et al., 2016).

The influence of rank positioning on U-I collaborations is also evident in the types of partnerships in which different universities engage. High-ranking universities are often involved in large-scale, high-impact, collaborative projects that sometimes involve multinational corporations or significant government funding (Fumasoli et al., 2020; Sursock, 2021). These projects can be highly prestigious, further enhancing the university's reputation and attracting more industry partners.

Additionally, the rank positioning of a university can influence the expectations and outcomes of U-I collaborations. Industry partners may have higher expectations from collaborations with top-ranked universities, anticipating groundbreaking innovations and significant returns on investment (Turk-Bicakci & Brint, 2005). This can put pressure on these universities to continuously deliver high-impact research outcomes, shaping the nature and focus of their collaborations (Hazelkorn, 2015). Conversely, lower-ranking universities may have more flexibility and opportunities to engage in niche or emerging areas of research, which might be overlooked by higher-ranked institutions.

By that, hypothesis 4 was developed as shown below:

Hypothesis 4: Better rank positioning positively affects U-I relations.

3. Methodology

In this study, we employed a comprehensive methodological approach to examine the factors influencing U-I collaborations across UK universities, invoking machine learning as a method suggested upon to explore problems grounded in the resource-based theory (Helfat et al., 2023), as is the case here. This pioneering approach within the realm of management sciences employs a neural network algorithm to analyze U-

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I collaborations, following the methodological guidance provided by Choudhury et al. (2021) on the use of machine learning in management science. This methodological innovation represents a departure from traditional statistical techniques typically used in management research, offering a novel and effective means of investigating the complex dynamics underpinning U-I collaborations. Our analysis was based on a dataset drawn from three key sources: the Higher Education Statistics Agency (HESA UK) (Sengupta & Ray, 2017a), Scimago Institutions Ranking (Hazelkorn, 2015), and Clarivate Publications, encompassing information from 121 UK universities and amounting to approximately 40,000 data points over an eight-year span. The choice of these sources was strategic, leveraging their robust and comprehensive coverage of higher education statistics, university rankings, and research publications, which are essential for a nuanced analysis of U-I collaborations.

To ensure the rigor and reliability of our analysis, a data preparation process was undertaken. We prioritized data integrity by thoroughly cleaning the dataset, by removing incomplete data entries, and ensuring that only universities with complete data across all variables of interest were included in the final analysis. Such selection was critical to uphold the analytical rigor of our study, and also because machine learning techniques cannot learn from incomplete data sources (Choudhury et al., 2021)

Academic load. The proxy for academic load was the ratio of professors to students within each university. This metric was selected under the premise that it provides a tangible indicator of the teaching responsibilities shouldered by the faculty (Buckner & Zhang, 2021). A lower professor-to-student ratio can suggest a higher teaching burden on individual professors, and this could bring less time and flexibility to engage in research activities, including collaborations with industry partners. Conversely, a higher ratio suggests a lighter teaching load, potentially allowing more time for research and collaborative endeavors. This proxy is particularly relevant as the time and effort faculty can allocate to research and engagement with industry

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partners are often constrained by their teaching commitments (Houston et al., 2006; Reymert & Thune, 2023). There are also individual levels of measuring the academic load and the impact yet, given the data availability this had to be estimated.

Administrative support. For administrative support, we used the ratio of administrative staff to professors as a proxy. This choice was predicated on the understanding that a higher ratio would indicate a stronger administrative infrastructure in place to support the academic staff. Robust administrative support is hypothesized to alleviate the non-research-related burdens on faculty (Cesaroni & Piccaluga, 2016), such as grant management, compliance with regulatory requirements, and other bureaucratic processes. By reducing these burdens, faculty members can ideally devote more time and energy to research and collaborative projects with industry. A higher staff-to-professor ratio is thus seen as indicative of an environment where administrative tasks are more efficiently managed, potentially enhancing the faculty's capacity to engage in U-I collaborations.

The analytical backbone of our study was a neural network algorithm, featuring a four-layer architecture with 64 neurons in each layer, with the Adam optimizer (Kingma & Ba, 2014) and the Rectified Linear Unit (ReLU) (Fukushima, 1975). This structure was selected for its proficiency in handling complex datasets with non-linear relationships (Kingma & Ba, 2014), and the hyperparameters were determined by using a grid search method (Ndiaye et al., 2018), utilizing Tensorflow-2.4.1 (Abadi et al., 2016) and Keras-2.4.3 (Chollet, 2015) libraries from Python-3.8. Neural networks, with their ability to discern intricate patterns and interactions among multiple variables (Arin et al., 2022), provided an ideal analytical tool for exploring the multifaceted nature of U-I collaborations. Additionally, it allows us to create scenarios to better comprehend non-linear relationships between variables (Casallas et al., 2023; Miric et al., 2023), by performing sensitivity experiments, which we do in this paper as a novelty in management sciences. Recognizing that different machine-learning methods can yield varied outcomes (Miric et al., 2023), we initially incorporated a random forest

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(Breiman, 2001) analysis using SK-learn-0.24.1 (Pedregosa et al., 2012). However, we found that the results from our random forest analysis closely matched those obtained from the neural network analysis. Considering this similarity and the fact that the neural network demonstrated greater precision upon validation, we chose to adopt the neural network as our primary analytical method.

The robustness of our neural network model was further ensured through a rigorous validation process. This involved partitioning our dataset into a training set accounting for 80% of the sample used to train the model, and a separate test set accounting for 20%, used to evaluate the model's performance. The test set acted as a stand-in for new, unseen data, allowing us to assess how well our model could generalize its learned patterns to make accurate predictions about U-I collaborations outside of the training dataset, additionally, we include an early stopping to avoid overfitting (Prechelt, 2012). Ensuring that our model accurately fits the training data while also performing well on the test data was crucial for establishing its reliability and applicability in real-world scenarios.

The final phase of our methodology centered on testing our hypotheses. We utilized our model to conduct a series of experiments, systematically varying key variables like the academic load and administrative support ratios, a method that was already validated by previous research e.g., (Casallas et al., 2023; Celis et al., 2023; Herhausen et al., 2024; J. Kim et al., 2023). By observing the effects of these variations on the number and nature of U-I collaborations, we were able to investigate the relationships proposed in our hypotheses. This experimental approach allowed for a robust examination of the dynamics at play, providing valuable insights into the factors that significantly influence U-I collaborations to evaluate the experiments, we compare them with a control run, which is the run without any input changes. To do it we leverage Bland–Altman plots (Altman & Bland, 1983; Bland & Altman, 1986) which plot the difference between two datasets against their mean, allowing us to interpret if the experiment produces positive, negative, or neutral changes. By leveraging this

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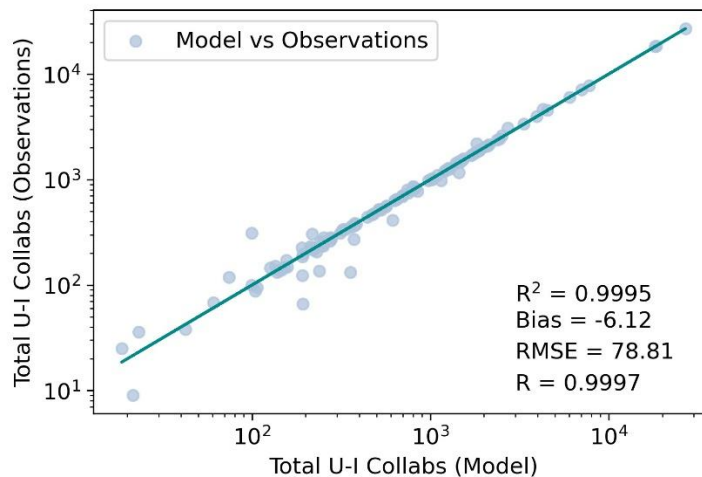
advanced analytical tool, our study not only contributes new insights into the dynamics of U-I collaborations but also sets a precedent for the application of neural networks in management science research, opening new avenues for exploration and understanding in this field.

4. Results

4.1. Validation of the neural network

In the present study, the efficacy of the developed neural network model was rigorously assessed by comparing its predictive output with a corresponding set of empirical observations, presented in Figure 4.1. The resultant plot displayed a marked congruence of data points along the diagonal, indicative of a strong linear relationship between the model predictions and the actual observations. This visual inference is corroborated by a high coefficient of determination, with an R^2 value of 0.99. Despite the high R^2 value, a bias of -6.12 was observed. While this deviation is considerable, it is a reasonable value for a scenario of non-exact sciences (Blackwell et al., 2017).

FIGURE 4.1: TOTAL U-I COLLABORATIONS FROM THE OBSERVATIONS AGAINST THE SIMULATED TOTAL U-I COLLABORATIONS



Complementing this, the Root Mean Square Error (RMSE) was equal to 78.81, providing a measure of the average magnitude of the predictive errors. While the RMSE value reflects the model's overall precision and is relatively low, it also

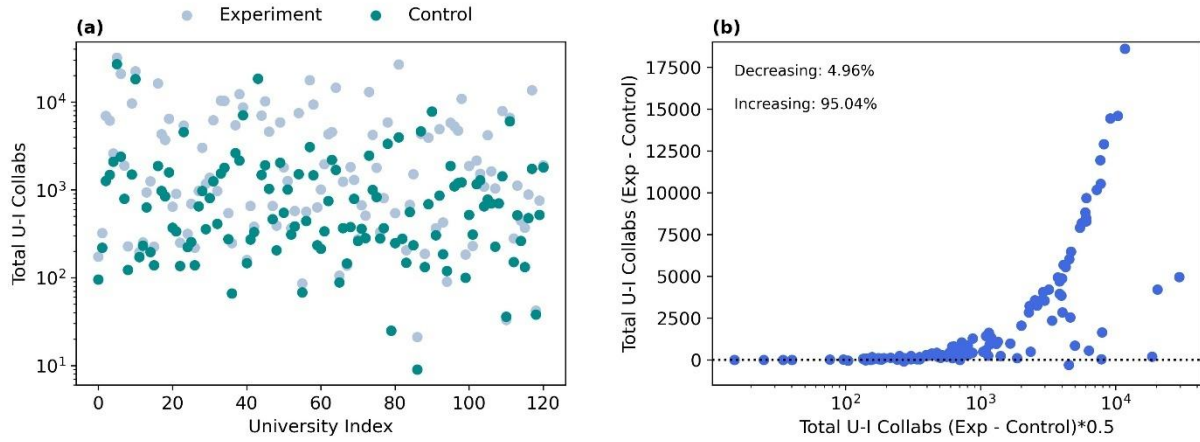
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highlights the potential for further calibration to refine the model's estimations, although this is out of the scope of this paper. Nonetheless, the use of more robust neural network structures could improve the model results, as shown by Celis et al. (2023) in a study that included social variables. For example, the spread of points away from the 1:1 relation line, particularly for lower and higher value ranges gives room for improvements. Nevertheless, the analysis and statistical parameters suggest that the model performs exceptionally well for a significant portion of the data range, which is why we argue that the model can be further utilized to perform sensitivity experiments, starting with an experiment where the results can be inferred previously.

To evaluate the predictive accuracy of the neural network model, an experiment was designed to test its response to controlled input variations. The experiment involved increasing the number of contracted research collaborations by 10 within the model's input parameters (other values yield similar results). This adjustment aimed to mimic a significant yet plausible escalation in collaborative activity (Heinzl et al., 2013), thus challenging the model to adapt its output accordingly. The analysis post-manipulation, Figure 4.2, revealed that 95% of the cases exhibited a corresponding increase, which is in line with the theoretical expectations for such an input change. This outcome supports the model's ability to accurately map changes in input to the appropriate changes in output, reflecting a precise understanding of U-I collaboration dynamics.

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FIGURE 4.2: VALIDATION EXPERIMENT. BLAND-ALTMAN PLOT, SHOWING THE DIFFERENCE BETWEEN THE EXPERIMENT AND THE CONTROL AGAINST THE MEAN THEIR MEAN.



A high degree of concordance with anticipated outcomes confirms the model and experiments structural integrity and validates its operational logic. Furthermore, the experiment underscores the model's applicability in forecasting the effects of strategic decisions within the U-I collaborative framework. Consequently, this validation exercise not only reinforces the model's credibility as a predictive tool but also highlights its potential utility in strategic decision-making and policy formulation within the research and development domain.

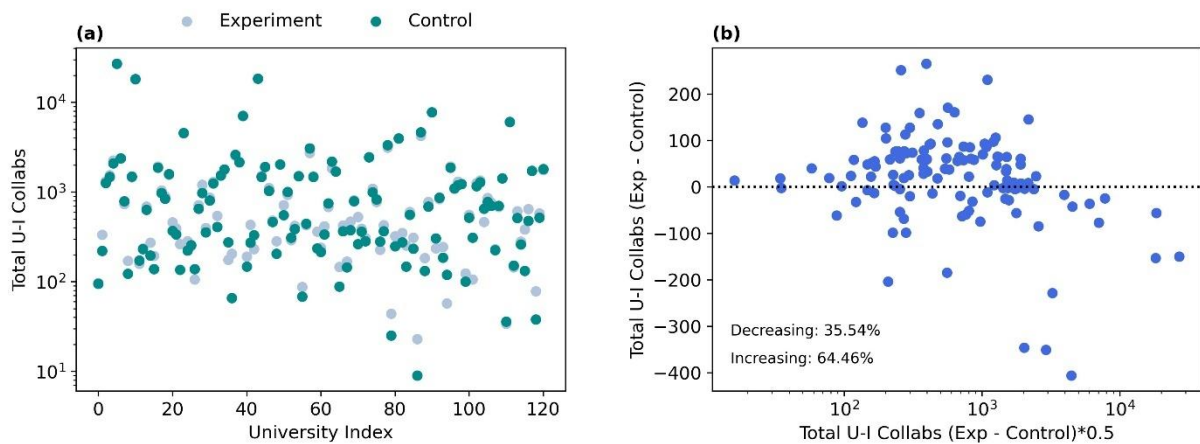
We compare key metrics between two distinct groups: experimental and control. The experimental group has been subjected to a particular variable or condition of interest, while the control group has not. Figure 4.2a in each series displays the raw metric values for each university indexed on the x-axis, with the y-axis representing the metric on a logarithmic scale to accommodate a wide range of values. Figure 4.2b in each series shows the differential impact of the experimental condition on the metric, with the x-axis representing the average metric value and the y-axis showing the difference between the experimental and control groups, also on a logarithmic scale. This series of Band-Almand graphs are designed to elucidate patterns and the magnitude of change induced by the experimental condition (Altman & Bland, 1983).

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4.2. Experiment 1 – The impact of a decreased academic load

The analysis of the first hypothesis presents a complex picture when considering the broader implications of reducing academic load. The manipulation in our neural network model, which involved adjusting the ratio of students to professors to simulate a reduced academic load, yielded mixed results. While 64.46% of universities showed a positive change in U-I collaborations, indicative of an increase in such activities, 35.54% of universities experienced a negative change. The results support Hypothesis 1, yet it also unveils a more complex, non-monotonic relationship, indicating that the outcome of reduced teaching loads on university-industry collaborations isn't always straightforward but depends on a variety of factors. This complexity suggests that decreasing teaching responsibilities does not uniformly enhance collaboration with industry; rather, the impact varies, underlining the importance of considering additional influences.

FIGURE 4.3: BLAND-ALTMAN PLOT, SHOWING THE DIFFERENCE BETWEEN THE EXPERIMENT AND THE CONTROL AGAINST THE MEAN THEIR MEAN.



These findings indicate that reducing the academic workload does not necessarily lead to a uniform increase in contracts with industry partners. This trend is consistent with existing literature, which suggests that there might be a conflict between the principles of academic duties and industry engagement (Perkmann et al., 2013). Notably, the data supports the notion that certain professors might be leveraging their research activities and student involvement to secure more industry contracts. It is not uncommon for

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professors in some fields to integrate extensive corporate interactions within their teaching curriculum (Schartinger et al., 2002); thereby, potentially inflating the apparent level of industry engagement without necessarily reflecting a genuine increase in collaborative research or consultancy work.

It's interesting to note that giving professors less teaching work might not always result in more partnerships with the industry. This goes against the assumption that professors will work more with the industry if they have fewer classes to teach. The situation suggests that professors juggle teaching, administration, research, and working with the industry. Reducing their teaching duties might unexpectedly bring a shift of focus to activities like research or administrative tasks instead of collaborating with the industry.

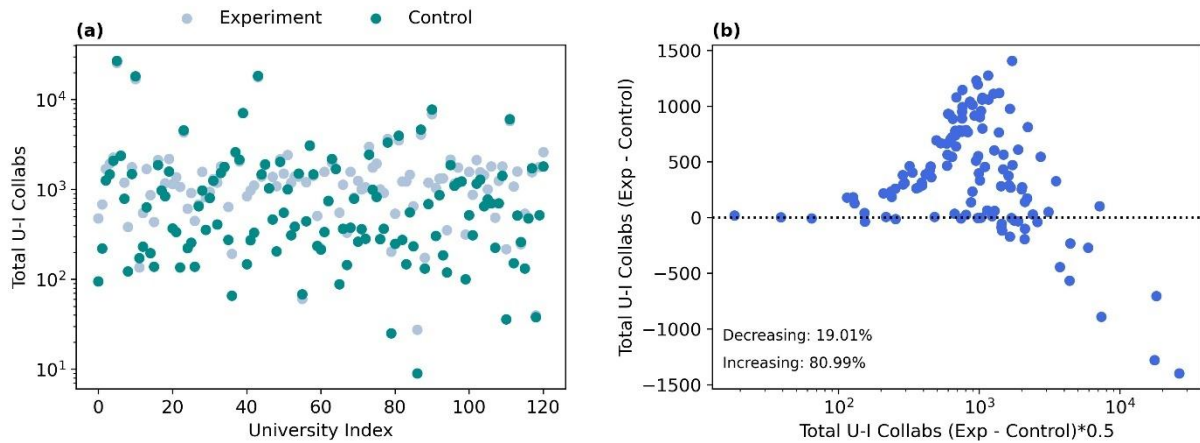
While a general trend supports the idea that less academic load can be conducive to U-I collaborations, the variability in responses suggests the influence of other mediating factors. These could include the individual priorities of faculty members, the specific nature of their research and how it aligns with industry needs, and the overall institutional culture regarding industry engagement.

4.3. Experiment 2 – The impact of a increased administrative support

In examining the second hypothesis, our manipulation involved an increase in the ratio of academics to staff, effectively simulating a significant boost in administrative support for faculty members, as demonstrated in Figure 4.4. The results of this manipulation were revealing: 81% of the universities in the study exhibited a positive change in U-I collaborations, suggesting a notable enhancement in these activities. This finding supports the hypothesis that increased administrative support positively influences U-I relations (hypothesis 2).

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FIGURE 4.4: BLAND-ALTMAN PLOT, SHOWING THE DIFFERENCE BETWEEN THE EXPERIMENT AND THE CONTROL AGAINST THE MEAN THEIR MEAN.



The substantial increase in positive U-I collaborations in most universities indicates that when administrative burdens are alleviated, faculty members are more able to engage effectively in collaborative activities with industry partners. Enhanced administrative support might manifest in various forms, such as more efficient grant management, streamlined processes for contract negotiation, and better handling of intellectual property and compliance issues (Leischnig & Geigenmüller, 2020b; Perkmann et al., 2013). These improvements can significantly reduce the time and effort faculty members spend on non-research activities, in turn allowing them to focus more on developing and sustaining industry collaborations.

The facilitative role of administrative support in industry-contract acquisition becomes particularly evident in this context. By providing a robust backbone of administrative services, universities enable their academic staff to concentrate on building and nurturing industry relationships. This support is crucial not just for initiating new collaborations but also for maintaining existing ones and ensuring their longevity and productivity.

However, the finding that 19% of universities showed a negative change despite increased administrative support introduces more complex interactions. This suggests that other factors may influence the efficacy of administrative support in promoting U-I collaborations. It could be that in some university contexts, increased

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administrative staff does not necessarily translate to more effective or efficient support. The quality, responsiveness, and alignment of administrative services with the specific needs of U-I collaborations are likely critical in determining their impact.

Moreover, this negative change in some universities could also point to potential issues of over-administration, where excess administrative procedures and personnel might inadvertently hinder the agility and flexibility required for effective U-I collaborations. This possibility highlights the need for a balanced approach to administrative support – one that provides necessary assistance without becoming overly cumbersome or bureaucratic.

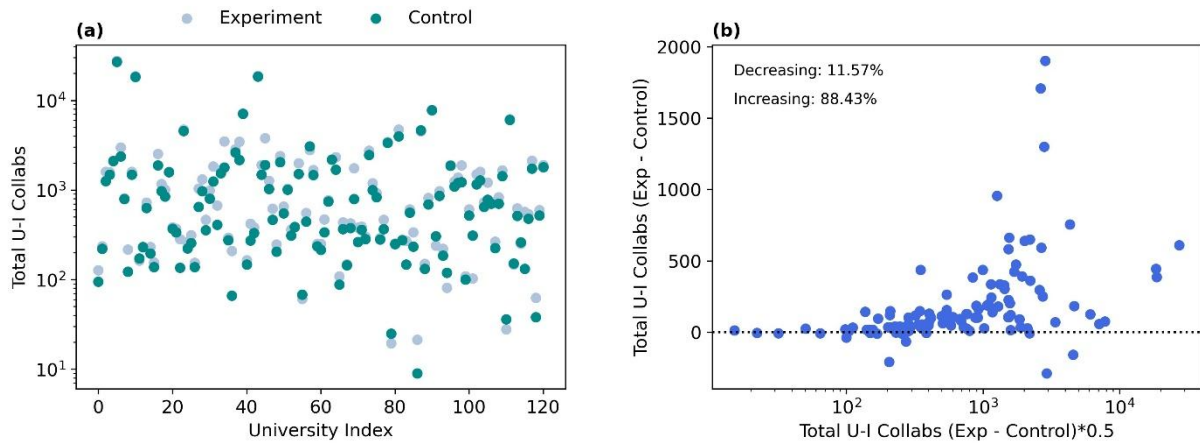
Another consideration is the existing culture and infrastructure within the university for supporting U-I collaborations. In institutions where such a culture is not strongly established or infrastructural elements are lacking, merely increasing administrative staff may not be sufficient. In these cases, broader institutional changes might be necessary to create an environment that truly fosters and supports industry collaborations (Azagra-Caro et al., 2017; Van Rijnsoever & Hessels, 2021).

4.4. Experiment 3 – The impact of an increased publication

The exploration of the third hypothesis in our study yielded insights that challenge our assumptions. The hypothesis posited that an increase in scientific output, specifically in terms of the number of publications, might have a negative impact on U-I collaborations (Figure 4.5). To test this, we manipulated our neural network model to simulate a tripling of publication output while keeping other variables constant (other values yield the same results). Contrary to the hypothesis, the results revealed a predominantly positive effect: $\approx 88\%$ of the universities showed an increase in U-I collaborations, while the others experienced a decrease

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FIGURE 4.5: BLAND-ALTMAN PLOT, SHOWING THE DIFFERENCE BETWEEN THE EXPERIMENT AND THE CONTROL AGAINST THE MEAN THEIR MEAN.



This outcome suggests that a higher rate of scientific publications does not necessarily detract from U-I collaborations but very often coincides with increased collaborative activities. This could be attributed to a significant portion of scientific research in universities being conducted in partnership with, or with the support of, industry partners. These collaborations are not only a source of funding and resources but also provide real-world contexts, data, and challenges that can drive impactful research. The resulting publications, therefore, are not just academic outputs but also markers of successful collaborations, reflecting the integration of academic expertise with industry needs.

The positive effect in most universities also indicates that industry partners view a large publication record as a marker of credibility and expertise (Banal-Estañol et al., 2013). In a landscape where cutting-edge innovation and specialized knowledge are highly valued, companies often turn to academics who have demonstrated their expertise through publications (Lockett et al., 2008; Shane, 2002). This dynamic positions universities as knowledge hubs and academics as key contributors for industries seeking to address complex challenges or drive innovation in their respective fields.

However, the negative changes observed in $\approx 12\%$ of universities highlight the multifaceted nature of this relationship. In some cases, a focus on increasing

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publication numbers might inadvertently shift the emphasis away from industry engagement towards more traditional academic pursuits (Aguinis et al., 2020; Olmos-Penuela et al., 2014). This could occur if the topics of high publication output are not aligned with industry interests, or if the pressure to publish drives researchers towards projects that are more academically oriented and less relevant to industry partners.

Moreover, the nature of the publications themselves is an important consideration. In disciplines where the research is more theoretical, or less directly applicable to practical industry needs, even a high volume of publications might not translate into effective U-I collaborations. Additionally, in environments where the pressure to publish is intense, there could be a tendency towards producing a larger quantity of work at the potential expense of depth or innovation, which might not align well with industry needs that often require focused, in-depth expertise.

Furthermore, the balance between research and industry engagement is a delicate one. In universities where the emphasis is heavily skewed towards publication output, faculty might find themselves with limited time or resources to dedicate to building and nurturing industry relationships. This could lead to missed opportunities for collaborations that require sustained interaction and engagement beyond the scope of a single research project.

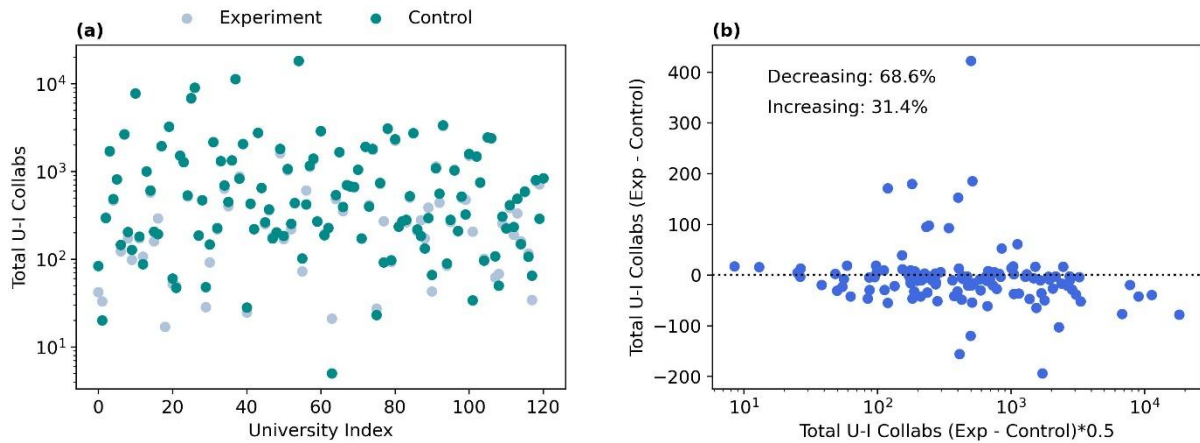
4.5. Experiment 4 – The impact of a better rank position

The examination of the fourth hypothesis provided intriguing results that challenge straightforward assumptions about the impact of university rankings on U-I collaborations. By improving the rank and simulating an elevation in their academic standing by reducing the rank⁹ position by 5 positions, we observed that 69% of universities showed a negative change in U-I collaborations, while 31% showed a positive change.

⁹ Ranking is considered an inverse variable, indicating that a lower number corresponds to a better position. This is why the experiment relies on reducing the numerical value

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FIGURE 4.6: BLAND-ALTMAN PLOT, SHOWING THE DIFFERENCE BETWEEN THE EXPERIMENT AND THE CONTROL AGAINST THE MEAN THEIR MEAN.



This outcome suggests that while improved rankings can negatively influence U-I collaborations for most universities, the impact is not universally detrimental. The positive changes observed in many universities could be attributed to the enhanced visibility and prestige that come with higher rankings. These factors can make universities more attractive to industry partners, leading to increased opportunities for collaboration. High rankings often signal a level of research excellence and academic quality that industries seek when scouting for potential academic partners, which could potentially lead to more consultancy projects and research contracts (Baltaru et al., 2022; Sursock, 2021).

However, the fact that several universities exhibited a negative response to improved rankings reveals more about that relationship. One explanation for this could be that the criteria driving higher university rankings, such as research output, faculty qualifications, and student numbers (Hazelkorn, 2015) do not necessarily align with the factors that facilitate effective industry collaboration. This misalignment suggests that the activities and focus required to improve university rankings might divert attention and resources from efforts to build and sustain industry relationships.

Moreover, for well-established universities with long-standing industry ties, the reliance on their inherent reputation and existing networks might outweigh the benefits brought by improved external rankings. These universities may already have

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a strong foothold in industry circles, with established pathways for collaboration that are not significantly enhanced by ranking improvements. In such cases, the efforts to climb higher in rankings could even be seen as redundant since these institutions already possess the reputation and connections needed to attract and maintain U-I collaborations.

The negative changes seen in some universities also raise questions about the potential drawbacks of overemphasizing ranking. Universities might prioritize research areas or strategies that contribute to ranking improvement, potentially overlooking fields or approaches more conducive to industry collaboration. This strategic focus might inadvertently narrow the scope of potential collaborations, limiting opportunities in areas not directly contributing to ranking improvement.

5. Discussion and conclusions

Our research into the dynamics of University-Industry (U-I) collaborations has shown key insights that both challenge and refine existing understandings in this field. Through the exploration of four hypotheses, we have identified a complex interplay of factors affecting these collaborations, each uncovering a depth of complexity that surpasses traditional beliefs. For instance, our findings suggest that an increase in both publication output and academic workload can lead to more collaborations. Additionally, considering the potential for such collaborations to enhance an institution's ranking, it might be assumed that a higher ranking could lead to more collaborations. However, our experiments reveal that this is not always the case and that the outcomes can sometimes be contrary to expectations. This highlights that there are deeper interactions at play that cannot be fully understood through conventional methods of study, and also that the internal dynamics of the universities play a major role. Although these effects can be observed in isolation, it is crucial to view them collectively to gain a comprehensive understanding of the underlying dynamics. Employing a machine learning algorithm represents an initial step towards achieving this holistic perspective.

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In the context of academic load, our findings suggest that the relationship between teaching responsibilities and U-I collaborations is not straightforward. While a lighter academic load did facilitate increased collaborations in many universities, the negative outcomes observed in several cases highlight a more complex reality. This suggests that factors such as the individual researcher's motivation, institutional culture towards research, and the nature of the academic discipline may significantly influence the propensity for engaging in U-I collaborations. Many of these factors and changes have been acknowledged in the literature. However, since most studies primarily employ cross-sectional methods and limited samples, they only capture one aspect of the narrative, often resulting in conflicting messages due to their focus on linear relationships. In contrast, the method employed in our paper offers the advantage of examining both sides of the issue, allowing us to observe non-linear interactions.

It's worth noting that in certain instances, a reduction in teaching responsibilities can result in an increase in theoretical research output, which may not always align closely with industry requirements. This may not necessarily foster stronger university-industry collaborations. The significance of administrative support in facilitating collaborations between academia and industry is clear from our findings. Our results show the positive impact that increased administrative support has in reducing non-research-related burdens, thereby improving engagement with industry partners. By comparing the effects of teaching and administrative roles, we find that while teaching activities can serve dual purposes, enhancing academic-industry relationships and contributing to research endeavors, administrative duties often present a barrier. This distinction underscores that excessive administrative tasks are a major barrier to collaboration. The contrast between the beneficial aspects of teaching and the detrimental effect of administrative overload suggests that reducing administrative burdens could significantly boost faculty involvement with industry, highlighting the need for better administrative support structures to foster such partnerships.

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However, the mere presence of administrative support is insufficient. The effectiveness of such support hinges on its nature, quality, and alignment with the strategic objectives of university-industry collaborations. It may be imperative for universities to evaluate and, if necessary, restructure their administrative support systems to ensure they are responsive to the needs of both academic staff and industry partners. Our experiments show the substantial role that administrative support plays in this regard.

Our findings regarding the impact of scientific output on U-I collaborations offer a different and new perspective. Contrary to the initial hypothesis, increased scientific output generally brings a rise in U-I collaborations. This indicates that scientific research, often embodied in publications, can serve as a bridge between academic and industry spheres. However, the negative impact observed in some institutions suggests a need to scrutinize the nature and direction of research endeavors. Universities should aim to foster a research environment that not only promotes high-quality output but also aligns with practical, industry-relevant issues.

Furthermore, while an improved ranking position was related to decreased collaborations in many instances, this was not a universal trend. This finding suggests that the value of university rankings in predicting or facilitating U-I collaborations is limited and possibly overshadowed by other factors like established reputation, internal networks, and the relevance of research to industry needs. It points to the potential risk of overvaluing rankings at the expense of developing deeper, more substantive industry relationships.

Our findings additionally suggest that a one-size-fits-all approach to enhancing U-I collaborations is inadequate. Universities need to adopt tailored strategies that consider their unique institutional profiles, research strengths, and academic cultures. For policymakers, the insights from this study highlight the importance of fostering an ecosystem that supports diverse pathways to effective U-I collaborations whilst recognizing the varying needs and strengths of different universities.

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Future research could explore the dynamic interplay between these factors across different academic disciplines, types of universities, and regional economic contexts. There is a rich avenue for exploration in examining how evolving industry trends, technological advancements, and economic shifts influence U-I collaborations. Longitudinal studies could be particularly enlightening, offering a view of how these relationships and their influencing factors evolve in response to both internal institutional changes and external environmental shifts.

Additionally, future research could address the limitations related to the data, particularly concerning the diverse nature of academic contracts. Different contracts emphasize varying aspects of academic roles; some prioritize teaching, while others focus more on research. Current proxy measures used to estimate academic workload do not account for these distinctions, potentially overlooking significant variations in faculty responsibilities

6. Theoretical contribution

In expanding the scope of RBT, our research underscores the critical role of intangible academic resources such as academic load and administrative support. Traditionally, RBT has focused on tangible assets, but our findings highlight that the strategic management of intangible resources, like the allocation of faculty time and the efficiency of administrative processes is equally crucial in fostering successful U-I collaborations. This extension enriches RBT by demonstrating that the value of resources in achieving competitive advantages extends beyond their physical attributes to include organizational capabilities and structures.

Our study also brings a different understanding of RBT by illustrating that more resources do not always equate to better outcomes. Specifically, the findings regarding academic load challenge the traditional RBT view, suggesting that the strategic allocation and utilization of resources, not just their availability, are key determinants of successful external collaborations. This contributes to a more refined understanding of resource management in RBT, where the focus shifts to how resources are managed and deployed within an organization.

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7. Managerial contribution

This study on University-Industry (U-I) collaborations offers valuable insights for university administrators, policymakers, and industry leaders. Key findings include the need for a nuanced approach to managing academic workload, emphasizing a balance between teaching and research tailored to faculty needs and university goals. The importance of having administrative support of quality is highlighted, suggesting universities should enhance their administrative systems to meet faculty and industry requirements. This may involve specialized training for staff, streamlined processes, and effective management systems for collaborations.

The study also reveals the connection between scientific output and U-I collaborations, suggesting that high-quality, industry-relevant research encourages industry engagement. Universities should align their research with industry trends and focus on interdisciplinary studies with practical applications. Additionally, while university rankings impact U-I collaborations, factors such as reputation and internal networks are also vital. Universities should thus balance ranking improvement with initiatives that strengthen industry relations and build robust networks. Overall, the study provides insights for enhancing U-I collaborations through tailored workload management, strategic administrative support, aligned research priorities, and a balanced approach to rankings and relationship-building.

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TOWARDS CHAPTER 5

Building on the insights into individual adaptations in academia explored in Chapter 3 and the examination of the complex, non-linear factors influencing university-industry collaborations in Chapter 4, this chapter shifts focus to the broader role of universities within the innovation ecosystem. While previous chapters relied on data from the UK-based Higher Education Statistics Agency (HESA), Chapter 5 introduces a complementary dataset from the Latin American Innovation Survey (LAIS). This addition provides a contrasting regional perspective, enabling a deeper and more contextualized understanding of how universities influence firms' innovation outcomes across diverse socio-economic and institutional landscapes.

Unlike the earlier emphasis on individual and organizational factors, Chapter 5 investigates the strategic role of universities as moderators in the relationship between firms' innovation expenditure and their resulting innovation performance. It explores the conditions under which university involvement amplifies—or, in some cases, mitigates—the effectiveness of firms' investments in innovation. This analysis goes beyond institutional and organizational boundaries to uncover the mechanisms through which universities act as catalysts for innovation.

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INNOVATION INVESTMENT AND PERFORMANCE: THE MODERATING ROLE OF UNIVERSITY COLLABORATIONS

Carlos Plata

TSM-Research, University of Toulouse Capitole, CNRS UMR 5303

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Abstract:

Considering the historical evolution of innovation dynamics, and its paradoxical state, and answering Nelson (2008) and Winter (2014), this paper analyzes the dynamics of innovation within the context of the Evolutionary Economic Theory. Specifically, this study looks to unravel the moderating influence of university cooperation on the relationship between innovation expenditure and innovation results. Using data from the Latin American Innovation Survey (LAIS) database and cleaning it up using Python to ensure data integrity. Subsequently, SPSS, coupled with the PROCESS macro, was employed to conduct moderation analysis. The moderating role of university cooperation was showcased showing that collaborative partnerships amplify the impact of innovation spending on innovation results, advancing the understanding of the impact of university-business collaborations. Additionally, the results revealed a positive relationship between innovation expenditure and innovation results, underscoring the significance of R&D investments.

Keywords:

Latin America, University-Business Collaboration, Evolutionary Economic Theory, Innovation Management, R&D Expenditure, Moderation Analysis.

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1. Introduction

In today's rapidly changing and highly competitive global economy, innovation has become a crucial driver of sustainable economic growth, technological progress, and overall organizational success (OECD, 2007). The path of innovation expenditure has evolved dynamically over time (OECD, 2023), shaped by complex interactions among economic, technological, and organizational factors. Understanding this evolution and its consequences is essential for gaining insights into the current state of innovation and its impact on economic development.

It's also crucial to recognize the diverse landscape of innovation on a global scale, with regions like Latin America presenting unique challenges and opportunities (Olavarrieta & Villena, 2014). Latin America, known for its diversity and dynamism, serves as an intriguing case for examining innovation dynamics through the lens of the Evolutionary Economic Theory (Nelson et al., 2008). Despite making substantial progress in various aspects of economic development, Latin American countries exhibit a mix of potential and barriers in their approach to innovation (Sierra-González et al., 2021). These challenges include relatively lower investments in research and development (R&D) compared with more advanced economies, institutional barriers hindering innovation and entrepreneurship, and variations in innovation ecosystems among countries (Olavarrieta & Villena, 2014). Thus, a comprehensive exploration of innovation dynamics in the region is essential within the broader context of economic evolution.

Within this context, the Evolutionary Economic framework provides a comprehensive perspective for understanding the intricate dynamics of innovation processes and their implications for economic development (Nelson, 2008). This theory emphasizes the constantly evolving nature of economic systems, highlighting the co-evolution of institutions, technologies, and organizations (Nelson & Winter, 2004; Simon, 1955). Innovation, in this framework, is not a one-time event but an ongoing process characterized by interactions and interdependencies among various agents, including

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universities, businesses, and government institutions (OECD & International Development Research Centre, 2010; Schumpeter, 1976).

At the heart of the innovation process lies the concept of innovation expenditure. This refers to the financial investments made by firms to support R&D activities (Rogers, 1998), as well as other initiatives aimed at promoting technological advancements and product/service innovations. While innovation expenditure is widely recognized as a critical factor in a firm's innovation capabilities, the relationship between spending on innovation and the actual obtained results varies across industries and sectors (Dai et al., 2020; Nga et al., 2022). This variability has piqued our interest in understanding the interactions among various agents, with universities playing a vital but often overlooked role (Nelson, 2008).

Universities have long been acknowledged as significant contributors to the innovation ecosystem (Scott, 2006). These academic institutions serve as central hubs for knowledge creation, cutting-edge research, and the development of human capital (D'Este & Perkmann, 2011; Etzkowitz, 2004; Perkmann, King, et al., 2011). Their role in nurturing talent, generating new ideas, and disseminating knowledge across various fields is instrumental in driving technological advancements and fostering innovation within the private sector (Carayannis & Campbell, 2009; P. R. Schaeffer et al., 2021). Consequently, the interaction between universities and businesses through collaborative partnerships has gained increasing attention as a means of maximizing the potential of innovation expenditure and improving innovation outcomes.

Moreover, understanding the moderating role of university cooperation has significant implications for policymakers, business leaders, and academic institutions. Policymakers can use these insights to design effective innovation policies that promote productive collaborations and drive economic growth (OECD, 2007). Business leaders can identify best practices for engaging in successful university partnerships to optimize their innovation efforts (Carayannis & Campbell, 2009).

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Similarly, academic institutions can leverage this knowledge to strengthen their connections with the industry and enhance the impact of their research outputs (Taheri, & Geenhuizen, 2016).

2. Literature Review

2.1.Theoretical Framework: The Evolutionary Economic Theory

The Evolutionary Economic Theory is a compelling framework that provides a complete perspective on the dynamics of economic systems and their evolution over time (Nelson & Winter, 2004). It recognizes that economies are not static entities, but rather constantly evolving structures influenced by several interrelated factors, including technological progress, institutional changes, and social interactions (Nelson & Winter, 2004; Simon, 1955). At its core, the Evolutionary Economic Theory emphasizes the co-evolution of various agents, including firms, universities, government institutions, and other societal actors, as they adapt and respond to changing economic conditions (Nelson, 1987; Vromen, 2012).

One of the key features of the Evolutionary Economic Theory is its focus on innovation as a central driver of economic development (Aghion & Howitt, 1992; Metcalfe & Ramlogan, 2008; Schumpeter, 1976). Innovation can be defined as doing things in a new way (Schumpeter, 1947), and by that, it is not limited to technological advancements but encompasses a broader set of processes that lead to the introduction of new ideas, products, services, and organizational practices (Lockett et al., 2008; Schumpeter, 1947). As agents within the economy continuously engage in knowledge-exchanging interactions, innovation emerges as a cumulative process, with each innovation building on and influencing the trajectory of future innovations (Callon, 1984; Latour, 2007).

Universities serve as reservoirs and producers of knowledge and play a vital role in generating new ideas and conducting cutting-edge research across various disciplines worldwide (Heinzl et al., 2013; Scott, 2006). Knowledge generated within universities

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has far-reaching implications for both the private and public sectors, as it provides a foundation for technological advancements and fosters the development of skilled human capital (Leischnig & Geigenmüller, 2020a; Perkmann & Walsh, 2008).

However, despite recognizing the importance of universities in the innovation ecosystem, the Evolutionary Economic Theory framework also highlights some theoretical gaps and challenges in understanding the dynamics of the university-business relationship (Nelson, 2008; Winter, 2014). One key theoretical gap revolves around the nature of knowledge exchange and its impact on innovation outcomes. While collaborative partnerships between universities and businesses are often touted as beneficial for both parties, the mechanisms and channels through which knowledge flows between them remain complex and multifaceted (D'Este & Perkmann, 2011; Lockett et al., 2008; Perkmann et al., 2013).

Furthermore, the Evolutionary Economic Theory framework also focuses on the role of institutional factors in shaping university-business collaborations (Nelson, 2008). Issues related to intellectual property rights, ownership of research outputs, and the development of a collaborative culture between academia and industry are paramount in determining the success of such partnerships. Understanding how institutional arrangements and collaboration influence the results of innovations and collaborative efforts is critical for designing effective policies and fostering a conducive environment for innovation (Schot & Steinmueller, 2018).

2.2.Evolution of Innovation Expenditure

Understanding the historical evolution of innovation expenditure is essential for contextualizing the contemporary landscape within the framework of the Evolutionary Economic Theory. Early in the 20th century, R&D activities were predominantly conducted by large corporations and government-funded institutions, focusing primarily on fundamental research (Schot & Steinmueller, 2018). For example, companies like General Electric and government laboratories like Los

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Alamos played instrumental roles in scientific discoveries and technological advancements during World War II (Usselman, 2013).

As the global economy evolved, a discernible shift in R&D spending patterns emerged. In the latter half of the 20th century, R&D efforts expanded across a broader spectrum of industries and sectors (Usselman, 2013). Notably, high-tech sectors like information technology, pharmaceuticals, and automotive became notable leaders in R&D investment, while in contrast, traditional industries such as manufacturing and agriculture experienced more gradual shifts in innovation expenditure patterns (Malerba & Adams, 2014).

Nevertheless, there has been a generalized rise in R&D spending (OECD, 2023). However, this increase in expenditure has not always translated into proportionate innovation outcomes, leading to a phenomenon comparable to the "productivity paradox", where despite the more R&D investments made, productivity goes down instead of up (Kijek & Kijek, 2019; Solow, 1987).

In this paradoxical state, increased investment in innovation does not necessarily yield expected increases in results. This intricate interplay between investment and outcomes underscores the need to look into different variables that could affect the attainment of these results. One example of such actors is universities, which have transitioned from traditional knowledge dissemination centers to active partners in innovation ecosystems (Scott, 2006).

2.3. Innovation in Latin America: A Regional Perspective

A region marked by its diversity and dynamism; Latin America presents a compelling case study for understanding the dynamics of innovation within the evolving framework of the Evolutionary Economic Theory. While Latin American countries have made significant strides in various aspects of economic development, the landscape of innovation within the region reflects a mix of promise and challenges that call for deeper exploration.

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One of the foremost challenges faced by Latin America in the innovation domain is the level of investment in research and development (R&D), where historically compared to more advanced economies, many countries in the region allocate a smaller proportion of their GDP to R&D (Olavarrieta & Villena, 2014). This lower investment directly impacts the firm's and region's capacity for technological advancement and innovation, slowing down the pace of progress (Amorós et al., 2021; Fernandez, 2017).

Institutional barriers play a significant role in hindering innovation and entrepreneurship. These barriers encompass intricate regulations, bureaucratic obstacles, and inconsistent intellectual property safeguards, all of which pose substantial challenges to innovators and entrepreneurs (Ketelhöhn & Ogliastri, 2013). Another reason may be the lack of trust in public founders, as noted by Sierra-González et al. (2021). These obstacles not only impede the progress and safeguarding of innovative concepts but also discourage foreign direct investment in ventures driven by innovation.

Additionally, access to funding and venture capital, which are crucial drivers of innovation, can be limited in the Latin American context (Sierra-González et al., 2021; Stein & Wagner, 2020). Startups and innovative enterprises often struggle to secure the necessary capital to fuel their growth, leading to missed opportunities for disruptive innovations that could transform industries (Fernandez, 2017).

Despite these challenges, Latin America is not without its successes in fostering innovation. One notable trend is the increasing university-industry collaborations (Olavarrieta & Villena, 2014). Universities and research institutions in the region are actively engaging in knowledge exchange, joint research projects, and technology transfer initiatives with businesses (OECD & Inter-American Development Bank, 2022), but this is not yet a widespread practice (Puerta-Sierra & Jasso, 2020). This collaborative spirit mirrors the global trend of open innovation, where organizations recognize the value of tapping into external expertise.

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Countries like Chile, Brazil, and Colombia have taken significant steps by implementing policies and incentives to encourage innovation and the creation of start-ups (Guerrero, 2021). These policies can include tax breaks for R&D activities, government subsidies, and targeted support for startups and technology hubs (Amorós et al., 2021). The goal is to create an enabling environment that encourages entrepreneurship and innovation-driven economic growth.

Nowadays, Latin America has witnessed the emergence of a vibrant startup ecosystem, particularly in major technology hubs like São Paulo, Medellín, and Mexico City (Lamy et al., 2021; Miranda et al., 2020). Innovative startups are motivated by well-being (Amorós et al., 2021) and are tackling regional challenges such as financial inclusion, healthcare access, and agriculture technology while simultaneously setting their sights on global markets (Lecuna et al., 2017). These enterprises often benefit from the presence of accelerators, incubators, and networking events that facilitate collaboration and knowledge sharing (OECD & Inter-American Development Bank, 2022).

However, it's important to emphasize that the state of innovation in Latin America is not homogenous across the entire region and that there are significant variations between countries, leading in innovation indicators, while others are still in the process of building and strengthening their innovation ecosystems (Ketelhöhn & Ogliastri, 2013). These differences can be attributed to variations in policy approaches, infrastructure development, and access to resources.

Nonetheless, it's important to highlight the diverse landscape of innovation in Latin America, where certain nations thrive on innovation indicators, while others diligently strive to build and boost their innovation ecosystems (Chavarro et al., 2010; Ketelhöhn & Ogliastri, 2013). These variations stem from disparities in policy approaches, infrastructure development, and resource availability. Therefore, it is vital to explore

novel avenues to enhance trust and secure funding for innovations (Sierra, 2019; Sierra-González et al., 2021).

2.4.Link between Innovation Expenditure and Innovation Results:

Innovation expenditure, often measured through research and development (R&D) spending (Rogers, 1998), is a critical driver of innovation capabilities within firms and industries (Pegkas et al., 2019). It represents the financial resources allocated to activities aimed at developing new products, services, processes, and technologies (OECD, 2015). Understanding the relationship between innovation expenditure and innovation results is of paramount importance for policymakers, business leaders, and researchers seeking to enhance innovation performance and foster economic growth (OECD, 2007).

Empirical research on the link between innovation expenditure and innovation results has yielded nuanced and sometimes conflicting findings (Calantone *et al.*, 2010). While it is widely accepted that innovation expenditure is positively associated with a firm's ability to innovate (Orozco et al., 2022; G. Pisano, 2006), the nature of this relationship is not always linear (Salter & Alexy, 2014). In the early stages of investment, an increase in R&D spending is typically associated with a significant boost in innovation outcomes (Fleming, 2007). Firms investing more in R&D often experience higher rates of new product introductions, improved process efficiency, and enhanced technological advancements (Salter & Alexy, 2014). Such initial investments enable firms to build a competitive edge and enter new markets with innovative offerings.

However, as innovation expenditure continues to rise, the relationship between spending and innovation results may exhibit diminishing returns (Ravichandran et al., 2017). This means that after a certain point, additional investments in R&D may not yield proportionate increases in innovation outcomes. This phenomenon can be attributed to various factors, including the increasing complexity and uncertainty of

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research projects, the challenges of managing larger R&D budgets, and the diminishing pool of viable innovative opportunities (Salter & Alexy, 2014).

Furthermore, the link between innovation expenditure and innovation results can vary across industries and sectors (Malerba & Adams, 2014). Industries characterized by rapid technological change and intense competition, such as the electronics and pharmaceutical sectors, often exhibit stronger positive relationships between R&D spending and innovation outcomes, whereas industries with more stable and mature technologies, such as certain traditional manufacturing sectors, may experience weaker relationships between innovation expenditure and innovation performance (Choi et al., 2014; Dai et al., 2020; Morbey, 1988; Nga et al., 2022).

Another important factor influencing the link between innovation expenditure and innovation results is the firm's absorptive capacity (Dodgson et al., 2014). Absorptive capacity refers to the firm's ability to recognize, assimilate, and apply external knowledge and technologies effectively (Cohen & Levinthal, 1990). Firms with high absorptive capacity are more adept at leveraging their innovation expenditures because they can effectively absorb and utilize external knowledge, research, and technologies acquired through partnerships, collaborations, and other forms of external interactions (Zhang, 2014).

Moreover, it is essential to consider the time span over which the relationship between innovation expenditure and innovation results unfolds. Innovation is often a time-intensive process, and the impact of R&D investments may not materialize immediately (Dodgson et al., 2014). The gestation period between investing in R&D and realizing tangible innovation outcomes can be prolonged, and firms need to have a long-term strategic outlook to fully capitalize on their innovation expenditures (Blind et al., 2023).

To enhance the understanding of the link between innovation expenditure and innovation results, researchers have also investigated the role of complementary

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factors (Teece, 1986). Complementary investments in organizational capabilities, human capital, and marketing strategies can amplify the effects of R&D spending on innovation outcomes (Greer et al., 2023; Prabhu, 2014; Pradana et al., 2020). For instance, investments in employee training and development can facilitate the implementation of innovative ideas generated through R&D activities (Greer et al., 2023; Orozco et al., 2022). Considering previous arguments, hypothesis 1 is described below and shown in figure 5.1.

Hypothesis 1: There is a positive relationship between innovation expenditure and innovation result.

2.5.Role of University Cooperation in Innovation:

Within the framework of the Evolutionary Economic Theory, university cooperation can appear as a pivotal element that influences the innovation process. As key knowledge-generating institutions, universities play a central role in fostering innovation through their research activities and the development of human capital (D'Este & Perkmann, 2011; Etzkowitz, 2004; Perkmann, King, et al., 2011). Collaborative partnerships between universities and businesses create synergistic interactions that facilitate the exchange of knowledge, expertise, and resources, leading to enhanced innovation outcomes (Heinzl et al., 2013; Shane, 2002). This section explores the multifaceted role of university cooperation in driving innovation and the link between innovation expenditure and innovation results.

First, university cooperation provides businesses with access to cutting-edge research and scientific advancements (Orozco et al., 2018; P. R. Schaeffer et al., 2021), which can act as a catalyst for technological innovation (Carayannis & Campbell, 2009). Universities are often at the forefront of knowledge creation, conducting groundbreaking research in diverse fields, including engineering, life sciences, information technology, and management (Canonico et al., 2020; Colyvas & Powell, 2006; Jones & Coates, 2020; Perkmann, Neely, et al., 2011). By collaborating with

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universities, businesses can tap into this pool of knowledge and leverage the latest discoveries and innovations to enhance their own R&D efforts (Carayannis et al., 2000).

Second, university cooperation fosters a culture of open innovation, where firms embrace external sources of knowledge and ideas (Cesaroni & Piccaluga, 2016). The Evolutionary Economic Theory emphasizes the importance of interactions and exchanges between different economic agents, and university-industry collaborations exemplify this concept (Hall & Rosenberg, 2010; Nelson, 2008). Businesses can benefit from the diverse perspectives and expertise of university researchers, leading to novel approaches and breakthrough innovations that may not have been possible within the confines of the firm's internal capabilities (Canonico et al., 2020; Etzkowitz, 2004; Jones & Coates, 2020; Perkmann, Neely, et al., 2011).

Furthermore, the role of university cooperation in innovation is closely linked to the discussion of the link between innovation expenditure and innovation results (Carayannis & Campbell, 2009). As innovation expenditure increases, firms can amplify their impact through collaborative efforts with universities (Dodgson, 2014). Firms with strong collaborative ties to universities can better assimilate and apply external knowledge, thus increasing the effectiveness of their innovation investments.

Moreover, the role of university cooperation in innovation extends beyond the immediate benefits of knowledge exchange. By engaging in collaborative partnerships, firms can gain access to a pool of talented students who often contribute to research projects and internships (Schartinger et al., 2002). They can also access experts with respective topics, giving the firm the know-how to engage in some of their projects (Shane, 2002). In addition, the firm can access technology or innovation spaces such as incubators, technological parks, or discussion groups where they can find mentorship on their innovation processes (Siegel et al., 2003). This interaction with top-tier students, experts, and spaces can serve as a talent pipeline, enabling firms to recruit

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skilled individuals and fostering a future-ready workforce capable of driving continuous innovation.

However, it is crucial to acknowledge that successful university cooperation requires effective communication, mutual understanding, and alignment of goals (Jones & Coates, 2020). This collaboration may face challenges due to differences in organizational cultures, intellectual property rights management, and the varying priorities of academia and industry (Andersen & Rossi, 2011; Chavarro et al., 2010; P. Hughes et al., 2020). Establishing effective mechanisms to address these challenges is critical for using the full potential of university cooperation in driving innovation outcomes.

2.6.Moderating Role of University Cooperation:

The moderating role of university cooperation in the relationship between innovation expenditure and innovation results represents a critical aspect within the Evolutionary Economic Theory framework. While the literature recognizes the importance of university-industry collaborations in fostering innovation, theoretical gaps and complexities exist and require a closer examination.

One of the key theoretical gaps in the Evolutionary Economic Theory and in understanding the moderating role of university cooperation lies in assessing the different forms and levels of collaboration between universities and businesses (Winter, 2014), especially in the Latin American and the Caribbean context (Nelson et al., 2008). University-industry collaborations can take various forms, ranging from informal knowledge exchange and joint research projects to more formal technology transfer agreements and research partnerships (Fromhold-Eisebith & Werker, 2013). Each form of collaboration may have distinct implications for the effectiveness of innovation investments.

For instance, informal knowledge exchange through conferences, seminars, and networking events may foster a free-flowing exchange of ideas and inspire creativity

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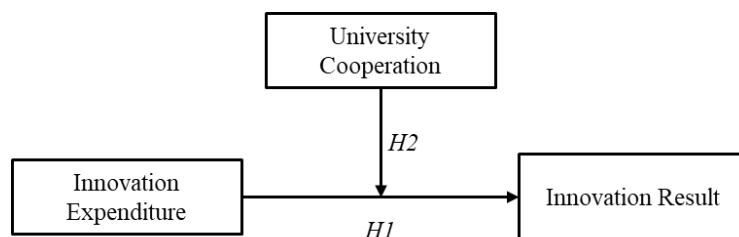
(Grimpe & Hussinger, 2013; V. Schaeffer et al., 2020b). However, the link between such interactions and concrete innovation outcomes may be difficult to measure (Sung & Gibson, 2000). On the other hand, formal research partnerships with well-defined goals and contractual agreements may lead to more tangible results, but they may also entail challenges related to intellectual property rights and the protection of proprietary information (Colyvas & Powell, 2006; Sadaghiani & Jamali, 2012).

Moreover, the depth and intensity of university cooperation can vary, and understanding the optimal level of collaboration remains a theoretical challenge (Landry et al., 2010). Too little collaboration may lead to missed opportunities for knowledge exchange, while excessive cooperation may result in information overload and the diversion of resources from core business activities.

Additionally, the impact of university cooperation on the relationship between innovation expenditure and innovation results may differ depending on the technological and institutional context (Dodgson et al., 2014). For example, in industries characterized by rapid technological advancements and disruptive innovation, such as the biotechnology or information technology sectors, university cooperation may play a more pronounced role in shaping the effectiveness of innovation investments. In contrast, in more established industries with mature technologies, the influence of university cooperation on innovation outcomes might be relatively subdued. By that, Hypothesis 2 is formulated below.

Hypothesis 2: University cooperation serves as a moderator of the relationship between firms' innovation expenditure and innovation results.

FIGURE 5.1: THEORETICAL MODEL



3. Methodology

3.1.Data Source and cleaning

The data for this study was obtained from the Latin American Innovation Survey (LAIS) database, a comprehensive and widely used dataset that provides valuable information on various aspects of firms' activities, including innovation expenditure and innovation results (Crespi et al., 2022). The LAIS is a panel database that covers a diverse range of industries and sectors, making it suitable for investigating the relationship between innovation expenditure, innovation results, and the moderating role of university cooperation.

Before initiating the analysis, it was crucial to prepare the data obtained from the LAIS database. This comprehensive database provided a significant amount of data that required cleaning to ensure its integrity and accuracy. The cleaning process was carried out using Jupyter Notebooks (version 6.5.2) with Python 3.11 as the programming language.

The scope of this study focused on firms with complete records in three key areas: innovation expenditure, innovation results, and collaborations.

Any firm lacking or presenting inconsistent data in these categories was not considered for analysis, ensuring a detailed overview of the participating firms while also acknowledging this criterion as a limitation of the study. After a thorough data cleaning process, the final dataset comprised 2,986 firms, tracked over 9 years from 2009 to 2017, years where the survey was active.

These firms represented a diverse range of industries, as classified by the International Standard Industrial Classification of All Economic Activities (ISIC). The major sectors included manufacturing (73%), wholesale and retail trade (7%), education (5%), and real estate, renting, and business activities (4%).

3.2. Variables

The primary variables of interest in this study were:

- Innovation Results¹⁰ (DV): This variable captures the tangible outcomes of firms' innovation efforts, including the introduction of new products, services, processes, or technologies. Innovation results served as the dependent variable in the analysis.
- Innovation expenditure in USD¹¹ (IV): This variable represents the financial investments made by firms in research and development (R&D) activities and other initiatives aimed at fostering innovation. Innovation expenditure was measured in U.S. dollars (USD) and served as the independent variable in the analysis.
- University Collaboration¹² (MOD): This variable represents the moderator of the relationship between innovation expenditure and innovation results. This was a dichotomous variable, with firms categorized into two groups: those with university collaboration (1) and those without no university collaboration (0).
- Employees (Control): This variable refers to the total number of individuals working for the firms, encompassing both full-time and part-time staff. This represents the human resource capacity of the company.
- EmpBac (Control): This variable represents the educational attainment level of employees, expressing the share of employees with a bachelor's degree.
- EmpPost (Control): This variable represents the educational attainment level of employees, expressing the share of employees with a master's or PhD degree.

¹⁰ The variable is calculated by the sum of innovation results including new goods, services, and products introduced by the firm, as well as the number of improved goods, services, and products. Additionally, the variable covers the quantity of innovations in goods and services, new processes implemented by the firm, and improvements in existing processes.

¹¹ The variable is calculated by the sum of innovation expenditures in USD in multiple categories, including in-house R&D, external R&D, hardware, software, ICT, machines and equipment, training, technology transfer, consultancies, knowledge acquisition, engineering and design, market research, and other related activities.

¹² The variable indicates whether the firm has engaged in cooperation with universities in areas such as R&D, engineering and design, training, technical assistance, accessing information, product trials, and financing.

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- Sales (Control)¹³: This variable refers to the total revenue a firm earns from its operations within a year. This metric serves as an indicator of the firm's market performance and economic size.
- IPApp (Control): This variable refers to the absorptive capacity of the firm expressed by the application of Intellectual Property Rights products.

It is important to note that since the innovation expenditure and sales in USD and innovation results by default do not show a normal distribution, the input variables are the logarithm of the original variable. This transformation is a standard way to normalize key variables and helps obtain more accurate results (Benoit, 2011; Love & Carriquiry, 2012).

3.3. Data Analysis

To investigate the moderating role of university cooperation in the relationship between innovation expenditure and innovation results, a moderation analysis was conducted using SPSS version 28. Specifically, the PROCESS macro developed by Hayes (2022) version 4 was employed to assess the conditional effects of innovation expenditure on innovation results, based on the presence or absence of university collaboration. The PROCESS macro eases the estimation of moderated regression models using ordinary least squares regressions (OLS), allowing for a comprehensive examination of the interaction effects and the assessment of the significance of moderation. Additionally, to ensure the reliability of the model and to avoid collinearity, a Variance Inflation Factors analysis was performed, the results of which are shown in Table 5.1. Furthermore, for the graphical representation of the effects, the two-way linear interaction macro (Aiken et al., 2010; Dawson, 2014) and the Python libraries Numpy, Pandas, Matplotlib, and Pyprocessmacro (Andre, 2022) were also used.

¹³ The variable is expressed in USD.

4. Results

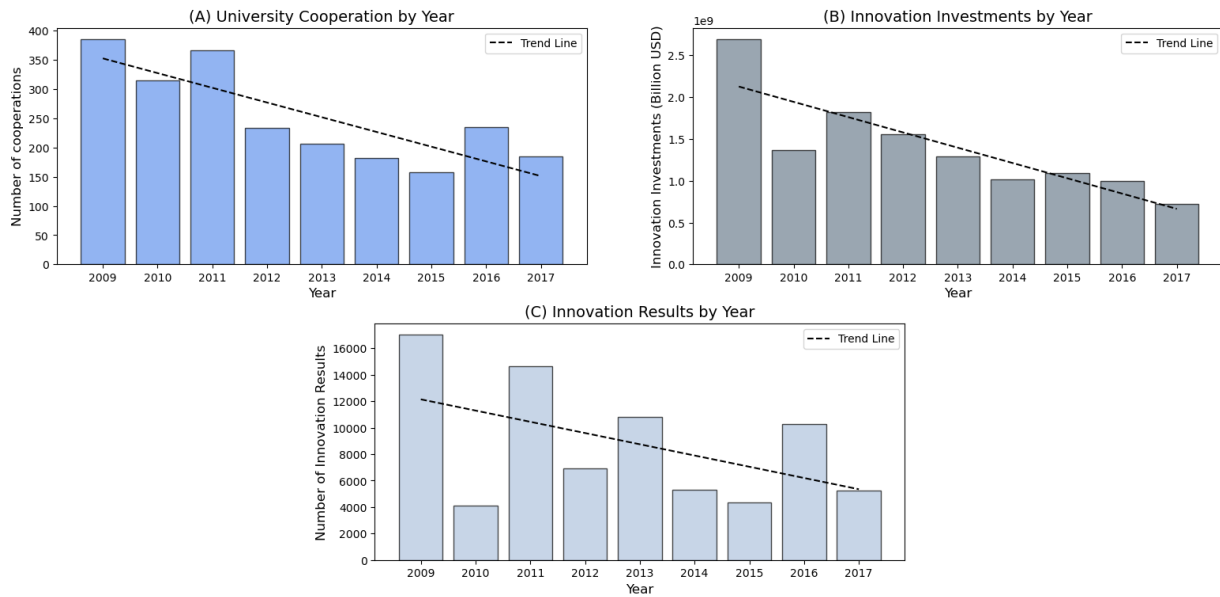
4.1. Evolutionary Trends

Figure 5.2 offers insights into the firm's innovation journey, illustrating the interplay between innovation investment, university cooperation, and innovation outcomes that transcends simplistic interpretations. This trend follows previous findings (Fernandez, 2017) but analyzed through an evolutionary economic lens, these dynamics are not merely sequences of actions and reactions but part of a broader adaptive process where fluctuations in innovation investment over time reflect the firm's responsiveness to external and internal pressures, from shifting economic landscapes to evolving industry norms and strategic recalibrations (Dodgson et al., 2014). For instance, the notable peak in investment during 2009 can be interpreted as a strategic adaptation to the post-global financial crisis environment (Hud & Hussinger, 2015), potentially catalyzed by recovery initiatives and policy-driven incentives aimed at revitalizing innovation activities.

The patterns of university cooperation (A), alongside the corresponding innovation outputs (B) and innovation investments (C), hint at a deeper, more complex relationship between academia and industry. While higher instances of collaboration suggest a greater engagement with academic institutions (G. Pisano, 2006), the true essence of these interactions and their impact on innovation outcomes requires a thorough exploration beyond quantitative measures. It shows the need to evaluate the qualitative aspects of these partnerships, such as the exchange of knowledge, joint research endeavors, and the cultivation of innovation ecosystems that foster mutual growth and adaptation, opening new ventures for future research.

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FIGURE 5.2: EVOLUTION OF THE VARIABLES



The linkage between investment levels and innovation outcomes further illustrates that the path from input to impact is not strictly linear. For instance, in 2017, where diminished investment coincided with superior innovation outcomes compared to 2014, challenge the conventional understanding, suggesting that factors like the strategic allocation of resources, the efficacy of collaborative ventures, and the capacity to leverage external knowledge play pivotal roles.

Further analysis, presented below, considers the broader context by analyzing the impact of the collaboration with universities and not just the evolutionary trends, which opens the door for a deeper understanding of the relationships that can be found by embracing an evolutionary economic perspective, this exploration can illuminate the adaptive strategies firms employ, the co-evolutionary potential of industry-academia partnerships, and the broader implications of these relationships for fostering resilient, innovative capabilities within the fluctuating contours of the economic and technological landscape.

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4.2.Descriptive Statistics, Correlations and Variance Inflation Factors (VIF)

Table 5.1 details the VIF, mean and standard deviation for all the variables in the study. This provides a foundational understanding of the data's distribution and variability. Additionally, the correlation matrix uncovers several intriguing relationships. Notably, the VIF assessment indicates no values surpassing 10, showing the absence of collinearity issues and ensuring the reliability of the subsequent model's results (Pardoe, 2021).

When analyzing the correlation matrix is found a positive correlation between innovation results and expenditure implies that higher investment in innovation often yields better outcomes (Orozco et al., 2022). The strength of this correlation is further enhanced when factoring in the quality and intensity of university collaboration, indicating a synergistic effect.

Interestingly, the data also reveals correlations between these primary variables and control factors like company size (measured by the number of employees) and market performance (indicated by sales figures). Additionally, when controlling for the employee's educational attainment it was found that both bachelors and postgraduate have positive a relationship with the innovation results indicating that a workforce with higher educational attainment potentially boosts innovation success, this trend is more pronounced among postgraduates, possibly due to the inclusion of Ph. D holders (Teirlinck & Spithoven, 2013) and masters specialized in innovation. However, no direct correlation was found between innovation outcomes and absorptive capacity (measured through IP applications), suggesting that not all innovation results immediately lead to intellectual property registrations, yet there is a noteworthy connection with university collaboration, underlining the significant role university partnerships play in IP application processes. Larger firms, often with more resources including highly educated employees and robust sales figures, tend to invest more in innovation, which aligns with industry patterns and theory.

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TABLE 5.1: DESCRIPTIVE STATISTICS, CORRELATIONS AND VIF

	Variable	VIF	Mean	SD	1	2	3	4	6	7	8
1	Innovation Results (log)	-	2.47	1.30	-						
2	Innovation expenditure (log)	1.0	12.9	2.3	.33**	-					
3	University Collaboration	1.2	.25	.43	.27**	.29**	-				
4	Employees	1.3	970	2530	.15**	.41**	.17**	-			
5	Bachelor's Degree	1.1	18.6	14.1	.09**	.14**	.16**	.10**	-		
6	Post Grad Degree	1.3	6.9	11.6	.18**	.21**	.38**	.15**	.37**	-	
7	Sales (log)	1.8	16.9	2.0	.27**	.64**	.20**	.45**	.06**	.02	.-
8	IP Applications	1.0	17.37	178.73	.03	.26	.45*	.02	.02	0.2	.00

Note. N = 2,986. ** $p < .01$

The correlations between university collaboration and both innovation outcomes and expenditures shed light on the integral role of collaboration in crafting successful innovation strategies. The significant correlations observed with postgraduate employees and IP application further suggest the potential of university collaborations as catalysts for intellectual property access.

4.3.Tendency Analysis

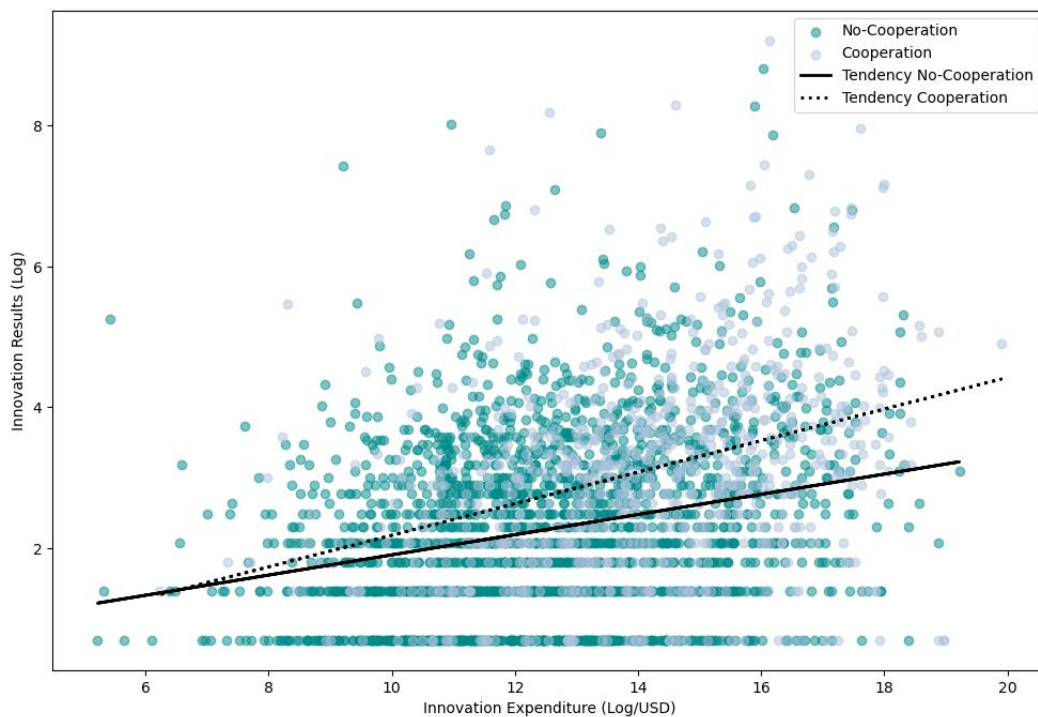
Figure 5.3 provides a visual representation of the relationship between innovation results and innovation expenditure, highlighting the role of university collaboration. The graph differentiates between firms without any university cooperation, presented in green, and those with some form of collaboration, shown in light blue. Additionally, it depicts a more pronounced slope for those engaged in collaboration, which is indicative of better innovation results.

From an evolutionary perspective, the graph substantiates the theory that firms integrating university collaborations into their innovation strategies not only navigate

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the innovation landscape more effectively but also exhibit superior adaptive capacities. This observation in addition to the analysis presented before supports hypothesis 1 affirming the notion that university partnerships act as catalysts in the innovation, optimizing the returns on innovation investment. The enhanced slope for firms engaged in academic collaborations symbolizes not just an incremental improvement in outcomes but highlights a shift towards more dynamic, co-evolutionary innovation processes.

FIGURE 5.3: INNOVATION RESULTS VS. INNOVATION EXPENDITURE



A closer look at the graph shows that the presence of university collaboration (dotted line) amplifies the benefits derived from innovation expenditure. This suggests a synergistic effect, implying that firms engaging in collaborative efforts with universities as part of their innovation process tend to achieve more favorable results.

The analysis underlines the value and positive effect of integrating university expertise into corporate innovation strategies, highlighting the potential for increased effectiveness and efficiency in innovation endeavors.

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4.4.Moderation Analysis

The previous results serve as an initial indicator of the positive impact of cooperation with universities on the innovation process. The moderation analysis, utilizing the PROCESS macro as shown in Table 5.2, was conducted to examine the moderating role of university cooperation (MaxCopUn) in the relationship between innovation expenditure (Expend) and innovation outcomes (Results), while controlling for variables such as company size (Employees), educational attainment (share of Bachelors and Postgraduates), market performance (Sales), and absorptive capacity (IP Applications).

The results provide valuable insights into the dynamic interplay between innovation expenditure, university cooperation, and their combined effect on innovation outcomes.

TABLE 5.2: REGRESSION ANALYSIS PREDICTING INNOVATION EXPENDITURE (EXPEND)

	B	SE	p
Constant	-.250	.223	.261
Innovation expenditure (Expend)	.108	.014	< 0.001
University cooperation (MaxCopUn)	-.520	.326	.110
MaxCopUn × Expend	.074	.023	< 0.001
Employes	.000	.000	.162
Bachelor's Degree	.001	.001	.992
Post Graduate Degree	.007	.002	< 0.001
Sales	.066	.014	< 0.001
IP Applications	.000	.000	.262
R ²		.158	

Note. N = 2,986; B = unstandardized regression coefficients; SE = standard error.

The overall model demonstrated a moderated relationship between innovation expenditure and innovation results by university cooperation, supporting hypothesis

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2, explaining 15.8% of the variance in the dependent variable ($R = 0.39$, $R\text{-squared} = 0.158$, $p < 0.001$). The F-test for the model was highly significant ($F = 70.2$, $df1 = 8$, $df2 = 2977$, $p < 0.001$), indicating that the model as a whole was a good fit for the data.

The main effect of innovation expenditure (Expend) was found to be significant (coeff = 0.10, se = 0.01, $t = 7.63$, $p < 0.001$), indicating that an increase in innovation expenditure was associated with higher innovation results, supporting hypothesis 1. This result is consistent with the expectation that firms that invest more in research and development are more likely to introduce innovative products, services, and processes, thereby achieving better innovation performance (Dai et al., 2020; Nga et al., 2022; Pegkas et al., 2019; Salter & Alexy, 2014). These findings reaffirm the central role of innovation expenditure in driving innovation capabilities and enhancing a firm's competitive advantage.

The observation that the mere presence of university-industry collaborations does not directly enhance innovation outcomes (coeff = -0.52, se = 0.22, $t = -1.59$, $p = 0.11$) challenges the assumption that by simply establishing partnerships is sufficient for boosting innovation performance. This insight push question the nature and quality of these collaborations more deeply. High-quality collaborations are characterized not just by interactions but also, meaningful engagements that foster a co-creation of knowledge and innovation. These engagements are built on mutual trust, shared goals, and a commitment to long-term collaboration, factors that are important for the innovation processes. The emphasis on quality over quantity in collaborations (Sierra, 2019) reflects the principles of Evolutionary Economic Theory, highlighting that economic evolution is pushed by qualitative transformations in knowledge and institutional structures.

This understanding underscores the complexity of innovation ecosystems, where innovation outcomes are the result of a dynamic interplay of various elements rather than the product of isolated factors (Apa et al., 2021; Fagerberg, 2006). The non-

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significant direct impact of university-industry collaborations on innovation outcomes hints at the intricate nature of these ecosystems, emphasizing the need for a strategic approach to fostering meaningful partnerships.

The interaction effect or the moderation role of university cooperation was found to be significant (coeff = 0.07, se = 0.02, $t = 3.16$, $p < 0.001$). This result indicates that the relationship between innovation expenditure and innovation results was influenced by the presence or absence of university cooperation, confirming hypothesis 2. This suggests that while financial investments are crucial for innovation (Nga et al., 2022), their efficacy is enhanced when integrated with the resources, knowledge, and networks provided by university collaborations. This synergy not only taps into the academic expertise and cutting-edge research but also brings to the forefront the concept of co-evolution and mutual adaptation (Nelson, 2008), as emphasized by Evolutionary Economic Theory. By aligning financial resources with collaborative academic ventures, industries can leverage specialized knowledge and technological advancements, thereby transforming investment into impactful innovation outcomes. This relationship shows the importance of strategic partnerships, where the collaboration extends beyond mere financial transactions, fostering a reciprocal flow of knowledge and resources that enhances the practical application of academic research and directs innovation towards market relevance and sustainability.

Furthermore, this positive interaction shows the strategic importance of university collaborations within the innovation strategies of industries, suggesting a paradigm where innovation is seen as an ecosystem rather than as isolated efforts. This implies that firms engaging in cooperation with universities could benefit from improved innovation outcomes and, consequently, could experience a better return on their innovation investments (ROI). Collaborating with universities emerges as a cost-effective alternative for acquiring and expanding knowledge and expertise. This reciprocal, co-evolutionary partnership between universities and industries acts as a catalyst in the evolving economic landscape, highlighting the need for an approach to

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investing in innovation—one that focuses on the creation and nurturing of collaborative networks for sustained innovation and economic growth.

In terms of the control variables, the non-significance of employees (coeff = 0.00, se = 0.00, $t = -1.39$, $p=0.16$) might initially seem counterintuitive, as workforce size is often assumed to affect innovation outcomes (Franco & Landini, 2022; McGuirk et al., 2015). However, this finding could suggest that simply increasing employee numbers is not enough to drive innovation results. Instead, the quality of the workforce, the organizational culture (Chavarro et al., 2010), or the specific nature of their roles may be more pivotal and open avenues for new research.

When delving deeper, it becomes clear that considering just the number of employees is insufficient. Upon incorporating educational attainment into the analysis, it was found that having postgraduate qualifications significantly affects innovation outcomes (coeff = 0.00, se = 0.00, $t = 3.11$, $p < 0.001$). This finding shows the critical role of advanced human capital in driving innovation (Greer et al., 2023). The significant impact of postgraduate degrees on innovation outcomes highlights the importance of specialized knowledge and expertise in the innovation process (Teirlinck & Spithoven, 2013). It suggests that higher levels of education among employees are associated with more effective identification, development, and implementation of innovative ideas. From an evolutionary perspective, this emphasizes the role of human capital as a crucial resource (Cañibano & Potts, 2019) in the adaptation and evolution of firms in response to changing technological and market landscapes. The ability of firms to harness advanced skills and knowledge is a key factor in their capacity to innovate and sustain a competitive advantage over time.

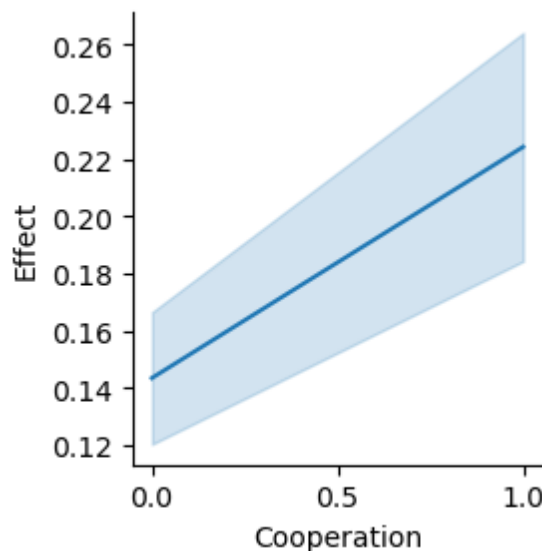
The significance of sales (coeff = 0.06, se = 0.01, $t = 4.43$, $p < 0.001$) from an evolutionary economic perspective suggest a reciprocal and evolutionary dynamic between market performance and innovation. Successful sales, far from being merely an outcome of innovation can act as a driver in the evolutionary process of economic development.

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They not only provide essential resources for further innovation activities but also serve as a mechanism for market validation, indicating that the innovation has successfully met current market demands. This feedback loop suggests a co-evolutionary relationship, where sales and innovation continuously influence and propel each other, enhancing the firm's adaptability and competitive advantage in the market.

When testing the highest-order unconditional effect, shown in Figure 5.4, indicated that the interaction term (Expend x MaxCopUn) improved the model fit (R-squared change = 0.002, $F = 10.01$, $p < 0.001$). This result provides further support for the argument that university cooperation played a moderating role in shaping the relationship between innovation expenditure and innovation results. The significant interaction term suggests that the joint effect of innovation expenditure and university cooperation on innovation outcomes is greater than the sum of their individual effects, demonstrating the value of collaborative efforts in driving innovation.

FIGURE 5.4: UNCONDITIONAL EFFECT

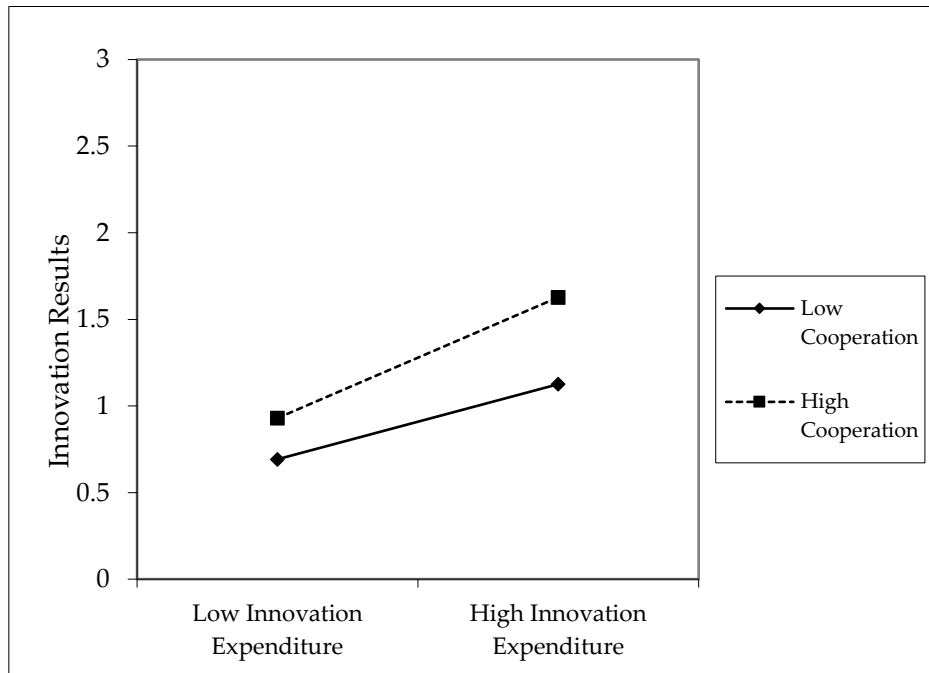


To further understand the conditional effects of the focal predictor (innovation expenditure - Expend) at different levels of university cooperation (MaxCopUn), the interaction plot was examined and presented in Figure 5.5. At a zero level of university

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cooperation ($\text{MaxCopUn} = 0$), the conditional effect of innovation expenditure was positive and significant (Effect = 0.10, $\text{se} = 0.01$, $t = 7.63$, $p < 0.001$). This result suggests that higher innovation expenditure was associated with increased innovation results when firms did not engage in collaborative partnerships with universities.

FIGURE 5.5: 2-WAY LINEAR INTERACTION



However, at a high level of university cooperation ($\text{MaxCopUn} = 1$), the conditional effect of innovation expenditure became even more significant (Effect = 0.18, $\text{se} = 0.02$, $t = 8.07$, $p < 0.001$). This finding suggests that the presence of university cooperation strengthened the positive relationship between innovation expenditure and innovation results. Firms that actively collaborated with universities for research, knowledge exchange, and technology transfer experienced amplified benefits from their innovation investments, leading to higher levels of innovation outcomes.

5. Discussion

Historically, innovation expenditure has exhibited a cyclical pattern characterized by periods of highs and lows (OECD, 2023). This behavior, although linked with innovation results, remains incompletely explained, suggesting the presence of a

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paradoxical state (Solow, 1987). This paradox shows the complexity of interactions affecting this relationship, particularly within the framework of the Evolutionary Economic Theory.

Given the dynamics of innovation processes and their implications for economic development in the LATAM region, this study examines the moderating role of university cooperation in shaping the relationship between innovation expenditure and outcomes. It aims to highlight the interplay between investments in innovation, collaborative partnerships with universities, and their combined influence on innovation outcomes.

The findings consistently support the theoretical ground of the Evolutionary Economic Theory. The observed positive and significant relationship between innovation expenditure and innovation results is interesting to see. Higher innovation expenditure, as measured by research and development (R&D) spending, was associated with improved innovation outcomes, such as the introduction of new products, services, and technologies. This result aligns with previous research (Dai et al., 2020; Nga et al., 2022; Pegkas et al., 2019; Salter & Alexy, 2014), which highlights the pivotal role of innovation expenditure in driving innovation capabilities and fostering a firm's competitive advantage.

Moreover, our findings have revealed a moderating effect of university cooperation on the relationship between innovation expenditure and innovation results. Collaborative partnerships between universities and businesses proved to be a significant factor influencing the effectiveness of innovation investments. Firms that engaged in university cooperation experienced even greater benefits from their innovation expenditures, leading to enhanced innovation outcomes, given the opportunity to LATAM firms to increase their ROI in innovations expenditure.

This result highlights the importance of an open space for knowledge exchange between academia and industry and the need for the creation of platforms, cultures,

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and ecosystems that allow more consistent relationships and collaborations. Most importantly, the study goes beyond identifying individual effects and delves into the concept of joint effects. The significant interaction effect indicates that the combined impact of innovation expenditure and university cooperation on innovation outcomes is greater than the sum of their individual effects. This finding shows the value of collaborative efforts and a possible cross-pollination of ideas and expertise in driving innovation within the evolving economic landscape. The presence of university cooperation appears to amplify the impact of innovation expenditure, enhancing firms' absorptive capacity and enabling them to effectively leverage external knowledge and technologies.

In the context of effective university-industry collaborations, the findings provide valuable insights. However, it is acknowledging that the diversity and complexity of such partnerships. Not all collaborations lead to successful innovation, and the factors contributing to success or failure can be multifaceted and context-specific.

Moreover, these collaborations often require a strategic and sustained effort. Effective university-industry collaborations necessitate a clear understanding of goals, a shared vision, and ongoing dialogue (De Wit-de Vries et al., 2019). In addition, they often involve not only the exchange of knowledge but also the co-creation of new knowledge through collaborative research projects. Therefore, firms that seek to establish fruitful collaborations with universities must invest in building and maintaining these relationships over the long term.

Moving forward, it is imperative to consider the limitations of this study based on data, methods, and analytical constraints. First, the data used in the analysis was obtained from the Latin American Innovation Survey (LAIS) database, which covers a broad range of industries, but may not capture the implications and sector-specific factors that could influence the relationship between innovation expenditure, university cooperation, and innovation results. Future research could consider using data from

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multiple sources or conducting industry-specific studies to gain a more comprehensive understanding of the dynamics at play.

Second, the exclusion of firms with missing data for innovation expenditure and innovation results may have introduced some bias in the sample. It is essential to acknowledge that these firms may have different characteristics that could impact the observed relationships. To address this limitation, future research could explore imputation techniques or conduct sensitivity analyses to assess the robustness of the findings.

In conclusion, this study contributes to the growing body of literature on the Evolutionary Economic Theory and the role of university cooperation in driving innovation. The findings demonstrate that innovation expenditure and university collaboration are both critical determinants of innovation outcomes. Collaborative partnerships with universities can amplify the impact of innovation investments, fostering an environment of open innovation and knowledge exchange. Moreover, policymakers and business leaders should recognize the value of nurturing collaborative relationships between academia and industry to enhance innovation performance and promote sustainable economic growth within the ever-evolving landscape of the Evolutionary Economic Theory. However, we acknowledge the need for ongoing research to unravel the intricacies of these partnerships and their impact on innovation landscapes, considering the diversity and complexity of such collaborations.

6. Implications

6.1. Managerial implications

This study shows the strategic value of university-industry collaborations in enhancing innovation outcomes, providing managers with actionable insights for leveraging academic partnerships to maximize the efficacy of innovation investments. By highlighting the amplifying effect of such collaborations on innovation

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performance, it shares the importance of proactively engaging with academic institutions to access cutting-edge research, advanced technologies, and talent pools. Managers are encouraged to cultivate a culture of open innovation, strategically allocate resources to foster productive university partnerships, and adapt innovation strategies to evolving economic landscapes. Embracing these practices not only increase innovation efficiency but also could help firms positioning for competitive advantage in the dynamic global marketplace, aligning with the evolutionary economic perspective that advocates for adaptability and co-evolution in the pursuit of sustained innovation and economic growth.

6.2.Theoretical implications

This study enriches the theoretical landscape by studying Evolutionary Economic Theory thought empirical analysis to explore the moderating influence of university cooperation on the innovation investment-outcome relationship. It advances the theoretical discourse by suggesting the synergistic effects of academia-industry collaboration on innovation processes within the evolving economic framework. Highlighting the co-evolutionary dynamics at play, the research emphasis on how university partnerships not only complement firms' R&D efforts but also actively participate in shaping the broader trajectory of technological progress and economic growth. This theoretical augmentation offers a deeper understanding of the intricate mechanisms through which university-industry interactions enhance innovation efficiency, providing a novel perspective on the complex interdependencies that constitute the innovation ecosystem.

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TOWARDS CHAPTER 6

Building upon our analysis of universities as catalysts in the innovation process (Chapter 5), I now shift our focus to examine the reciprocal effects of university-industry collaborations on the universities themselves. While previous chapters emphasized the impact of collaborations on firms and the broader innovation ecosystem, Chapter 6 delves into how engaging with industry partners influences a university's internal capabilities, access to financial resources, and symbolic reputation.

In contrast to earlier discussions centered on external outcomes, this chapter investigates how universities leverage collaborations to enhance their own strategic assets. By exploring how partnerships contribute to the development of internal competencies, secure financial support, and elevate institutional prestige, Chapter 6 aims to uncover the mechanisms through which universities strengthen their position within the academic and research landscape. This examination is crucial for understanding the full spectrum of mutual benefits in university-industry collaborations and for informing strategies that universities can adopt to maximize the advantages of such partnerships.

CHAPTER 6

CHAPTER 6

THE ROLE OF INTERNAL CAPABILITIES AND FINANCIAL RESOURCES IN THE RELATIONSHIP BETWEEN U-I COLLABORATIONS AND SYMBOLIC REPUTATION

Carlos Plata

TSM-Research, University of Toulouse Capitole, CNRS UMR 5303

Prior versions of this project have been presented at the EURAM conference 2024

Abstract

This paper investigates the intricate relationships among internal capabilities, U-I collaboration, financial resources, and symbolic reputation in organizations. By a parallel mediation analysis, the study uncovers key insights into how these variables interact. The findings reveal that organizations with robust internal capabilities are more inclined to engage in effective collaboration with stakeholders. Additionally, financial resources play a pivotal role in enabling and empowering organizations to invest in their internal capacities and foster fruitful partnerships. Notably, symbolic reputation exhibits complex dynamics with the other variables, suggesting that organizations with a strong reputation may rely less on internal capabilities and financial resources. These results underscore the significance of knowledge-based capabilities, collaborative resources, and strategic resource allocation in effective reputation management. By contributing to the resource-based theory, this study offers valuable insights for organizations aiming to optimize their performance and enhance their reputation in today's competitive landscape

Keywords:

University-industry collaboration, knowledge transfer, symbolic performance, internal capabilities.

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1. Introduction

In today's rapidly evolving and competitive higher education landscape, universities face increasing pressures to demonstrate excellence, foster innovation, and highlight their distinctiveness (Hazelkorn, 2015). Building and maintaining a strong symbolic reputation is vital for universities to attract and retain high-quality students, recruit renowned faculty, secure research collaborations, and engage industry partners (Baltaru et al., 2022). For example, a positive symbolic reputation understood as the extent of favorable evaluation from the public (J.-N. Kim et al., 2007), enhances a university's credibility, perceived quality of education, and research capabilities, positioning it as a preferred destination for stakeholders (Altbach, 2021).

Resource-based theory (Barney, 1991) provides a valuable lens to understand how universities can strategically manage their resources to shape their external perceptions and gain a competitive advantage. According to this theory, a firm's resources and capabilities are the primary determinants of its performance and sustained competitive advantage (Barney et al., 2021). Applied to the context of universities, this theory emphasizes the importance of knowledge-based resources, financial resources, and internal capabilities in driving a university's success.

University-Industry (U-I) collaborations have emerged as a prominent avenue for universities to leverage external knowledge resources and enhance their capabilities (Etzkowitz, 2004; Friedman & Silberman, 2003; Perkmann, Neely, et al., 2011). Through collaborative research projects, joint initiatives, and knowledge exchange, universities can tap into industry expertise, gain access to cutting-edge technologies, and develop practical solutions to real-world challenges (Grimpe & Hussinger, 2013; Hagen, 2008; Heinzl et al., 2013; Perkmann et al., 2013; Schartinger et al., 2002). U-I collaborations enable universities to strengthen their research capabilities, enhance their curriculum, and foster an entrepreneurial culture; all of which contribute to their symbolic reputation (Crow et al., 2020; Perkmann, Neely, et al., 2011; Peters et al., 2004).

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Financial resources play a crucial role in supporting universities' strategic initiatives and reputation-building efforts. Adequate funding enables universities to invest in state-of-the-art infrastructure, recruit and retain talented faculty, offer competitive scholarships and research grants, and implement marketing and branding campaigns (Aksoy & Beaudry, 2021; Leischnig & Geigenmüller, 2020b; Neves & Brito, 2020; Perkmann, Neely, et al., 2011). By allocating financial resources effectively, universities can enhance their symbolic reputation and differentiate themselves from their peers.

Internal capabilities encompass the collective competencies, skills, and assets within universities that contribute to their performance and reputation. These capabilities include quality of teaching, research output, student support services, industry engagement, and technology transfer (Barr, 2009; Beath et al., 2012; Carayannis & Campbell, 2009). Strong internal capabilities enable universities to deliver exceptional education, produce groundbreaking research, establish mutually beneficial partnerships with industry, and develop graduates who are well-equipped for the workforce (Becerra et al., 2019; Leischnig & Geigenmüller, 2020b; Scott, 2006; Wright et al., 2009).

While the importance of U-I collaborations, financial resources, internal capabilities, and symbolic reputation for universities is acknowledged, there is a need for a comprehensive analysis of their interrelationships (D'Este & Perkmann, 2011). Understanding how U-I collaborations influence a university's access to financial resources, shape its internal capabilities, and impact its symbolic reputation (Baltaru et al., 2022) is essential for universities seeking to strategically manage their resources and enhance their competitive advantage.

Therefore, this study aims to investigate the relationships between U-I collaborations, financial resources, internal capabilities, and symbolic reputation within universities from a resource-based perspective. The analysis was done by taking a quantitative approach using a double mediation model, inputting data coming from the UK's Higher Education Statistics Agency and Scimago Institutions Ranking. By examining

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these relationships, we aim to contribute to the existing body of knowledge on how universities can strategically allocate and leverage their resources to strengthen their performance and reputation.

The findings of this study will deepen our understanding of how U-I collaborations influence a university's access to financial support and its internal capacity for research, teaching, and industry engagement. Additionally, we will explore the nuanced relationship between U-I collaborations and symbolic reputation, considering the mediating effects of financial resources and internal capabilities.

By providing empirical evidence and insights into these interrelationships, this study aims to inform university administrators, policymakers, and scholars about the complex mechanisms underlying university functioning and reputation-building strategies. The implications of this research can guide universities in adopting a resource-based approach to collaboration with businesses and managing their knowledge resources, financial resources, and internal capabilities, to increase their symbolic reputation bringing positive impacts such as the increased visibility of research outputs (Sursock, 2021) and the obtaining of attract international collaborations, research partnerships, and funding opportunities (R. Tijssen, 2021), ultimately contributing to their long-term success

In the following sections, we will present the research methodology specific to the university context, analyze the data collected from universities, discuss the implications of our findings from a resource-based perspective, and provide suggestions for future research and practical implications for university decision-making and strategic planning.

2. Literature Review

Collaborations between universities and industry have gained significant importance and have become a driving force for innovation, economic growth, and knowledge exchange (Bercovitz & Feldman, 2006). These collaborations involve various forms of

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partnerships, including research collaborations, joint projects, technology transfer agreements, and industry-sponsored research initiatives (Hagen, 2008; Heinzl et al., 2013; Schartinger et al., 2002; Van Rijnsoever & Hessels, 2021).

Defining collaborations between universities and industry is essential to understanding their nature and scope. These collaborations can be broadly defined as strategic alliances, or partnerships, where universities and industry entities come together to share resources (Ajith Kumar & Ganesh, 2009; Argote et al., 2000; Leischnig & Geigenmüller, 2020b; Watson et al., 2016), expertise, and knowledge for the mutual benefit of both entities. Such collaborations enable the integration of academic research and industrial practices, leading to innovation, commercialization, and societal impact (Baglieri et al., 2018; Chilana et al., 2015; Perkmann et al., 2013).

The benefits of university-industry collaborations are manifold. Firstly, these collaborations facilitate the transfer of knowledge and technology between academia and the industry. Universities serve as repositories of research and expertise (Etzkowitz, 2004; Friedman & Silberman, 2003; Perkmann, Neely, et al., 2011), while industries possess the practical know-how, market insights, and resources needed to bring innovations to the market (Leischnig & Geigenmüller, 2020b). By bridging these two worlds, collaborations enable the efficient exchange of ideas, skills, and resources.

Secondly, collaborations between universities and the industry create opportunities for applied research and development (Colyvas & Powell, 2006; Etzkowitz, 2004; Friedman & Silberman, 2003; Penan, 1996; Perkmann, Neely, et al., 2011). Industry partners often bring real-world challenges and industry-specific expertise, allowing universities to align their research efforts with practical needs and market demands. Through joint projects and research collaborations, universities can develop innovative solutions, test prototypes, and contribute to technological advancements in various sectors (Hagen, 2008; Heinzl et al., 2013; Leischnig & Geigenmüller, 2020b; Schartinger et al., 2002).

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Moreover, university-industry collaborations foster a culture of innovation and entrepreneurship (Crow et al., 2020; Perkmann, Neely, et al., 2011; Peters et al., 2004). By working closely with industry partners, universities gain insights into emerging trends, market dynamics, and industry practices. This exposure helps shape the curriculum, teaching methodologies, and research directions, ensuring the relevance and applicability of academic programs (Good et al., 2019). Collaborations also provide a platform for students and researchers to engage with industry professionals, fostering an entrepreneurial mindset and creating avenues for commercializing research outcomes (Crow et al., 2020; Perkmann et al., 2013).

Previous research (D'Este & Perkmann, 2011; Etzkowitz, 2004; Perkmann, Neely, et al., 2011; G. P. Pisano, 2006) on university-industry collaborations has explored these benefits and challenges. Scholars have examined different collaboration models, assessed the impact on knowledge transfer, innovation, and economic outcomes, and investigated the factors influencing the success of such collaborations.

However, it is important to acknowledge the challenges that come with university-industry collaborations. Differences in goals, timelines, intellectual property rights, and funding models can create complexities in managing these partnerships (A. Hughes & Kitson, 2012; Miller et al., 2016b; Siegel et al., 2003). Maintaining a balance between academic freedom and industry objectives, ensuring equitable sharing of benefits, and addressing potential conflicts of interest are crucial considerations for successful collaborations (Jones & Coates, 2020; Lee, 1996; Vaara et al., 2012).

2.1.Symbolic Reputation as the Dependent Variable

Symbolic reputation, as the dependent variable in this study, represents the perception, image, and standing of universities within the broader academic community and society at large. It is an essential measure of the university's reputation, prestige, and recognition in terms of its academic achievements, research contributions, and overall impact (Altbach, 2021).

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Symbolic reputation is often captured and assessed through various ranking systems, such as SCImago Institutions Rankings (SIR) and the QS World University Rankings gaining global recognition (Vernon et al., 2018). These rankings consider factors like research output, citations, faculty quality, international collaborations, and reputation surveys among academics, employers, and industry professionals (Altbach, 2015; Hazelkorn, 2015; Van Rijnsouwer & Hessels, 2021). They provide a quantitative and comparative assessment of universities' symbolic reputation on a global or regional scale.

The symbolic reputation of universities is crucial for attracting high-caliber faculty members, talented students, research funding, and industry collaborations (Baltaru et al., 2022). A strong symbolic reputation signifies excellence in teaching and research, which demonstrates the university's ability to provide high-quality education, further advancement of knowledge in various fields, and make significant contributions to society. Yet, the rankings have been subject to criticism for their methodology, which may not capture the full range of a university's internal capabilities (Hicks & Wouters, 2015; Vernon et al., 2018). For example, rankings often focus on research output and reputation, while neglecting other areas (Butler, 2007) such as teaching quality, student experience, and community engagement.

Universities with a strong symbolic reputation tend to attract international collaborations, research partnerships, and funding opportunities (R. Tijssen, 2021). Industry partners and stakeholders often seek to collaborate with reputable universities, recognizing the potential for cutting-edge research, the access to highly skilled graduates, and the credibility associated with renowned institutions (Fumasoli et al., 2020; Hazelkorn, 2015).

Additionally, a strong symbolic reputation enhances the visibility and impact of the university's research outputs (Sursock, 2021). It increases the likelihood of publications being cited, research findings being adopted, and innovations being recognized and

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commercialized. This, in turn, further contributes to the university's reputation and influence within academic and industry circles (Hazelkorn, 2015).

However, it is important to note that symbolic reputation is not solely dependent on rankings or external evaluations. Factors such as regional context, historical significance, alumni network, cultural impact, and societal engagement also shape a university's symbolic reputation (Bonaccorsi et al., 2021). Therefore, understanding and managing the determinants of symbolic reputation is crucial for universities seeking to enhance their academic standing and attract collaborations with industry partners.

Previous research has explored the dynamics of symbolic reputation and its impact on various stakeholders. Studies have investigated the factors influencing university rankings, examined the relations between symbolic reputation and research performance (Christensen & Gornitzka, 2017), and explored the strategies employed by universities to improve their symbolic reputation (Steiner et al., 2013), however, how symbolic reputation can be affected by collaborations with external parties is an unexplored relation.

2.2.University-industry collaborations as the Independent Variable

University-industry collaborations serve as the focal independent variable in this study, representing the strategic partnerships and interactions between universities and the industry. These collaborations encompass a range of mechanisms through which universities share their expertise, research findings, and intellectual property with industry partners, leading to knowledge transfer, innovation, and societal impact (Berbegal-Mirabent et al., 2012).

University-industry collaborations involve various activities, including collaborative research projects, technology licensing, industry-sponsored programs, consulting services, and entrepreneurship support (Baglieri et al., 2018; Chilana et al., 2015;

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Etzkowitz, 2004; Friedman & Silberman, 2003; Penan, 1996; Perkmann, Neely, et al., 2011).

Collaborative research projects play a central role in university-industry collaborations, allowing researchers from academia and industry to jointly address research questions, solve practical problems, and develop innovative solutions (Hagen, 2008). Through these projects, researchers share insights, leverage each other's expertise and resources, and generate new knowledge with real-world applications (Etzkowitz, 2004; Friedman & Silberman, 2003; Perkmann, Neely, et al., 2011).

Industry-sponsored programs provide a direct avenue for industry involvement in university research activities (Mustar et al., 2008). These programs involve financial support, collaborative projects, and knowledge sharing, allowing industry partners to tap into the expertise of university researchers and gain access to cutting-edge research findings (Shane, 2002).

Consulting services represent another form of knowledge transfer within university-industry collaborations (Becerra et al., 2019). Faculty members and researchers provide expert advice, analysis, and problem-solving solutions to industry partners through consulting engagements (Olmos-Penuela et al., 2014). These interactions leverage the intellectual capital of the university, providing practical insights and actionable recommendations to address industry-specific challenges (Hewitt-Dundas, 2012).

Furthermore, universities foster entrepreneurship and support knowledge transfer through the establishment of startup incubators, technology transfer offices, and entrepreneurship programs (Crow et al., 2020). These initiatives encourage researchers, students, and staff to commercialize their ideas, inventions, and research findings, promoting innovation and economic development (Baglieri et al., 2018; Chilana et al., 2015; Peters et al., 2004; Scillitoe & Chakrabarti, 2010).

By that, understanding the dynamics of university-industry collaborations is essential for both universities and industry partners seeking to establish successful and

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impactful collaborations. Accordingly, effective collaborations require the establishment of robust communication channels, trust, and shared goals between the university and the industry. Developing streamlined processes, establishing clear intellectual property rights, and implementing mechanisms for ongoing collaboration and knowledge exchange are critical for fostering successful university-industry collaborations.

2.3.Financial Resources as the First Mediator

Financial resources play a significant role as the first mediator in the relationship between knowledge transfer processes and the symbolic reputation of universities. Financial resources refer to the amount of money that the university has available to allocate toward various activities, including research, infrastructure development, and industry collaborations (AI-Youbi et al., 2021).

The availability of sufficient financial resources is crucial for facilitating effective knowledge transfer processes and establishing successful collaborations with industry partners (Perkmann, Neely, et al., 2011). Universities with adequate funding are better equipped to invest in research facilities, state-of-the-art equipment, and other resources that facilitate the creation and dissemination of knowledge (Leischnig & Geigenmüller, 2020b). These resources provide a solid foundation for engaging in knowledge exchange activities and attracting industry partners.

The measurement of financial resources can be conducted through various indicators, such as the overall budget allocated to research and development, the amount of external funding secured, endowments, grants, and contracts (AI-Youbi et al., 2021; Becerra et al., 2019; Friedman & Silberman, 2003). These measures reflect the financial capacity of the university to support knowledge transfer processes and strengthen collaborative initiatives with industry.

The influence of financial resources as a mediator lies in its ability to enhance the impact and reach of knowledge transfer activities. Universities with ample financial

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resources can invest in research and development projects, hire top-notch faculty, provide competitive stipends to students, and establish robust support systems (Aksoy & Beaudry, 2021; Carayannis & Campbell, 2009; Friedman & Silberman, 2003). These initiatives contribute to successfully attracting and retaining top talent (Perkmann, Neely, et al., 2011), innovation, and technology to industry partners (Neves & Brito, 2020), thereby positively impacting the symbolic reputation of the university.

It is important to note that financial resources alone are not sufficient to ensure successful university-industry collaborations (Gold et al., 2001). However, they serve as critical enablers by providing the necessary infrastructure, support, and opportunities for effective knowledge transfer processes. When combined with strong internal capabilities and conducive collaborative frameworks, financial resources significantly enhance the university's ability to establish fruitful partnerships and boost its symbolic reputation.

Hypothesis 1: Higher levels of financial resources available to the university positively mediate the relationship between knowledge transfer processes and symbolic reputation.

2.4.Internal Capabilities as the Second Mediator

Internal capabilities refer to the collective knowledge, skills, and expertise within the university that contribute to its ability to engage in effective knowledge transfer processes and collaborations with industry partners (Carayannis & Campbell, 2009; G. P. Pisano, 2006). These capabilities encompass various dimensions, including the competencies of faculty members, the skills and creativity of students, and the support and expertise provided by staff members (Anderson et al., 2007; Carayannis et al., 2000; Liu & Huang, 2018).

Faculty capabilities play a crucial role in driving knowledge transfer processes and successful collaborations. The expertise and research capabilities of faculty members are essential for fostering effective knowledge exchange and partnerships with

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industry (Becerra et al., 2019; Crow et al., 2020; Neves & Brito, 2020). Measures of faculty capabilities may include research output, publications, patents, awards, and collaborations with industry partners (Fumasoli et al., 2020; Perkmann, King, et al., 2011).

Students also contribute significantly to knowledge transfer processes through their skills, creativity, and capacity to apply theoretical concepts to real-world problems. Their involvement in research projects, internships, industry placements, and entrepreneurial activities showcases their capabilities and contributes to the collaborative efforts between universities and industry (Bercovitz & Feldman, 2006; Lin & Bozeman, 2006).

Furthermore, the knowledge and expertise of staff members, including administrative staff, research support staff, and technical personnel, play a vital role in facilitating effective collaboration and knowledge transfer (Jones & Coates, 2020). Their qualifications, training, experience, and involvement in industry-related projects all contribute to the overall internal capabilities of the university.

Internal capabilities act as a crucial mediator in the relationship between knowledge transfer processes and the symbolic reputation of universities. Universities with highly skilled and motivated faculty, talented students, and knowledgeable staff are better positioned to generate valuable intellectual property, attract industry funding, and produce impactful research (Argote et al., 2000; Barbini et al., 2021; Becerra et al., 2019; Hausberg & Korreck, 2020). This, in turn, enhances the symbolic reputation of the university.

By having strong internal capabilities, universities can effectively transfer knowledge, promote innovation, and establish collaborative relationships with industry partners. This not only benefits the university-industry collaborations themselves but also contributes to the overall reputation and standing of the university. Therefore,

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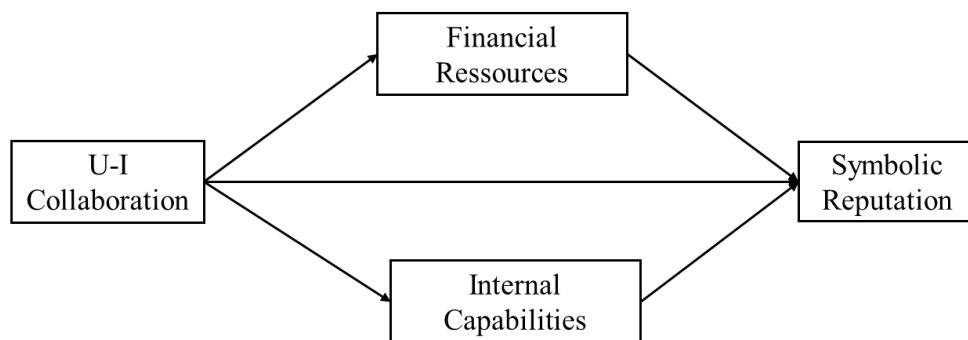
understanding and nurturing internal capabilities are essential for universities aiming to enhance their symbolic reputation through successful collaborations with industry.

Hypothesis 2: The internal capabilities of the university, including the expertise of faculty, the skills of students, and the support of staff, positively mediate the relationship between knowledge transfer processes and symbolic reputation.

2.5.Theoretical Model

Based on the priory established variables and connections, a theoretical model, shown in Figure 6.1, is developed based on the resource-based view theory (Barney, 1991). This theory suggests that the effectiveness of the relationships is affected by the availability and accessibility of resources (Barney et al., 2021) Resources such as funding, infrastructure, and expertise are essential for effective university-industry collaborations (Argote & Ingram, 2000; Geuna & Muscio, 2009; Neves & Brito, 2020; Perkmann, Neely, et al., 2011). The resource-based view posits that organizations with greater access to these resources are more likely to innovate and generate new ways of work (Nonaka & Teece, 2001), and with this, they could engage in effective relations. Therefore, university and industry partners need to have access to sufficient resources.

FIGURE 6.1. THEORETICAL MODEL



3. Method

3.1.Sample Selection and Variable Definition

The data used in this study was obtained from two distinct sources and covers the period between 2015 and 2021. The first set stems from the UK's Higher Education

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Statistics Agency¹⁴ (HESA) database, which provides comprehensive and detailed data on higher education institutions (Sengupta & Ray, 2017b). The data from the HESA included university-industry collaborations, student enrollment, employment, and financial figures.

The second source of data is the Scimago Institutions Ranking¹⁵, which assesses both the global and national positioning of each university (Hazelkorn, 2015). To attain an accurate representation of the behavior of the institutions, the positions attained the four rankings provided: overall, research, innovation, and societal. To operationalize the key variable available in appendix 1, they were defined and measured using the following constructs:

University and Industry Collaboration was assessed using three indicators. First, the Total Number of Consultancies, which represents the cumulative number of consultancy projects undertaken by the university in collaboration with industry partners. These consultancies involve providing specialized expertise and services to address industry-specific challenges. Second, total number of contracted research projects, which reflects the count of research initiatives contracted by external organizations and conducted by the university. These collaborative research projects aim to address specific research objectives while leveraging the expertise of both academia and industry. Lastly, the total number of facility and equipment-related contracts, which captures the extent to which the university and industry partners engage in collaborative utilization of university resources, facilities, and equipment.

Financial Resources were calculated by deducting the total research grants received by the university and the value of contracts signed between the university and business partners from the total income of the university. This calculation aimed to provide a comprehensive and rigorous measure of the net financial resources available to the university. Accounting for both research grants and collaborative

¹⁴ <https://www.hesa.ac.uk/>

¹⁵ <https://www.scimagoir.com/>

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contracts, it ensured a more accurate assessment of the university's financial capacity to support collaborative initiatives.

Internal Capabilities were evaluated based on two dimensions. First, the Number of Staff, which encompassed both academic and non-academic personnel employed by the university. This included faculty members, researchers, administrators, and support staff, all of whom contribute to the university's internal capabilities and expertise. Second, Research Students, specifically graduate students pursuing research-focused degrees. These students play a crucial role in industry collaborations as they contribute their skills, knowledge, and fresh perspectives to collaborative projects.

Symbolic Reputation was measured by the Global Position in the Scimago Institutions Rankings. This ranking system provides a comprehensive assessment of research institutions worldwide, considering factors such as research output, impact, and collaborations. By examining the global position of the university in this ranking, it captured the symbolic reputation and standing of the institution within the academic community.

Following the data retrieval process, the data underwent a compilation and cleaning process to ensure the accuracy and completeness of the final dataset. Given that the data collected spanned a longitudinal period between 2015 and 2021, institutions with missing data due to a lack of reporting from the institution were excluded from the dataset. This process resulted in a final sample of 77 institutions per year with a total of over 19,000 data points.

3.2. Analysis

After the data was carefully compiled and organized in Microsoft Excel to ensure accuracy and consistency, descriptive statistics were calculated to examine the means, standard deviations, and other relevant measures for each variable of interest. This

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initial exploration of the data provided insights into the distribution and characteristics of the study variables.

To test the proposed hypotheses and investigate the mediating role of financial resources and internal capabilities, the PROCESS macro V4.2 by Hayes (Hayes, 2022) in SPSS V28.0.1.1 was employed. This widely recognized macro is commonly used in mediation and moderation analyses due to its robustness and ability to estimate direct and indirect effects. By specifying the appropriate model and variables, estimates were obtained for the total, direct, and indirect effects, as well as their significance levels.

Furthermore, to enhance the interpretation of the mediation effects, the capabilities of RStudio running R V 4.2.0 and the mediation package V 4.5.0 (Tingley et al., 2014) were leveraged. This facilitated the generation of graphical representations, such as mediation plots, to visualize the relationships and better understand the underlying mechanisms. These plots provide a clear depiction of the paths and mediation effects, aiding in the interpretation and communication of the findings.

4. Results

The results of the analysis provide a comprehensive view of the relationships between internal capabilities (INT), U-I collaboration (U_I), financial resources (FIN), and symbolic reputation (RankGlo). Internal capabilities (INT) have a mean of 4219.2 and a standard deviation of 3284.2. The positive and significant correlation between INT and U-I collaboration ($\beta = 0.231$, $p < 0.01$) suggests that organizations with stronger internal capabilities are more likely to engage in effective collaboration with their users and stakeholders.

Financial resources (FIN), with a mean value of £232,443.9 and a standard deviation of £151,274.9, exhibit positive correlations with both INT ($\beta = 0.954$, $p < 0.01$) and U-I collaboration ($\beta = 0.219$, $p < 0.01$). These results imply that organizations with greater financial resources are better equipped to invest in internal capabilities and foster collaborative relationships with external partners.

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Financial resources play a pivotal role as a facilitator, empowering organizations to invest in nurturing their internal capabilities and forging productive collaborations (AI-Youbi et al., 2021). This significance becomes particularly pronounced in the higher education, where augmenting financial resources can be a difficult endeavor. This challenge stems from the time-intensive nature of resource accumulation, with revenue streams primarily constrained to tuition fees, research grants, and external funding sources like contracts and donations (Auranen & Nieminen, 2010; Powers, 2004).

Furthermore, the acquisition of talent in the form of professors is not solely dependent on financial abundance but also relies on the institution's reputation. Moreover, constraints related to hiring windows may persist, meaning that even with sufficient financial resources, institutions may still face impediments in accessing or enhancing their capabilities (Perry et al., 2000).

Symbolic reputation (RankGlo), with a mean of 530.9 and a standard deviation of 179.7, demonstrates negative correlations with INT ($\beta = -0.84$, $p < 0.01$), U-I collaboration ($\beta = -0.20$, $p < 0.01$), and FIN ($\beta = -0.76$, $p < 0.01$). These findings suggest an intriguing dynamic between symbolic reputation and the other variables. Organizations with a strong symbolic reputation may rely less on internal capabilities and collaborative efforts, as their reputation serves as a signal of their credibility and competence; (Shen et al., 2023). Additionally, the negative correlation with financial resources implies that organizations with an established reputation may face fewer financial constraints, possibly due to increased trust and support from stakeholders.

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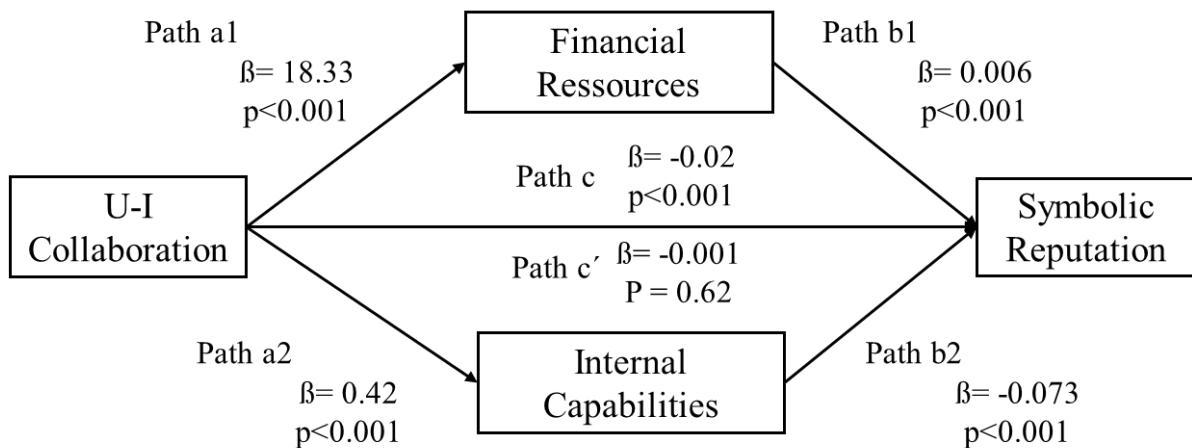
TABLE 6.1: DESCRIPTIVE STATISTICS AND CORRELATIONS

Variable	Mean	SD	1	2	3	4
1. Internal Capabilities (INT)	4219,2	3284,2	--			
2. U-I Collaboration (U_I)	1003,6	1799.3	,231**	--		
3. Financial Resources (FIN)	£232.443,9	£151.274,9	,954**	,219**	--	
4. Symbolic Reputation (RankGlo)	530.9	179,7	-,84**	-,20**	-,76**	--

Note. N = 536 ** $p < .01$

The results obtained from the PROCESS macro (Hayes, 2022) analysis provide valuable insights into the relationships among the variables under investigation. Firstly, in path *a1* with the outcome variable Financial Resources the analysis revealed a significant positive relationship with the predictor variable U-I collaborations ($\beta = 18.3990$, $p < 0.001$). This finding suggests that organizations with higher levels of industrial collaborations tend to have greater access to financial resources. It indicates that U-I collaborations play a crucial role in attracting financial support, securing investments, or effectively utilizing existing financial assets.

FIGURE 6.2: RESULTS PARALLEL MEDIATION



Moving on to path *a2* with Internal Capabilities as outcome variable, the analysis demonstrated a significant positive relationship with the predictor U-I collaborations

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($\beta = 0.4217$, $p < 0.001$). This finding suggests that organizations with abundant collaborations tend to exhibit stronger internal capabilities. These capabilities may include factors such as skilled personnel, research students, and well-developed infrastructure. The positive association implies that industrial relations serve as a foundation for building and enhancing an organization's internal capacity, enabling it to effectively leverage the relations for achieving strategic objectives and maintaining a competitive edge.

The model summary indicates that the predictors collectively explain a substantial amount of variance in the symbolic reputation ($R\text{-sq} = 0.7432$, $p < 0.001$). This finding suggests that the selected variables contribute significantly to the variation observed in symbolic reputation.

Interestingly, the direct effect analysis reveals some intriguing patterns. While U-I collaboration does not demonstrate a significant direct effect on symbolic reputation ($\beta = -0.0011$, $p = 0.6205$), path C, both financial resources and internal capabilities exhibit noteworthy direct effects. Financial resources, path *b1*, shows a significant positive direct effect ($\beta = 0.0006$, $p < 0.001$), indicating that increased financial resources are associated with higher levels of symbolic reputation. On the other hand, for internal capabilities, path *b2* exhibits a significant negative direct effect ($\beta = -0.0731$, $p < 0.001$), suggesting that greater internal capabilities are associated with lower levels of symbolic reputation. These findings imply that the impact of internal capabilities on symbolic reputation might be more nuanced than initially anticipated, and further exploration is needed.

Using Financial Resources as a first mediator, results show a significant positive indirect effect ($\beta = 0.0112$, $p < 0.001$), supporting *hypothesis 1*. This indicates that U-I collaborations indirectly contribute to an organization's symbolic reputation by increasing its financial resources. The availability of financial means enables organizations to engage in reputation-building activities, such as marketing campaigns, public relations efforts, or corporate social responsibility initiatives. Thus,

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organizations with industrial partners are more likely to have access to the necessary financial resources for cultivating a positive symbolic reputation. The visualization of the effect can be found in the appendix 2.

The second mediator, Internal Capabilities, also revealed a significant yet negative indirect effect ($\beta = -0.0308$, $p < 0.001$), not supporting *hypothesis 2*. This suggests that organizations with higher U-I collaborations have lower symbolic reputations due to their stronger internal capabilities. When organizations possess robust internal capabilities, they may rely less on external reputation-building efforts, as their internal strengths and competencies drive their success and recognition. Consequently, their reliance on symbolic reputation as an external signal may be reduced, resulting in a potential decrease in their symbolic reputation. The visualization of the effect can be found in the appendix 3.

The total effect analysis, path c , reveals that U-I collaborations have a significant negative total effect on symbolic reputation ($\beta = -0.0207$, $p < 0.001$). This finding suggests that U-I collaborations indirectly influence symbolic reputation through other mediating variables included in the model. However, the direct effect of U-I collaborations on the symbolic collaborations path c' , is not significant ($\beta c' = -0.0011$, $p = 0.6205$), implying that the relationship between U-I collaborations and symbolic reputation is fully mediated by other variables.

The findings highlight the multi-faceted role of knowledge resources in shaping various aspects of organizational dynamics. They indicate that industry collaborations have a positive influence on financial resources and internal capabilities within organizations. However, the impact on symbolic reputation is more nuanced, with indirect effects attained through financial resources and internal capabilities. These results provide valuable insights into the interplay between U-I collaborations and organizational outcomes, shedding light on the complex mechanisms underlying organizational functioning and reputation-building strategies.

5. Discussion

The findings of this study provide a comprehensive analysis of the relationships among U-I collaborations, financial resources, internal capabilities, and symbolic reputation within organizations. These results deepen our understanding of how these variables interact and their implications for organizational performance and reputation management.

The results suggest that organizations with higher U-I collaborations are more likely to have access to financial support. This finding underscores the importance of knowledge-based capabilities in attracting financial resources or effectively utilizing existing financial assets (Aksoy & Beaudry, 2021; Leischnig & Geigenmüller, 2020b). It implies that organizations with a strong knowledge base can effectively articulate their value proposition to investors and stakeholders, increasing their chances of obtaining the necessary funds for growth and innovation.

Furthermore, the relationship between U-I collaborations and internal capabilities highlights the pivotal role of U-I collaborations in shaping an organization's internal capacity. Organizations with abundant U-I collaborations are better equipped to develop and enhance internal capabilities such as skilled personnel, efficient processes, advanced technology, and well-developed infrastructure (Bercovitz & Feldman, 2006; Jones & Coates, 2020; Lin & Bozeman, 2006). This finding aligns with the resource-based view of the firm (J. B. Barney et al., 2021), which suggests that U-I collaborations serve as a foundation for building sustainable competitive advantages and achieving organizational objectives.

Regarding the relationship between U-I collaborations and symbolic reputation, the non-significant direct effect implies that U-I collaborations alone may not directly influence an organization's symbolic reputation. Symbolic reputation encompasses the perceptions, image, and reputation of an organization among its stakeholders (J.-N. Kim et al., 2007). While U-I collaborations are essential for building and sustaining a

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strong organizational reputation (Baltaru et al., 2022), their impact on symbolic reputation may be mediated by other factors.

The indirect effects through financial resources and internal capabilities shed light on the mechanisms through which U-I collaborations indirectly influence symbolic reputation. The indirect effect through financial resources suggests that organizations with higher U-I collaborations are more likely to possess the financial means to invest in reputation-building activities. This includes initiatives such as marketing campaigns, branding efforts, corporate social responsibility activities, and strategic partnerships that enhance the organization's image and reputation (Baltaru et al., 2022).

Conversely, the indirect effect through internal capabilities suggests that organizations with stronger internal capabilities may rely less on external reputation-building efforts. These organizations leverage their internal strengths and competencies to build their reputation, emphasizing their track record of delivering value to stakeholders. While this may result in a reduced reliance on symbolic reputation as an external signal of their capabilities, it does not diminish the importance of building and maintaining a positive reputation among stakeholders (Fumasoli et al., 2020; Hazelkorn, 2015).

In a broader context, it is important to consider the dynamic nature of these relationships and the potential moderating factors that may influence them. Organizational characteristics such as industry type, organizational size, and the competitive landscape can shape the strength and direction of these relationships.

Additionally, the findings highlight the need for organizations to adopt a balanced approach to managing their knowledge resources, financial resources, internal capabilities, and symbolic reputation. While U-I collaborations are valuable assets (Carayannis & Campbell, 2009), organizations should also prioritize the effective allocation of financial resources and the development of internal capabilities to drive

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performance and enhance reputation (Jones & Coates, 2020). A holistic and integrated approach that considers the interplay between these variables is crucial for long-term organizational success.

Finally, from a theoretical standpoint, this study makes important contributions to the resource-based theory (J. B. Barney et al., 2021). By examining the relationships between resources, capabilities, and symbolic reputation, the research expands our understanding of how organizations can strategically manage their resources to shape external perceptions, the results show that even though there could be an important influence of the amount of available resources the greater impact comes in how these resources get used and configured to maximize the results. The findings challenge traditional assumptions and provide a more nuanced understanding of the complex dynamics involved in reputation management. Moreover, the study highlights the role of collaborative resources and the significance of resource allocation in reputation building.

There are some limitations to this study that need to be acknowledged. Firstly, the data used was limited to universities in the UK, which may not be generalizable to other countries. Secondly, the dataset was limited to universities that had data from all the years in question, which may have excluded some universities from the sample. Finally, the study relied on secondary data, which may have limitations in terms of accuracy and completeness, Since the data is partially self-reported by universities, there is a risk of inconsistencies or biases in responses. Additionally, not all variables are mandatory, allowing some institutions to omit or selectively report certain data points. Despite these constraints, the study offers valuable insights into the key factors shaping outcomes in higher education, contributing to a deeper understanding of the dynamics at play in university-industry collaborations.

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7. Appendix:

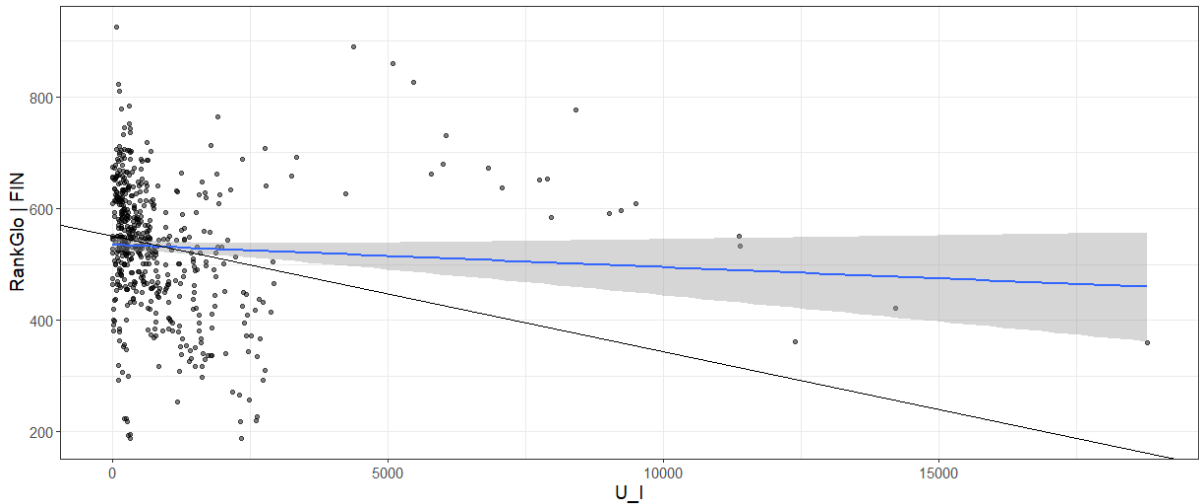
7.1. Appendix 1: Variable List

Model Concept	Type of variable	Detailed
University and Industry Collaboration	Consultancy	Number SMEs
		Number Other (non-SME) commercial businesses
		Number Non-commercial organisations
	Contracted Research	Number SMEs
		Number Other (non-SME) commercial businesses
		Number Non-commercial organisations
	Facilities And Equipment Related	Number SMEs
		Number Other (non-SME) commercial businesses
		Number Non-commercial organisations
Financial Resources	Finances	Tuition fees and education contracts
		Funding body grants
		Research grants and contracts
		Other income - other services rendered
		Other income - other
		Endowment and investment income
Internal Capabilities	Total Staff	Managers, directors, and senior officials
		Professional occupations
		Associate professional and technical occupations
		Clerical and manual occupations
		Total academic staff
		Managers, directors, and senior officials
		Professional occupations
		Associate professional and technical occupations
		Administrative and secretarial occupations
		Skilled trades occupations
		Caring, leisure and other service occupations
		Sales and customer service occupations
		Process, plant, and machine operatives
		Elementary occupations
		Total non-academic staff

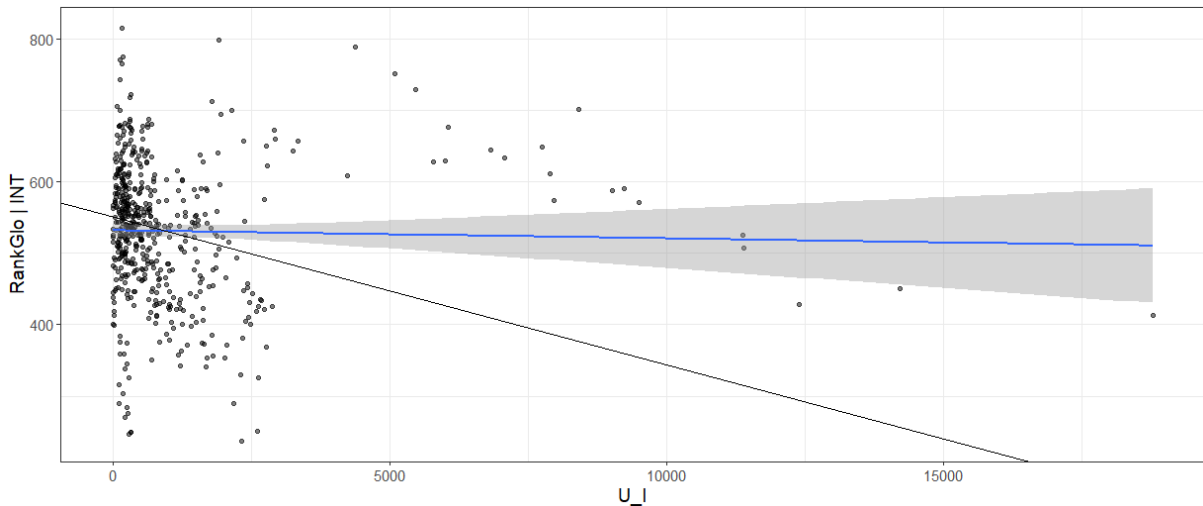
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Model Concept	Type of variable	Detailed
		Total
Symbolic Reputation	Scimago Ranking	Overall Global Ranking

7.2. Appendix 2: Visualization effect Path A



7.3. Appendix 3: Visualization effect Path B



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1. General Conclusion

This dissertation has undertaken an exploration of the multifaceted dynamics underpinning university-industry collaborations, with a particular emphasis on the roles of academics, knowledge transfer mechanisms, innovation processes, and the development of novel analytical tools for assessing scientific production. Grounded in theoretical frameworks such as Evolutionary Economic Theory (Nelson, 1987), Resource-Based Theory (Barney et al., 2021), Actor-Network Theory (Callon, 1984), and the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), the research has traversed both theoretical explorations and empirical investigations across diverse geographical contexts, including the United Kingdom, the European Union, and Latin America.

A central theme emerging from this work is the pivotal role that academics play in initiating, developing, and sustaining effective university-industry collaborations. The study highlights how academics are the backbone of the knowledge transfer process, bringing their expertise, adaptability, and innovative capacities to bridge the gap between theoretical research and practical application. By assuming multifaceted roles, academics contribute significantly to meeting industry needs, driving innovation, and fostering mutual advancement. Their proactive engagement, strategic adaptations, and ability to navigate complex networks highlight their critical importance in the success of collaborative projects.

The research also looks into the complexities of knowledge transfer mechanisms, particularly the significance of intangible knowledge exchange within university-industry relationships. Through a bibliometric and systematic literature review, it becomes evident that effective collaborations are often facilitated by informal networking and personal interactions rather than being constrained by traditional factors such as industry type, firm size, or academic specialization (Andersen & Rossi, 2011; Berbegal-Mirabent et al., 2012; Hewitt-Dundas, 2012; Hughes & Kitson, 2012; Martinelli et al., 2008). This finding underscores the importance of interpersonal

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relationships and trust in fostering knowledge exchange and highlights the need for streamlined protocols and procedures to enhance the efficiency of collaborations.

The development and application of the Unity Index provides a novel analytical tool that addresses the limitations of traditional univariate indicators of scientific production. By integrating multiple dimensions of academic impact, the Unity Index offers a more holistic assessment that can inform bibliometric studies and enhance the evaluation of scholarly output.

Quantitative analyses employing traditional statistical techniques (Creswell & Plano Clark, 2018) and neural network modeling (Kingma & Ba, 2014) bring light on the factors that facilitate or hinder effective university-industry collaborations. The findings reveal that reducing academic workload and enhancing administrative support substantially improve collaboration effectiveness. Interestingly, the roles of scientific output and institutional prestige are found to be more complex than traditionally assumed, suggesting that alignment with industry objectives and practical applications of research are crucial for successful partnerships.

The empirical context of Latin America provides valuable insights into how university cooperation amplifies the effects of innovation expenditure on outcomes. The research suggests that collaborative partnerships with universities enhance the effectiveness of innovation investments, highlighting the critical role of universities in driving economic growth within developing economies, underscoring the applicability of Evolutionary Economic Theory in different regional contexts, and emphasizing the importance of tailoring strategies to specific environments.

The dissertation also looks into uncovering the roles of internal capabilities (Leischnig et al., 2014), financial resources (Baltaru et al., 2022), and symbolic reputation (Hazelkorn, 2015) in facilitating collaborations. The findings suggest that symbolic reputation can, in some cases, substitute for other resources, offering a new perspective on resource interdependencies and strategic asset management within organizations.

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This has significant implications for how organizations allocate resources and prioritize investments in building reputation versus enhancing internal capabilities.

Throughout the research, the integration of multiple theoretical frameworks allows for a comprehensive analysis of the phenomena under study. The application of ANT and the Triple Helix Model enriches the understanding of the relational and systemic aspects of university-industry collaborations, emphasizing the importance of networks, stakeholder interactions, and the broader socio-economic environment in shaping outcomes.

Ultimately, this dissertation reaffirms the transformative potential of effective university-industry collaborations. By bridging the gap between academia and industry, fostering innovation, and contributing to economic growth, these partnerships play a vital role in addressing the complex challenges of the modern world and promoting a more interconnected and prosperous global society.

2. Research Implications

This dissertation makes contributions to the theoretical understanding of university-industry collaborations by extending and refining established frameworks. Firstly, the dissertation advances Resource-Based Theory (Barney et al., 2021) by uncovering the complex interplay between internal capabilities, financial resources, symbolic reputation, and collaborative practices within organizations. The research reveals that symbolic reputation can, in some instances, substitute for other resources, such as internal capabilities and financial assets, in facilitating effective collaborations. This challenges the traditional emphasis of Resource-Based Theory on tangible and intangible assets residing within the firm (Aksoy & Beaudry, 2021; Leischnig & Geigenmüller, 2020), suggesting that external perceptions and reputational capital are equally crucial strategic resources. By integrating the concept of symbolic reputation into the theory, the study provides a more holistic understanding of how organizations leverage both internal and external resources to achieve competitive advantage and enhance performance. This extension suggests a possible reevaluation of resource

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hierarchies within the theory and encourages scholars to consider reputation management as a strategic capability.

The incorporation of Actor-Network Theory (Latour, 2007) offers a new perspective on the relational and networked aspects of university-industry collaborations. By emphasizing the interactions between human and non-human actors the research shows how these networks shape the individual behaviors. The findings highlight the importance of individual agency, negotiation, and the co-construction of collaborative relationships within these networks. This contributes to ANT by providing empirical evidence of how actors mobilize networks, translate interests, and stabilize collaborations in the context of higher education and industry partnerships. It highlights the dynamic and emergent nature of networks, suggesting that successful collaborations result from continuous alignment and re-alignment of actors' goals and resources. This perspective enriches theoretical discussions on the fluidity of networks and the role of agency in shaping organizational and innovation processes.

Additionally, applying Evolutionary Economic Theory (Nelson, 1987) within the context of university-industry collaborations, especially in Latin America, extends the theory's applicability beyond its traditional focus on firm-level innovation in developed economies (Nelson & Winter, 2004). By showing how university cooperation can amplify the effects of innovation expenditure on outcomes, the research highlights the evolutionary mechanisms through which collaborative networks contribute to economic development. This highlights the role of universities as catalysts in the innovation ecosystem, influencing the evolutionary trajectory of industries and economies. The findings suggest that evolutionary processes are not solely driven by firm-level activities but are significantly shaped by inter-organizational collaborations and knowledge exchanges, thereby enriching the theory's explanatory power regarding innovation dynamics in diverse economic contexts.

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The application of the Triple Helix Model (Etzkowitz & Leydesdorff, 2000) is also advanced through this research. The model traditionally conceptualizes innovation as the outcome of interactions among universities, industries, and governments (Leydesdorff & Etzkowitz, 1996). By examining these interactions across different regions—such as the UK, EU, and Latin America—the dissertation highlights how the model operates under varying institutional arrangements and socio-economic conditions. The findings suggest that the efficacy of the Triple Helix Model is contingent upon the strength of each helix and the quality of their interactions. For instance, in regions where government support is limited or institutional frameworks are underdeveloped, university-industry collaborations become even more important. This prompts an understanding of the model to account for regional disparities and the need for adaptability in its application. Moreover, by integrating the concept of intangible knowledge transfer and emphasizing the role of academics as key agents, the research adds depth to the model, suggesting that individual actors and micro-level interactions significantly influence macro-level innovation outcomes.

Furthermore, the development of the Unity Index represents an advancement in the field of bibliometrics and scientometrics. By proposing the first idea of a multivariate approach to assessing scientific production, the index addresses the limitations of traditional univariate metrics, such as publication counts or citation numbers. This contributes to theoretical discussions on how academic performance and impact are conceptualized and measured. The introduction of the Unity Index encourages scholars to consider more holistic and integrated approaches in bibliometric analyses, potentially influencing future research on academic assessment and the development of new evaluation frameworks.

3. Managerial Implications

The findings of this dissertation also carry implications for managers in both academic institutions and industry organizations. By showcasing some of the factors that facilitate effective university-industry collaborations, the research offers practical

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guidance for enhancing partnerships, fostering innovation, and achieving mutual benefits.

For university managers and administrators, the research shows the important role they play in creating an environment that supports and encourages academics to engage in industry collaborations. One key implication is the need to re-think academic workloads. High teaching and administrative burdens can impede academics' ability to participate in collaborative projects effectively. Managers should consider strategies to balance teaching, research, and service duties, allowing academics sufficient time and flexibility to engage with industry partners that could bring financial gains. This might involve adjusting teaching loads, providing sabbaticals focused on collaborative work, or reallocating administrative responsibilities.

Enhancing administrative support is another critical area. Providing better administrative assistance can alleviate the logistical and bureaucratic challenges associated with collaborations, such as contract negotiations, intellectual property management, and project coordination. Universities can establish and improve the already existing offices or teams specializing in facilitating industry partnerships, thereby streamlining processes and allowing academics to focus on the substantive aspects of collaboration.

Incentivizing collaborative engagement is essential for motivating academics to pursue industry partnerships. Implementing reward systems that recognize and value collaborative activities—such as considering them in performance evaluations, promotions, and recognition programs—can encourage academics to invest time and effort into these endeavors. Professional development opportunities are also crucial. Offering training and workshops on collaboration skills, including effective communication, negotiation, and project management, can equip academics with the competencies needed for successful engagement with industry.

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Leveraging institutional reputation can help attract industry partners. Managers should strategically promote their university's strengths, areas of expertise, and success stories in collaborations to enhance appeal to potential industry collaborators. Aligning research objectives with industry needs is vital; encouraging academics to focus on industry-relevant challenges and facilitating forums where industry representatives can share their needs and priorities with academic staff can lead to more meaningful and impactful partnerships.

For industry managers and leaders, engaging with academic partners offers numerous benefits for innovation and competitiveness. Identifying mutual interests is a fundamental step. Managers should seek collaborations that align with their organization's strategic objectives and leverage the specialized expertise of academics. Clear articulation of project goals, expectations, and desired outcomes is essential to ensure alignment and mutual understanding.

Facilitating open communication is critical to bridging the gap between theoretical research and practical application. Establishing regular meetings, updates, and open channels of dialogue can ensure alignment, address challenges promptly, and foster a collaborative spirit. Investing in long-term relationships with universities can yield ongoing benefits. Managers should view collaborations as long-term investments rather than transactional engagements.

Providing resources and support—such as financial backing, access to data, or practical assistance—demonstrates commitment to the collaboration and can enhance its success. Understanding academic constraints is important for setting realistic expectations. Recognizing the unique pressures, timelines, and approval processes within the academic environment requires flexibility and patience from industry partners. By accommodating these factors, industry managers can build stronger, more effective relationships with academics.

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Cultivating trust and respect is fundamental to a positive collaboration environment. Building trust through transparency, reliability, and mutual respect fosters open communication and a willingness to address challenges collaboratively. Promoting knowledge sharing by encouraging the open exchange of ideas and information enhances learning and innovation for both partners. Addressing cultural differences—whether organizational, professional, or national—is important to prevent conflicts and misunderstandings. Open discussions about expectations, working styles, and cultural norms can help mitigate potential issues.

4. Limitations and Future Research

4.1. Limitations

While this dissertation provides important insights into the dynamics of university-industry collaborations, limitations should be acknowledged. Firstly, the mixed-methods approach, although robust in capturing both quantitative and qualitative dimensions, may still be subject to inherent biases. The qualitative component relies on semi-structured interviews with a select group of European-based academics, which may not fully represent the diverse experiences and perspectives of all academics engaged in such collaborations. The sample size and selection, while sufficient for exploratory analysis, may affect the transferability of the findings to different disciplines, institutions, and cultural contexts. Qualitative research, by nature, prioritizes contextual richness and in-depth understanding over broad generalization (Lincoln & Guba, 1985; Miles & Huberman, 1994). However, the insights generated from this study offer valuable perspectives that can resonate with similar contexts, particularly where university-industry collaborations involve comparable institutional dynamics and academic engagement processes.

Secondly, quantitative analyses are based on data sourced from secondary databases, even from reputable sources, which makes the research dependent on existing variables and may omit factors not captured in these datasets. Additionally, as the data

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is self-reported and not all the variables are mandatory allowing the universities and firms to be selective in their answers some potential inconsistencies or inaccuracies in the data collection methods of these sources could affect the validity of the results.

Thirdly, the geographical focus on the United Kingdom, the European Union, and Latin America provides valuable regional insights but can limit the applicability of the findings to other contexts. Cultural, economic, and institutional differences in other regions, such as Asia, Africa, or North America, may influence university-industry collaborations in ways not explored in this study.

Additionally, the study predominantly examines the individual role of academics in university-industry collaborations, potentially overlooking the qualitative perspectives of industry partners and policymakers. This focus, while intentional, means that the research may not fully capture the motivations, challenges, and contributions of all stakeholders involved in collaborations.

Lastly, the cross-sectional nature of the research captures a snapshot in time and may not account for the dynamic and evolving nature of university-industry collaborations. Changes in economic conditions, technological advancements, and policy landscapes over time could alter the factors influencing collaborations, which are not addressed in this study.

4.2.Future Research

Building on the findings and acknowledging the limitations of this dissertation, several avenues for future research emerge. Firstly, expanding the scope of the study to include a broader range of geographical regions would enhance the generalizability of the findings of the quantitative section of the dissertation in chapters 4 to 6, . Comparative studies involving universities and industries in Asia, Africa, and North America could provide a more global perspective on collaboration dynamics. Such

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research would help identify universal principles as well as region-specific factors influencing university-industry partnerships.

Secondly, incorporating the perspectives of industry practitioners and policymakers would provide a more holistic understanding of the collaborations. Future studies could employ approaches that include interviews, surveys, or case studies with representatives from industry and government. This would illuminate motivations, expectations, and challenges from all sides, facilitating more comprehensive strategies to enhance collaborations.

Thirdly, longitudinal studies could offer insights into how university-industry collaborations evolve over time. Examining partnerships across different stages—from initiation to maturation—would help identify factors that contribute to the sustainability and long-term success of collaborations. Such research could also assess the long-term impacts of collaborations on innovative outcomes, economic growth, and societal advancement.

Further refinement and validation of the Unity Index present another avenue for future research. Researchers could test the index across various disciplines, institutional settings, and cultural contexts to assess its robustness and applicability. Exploring alternative methodologies, adjusting weighting schemes, or integrating additional metrics could improve the index's accuracy and usefulness in evaluating scientific production.

Additionally, future studies could delve deeper into the impact of emerging technologies on university-industry collaborations. As digital platforms, artificial intelligence, and remote collaboration tools become increasingly prevalent, understanding how these technologies facilitate or hinder knowledge transfer is crucial. Research could explore how virtual environments affect communication, trust-building, and the overall effectiveness of collaborations.

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Moreover, exploring cultural and organizational factors that influence collaborations would enhance the understanding of interpersonal and inter-organizational dynamics. Studies could examine how cultural differences, organizational structures, leadership styles, and communication practices impact the formation and effectiveness of partnerships. This could be particularly relevant in international collaborations involving diverse stakeholders.

Finally, ethical considerations in university-industry collaborations warrant further examination. Future research could address issues related to intellectual property rights, conflicts of interest, academic freedom, and the ethical implications of research commercialization.

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GENERAL CONCLUSION, LIMITATIONS AND IMPLICATIONS

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ABSTRACT

This dissertation explores the multifaceted dynamics of university-industry collaborations. Grounded in interdisciplinary theoretical frameworks, the research investigates how relational dynamics and institutional factors interact to shape the effectiveness of these collaborations across diverse geographical contexts: the United Kingdom, the European Union, and Latin America. Employing a mixed-methods approach that integrates qualitative insights from semi-structured interviews with quantitative analyses using advanced statistical methods and the development of a novel bibliometric tool (the Unity Index), the study uncovers that personal interactions and adaptations by academics are crucial for effective knowledge transfer. It also reveals that universities play a moderating role in enhancing innovation outcomes and that collaborations positively impact universities by strengthening internal capabilities, increasing financial support, and enhancing symbolic reputation. The findings offer valuable insights for academics, university administrators, industry practitioners, and policymakers, highlighting strategies to enhance collaboration effectiveness and foster innovation in an increasingly interconnected global landscape.

Keyword:

University-Industry Collaborations, Knowledge Transfer, Academics, Innovation

RESUME

Cette thèse explore les dynamiques complexes des collaborations entre universités et industries. S'appuyant sur des cadres théoriques interdisciplinaires, la recherche examine comment les dynamiques relationnelles et les facteurs institutionnels interagissent pour façonner l'efficacité de ces collaborations dans divers contextes géographiques : le Royaume-Uni, l'Union européenne et l'Amérique latine. En adoptant une méthodologie mixte intégrant des données qualitatives issues d'entretiens semi-structurés et des analyses quantitatives utilisant des méthodes statistiques avancées ainsi que le développement d'un outil bibliométrique novateur (Unity Index), cette thèse met en lumière l'importance des interactions personnelles et des adaptations des universitaires pour un transfert de connaissances efficace. Elle révèle également que les universités jouent un rôle modérateur en renforçant les résultats en matière d'innovation et que ces collaborations ont un impact positif sur les universités en renforçant leurs capacités internes, en augmentant les soutiens financiers et en améliorant leur réputation symbolique. Les résultats offrent des perspectives précieuses pour les universitaires, les administrateurs universitaires, les praticiens industriels et les décideurs politiques, en soulignant des stratégies pour améliorer l'efficacité des collaborations et favoriser l'innovation dans un paysage mondial de plus en plus interconnecté.

Mots-clés :

Collaboration Université-Industrie, Transfert de Connaissances, Universitaires, Innovation