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Academic researchers' motivations to engage in university–industry collaboration in cross-border regions

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Abstract
More than ever, universities and policymakers are paying attention to faculty members' engagement in industries' projects because university–industry collaboration (UIC) is seen as the key to economic development. However, the UIC differs from country to country, and researchers may have different motivations. This study explored the relationship between university researchers' motivations and varied UIC channels. A questionnaire was administered to the relevant faculty in public universities in two cross-border regions of Portugal and Spain. Drawing on data gathered from 841 researchers, the results reveal differences in these academics' motivations to engage in different channels. Pecuniary motivations (i.e., access to funding and commercialization) drive UIC through joint and contract research, while non-pecuniary motivations (i.e., learning opportunities and access to resources) inhibit cooperation through the same two engagement channels. In addition, joint and contract research involvement also depends on researchers' age, academic status, department size, and field of study. This study provides empirical evidence on the motivations and channels of UIC in two cross-border regions of Portugal and Spain. Furthermore, it presents important results for universities and policymakers who need to increase motivation and improve UIC channels.

Keywords University–industry collaboration · Researchers' motivations · Interaction channels · Academic engagement

JEL Classification I23 · O32 · O33 · O38

1 Introduction

During the twentieth century, the trend towards a knowledge-based society led universities to focus more heavily on economic and social development as part of their mission. The third mission of universities, which includes knowledge transfer and university–industry collaboration (UIC), has gained great relevance in recent years (Martínez-Ardila et al., 2023). This is because it is considered a key element that impacts the economic development of countries (Baldini, 2010).

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Studies on the mechanisms that facilitate UIC have grown substantially (e.g., Minguillo et al., 2015; Oliver, 2022; Perkmann et al., 2013; Wright et al., 2008), becoming a central element of the innovation strategies of most countries and universities (Messeni Petruzzelli & Murgia, 2020; Wang & Liu, 2022). The UIC can be established through different types of interaction, such as joint basic research, contract research, or forms of research-oriented consultancy (Kilian et al., 2015). The results of collaboration can take a variety of forms, from study reports, design artifacts, prototypes, patents, and even spin-offs (Perkmann & Walsh, 2007).

According to some authors (e.g., Audretsch & Belitski, 2021; Cerver Romero et al., 2021; Etzkowitz, 2016), UIC has expanded the involvement of professors and researchers in academic activities that go beyond their traditional functions, extending up to entrepreneurial research and the development of innovations designed to benefit society as a whole. Furthermore, this collaboration has led to a general increase in research productivity among academics (Ponomariov & Boardman, 2010).

However, despite there being growth in UIC studies (e.g., Alexandre et al., 2022; Bamford et al., 2023; Dias & Selan, 2023; O'Dwyer et al., 2023; Schoen et al., 2014; Tian et al., 2022; Vivona et al., 2023), there are still few empirical studies that explore the motivations behind why some researchers engage in this type of collaboration and others do not (Kilian et al., 2015; Martínez-Ardila et al., 2023; Rossoni et al., 2023). Furthermore, little work has been carried out on UIC channels and the factors that possibly act as barriers, that is, that make participation in UIC difficult from the perspective of individual researchers, especially in cross-border regions (Knoll et al., 2021; Mascarenhas et al., 2022). A widely shared conclusion (e.g., Bertello et al., 2022; Freitas & Von Tunzelmann, 2008) is that policies cannot be transferred from one country to another and that in cross-border regions it becomes difficult to reach consensus between countries. In other words, replicating policies at an international level seems to be the perfect way to guarantee that policies will not be able to achieve their objectives (Guan et al., 2006). Therefore, the UIC varies from country to country and researchers may have different motivations.

Here lies the problem statement of this paper which aims to explore the relationship between researchers' motivations and UIC channels in two cross-border regions of Portugal and Spain. In this study, we investigate whether the idea of the entrepreneurial university is reflected in academic researchers' motivations. Drawing upon the study of D'Este and Perkmann (2011), the purpose is to present evidence on the motivational drivers underpinning several forms of engagement with industry, including informal collaboration (i.e., joint research, contract research, and consulting), as well as formal engagement via academic entrepreneurship. We found that non-pecuniary motivations (i.e., opportunities to learn and access to resources) are negatively related to the frequency of UIC through both joint and contract research, while pecuniary motivations (i.e., access to funding and commercialization) positively affect academics' likelihood of engaging with industries through the same two channels.

It is worthwhile noting that our research differentiates from the benchmark study of D'Este and Perkmann (2011) in two different ways. First, while the scope of their research is circumscribed to one single country (United Kingdom–UK), our analysis is based on a sample gathered from two cross-border regions (Northern region of Portugal and Castile and Leon–Spain). This allowed us to increase the generalizability of the findings by expanding empirical research on academic entrepreneurship in Portuguese and Spanish regions, as well as in other countries with similar socioeconomic environments. Second, while D'Este and Perkmann (2011) have found that commercialization appears as the least important motivation for engaging with industry (with

research-related reasons dominating UIC in the UK context), our results have shown exactly the opposite, that is, they revealed that UIC is mostly explained by a commercialization-driven behavior in the two cross-border regions.

This analysis, therefore, contributes to the debate on the entrepreneurial university by shedding light on its microfoundations. Understanding the individual motivational drivers for UIC is important for judging the ultimate organizational and societal implications of the entrepreneurial university (Siegel et al., 2007). Our discussion suggests that undue policy emphasis on academic research obscures the fact that industry engagement often generates considerable benefits for commercialization. We conclude that, given academics' motivations, talk of convergence between scholarship and commerce can be premature, although the interaction between these realms continues to be mutually beneficial.

This work also contributes to the emerging body of literature on informal and collaborative modes of UIC (D'Este & Perkmann, 2011; Grimpe & Fier, 2010; Link et al., 2007). While previous research has often focused on more easily measurable interactions such as patenting, licensing, and academic entrepreneurship, collaboration has remained in the background, with some exceptions (e.g., Alexandre et al., 2022; Bamford et al., 2023; D'Este & Perkmann, 2011; Dias & Selan, 2023; Martinelli et al., 2008; Perkmann & Walsh, 2007; Ponomariov, 2008; Tian et al., 2022). To fill this gap, we explore the drivers of informal interactions, and how they differ from collaborations underpinned by academic entrepreneurship. In doing so, we aimed to shed further light on the following research questions: *How to evidence and capture the impact generated by U–I informal collaboration? How do academic researchers make meaning of engagement and impact?*

In light of the above, our problem statement is extremely important both conceptually and practically because collaborations constitute the majority of U–I interactions. In the context of cross-border regions, this issue is of particular relevance for several reasons. First, collaboration between universities and industries fosters innovation by bringing together academic knowledge and practical expertise. This synergy can lead to the development of new technologies, products, and solutions which benefit both academia and industrial sectors. In this regard, cross-border collaboration expands the pool of resources, ideas, and perspectives, facilitating a more comprehensive approach to research and development. Second, UIC contributes to economic growth by promoting knowledge and technology transfer from academic institutions to businesses. This transfer can generate the creation of new industries, job opportunities, and economic development in cross-border regions. Third, cross-border collaboration allows for the sharing of best practices and the pooling of resources, enhancing the competitiveness of both universities and industries on a global scale. Fourth, UIC also provides students with real-world exposure allowing them to gain practical skills and experiences. This experiential learning is valuable for students and helps bridge the gap between academic knowledge and industry requirements. At this level, cross-border collaborations have the potential to encourage the development of joint educational programs that address the specific needs of the region, producing a workforce with diverse skills.

The article is structured as follows. After this introductory point, we outline the discussion on the entrepreneurial university and show how it raises questions on academics' motivation to engage with industry. Then, the methodology used in the study was explained. In the following section, the results obtained were presented, as well as their discussion against the context of the existing literature. We conclude by discussing implications and limitations and pointing out some future research directions.

2 Theoretical background

2.1 Entrepreneurial university

The role of the university has changed considerably over time (Audretsch, 2014), with open innovation changing how universities promote the dissemination and commercialization of their research to industry and the general public (Beck et al., 2019). Since the creation of Humboldt University, with its focus on academic freedom and independence of inquiry, universities have become more entrepreneurial (Guerrero et al., 2016; Urbano & Guerrero, 2013). They now contribute to open innovation in science and also to responsible research (Chesbrough & Bogers, 2014). The concept that universities are fueling the entrepreneurial ecosystem and driving regional growth is emerging as a popular topic worldwide, as entrepreneurial universities are perceived to act as catalysts for rational and regional economic development (Abreu et al., 2016; Bramwell & Wolfe, 2008).

In many developed countries (e.g., the United Kingdom and the United States), universities are encouraged to contribute to regional and national economic development and assume responsibility for transferring knowledge from academia to industries (Audretsch & Belitski, 2022). This widens the gap between research-led and teaching-led universities in their ability to create and disseminate knowledge as well as to engage with the broader public (Clauss et al., 2018).

The entrepreneurial university concept is now recognized as an important driver for self-development and innovation, and as an appropriate response for success in highly turbulent and unpredictable markets, representing the next step of development in higher education (Sperrer et al., 2016). The entrepreneurial university thus serves as a channel for spillovers contributing to economic and social development through a multi-faceted mission including education, research, and entrepreneurial activities. This mission's outcomes are associated with enhanced production functions such as more human, knowledge, social, and entrepreneurship capital (Brown, 2016).

Policymakers have shown considerable interest in higher education institutions' role in regional entrepreneurship (Cunningham & Menter, 2021; Sánchez-Barrioluengo & Benneworth, 2019), yet most studies on the link between university and entrepreneurship have focused on academic entrepreneurship solely in the form of researchers' involvement in startups (Powers & McDougall, 2005). In the knowledge economy, academic entrepreneurship occurs at the boundaries between diverse academic and professional contexts, but support mechanisms must be in place to pass knowledge across these borders (Urbano & Guerrero, 2013). General theories of entrepreneurship have proposed that entrepreneurs are shaped by contextual influences. University researchers, in particular, can convey information about new opportunities and reduce the uncertainties associated with entrepreneurship, thereby increasing the probability of entrepreneurial activities taking place.

According to Abreu et al. (2016), heterogeneity in the university's objectives, mechanisms of knowledge creation, and dissemination results indicate that not all university managers perceive their organizations to be entrepreneurial, as the degree of engagement with external stakeholders is likely to differ between teaching-led and research-led universities. Universities experiment with several economic and social challenges that require different approaches when aligning entrepreneurial activities with the traditional core university missions (Audretsch & Belitski, 2022). As the university's role in the entrepreneurial ecosystem has changed (Audretsch, 2014), investment in human capital is no longer sufficient to ignite an entrepreneurial ecosystem (Belitski et al., 2019; Isenberg, 2010); instead,

universities are expected to engage in multiple networks with government, spin-offs, students, entrepreneurs, investors, research institutions, science parks, and companies (Miller et al., 2014).

However, three key challenges act as barriers for universities to become entrepreneurial. Firstly, universities may lack an appropriate entrepreneurial culture, which Audretsch (2014) defines as a critical element for the entrepreneurial university. Secondly, most entrepreneurial universities focus on pecuniary benefits (D'Este & Perkmann, 2011), while higher education institutions with different degrees or entrepreneurial profiles should focus on both pecuniary and non-pecuniary goals (Franke et al., 2014; Slaughter & Leslie, 1997). Thirdly, as universities seek market opportunities using formal and informal modes of collaboration, knowledge creation should be followed by its dissemination (Beck et al., 2019).

Despite these challenges, by actively engaging in technology development, universities are ambidextrous in their ability to produce both scientific knowledge and technology outputs (Ambos et al., 2008). For example, in rapidly developing areas such as biotechnology, star scientists excel both as academic researchers and academic entrepreneurs (Zucker & Darby, 1996). In the research conducted by Owen-Smith (2003), the authors reported a convergence towards a hybrid system which establishes an interplay between scientific and technological success. However, some critical voices have been calling attention to the potentially detrimental effects of entrepreneurial science arguing that academic science is being instrumentalized and even manipulated by industry (Krimsky, 2003; Slaughter & Leslie, 1997). Many universities appear to have become knowledge businesses that are focused on providing services to specific stakeholders rather than on generating public goods for national audiences (McKelvey & Holmén, 2009). The perceived risks related to this reality include lower levels of scientific production (Agrawal & Henderson, 2002), a slowing down of open knowledge diffusion (Rosell & Agrawal, 2009), and a shift from basic research towards more applied topics and less academic freedom (Behrens & Gray, 2001).

2.2 University–industry collaboration (UIC)

Knowledge is perceived as a key driver of entrepreneurial alertness and creativity (Meredith & Pilkington, 2018), with knowledge transfer being frequently cited as an objective for businesses, policymakers, and universities (Bamford et al., 2023). Firms in several industries have increasingly accepted the crucial role played by scientific knowledge creation and technological opportunities, seeking alliances to enhance their knowledge base, in the hope of gaining a competitive edge (Bamford et al., 2023).

The open innovation science literature suggests that stimulating knowledge dissemination between researchers, universities, and external stakeholders increases the use of that knowledge (Beck et al., 2019), which can be achieved by focusing on the university's third mission and the quadruple helix (Miller et al., 2014). For this reason, policymakers provide financial incentives to researchers and universities to promote both knowledge creation and dissemination via knowledge spillovers, as well as via direct knowledge transfers between industries and universities (Acs et al., 2013; Link & Siegel, 2005).

From a historical standpoint, university–industry collaborations (UICs) have grown significantly in the past thirty years but have recently accelerated, with an impetus for innovation, technology transfer, and policy development (Bamford et al., 2023; D'Este et al., 2019). This topic is of increasing importance in literature dealing with economic growth and innovation since it refers to UICs as an interaction channel in which both parties benefit

from the transfer of knowledge, expertise, or technology, and the application of research findings to practical problems, scientific questions, or the creation of new research opportunities (Figueiredo & Ferreira, 2022). According to Perkmann et al. (2013), UICs enable universities to leverage their expertise and resources to address practical problems and to develop new technologies, while providing businesses access to cutting-edge research and development capabilities.

Successful UICs have engendered several innovations worldwide, with academia affording a source of creativity and young inventive talent (Siegel et al., 2003), and industry focusing on the development of new products, processes, and services that not only improve the quality of human life but also generate financial returns (Hidalgo & Albors, 2011). Therefore, while previous studies have explored several aspects of UICs, few have addressed the factors behind the success of such partnerships (Rossoni et al., 2023). Some reviews are available dealing with the measurement and evaluation of technology transfer (Autio & Laamanen, 1995), cooperation partners (Mascarenhas et al., 2018), and context perspectives of collaboration processes (Nsanzumuhire & Groot, 2020). Whilst these studies have offered important insights into different facets of UICs, they do not provide a comprehensive overview neither of the types of UICs and forms of collaboration (Rossoni et al., 2023), nor of the pecuniary and non-pecuniary motivations that lead academics to engage with industry (D'Este & Perkmann, 2011; Galati et al., 2020).

2.2.1 Types of UIC and forms of collaboration

According to Perkmann and Walsh (2007), UICs vary considerably with respect to their collaborative relationships, but the most frequently types of interactions described in the literature are some of the following: employment of graduates by companies (Chryssou, 2020; Schartinger et al., 2002), joint publications (Galán-Muros & Plewa, 2016; Schartinger et al., 2002), informal meetings and conversations (Chryssou, 2020; Schartinger et al., 2002), joint supervision of PhD and Master degrees (Galán-Muros & Plewa, 2016; Schartinger et al., 2002), training of company members (Chryssou, 2020; Schartinger et al., 2002), collaborative research and joint research programs (Galán-Muros & Plewa, 2016; Schartinger et al., 2002), contract research and technology-related consulting (Chryssou, 2020; Galán-Muros & Plewa, 2016), use of intellectual property rights (IPRs) by public scientific organizations (Polt et al., 2001), use of university facilities by companies (Galán-Muros & Plewa, 2016; Schartinger et al., 2002), and licensing of university patents by firms (Chryssou, 2020; Schartinger et al., 2002).

Considering the diversity of collaborative interactions and drawing upon the research conducted by D'Este and Perkamann (2011) and Rossoni et al. (2023), this study focuses on UICs established through three main channels: collaborative (or joint) research, contract research, and consulting. It is worthwhile noting that, these types of collaboration have been referred to as informal partnerships (Link et al., 2007) although most of these arrangements tend to be formalized in contracts (D'Este & Perkmann, 2011).

Collaborative (or joint) research refers to formal collaborative arrangements aimed at cooperation on R&D projects (Hall et al., 2001). In some situations, the content of this research can be considered pre-competitive, with these projects being frequently subsidized by public funding (D'Este & Perkmann, 2011). On the other hand, contract research refers to research that is directly commercially relevant to firms and, therefore, is usually ineligible for public support (D'Este & Perkmann, 2011). According to Van Looy et al. (2004), contract research is explicitly commissioned by firms and its results have more

practical applicability than those of the collaborative research arrangements. Consulting, in turn, refers to research or advisory services provided by individual academic researchers to their industry customers (Perkmann & Walsh, 2008). Consulting projects are directly contracted by the industry partner and the income derived from them can be delivered to individuals or it can be channeled through university research accounts to support investigation projects (D'Este & Perkmann, 2011).

Now that the empirical significance of UIC has been established, the question arises as to how UIC relates to the idea of an entrepreneurial university. On the one hand, it could be argued that collaborative forms of engagement constitute just another, less formalized, form of technology transfer that is governed by dynamics similar to patenting and academic entrepreneurship (D'Este & Perkmann, 2011), where academic researchers become active participants in technology development and commercialization (Etzkowitz, 1998). On the other hand, UIC can be governed by a logic that fits into the traditional values of the scientific system (see the elaboration of Merton, 1973 and Polanyi, 2000 [1962]), where collaborative industry engagement benefits academic research through the establishment of relationships with knowledge users and the mobilization of resources which complement public research funding (D'Este & Perkmann, 2011).

In light of the above, in this paper, we seek clarification on the nature of UIC through collaborative (joint) research, contract research, and consulting, by exploring the academic researchers' motivation to engage with industry.

2.2.2 Academic researchers' motivations to engage with industry

According to Mintzberg (1983), universities are professional bureaucracies whose members are relatively free to pursue activities that they believe are in the overall interests of the organization. For faculty members, the decision to work directly with industries depends on whether this collaboration will significantly complement their investigations (D'Este & Perkmann, 2011). Some studies have also shown that university peers' social influence has a quite strong effect on engagement in entrepreneurship (e.g., Meoli et al., 2020; Merida & Rocha, 2021). Cooperation with companies can be an opportunity not only to exchange knowledge but also to obtain financing, have access to new technologies, or engage in prototype creation (Balconi & Laboranti, 2006). However, Lee (2000) reports that university researchers collaborate with firms to advance or complement their research agenda rather than to foster industrial development and innovation. Thus, academics' reasons for participating in UIC, as well as these projects' duration, are strongly correlated with university researchers' subsequent benefits (Lee, 2000).

Scholars investigating academics' motivations to engage with industry usually tend to group them according to their nature. A generally accepted classification categorizes motivations as financial (or pecuniary) and non-financial (or non-pecuniary) (e.g., D'Este & Perkmann, 2011; Galati et al., 2020).

Concerning pecuniary motivations, the deployment of these incentive mechanisms presupposes that academic researchers respond to financial incentives intertwined with the successful commercialization of their ideas (Jensen & Thursby, 2001). This logic is somehow implicit in life cycle theories that maintain that junior researchers focus on building a reputation in academia, while later in their careers they capitalize on their expertise by reaching out to industry (Stephan & Levin, 1992). Another instance is the research conducted by Owen-Smith and Powell (2001). These authors have found support for the idea that academics are attracted by monetary profit. On the one hand, in the life

sciences—where patents have a higher monetary value—researchers resort to patenting to enhance their incomes. On the other hand, in the physical sciences, patenting is less attractive because of lower monetary pay-offs and, therefore, UIC is seen as a way of developing relationships with firms, having access to equipment, and exploiting other research-related opportunities (Owen-Smith & Powell, 2001).

Furthermore, in the academic context, the literature also highlights that a researcher may create an academic spin-off to pursue higher profits and generate personal payoffs (D'Este & Perkmann, 2011) to supplement their relatively low remuneration (Novotny, 2014). Therefore, the expected benefits from commercialization play an important role in determining an academic's engagement with industry (D'Este & Perkmann, 2011; Galati et al., 2020; Phan & Siegel, 2006).

At the same time, other contributions suggest that working with industry is not necessarily underpinned by entrepreneurial intentions to respond to economic opportunities. In particular, D'Este and Perkmann (2011) concluded that universities should focus on non-monetary incentives to foster academic entrepreneurship. Confirming previous studies (e.g., Baldini et al., 2007; Morales-Gualdrón et al., 2009), these authors have argued that the motivations specific to the academic sector are regarded as more important than financial factors. In a similar vein, Lam (2011) stressed that financial motivations are of secondary importance when compared to reputational or intrinsic ones.

Based on the above, D'Este and Perkmann (2011) highlighted the role of professional development and learning in motivating academics to engage with industry. Specifically, learning meant access to information on industry problems and industry research, and the possibility to become part of a network. They found that academics are also motivated by the opportunity to apply research, which in turn generates feedback from the industry. Even if academics fear that UICs may threaten their intellectual freedom, such partnerships create new opportunities (Galati et al., 2020). In addition to financial resources, other types of resources can be obtained from industrial partners, such as information, skills, or technologies (Huszár, Pronay, & Buzas, 2014), as well as access to laboratory equipment provided by industry, materials, and data for research (D'Este & Perkmann, 2011).

Our review of the literature on the academic researchers' motivation to engage with industry reveals discordance between the two groups. While the first group (pecuniary motivations) emphasizes researchers' utility-maximizing commercialization behavior, the second one (non-pecuniary motivations) finds that academics operate in a strongly institutionalized environment sporting science-specific norms and values (D'Este & Perkmann, 2011). The former group, therefore, argues that researchers collaborate with industry to pursue commercialization while the latter believes that academics pursue industry engagement to support their research.

In light of the above, we developed an exploratory study to clarify which type of UIC is driven by pecuniary (commercialization-driven behavior) and non-pecuniary (research-driven behavior) motivations. We present results from a unique dataset, collected from two cross-border regions at the North of Portugal and Castille and Leon universities, which is distinct in two ways. Firstly, previous research presents evidence of industry engagement based on academics' attitudes but does not connect them with actual collaboration (Galati et al., 2020). Thus, instead of looking at the attitudinal aspects of these partnerships, we are focused on exploring the academics' motivations to engage in actual collaboration which includes collaborative (joint) research, contract research, and consulting. Secondly, while existing studies emphasized specific types of academic industry involvement, such as patenting, licensing, and academic entrepreneurship (e.g., Owen-Smith & Powell, 2001; Phan & Siegel, 2006), we have data on a whole range of different UIC channels, which allows

performing a holistic and complete comparison between classic and informal collaboration modes.

2.3 Cooperation in cross-border regions

Cross-border regions can be seen as a territorial unit "that has historical, socio-economic and cultural commonalties, as well as, at least tentatively, its own regional identity and autonomous [political and social] institutions and therefore claim an autonomous definition of its needs and interests which it is capable to articulate and defend" (Raich, 1995, p. 25). Perkman (2003, p. 157) states that cross-border regions are "bounded territorial units composed of the territories of authorities participating in a cross-border cooperation initiative".

In recent years, the number of studies has increased, showing that cross-border cooperation programs can become the driving force for the empowerment of local and regional communities in the face of nation-state dominance (Mascarenhas et al., 2022; Nadalutti, 2014). For example, in Europe with the abolition of borders, there have been several incentives for cross-border cooperation with the aim of greater European integration (Perkmann, 2003). Since the 1960s, the European Union has actively tried to encourage networking and active involvement of public authorities and political institutions, especially in homogeneous territories with functional interdependencies (Gualini, 2003). In 1980, in the Madrid Convention, concluded by the Council of Europe, cross-border cooperation activities were defined as "any concerted action designed to reinforce and foster unneighborly relations between territorial communities and authorities within the jurisdiction of other Contracting Parties and the conclusion of any agreement and arrangement necessary for this purpose" (Council of Europe, 1980). In 1990, a community initiative (Interreg) was created by the European Commission to encourage and support cross-border cooperation, which in the period from 2000 to 2006 had a budget of 4875 billion euros (1999 prices). Interreg subsidizes local cross-border projects carried out in collaboration between local authorities and other organizations located in adjacent border areas. The objective is to develop cross-border social and economic centers through common development strategies, and eligible projects must have a structural economic benefit for the border area.

In the case of the US and Mexico, there is a narrow strip of Mexican territory immediately adjacent to the US border that has been declared a Special Economic Zone by the Mexican government (Perkmann & Sum, 2002). Similarly, the remarkable dynamics of the "Greater China" cross-border region (composed of Singapore-Johor-Riau) were triggered by the establishment of Special Economic Zones in Southern China, with subsequent public–private coordination in the region (Perkmann & Sum, 2002).

According to Perkmann (2003), cross-border cooperation is important to solve practical problems and create greater political, economic, and cultural cohesion among local actors involved in cooperation activities. Local actors involved in cross-border networks have greater responsiveness to generate targeted development projects (Church & Reid, 1999).

3 Methodology

3.1 Data collection and sample

A large-scale survey was conducted in public universities to obtain information for the present study on academics' motivations to engage with industry. To develop this study,

the territories of Northern Portugal and Castile and Leon (Spain) were selected as they are cross-border territories with collaborative practices. Furthermore, in recent years these two regions have had several projects financed by the Transborder Cooperation Operational Program (POCTEP-Interreg) with the support of the European Union. According to Mascarenhas et al. (2022), in 2019, the Northern region's gross domestic product (GDP) represented 29.5% of the national GDP. In a five-year timeframe (2014–2019), this region's economic growth has exceeded Portugal's average. Companies are the main drivers of innovation with 65.0% of the Northern region's businesses engaged in innovation-related activities. Of these firms, 24.5% used public funding, and 13.8% were involved in collaboration to generate innovation (Onnerfors et al., 2019).

However, while the Northern region has been showing an increase in its innovation performance, which has earned it a rating of strong innovator, the Castille and Leon's region has been rated as a moderate innovator, with its innovation performance decreasing in recent years (Mascarenhas et al., 2022). Therefore, this cross-border region represents a relevant setting for research allowing us to conclude UICs based on two geographical areas with varying levels of research and innovation performance.

The questionnaire was distributed to 4095 academics in research centers in the North region of Portugal and the Castille and Leon region in Spain, between March 2018 and March 2019 with an average duration of 20 min. By the end of the data collection period, 841 valid questionnaires had been obtained from 464 Spanish and 377 Portuguese researchers (response rate = 20.5%). To collect the data, an email with the questionnaire link was sent to Portuguese and Spanish Professors with the help of the research centers and research offices of the respective Universities.

Based on the findings reported in the extant literature (e.g., D'Este & Patel, 2007; D'Este & Perkmann, 2011), the current survey focused on two categories of information. The first was the frequency of faculty members' engagement in UICs in three different channels (i.e., joint research, contract research, and consulting activities). The second category was the respondents' reasons for cooperating with industries with regard to pecuniary and non-pecuniary incentives. These researchers were involved in projects in six different fields: the exact and natural sciences, engineering and technology, agricultural sciences, medical sciences, social and human sciences, and sports (Table 1). The data were analyzed using ordered logistic regression with different UIC channels as the dependent variables. SPSS Statistics 28.0 software facilitated the data processing.

3.2 Variables

3.2.1 Dependent variable

This study included three target variables to explore the frequency of academics' engagement in UIC using three channels: joint research, contract research, and consulting activities. The respondents answered the following question: "How frequently did you engage in the following types of activities from 2014 to 2017?" They were given a choice of five intervals: "None," "Once or twice," "3–5 times," "6–9 times," and "10 times or more." This scale was developed based on D'Este and Perkmann's (2011) work, and the answers were coded with values ranging from 0 to 2: 0 if the researcher was not involved in any type of activity, 1 if the researcher engaged in one or two times in a relevant activity, and 2 if the researcher participated three or more times in a UIC-related activity (see Table 5). There is little overlap among these channels, while a positive and significant correlation

Table 1 Characterization of the sample

		Portugal		Spain	
		N	%	N	%
Sample		377	–	464	–
Gender	Feminine	138	36.6	246	53.0
	Male	239	63.4	218	47.0
Age	Average	49.5	–	49.6	–
Professional category	Assistant Professor/Researcher	220	58.4	80	17.2
	Associate Professor/Researcher	89	23.6	115	24.8
	Lecturer/Researcher	44	11.7	157	33.8
	Other (contract and post-doc)	24	6.4	112	24.1
Service time	< 5 years	16	4.2	50	10.8
	6–10 years	21	5.6	35	7.5
	11–15 years	28	7.4	41	8.8
	16–20 years	64	17.0	68	14.7
	21–25 years	101	26.8	101	21.8
	26–30 years	79	21.0	84	18.1
	> 30 years	68	18.0	85	18.3
Scientific area	Natural sciences	90	23.9	46	9.9
	Engineering and technology	125	33.2	102	22.0
	Agrarian sciences	54	14.3	80	17.2
	Medical sciences	32	8.5	99	21.3
	Social and human sciences	58	15.4	25	5.4
	Sport	18	4.8	112	24.1

exists between each of them; Spearman correlation coefficients range from 0.18 to 0.39. Since our dependent variables are discrete and ordered, we used ordered logit models for our estimations.

The UIC channels used by the highest percentage of researchers were joint research (76.6%) and contract research (72.7%). In addition, more than half of the academics surveyed reported using each of these two channels at least one time in the timeframe considered.

3.2.2 Independent variables

Academics' motivations for interacting with industries were included as explanatory variables. These motives were derived from the participant's responses to the next item: "Please rank the following reasons for getting involved in industries' projects according to their importance.". The respondents scored the importance of each motivation on a 5-point Likert scale ranging from 1 ("Not important") to 5 ("Extremely important"). The reasons scale was adapted from D'Este and Perkmann's (2011) study. Eleven indicators were included: (1) research funding from industries, (2) research funding from governments, (3) information on industries' problems, (4) information on industries' research, (5) feedback from industries, (6) applicability of research, (7) opportunity to join networks, (8) access to materials, (9) access to research expertise, (10) access to equipment, and (11) opportunities

to acquire IPRs. We carried out a factor analysis (principal component analysis–PCA) on the eleven items to evaluate if they correspond to more general motivations for academics to engage in UIC. We then used these factors—which we labeled as motivations—as independent variables (see Table 6).

As mentioned previously, each target variable was regressed concerning the extent to which the respondents assessed the motivations as important. Following D'Este and Perkmann's (2011) example, the importance attributed to specific kinds of motivations was measured based on the mean scores assigned to each reason for engaging in UIC. For instance, the non-pecuniary motivations comprised three items, so the average score was the average of these three indicators. Each item on the survey was measured on a 5-point Likert scale, which meant that the pecuniary and non-pecuniary motivations' scores also ranged between 1 ("Not important") and 5 ("Extremely important").

3.2.3 Control variables

The control variables reflect the individual characteristics of academics and their organizational environments. Drawing on previous studies (e.g., D'Este & Perkmann, 2011; Perkmann et al., 2021), to control the effects of individual experience and career stage on academic engagement, we included two variables: (1) researchers' age, and (2) academic status (i.e., the researcher professional category). Furthermore, since the organizational environment also influences the extent to which researchers engage with industry (e.g., Belkhodja & Landry, 2007; D'Este & Perkmann, 2011; Feldman et al., 2002; Perkmann et al., 2021), the size of the department to which academic is affiliated was included in the analysis, measured by the average annual budget for R&D available to the department. Finally, we also included scientific disciplines and regional location, measured using dummy variables, to control for differences across research fields and geographical positions.

3.3 Non-response and common-method bias

To test for non-response bias, the responses of early and late respondents were compared to all the variables included in our analysis and a set of control variables: researchers' age, academic status, size of the department, and the scientific disciplines (Armstrong & Overton, 1977). Then a paired sample *t*-test was performed on those variables; the results showed that there were no significant differences between those two groups of respondents. Accordingly, we believe that non-response bias was not an issue in our study (Armstrong & Overton, 1977).

Self-selection bias was also assessed because we are exploring the researchers' motivations to interact with industry. Since we do not account for why researchers decide to pursue UICs, our results could be distorted by sample bias. To address this issue, we followed the procedures recommended by Manning et al. (1987) performing a two-stage regression model. In the first stage, we ran a logit model with the dependent variable for whether a researcher engaged with industry or not. Similarly to D'Este and Perkmann (2011), we included 16 independent variables to capture the perceived barriers[1] to engaging with

[1] The 16 barriers are dummy variables which take the value 1 if the respondent assessed the barriers as very, or extremely important. The 16 barriers are: ignorance of academic research by industry; lack of interest in academic research; lack of established procedures for collaboration with industry; difficulty in sharing joint research results; limited professional networks; difficulty in obtaining research results; potential conflicts with industry regarding royalty payments for patents or other IPRs; complexity in administrative

industry, and some individual and departmental features. From this model, we estimated the predicted probability for each individual to engage with the industry. In the second stage, we used the frequency of engagement in several channels as dependent variables (see Sect. 3.2.1), using the ordered logit regressions.

We also mitigated any possible issues caused by gathering most of the data from a single source by using several procedures when designing the questionnaire (Podsakoff & Organ, 1986; Podsakoff et al., 2003). For instance, the alignment of the questions in the survey did not follow the reasoning of our exploratory study, and the respondents were not informed about the targeted relationships. On the other hand, the questionnaire had a large number of questions that measured more variables than those in this study, as our investigation was part of a larger research project (Siemsen et al., 2010). Additionally, the respondents were informed in the invitation email and, also, on the initial page of the questionnaire about the anonymity of the respondent, as well as guaranteeing the confidentiality of the responses (Podsakoff & Organ, 1986; Podsakoff et al., 2003).

Nevertheless, two additional post-hoc procedures were performed to ensure that common method bias was not an issue. First, we performed Harman's (1976) single-factor test that comprised all the variables into an unrotated exploratory factor analysis (EFA). With this procedure, we found 14 factors that had eigenvalues above 1. They explained 62% of the variance. The first factor was only responsible for explaining 31% of the variance, which is way below the threshold of 50% suggested by Podsakoff et al. (2003). Second, the correlations between variables were also examined (see Table 6). Common method bias is an issue when any correlation is above 0.90 (Bagozzi et al., 1991). The present study's correlations are below the recommended limit. Consequently, the results of both tests support the conclusion that common method bias was not a significant problem in this research.

4 Results

4.1 Classifying the motivations for interacting with industry

Table 2 presents the descriptive statistics for the different incentives by field of study to indicate the percentage of academics assessing an incentive as "Very important" or "Extremely important" (i.e., scores of 4 and 5, respectively). Two aspects of the results are of particular interest. First, significant variation exists in the items researchers classified as important. A full 88.6% of the respondents rated the research's applicability as extremely relevant, but only 23.9% rated access to research expertise as equally important. Opportunities to join networks were considered essential by 42.2% of the researchers surveyed, suggesting that establishing contacts was a much less important reason than others for engaging in UIC. Second, academics' motivations varied significantly according to their fields, but most respondents—regardless of their area of research—valued funds from

Footnote 1 (continued)

hiring procedures; difficulty in establishing contacts with individuals in the industry; lack of adequate government funding for joint research; industry imposes delays in the dissemination of research results and publications; firms with limited capability to assimilate research results; difficulty in finding firms with an appropriate profile (e.g., highly innovative partners); lack of financial resources by firms; lack of mutual understanding about work experiences and priorities; high staff turnover. The results of the first-stage logistic regressions are available on request.

industries, opportunities to join networks, opportunities to acquire IPRs, feedback from industries, access to materials, access to research expertise, and access to equipment.

A factor analysis was conducted on the eleven items described in Sect. 3.2.2. The results provided two factors that could be used as independent variables (see Table 3). The first comprised eight items related to opportunities to learn and gain access to resources arising from industries' projects, which were labeled "non-pecuniary motivations." The second factor included three items connected to access to funding and commercialization opportunities derived from UIC, which were termed "pecuniary motivations" (PCA results are reported in Table 7). It is worth noting that this classification is consistent with the categorization of motivations as financial (pecuniary) and non-financial (non-pecuniary) as proposed by D'Este and Perkmann (2011) and Galati et al. (2020).

These factors also had values of Cronbach's alpha (α) above the threshold of 0.60 recommended for exploratory research (Hair et al., 2019), allowing us to proceed with the analysis. A first evaluation of the results shows that non-pecuniary motivations are related to supporting academics' research, while pecuniary motivations are aimed at deriving economic benefits from research. We look at the implications of this in the discussion section.

4.2 Relationship between types of motivation and UIC channels

The factor analysis identified two independent motivations for academics to interact with industries. Regression analysis was subsequently conducted to evaluate these motivations' impact on UIC using three different channels: joint research, contract research, and consulting activities (see Table 4). Drawing upon D'Este and Perkamann (2011) and Rossoni et al. (2023), we focused on these types of collaboration because they are usually referred to as informal partnerships (see discussion provided in Sect. 2.2.1).

Pecuniary and non-pecuniary motivations have a distinct influence on the frequency of interactions across these channels. On the one hand, non-pecuniary motivations (i.e., opportunities to learn and access to resources) are negatively correlated with higher levels of UIC involving joint research ($\beta = -0.098$; $p < 0.05$) and contract research ($\beta = -0.159$; $p < 0.001$), but these reasons do not have a statistically significant effect on engagement via consulting activities ($\beta = -0.026$; n.s.). This means that researchers who regard non-pecuniary motivations as particularly important engage less frequently in joint and contract research. In the benchmark study of D'Este and Perkmann (2011), *learning* motivation was positively associated with higher frequencies of industry engagement in joint research, contract research, and consulting activities. The cited authors also confirmed that *access to in-kind resources* negatively influences academics' level of engagement with industries through contract research, consulting activities, spin-offs, and patenting of results, as well as having a non-significant impact on UIC via joint research. The present study's results unexpectedly contrast with those reported by D'Este and Perkmann (2011) as both non-pecuniary motivations (i.e., opportunities to learn and access to resources) hurt academics' frequency of engagement in UIC based on both joint and contract research.

On the other hand, pecuniary motivations (i.e., access to funding and commercialization) are positively associated with joint research ($\beta = 0.308$; $p < 0.001$) and contract research ($\beta = 0.186$; $p < 0.001$), yet these reasons have no significant impact on the frequency of UIC based on consulting activities ($\beta = 0.078$; n.s.). These results suggest that academics attributing more relevance to pecuniary motivations engage more frequently in joint and contract research. In this regard, D'Este and Perkmann (2011) highlighted two main findings: (1) *commercialization* as a main motivation was positively associated with

Table 2 Percentage of researchers assessing motivation indicators as very or extremely important (four and five on the Likert scale)

	Exact and natural sciences	Engineering and technology	Agricultural sciences	Medical sciences	Social and human sciences	Sport	Total
Research income from industry	70.8%	70.6%	54.9%	57.4%	53.1%	71.1%	71.8%
Research income from government	75.0%	71.6%	75.0%	73.0%	51.6%	75.4%	71.8%
Information on industry research	65.8%	63.5%	64.7%	64.3%	67.2%	71.1%	65.7%
Information on industry problem	74.2%	73.5%	71.6%	61.7%	73.4%	77.2%	72.0%
Becoming part of a network	39.2%	40.3%	49.1%	48.7%	39.1%	36.8%	42.2%
Seeking IPRs	41.7%	45.9%	57.8%	53.0%	35.9%	56.1%	48.9%
Applicability of research	88.3%	90.0%	89.7%	88.7%	82.8%	88.6%	88.6%
Feedback from industry	63.3%	71.6%	84.5%	78.3%	54.7%	63.2%	70.5%
Access to materials	50.8%	48.8%	67.2%	60.9%	45.3%	47.4%	53.4%
Access to research expertise	18.3%	21.8%	38.8%	30.4%	21.9%	13.1%	23.9%
Access to equipment	52.5%	50.2%	52.6%	58.3%	46.9%	35.9%	49.7%
Number of observations	120	211	116	115	64	114	740

The total number of observations slightly varies from the initial value of 841 due to missing values

Table 3 Summary of factor analysis results. *Source* Based on D'Este and Perkmann (2011) and Galati et al. (2020).

Items	Taxonomy of motivations	
Access to research expertise	Access to resources	Non-pecuniary motivations
Access to equipment		
Access o materials		
Feedback from industry	Learning	
Becoming part of a network		
Information on industry problems		
Information on industry research		
Applicability of research		
Research income from industry	Access to funding	Pecuniary motivations
Research income from government		
Seeking IPRs	Commercialization	

Table 4 OLR results for the relationship between academic motivations and frequency of interaction

	Joint research	Contract research	Consulting
Non-pecuniary motivations	−0.098(+) (0.039)	−0.159*** (0.038)	−0.026 (0.037)
Pecuniary motivations	0.308*** (0.042)	0.186*** (0.041)	0.078 (0.040)
Researcher Age	0.010(+) (0.005)	0.002 (0.004)	0.008 (0.004)
Academic status	−0.092(+) (0.039)	0.062 (0.038)	−0.079(+) (0.036)
Department size	0.331*** (0.065)	0.133(+) (0.065)	0.313*** (0.064)
Exact and natural sciences	–	−0.326(+) (0.149)	–
Engineering and technology	–	−0.380** (0.133)	–
Agricultural sciences	–	−0.622*** (0.152)	−0.334(+) (0.151)
Medical sciences	–	−0.508*** (0.151)	–
Social and human sciences	–	−0.367(+) (0.178)	–
Sport	–	−0.500** (0.154)	–
Regional dummies	Included	Included	Included
Number of observations	841	841	841
Likelihood ratio chi-square	140.089*** (12)	140.099*** (12)	87.829*** (12)
Pseudo R^2 Nagelkerke	0.186	0.166	0.107

Target variables: frequency of engagement in the three channels. Two-tailed *t*-test with *p*-values significant at: $+p<0.05$; $**p<0.005$; $***p<0.001$. The values in brackets represent the standard errors. For scientific fields, only statistically significant coefficients are included. The likelihood ratio chi-square test has a *p*-value below the significance level of 5%, which means that the joint significance and the coefficients are significantly distributed asymptotically as $\chi 2$ under a null hypothesis without significance, with degrees of freedom in parentheses

consulting activities but showed no significant relationship with frequency of engagement in joint and contract research; (2) the *access to funding* motivation was positively

associated with higher frequencies of industry engagement in joint research, contract research, and consulting activities. Based on this evidence, we conclude that our results addressing pecuniary motivations are somehow consistent with those of the benchmark study of D'Este and Perkmann (2011).

To summarize, these results allow us to address our problem statement by highlighting that most academics develop industry partnerships to enhance their revenue (through commercialization) and to further their research (through access to funding). We found that, in an Iberian cross-border setting, UIC informal collaboration—represented by joint and contract research—is mostly explained by a commercialization-driven behavior. In other words, although academic researchers attribute financial and non-financial meanings to UIC, they rank non-pecuniary motivations as the least important reasons for engaging with industry while financial-related motivations dominate.

The findings for the control variables also reveal that researchers belonging to larger departments tend to engage with industries across various channels: joint research ($\beta = 0.331$; $p < 0.001$), contract research ($\beta = 0.133$; $p < 0.05$), and consulting activities ($\beta = 0.313$; $p < 0.001$). Only a few previous studies have considered how the quality of university environments influences academics' engagement in UIC, and these investigations have used different measures. The latter include the relevant universities' investigation intensity (i.e., no effect on the frequency of engagement through commercialization) (Johnson et al., 2017), research intensity rank (i.e., no impact on various interaction channels) (Libaers, 2014), and department quality index (i.e., a positive effect on different channels) (Schuelke-Leech, 2013). Perkmann et al. (2021) argue that these inconsistent findings are due to the diverse measures employed to assess the same dimension. The present results thus contribute to clarifying this issue by revealing that department size measured as the average annual R&D budget increases the frequency of UIC through three interaction channels (i.e., joint research, contract research, and consulting activities).

In addition, being an older researcher has a positive influence on the frequency of UIC through joint research ($\beta = 0.010$; $p < 0.05$), but a higher academic rank negatively affects the frequency of engagement with industries based on joint research ($\beta = -0.092$; $p < 0.05$) and consulting activities ($\beta = -0.079$; $p < 0.05$). Academic engagement with industries is usually linked to personal contacts, and older and more experienced academics are more likely to have larger networks that enable them to find industry partnerships (Haeussler & Colyvas, 2011). Networks' effects reinforce UIC by positively influencing academics' attitudes toward industries and these researchers' cooperative behavior (D'Este & Patel, 2007; Perkmann et al., 2013).

Some variation was also detected by fields of study. For example, faculty members focused on the agricultural sciences are less likely to engage in contract research ($\beta = -0.622$; $p < 0.001$) and consulting activities ($\beta = -0.334$; $p < 0.05$). Similarly, the findings also showed that academics specializing in the exact and natural sciences ($\beta = -0.326$; $p < 0.05$), engineering and technology ($\beta = -0.380$; $p < 0.005$), medical sciences ($\beta = -0.508$; $p < 0.001$), social and human sciences ($\beta = -0.367$; $p < 0.05$), and sports ($\beta = -0.500$; $p < 0.005$) are less likely to engage in contract research. The data on researchers in all the other fields, however, did not show a significant relationship between the area of research and the frequency of UIC through joint research.

In light of the above, we conclude that the reported findings are inconsistent with the extant literature. For example, Abreu and Grinevich (2013) report that United Kingdom academics conducting research in engineering, business, and media are the most actively engaged in consultancy. Thrusby and Thursby (2011) further found that United States faculty members working in biotechnology and nanotechnology participate more often in UIC

than their counterparts in other academic fields. A plausible explanation for the current results is that academic researchers focusing on the hard sciences may engage more often with industries. In these fields, breakthroughs produce a higher degree of tacit knowledge, so researchers must directly collaborate with industries rather than merely mediate knowledge transfer.

Finally, to confirm that these results are empirically robust, supplementary analyses were conducted using different measures for the target variables. As suggested by D'Este and Perkmann (2011), dummy dependent variables were introduced, and logistic regressions were run (see Tables 8 and 9). The results are similar to those shown in Table 4. Because the information was collected with a one-wave survey, the results cannot provide conclusive answers about the direction of causality. Nevertheless, previous studies have reported that motivations are more likely to determine the frequency of engaging in a specific behavior than vice versa (e.g., D'Este & Perkmann, 2011; Galati et al., 2020; Perkmann et al., 2021; Rossoni et al., 2023), so, in the present study, better results would most likely be obtained by exploring the relevant relationships' direction based on motivations to use UIC channels.

5 Discussion and implications

This study explored what motivates researchers to interact with industries through different channels. Two main incentives for UIC were identified: non-pecuniary (i.e., opportunities to learn and access to resources) and pecuniary (i.e., access to funding and commercialization). One of these factors reflects a research-driven behavior (non-pecuniary motivations) and the other is a commercialization-driven behavior (pecuniary motivations). Our results suggest that most academics engage with industry to increase their income (through commercialization) and to further their research (through access to funding); in other words, U–I partnerships are mostly driven by pecuniary motivations.

Previous studies have shown that cooperating with industries offers university faculty various advantages. Researchers can gain access to state-of-the-art techniques (Santoro, 2000), new equipment (Acworth, 2008), feedback from practitioners on findings (Arvanitis et al., 2008), new ideas for future investigations, and inspiration for ways to solve problems (Lee, 2000; Welsh et al., 2008). Despite these benefits, academics' motivations to engage in UIC can be weakened by institutional and/or organizational barriers (Franco & Haase, 2015). Among the most frequently cited is the lack of organizational support for or encouragement of faculty members' interactions with industries because academics have to adapt their projects to match the knowledge transfer mechanisms associated with UIC (Debackere & Veugelers, 2005). Insufficient resources are available for those wishing to interact with private businesses, which also frequently stops academics from initiating university–industry partnerships (Mudambi & Swift, 2009; Siegel et al., 2003).

In light of the above, the fact that non-pecuniary motivations are negatively related to most forms of UIC requires further comment. The channels of engagement underpinned by research-related motivations, particularly, learning and access to resources, are all based on direct collaboration with industry partners, which suggests that academic research interests benefit most from highly interactive, bench-level relationships with firms. In this regard, the items related to learning motivation refer to the expected benefits from gaining new insights, receiving feedback on research, and accessing new knowledge through engagement with the industry. These benefits are likely to arise from an important yet often

under-appreciated aspect of public research (D'Este & Perkmann, 2011). Thus, the present research's findings on the negative effect of opportunities to learn and access resources at UIC could be explained by the institutional obstacles Iberian universities put in the way of academics who try to increase their engagement with industries using different channels.

On the other hand, pecuniary motivations (i.e., access to funding and commercialization) were found to have a positive relationship with both joint and contract research, which matches previous studies' results (e.g., Ankrah et al., 2013; Lam, 2007; Welsh et al., 2008). Shortages in public funding can affect UIC by triggering a search for complementary resources to finance academic research (Ankrah et al., 2013; Lam, 2007). Lee (2000) conducted a study of United States Science and Engineering University faculty members, which confirmed that the most significant driver of UIC is obtaining funds for research activities. D'Este and Perkmann (2011) carried out a similar investigation that showed that researchers who consider access to funding especially important tend to engage more frequently in joint research, contract research, and consulting activities.

The expected benefits of commercialization may also be an antecedent of UIC in two different ways (D'Este & Perkmann, 2011; Phan & Siegel, 2006). First, commercialization (i.e., technology transfer) can occur due to academic entrepreneurship, which may produce startups that commercially exploit a patented invention or accumulations of unpatented expertise (Shane, 2004). Second, commercialization is further linked with industries' exploitations of academics' inventions to gain financial returns (Perkmann et al., 2013). Despite the evidence found of universities' entrepreneurial activities, a tension appears to exist between commercialization and academics' motivations to conduct research. According to D'Este and Perkmann (2011), faculty members participate in commercialization interactions with industries because these researchers are interested in receiving personal payoffs from their knowledge and technologies' practical applications. However, the cited authors also emphasize that academics do not appear to derive significant research-related benefits from this entrepreneurial behavior.

5.1 Theoretical contribution

Conceptually, the ultimate implication of our findings in the UIC setting is that the focus of economic opportunity recognition is largely limited to academic researchers who pursue academic entrepreneurship for economic reasons. This may lie with industry partners with whom they contract or undertake joint research. This means that most, if not all, academics are motivated more by the pursuit of economic opportunity than by finding solutions to interesting problems. Thus, the current findings contribute to deepening the existing knowledge about how academics' motivations for participating in industries' projects influence the frequency with which these researchers engage in joint research, contract research, and consulting activities. This contribution is extremely important because this study explored UIC from a university management perspective rather than that of industries (e.g., Alexandre et al., 2022; Bamford et al., 2023; Tian et al., 2022). University–industry links assume distinct forms and a larger proportion of researchers are involved. The present findings also indicate that academics' engagement in UIC is a multi-level phenomenon that is influenced by individual faculty members' characteristics and organizational and institutional contexts. The results regarding the microfoundations of these researchers' participation in industry projects highlight that academics can redirect their career trajectories to include entrepreneurial activities facilitated by these partnerships.

5.2 Implications for practice

On a more practical level, higher education institutions also need to integrate financial incentive systems for commercialization into general policies that encourage collaboration with industry. The results of this study will provide university authorities with information about the human capital (e.g., employees, academics, researchers, and students) that constitute potential entrepreneurs. Universities should therefore develop a range of policies, structures, and cultures aimed at reinforcing better methods of quality education and training, based on the personal growth that supports the creativity and entrepreneurial experience. The impact on industry is also reflected in the need for strong cooperation agreements between universities and industry. Small and medium-sized enterprises (SMEs) in particular need these mechanisms to survive in the competitive environment, as their main strategic advantages in the new economy lie in knowledge and human capital. Although universities produce ideas and skilled workers, the industry has the economic resources to transform those ideas into economically useful products.

Furthermore, higher education institutions need to focus on developing research known for its excellence, reaching a critical mass in the relevant areas of specialization, and using different types of UIC to attain organizational goals. Public universities tend to be more oriented toward practical and applied investigations, so researchers' pecuniary motivations (i.e., access to funding and commercialization) are particularly significant drivers of academics' engagement in industry projects. However, universities face a twofold challenge in UIC. On the one hand, they struggle to combine academic research agendas more effectively with practical applications. On the other hand, these institutions also have difficulty ensuring academics' active involvement in joint research projects with industries.

Another implication can also be found at the university department level. The present results confirm that department size has a leveraging effect on faculty members' frequency of engagement in joint research, contract research, and consulting activities, so smaller department heads must focus more strongly on academic entrepreneurship to encourage their researchers to establish industry partnerships. At this level, more effort should be made to record and share showcase stories of successful academic entrepreneurs. Department heads need to encourage the simultaneous development of entrepreneurial support mechanisms and an entrepreneurial culture within their department.

5.3 Implications for policymakers

In terms of policy, the insights provided by this study's findings can also help policymakers understand what motivates academics to interact with industries. Overall, this research confirms what the existing literature has stressed—the role of pecuniary motivations (e.g., D'Este & Perkmann, 2011; Novotny, 2014; Phan & Siegel, 2006)—so incentives to encourage UIC should center around providing financial support. Government agencies have made concerted efforts to increase academics' engagement in UIC, but, if policymakers want to increase academic research's applicability through joint projects with industries, universities, and companies both need to be given the skills to initiate and maintain these collaborations. When cooperating with the best academic researchers, firms have to be more fully aware that these faculty members will only work with them if their academic career is strengthened as a result. In addition, policymakers can reduce UIC's transaction costs by generating guidelines or standard contracts to support both partners during

negotiations. Many political measures emphasize commercialization as a central mechanism for making university knowledge relevant to the economy and society. These include the Bayh–Dole Act in the United States and similar legislative initiatives in other countries (D'Este & Perkmann, 2011), which seek to increase third-stream engagement in universities through grants to technology transfer offices based on government support.

5.4 Limitations and future research

Our paper has some limitations that suggest avenues for future research. The first restriction is related to the sample being limited to public universities in the North region of Portugal and the Castille and Leon region in Spain. The convenience sample largely consists of academic researchers in the two cross-border regions, so generalizations to other populations should not be made. Future investigations could replicate this study in other countries, as well as in polytechnic institutes and private universities by using alternative approaches to sampling, to explore any significant differences these contexts produce in the results.

Another limitation is that this research only considered how pecuniary and non-pecuniary motivations influence academics' engagement in UIC using different interaction channels, without taking into account these projects' impact on universities and firms' performance. Although this topic was not covered by the present study, researchers may get interesting results by investigating any correlations between faculty's motivations and output variables. Additional studies could also focus on examining digital technologies' impact on the evolution of academics' motivations to engage in UIC. These tools can integrate various changes and challenges that need to be considered when exploring U–I partnerships in a digitalized world (Rippa & Secundo, 2019), so UIC participants should understand this issue more clearly when starting and developing relevant projects.

Finally, strategically positioned within the framework of U–I relations (Alexandre et al., 2022), the cost of collaboration in these partnerships as a result of their governance structures has also come under scrutiny (Vivona et al., 2023), and continues to shape debates on governance mode choices in technology transfer processes (Schoen et al., 2014). Therefore, future research should extend our understanding of the opportunities, potentialities, and limits of UICs, focusing on providing evidence on how UICs are managed and their implications for regions, countries, and society as a whole.

6 Conclusion

This study's results contribute to a better understanding of varying modes of UIC. We provide evidence on how to promote UICs through pecuniary and non-pecuniary motivations, which were mainly captured through three different channels. Previous research has mostly focused on easily measurable interactions such as patenting, licensing, and academic entrepreneurship, so collaboration through other channels—such as joint research, contract research, and consulting activities—has remained relatively unexplored, with some exceptions (e.g., Alexandre et al., 2022; Bamford et al., 2023; D'Este & Perkmann, 2011; Dias & Selan, 2023; Martinelli et al., 2008; Perkmann & Walsh, 2007; Ponomariov, 2008; Tian et al., 2022). To address this gap, the present study explored the drivers of UIC by analyzing how these projects differ from collaborations supported by academic entrepreneurship (e.g., startups). The findings include that non-pecuniary motivations (i.e., opportunities to

learn and access to resources) are negatively related to the frequency of UIC through both joint and contract research, while pecuniary motivations (i.e., access to funding and commercialization) positively affect academics' likelihood of engaging with industries through the same two channels. As such, this exploratory study has shown that UICs are mostly explained by commercialization-driven behaviors in the two cross-border regions.

Against this background, our results suggest that a vision of an entrepreneurial university can capture the complex nature of U–I partnerships. Rather than academic researchers being interested in maintaining their autonomy by ensuring that collaboration with industry is conducive—or at least compatible with—their research activities, a hybrid order in which universities and industry converge to become common drivers of technological and economic development seems more suitable to explain UICs. In other words, for universities, the benefits of UICs are best achieved by encouraging academics to become economic entrepreneurs. All in all, this research challenges the idea that announcements of the entrepreneurial university may be premature and based on overgeneralizations of life science discoveries (Owen-Smith & Powell, 2001); instead, our analysis in a cross-border setting provides a useful correction in this regard, while dispelling many of the concerns expressed by some observers about the alleged divestment of higher education institutions.

Appendix

See Tables 5, 6, 7, 8 and 9.

Table 5 Summary of descriptive statistics for target variables

Target Variables	Min	Max	Mean	S.D	% Observations (Value 0)	% Observations (Value 1)	% Observations (Value 2)
Joint research	0	2	1.07	0.73	23.4%	46.1%	30.5%
Contract research	0	2	1.02	0.75	27.3%	43.8%	28.9%
Consulting	0	2	0.93	0.80	35.9%	35.6%	28.5%

The number of valid observations is 841

Table 6 Summary of descriptive statistics and correlations for independent and control variables

	Mean	S.D	Min	Max	1	2	3	4	5	6	7	8	9	10
1. Non-pecuniary motivations	2.98	1.08	1	5										
2. Pecuniary motivations	3.76	1.15	1	5	**0.260**									
3. Researcher age	49.54	8.43	24	73	−0.027	**−0.126**								
4. Academic status	2.23	1.11	1	4	−0.059	0.033	**0.238**							
5. Department size	1.48	0.62	1	3	−0.041	**0.291**	**−0.081**	**−0.141**						
6. Exact and natural sciences	0.14	0.35	0	1	−0.046	0.055	−0.011	**−0.172**	0.015					
7. Engineering and technology	0.25	0.43	0	1	−0.067	**0.081**	0.007	**−0.077**	**0.095**	**−0.236**				
8. Agricultural sciences	0.14	0.35	0	1	**0.131**	**−0.034**	0.063	0.012	0.021	**−0.163**	**−0.231**			
9. Medical sciences	0.14	0.34	0	1	0.056	**−0.069**	0.062	**0.171**	**−0.167**	**−0.162**	**−0.230**	**−0.159**		
10. Social and human sciences	0.08	0.27	0	1	−0.009	**−0.090**	−0.012	**−0.070**	−0.038	**−0.117**	**−0.166**	**−0.115**	**−0.114**	
11. Sport	0.14	0.34	0	1	−0.028	**0.081**	**−0.104**	**0.131**	**0.106**	**−0.162**	**−0.229**	**−0.158**	**−0.138**	**−0.114**

Correlation coefficients significant at 0.05 significance level (in bold)

Table 7 Results of factor analysis in academic motivations for interacting with industry

	Mean	S.D	Factor 1	Factor 2
Access to research expertise	2.67	1.16	**0.800**	−0.171
Access to equipment	3.23	1.19	**0.789**	0.146
Applicability of research	4.19	0.72	**0.782**	0.041
Access to materials	3.43	1.10	**0.703**	0.152
Feedback from industry	3.76	0.95	**0.641**	0.251
Becoming part of a network	3.23	1.08	**0.620**	0.288
Information on industry problems	3.85	0.95	**0.559**	0.526
Information on industry research	3.67	0.95	**0.552**	0.417
Research income from industry	3.82	1.16	−0.104	**0.839**
Research income from government	3.93	1.11	0.105	**0.784**
Seeking IPRs	3.17	1.19	0.437	**0.567**
Rotation sums of squared loadings			3.650	2.375
Proportion of variance explained (%)			33.178	21.591
Cumulative proportion of variance explained (%)			33.178	54.769
Cronbach's Alpha			0.838	0.694

The values in bold indicate to which factor the indicator was assigned

Table 8 Results of binary logistic regression when interaction channels are treated as dummy variables

	Joint research	Contract research	Consulting
Non-pecuniary motivations	−0.372*** (0.088)	−0.207$^{(+)}$ (0.081)	**−0.251*** ** (0.076)
Pecuniary motivations	0.471*** (0.090)	0.531*** (0.089)	−0.152 (0.080)
Researcher Age	0.022$^{(+)}$ (0.010)	**0.026$^{(+)}$** (0.011)	0.008 (0.009)
Academic status	**−0.034** (0.086)	−0.014 (0.038)	−0.155$^{(+)}$ (0.304)
Department size	**0.085** (0.152)	**0.268** (0.148)	0.582*** (0.136)
Exact and natural sciences	–	−0.924$^{+)}$ (0.369)	–
Engineering and technology	–	−0.989** (0.343)	–
Agricultural sciences	–	−1.397*** (0.372)	−0.803* (0.294)
Medical sciences	–	−1.277*** (0.386)	–
Social and human sciences	–	−1.013$^{(+)}$ (0.405)	–
Sport	–	−1.577** (0.403)	–
Regional dummies	Included	Included	Included
Intercept	0.667	−1.660$^{(+)}$	−1.499$^{(+)}$
Number of observations	841	841	841
Wald $\chi 2$	68.492*** (12)	132.286*** (12)	75.875*** (12)
Pseudo R^2 Nagelkerke	0.118	0.211	0.118

Target variables are dichotomous taking the value of 1 if the researcher used any engagement channels and 0 otherwise. Two-tailed *t*-test with *p*-values significant at: $+p<0.05$; $*p<0.01$; $**p<0.005$; $***p<0.001$. The values in brackets represent the standard errors. For scientific fields, only statistically significant coefficients are included. The Wald chi-square test has a *p*-value below the significance level of 5%, which means that the joint significance and the coefficients are significantly distributed asymptotically as $\chi 2$ under a null hypothesis without significance, with degrees of freedom in parentheses. The values in bold highlight the differences shown for the relationships that were statistically significant in Table 3 and that are not in Table 8 (and vice-versa)

Table 9 Results of binary logistic regression when interaction channels are treated as dummy variables (based on median)

	Joint Research (2 times or more)	Contract Research (2 times or more)	Consulting (2 times or more)
Non-pecuniary motivations	−0.078(+) (0.088)	−0.186(+) (0.084)	0.122 (0.087)
Pecuniary motivations	0.782*** (0.103)	0.275** (0.090)	**0.498*** ** (0.094)
Researcher Age	**0.011** (0.010)	−0.007 (0.009)	0.013 (0.010)
Academic status	−0.321*** (0.088)	**0.192**(+) (0.080)	**−0.128** (0.084)
Department size	0.849*** (0.137)	**0.258** (0.135)	0.534*** (0.135)
Exact and natural sciences	–	**−0.550** (0.305)	–
Engineering and technology	–	−0.571(+) (0.267)	–
Agricultural sciences	–	−1.362*** (0.335)	**-0.500** (0.325)
Medical sciences	–	−0.969*** (0.312)	–
Social and human sciences	–	−0.665(+) (0.380)	–
Sport	**−0.697**(+) (0.339)	−0.799* (0.306)	–
Regional dummies	Included	Included	Included
Intercept	−2.899***	−1.839**	−3.320***
Number of observations	841	841	841
Likelihood ratio chi-square	173.672*** (12)	76.592*** (12)	100.357*** (12)
Pseudo R^2 Nagelkerke	0.264	0.124	0.161

Target variables are dichotomous taking the value of 1 if the degree of engagement is above the median for a given engagement channel and 0 otherwise. Two-tailed *t*-test with *p*-values significant at: $+p<0.05$; $*p<0.01$; $**p<0.005$; $***p<0.001$. The values in brackets represent the standard errors. For scientific fields, only statistically significant coefficients are included. The Wald chi-square test has a p-value below the significance level of 5%, which means that the joint significance and the coefficients are significantly distributed asymptotically as $\chi 2$ under a null hypothesis without significance, with degrees of freedom in parentheses. The values in bold highlight the differences shown for the relationships that were statistically significant in Table 3 and that are not in Table 9 (and vice-versa)

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References

Abreu, M., Demirel, P., Grinevich, V., & Karataş-Özkan, M. (2016). Entrepreneurial practices in research-intensive and teaching-led universities. *Small Business Economics, 47*, 695–717.

Abreu, M., & Grinevich, V. (2013). The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. *Research Policy, 42*(2), 408–422.

Acs, Z. J., Audretsch, D. B., & Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics, 41*, 757–774.

Acworth, E. B. (2008). University-industry engagement: The formation of the Knowledge Integration Community (KIC) model at the Cambridge-MIT Institute. *Research Policy, 37*(8), 1241–1254.

Agrawal, A., & Henderson, R. (2002). Putting patents in context: Exploring knowledge transfer from MIT. *Management Science, 48*(1), 44–60.

Alexandre, F., Costa, H., Faria, A. P., & Portela, M. (2022). Enhancing University-Industry collaboration: The role of intermediary organizations. *The Journal of Technology Transfer, 47*(5), 1584–1611.

Ambos, T. C., Mäkelä, K., Birkinshaw, J., & D'Este, P. (2008). When does university research get commercialized? Creating ambidexterity in research institutions. *Journal of Management Studies, 45*(8), 1424–1447.

Ankrah, S. N., Burgess, T. F., Grimshaw, P., & Shaw, N. E. (2013). Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit. *Technovation, 33*(2–3), 50–65.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research, 14*(3), 396–402.

Arvanitis, S., Kubli, U., & Woerter, M. (2008). University-industry knowledge and technology transfer in Switzerland: What university scientists think about co-operation with private enterprises. *Research Policy, 37*(10), 1865–1883.

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *The Journal of Technology Transfer, 39*(3), 313–321.

Audretsch, D. B., & Belitski, M. (2021). Three-ring entrepreneurial university: In search of a new business model. *Studies in Higher Education, 46*(5), 977–987.

Audretsch, D. B., & Belitski, M. (2022). A strategic alignment framework for the entrepreneurial university. *Industry and Innovation, 29*(2), 285–309.

Autio, E., & Laamanen, T. (1995). Measurement and evaluation of technology transfer: Review of technology transfer mechanisms and indicators. *International Journal of Technology Management, 10*(7–8), 643–664.

Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly, 36*(3), 421–458.

Balconi, M., & Laboranti, A. (2006). University–industry interactions in applied research: The case of microelectronics. *Research Policy, 35*(10), 1616–1630.

Baldini, N. (2010). University spin-offs and their environment. *Technology Analysis & Strategic Management, 22*(8), 859–876.

Baldini, N., Grimaldi, R., & Sobrero, M. (2007). To patent or not to patent? A survey of Italian inventors on motivations, incentives, and obstacles to university patenting. *Scientometrics, 70*(2), 333–354.

Bamford, D., Reid, I., Forrester, P., Dehe, B., Bamford, J., & Papalexi, M. (2023). An empirical investigation into UK university–industry collaboration: The development of an impact framework. *The Journal of Technology Transfer*, 1–33.

Beck, S., Mahdad, M., Beukel, K., & Poetz, M. (2019). The value of scientific knowledge dissemination for scientists–A value capture perspective. *Publications, 7*(3), 54.

Behrens, T. R., & Gray, D. O. (2001). Unintended consequences of cooperative research: Impact of industry sponsorship on climate for academic freedom and other graduate student outcome. *Research Policy, 30*(2), 179–199.

Belitski, M., Aginskaja, A., & Marozau, R. (2019). Commercializing university research in transition economies: Technology transfer offices or direct industrial funding? *Research Policy, 48*(3), 601–615.

Belkhodja, O., & Landry, R. (2007). The Triple-Helix collaboration: Why do researchers collaborate with industry and the government? What are the factors that influence the perceived barriers? *Scientometrics, 70*(2), 301–332.

Bertello, A., Ferraris, A., De Bernardi, P., & Bertoldi, B. (2022). Challenges to open innovation in traditional SMEs: An analysis of pre-competitive projects in university-industry-government collaboration. *International Entrepreneurship and Management Journal, 18*(1), 89–104.

Bramwell, A., & Wolfe, D. A. (2008). Universities and regional economic development: The entrepreneurial University of Waterloo. *Research Policy, 37*(8), 1175–1187.
Brown, R. (2016). Mission impossible? Entrepreneurial universities and peripheral regional innovation systems. *Industry and Innovation, 23*(2), 189–205.
Cerver Romero, E., Ferreira, J. J., & Fernandes, C. I. (2021). The multiple faces of the entrepreneurial university: A review of the prevailing theoretical approaches. *The Journal of Technology Transfer, 46*(4), 1173–1195.
Chesbrough, H., & Bogers, M. (2014). Explicating open innovation: clarifying an emerging paradigm for understanding industrial innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *New Frontiers in Open Innovation* (pp. 3–28). Oxford University Press.
Chryssou, C. E. (2020). University–industry interactions in the Sultanate of Oman: Challenges and opportunities. *Industry and Higher Education, 34*(5), 342–357.
Church, A., & Reid, P. (1999). Cross-border co-operation, institutionalization and political space across the English Channel. *Regional Studies, 33*(7), 643–655.
Clauss, T., Moussa, A., & Kesting, T. (2018). Entrepreneurial university: A stakeholder-based conceptualisation of the current state and an agenda for future research. *International Journal of Technology Management, 77*(1–3), 109–144.
Council of Europe. (1980). European outline convention on transfrontier cooperation between territorial communities or authorities. http://conventions.coe.int/Treaty/en/Treaties/Html/106.htm. Accessed 10 Dec 2023.
Cunningham, J. A., & Menter, M. (2021). Transformative change in higher education: Entrepreneurial universities and high-technology entrepreneurship. *Industry and Innovation, 28*(3), 343–364.
D'Este, P., Llopis, O., Rentocchini, F., & Yegros, A. (2019). The relationship between interdisciplinarity and distinct modes of university-industry interaction. *Research Policy, 48*(9), 103799.
D'Este, P., & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy, 36*(9), 1295–1313.
D'Este, P., & Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. *The Journal of Technology Transfer, 36*(3), 316–339.
Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy, 34*(3), 321–342.
Dias, A., & Selan, B. (2023). How does university-industry collaboration relate to research resources and technical-scientific activities? An analysis at the laboratory level. *The Journal of Technology Transfer, 48*(1), 392–415.
Etzkowitz, H. (1998). The norms of entrepreneurial science: Cognitive effects of the new university–industry linkages. *Research Policy, 27*(8), 823–833.
Etzkowitz, H. (2016). The entrepreneurial university: Vision and metrics. *Industry and Higher Education, 30*(2), 83–97.
Feldman, M., Feller, I., Bercovitz, J., & Burton, R. (2002). Equity and the technology transfer strategies of American research universities. *Management Science, 48*(1), 105–121.
Figueiredo, N. L., & Ferreira, J. J. (2022). More than meets the partner: A systematic review and agenda for University-Industry cooperation. *Management Review Quarterly, 72*(1), 231–273.
Franco, M., & Haase, H. (2015). University–industry cooperation: Researchers' motivations and interaction channels. *Journal of Engineering and Technology Management, 36*, 41–51.
Franke, N., Poetz, M. K., & Schreier, M. (2014). Integrating problem solvers from analogous markets in new product ideation. *Management Science, 60*(4), 1063–1081.
Freitas, I. M. B., & Von Tunzelmann, N. (2008). Mapping public support for innovation: A comparison of policy alignment in the UK and France. *Research Policy, 37*(9), 1446–1464.
Galán-Muros, V., & Plewa, C. (2016). What drives and inhibits university-business cooperation in Europe? A comprehensive assessement. *R&d Management, 46*(2), 369–382.
Galati, F., Bigliardi, B., Passaro, R., & Quinto, I. (2020). Why do academics become entrepreneurs? How do their motivations evolve? Results from an empirical study. *International Journal of Entrepreneurial Behavior & Research, 26*(7), 1477–1503.
Grimpe, C., & Fier, H. (2010). Informal university technology transfer: A comparison between the United States and Germany. *The Journal of Technology Transfer, 35*, 637–650.
Gualini, E. (2003). Challenges to multi-level governance: Contradictions and conflicts in the Europeanization of Italian regional policy. *Journal of European Public Policy, 10*(4), 616–636.
Guan, J. C., Mok, C. K., Yam, R. C., Chin, K. S., & Pun, K. F. (2006). Technology transfer and innovation performance: Evidence from Chinese firms. *Technological Forecasting and Social Change, 73*(6), 666–678.

Guerrero, M., Urbano, D., & Fayolle, A. (2016). Entrepreneurial activity and regional competitiveness: Evidence from European entrepreneurial universities. *The Journal of Technology Transfer, 41*, 105–131.
Haeussler, C., & Colyvas, J. A. (2011). Breaking the ivory tower: Academic entrepreneurship in the life sciences in UK and Germany. *Research Policy, 40*(1), 41–54.
Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2–24.
Hall, B. H., Link, A. N., & Scott, J. T. (2001). Barriers inhibiting industry from partnering with universities: Evidence from the advanced technology program. *The Journal of Technology Transfer, 26*(1–2), 87–98.
Harman, H. H. (1976). *Modern factor analysis* (3rd ed.). Chicago: University of Chicago Press.
Hidalgo, A., & Albors, J. (2011). University-industry technology transfer models: An empirical analysis. *International Journal of Innovation and Learning, 9*(2), 204–223.
Huszár, S., Pronay, S., & Buzas, N. (2014). *Researchers' motivation and expectation in connection with patenting and technology transfer offices in Hungary*. Academic Proceedings. 2014 University-Industry Interaction Conference: Challenges and Solutions for Fostering Entrepreneurial Universities and Collaborative Innovation, 23–25.
Isenberg, D. J. (2010). How to start an entrepreneurial revolution. *Harvard Business Review, 88*(6), 40–50.
Jensen, R., & Thursby, M. (2001). Proofs and prototypes for sale: The licensing of university inventions. *American Economic Review, 91*(1), 240–259.
Johnson, M., Monsen, E. W., & MacKenzie, N. G. (2017). Follow the leader or the pack? Regulatory focus and academic entrepreneurial intentions. *Journal of Product Innovation Management, 34*(2), 181–200.
Kilian, T., Schubert, P., & Bjørn-Andersen, N. (2015). Benefits and barriers of university industry collaborations from a Researcher's Perspective: Development of Formative Scales and Cluster Analysis. In *ECIS 2015 Proceedings* (p. 101). Association for Information Systems. AIS Electronic Library (AISeL).
Knoll, B., Riedel, N., Schwab, T., Todtenhaupt, M., & Voget, J. (2021). Cross-border effects of R&D tax incentives. *Research Policy, 50*(9), 104326.
Krimsky, S. (2003). *Science in the private interest: Has the lure of profits corrupted the virtue of biomedical research?* Rowman & Littlefield.
Lam, A. (2007). Knowledge networks and careers: Academic scientists in industry–university links. *Journal of Management Studies, 44*(6), 993–1016.
Lam, A. (2011). What motivates academic scientists to engage in research commercialization:'Gold', 'ribbon'or 'puzzle'? *Research Policy, 40*(10), 1354–1368.
Lee, Y. S. (2000). The sustainability of university-industry research collaboration: An empirical assessment. *The Journal of Technology Transfer, 25*(2), 111–133.
Libaers, D. (2014). Foreign-Born academic scientists and their interactions with industry: Implications for university technology commercialization and corporate innovation management. *Journal of Product Innovation Management, 31*(2), 346–360.
Link, A. N., & Siegel, D. S. (2005). University-based technology initiatives: Quantitative and qualitative evidence. *Research Policy, 34*(3), 253–257.
Link, A. N., Siegel, D. S., & Bozeman, B. (2007). An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and Corporate Change, 16*(4), 641–655.
Manning, W. G., Duan, N., & Rogers, W. H. (1987). Monte Carlo evidence on the choice between sample selection and two-part models. *Journal of Econometrics, 35*(1), 59–82.
Martinelli, A., Meyer, M., & Von Tunzelmann, N. (2008). Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a medium-sized, research-oriented university. *The Journal of Technology Transfer, 33*(3), 259–283.
Martínez-Ardila, H., Castro-Rodriguez, A., & Camacho-Pico, J. (2023). Examining the impact of university-industry collaborations on spin-off creation: Evidence from joint patents. *Heliyon, 9*(9), e19533.
Mascarenhas, C., Ferreira, J. J., & Marques, C. (2018). University–industry cooperation: A systematic literature review and research agenda. *Science and Public Policy, 45*(5), 708–718.
Mascarenhas, C., Marques, C., Ferreira, J. J., & Galvão, A. (2022). University-Industry collaboration in a cross-border Iberian regions. *International Regional Science Review, 45*(4), 444–471.
McKelvey, M., & Holmén, M. (Eds.). (2009). *Learning to compete in European universities: From social institution to knowledge business*. Edward Elgar.
Meoli, A., Fini, R., Sobrero, M., & Wiklund, J. (2020). How entrepreneurial intentions influence entrepreneurial career choices: The moderating influence of social context. *Journal of Business Venturing, 35*(3), 105982.

Meredith, J. R., & Pilkington, A. (2018). Assessing the exchange of knowledge between operations management and other fields: Some challenges and opportunities. *Journal of Operations Management, 60*, 47–53.

Merida, A. L., & Rocha, V. (2021). It's about time: The timing of entrepreneurial experience and the career dynamics of university graduates. *Research Policy, 50*(1), 104135.

Merton, R. K. (1973). *The sociology of science. Theoretical and empirical investigations*. University of Chicago Press.

Messeni Petruzzelli, A., & Murgia, G. (2020). University-Industry collaborations and international knowledge spillovers: A joint-patent investigation. *The Journal of Technology Transfer, 45*(4), 958–983.

Miller, K., McAdam, M., & McAdam, R. (2014). The changing university business model: A stakeholder perspective. *R&D Management, 44*(3), 265–287.

Minguillo, D., Tijssen, R., & Thelwall, M. (2015). Do science parks promote research and technology? A scientometric analysis of the UK. *Scientometrics, 102*(1), 701–725.

Mintzberg, H. (1983). *Structure in fives: Designing effective organizations* (International). Upper Saddle River.

Morales-Gualdrón, S. T., Gutiérrez-Gracia, A., & Roig Dobón, S. (2009). The entrepreneurial motivation in academia: A multidimensional construct. *International Entrepreneurship and Management Journal, 5*(3), 301–317.

Mudambi, R., & Swift, T. (2009). Professional guilds, tension and knowledge management. *Research Policy, 38*(5), 736–745.

Nadalutti, E. (2014). What kind of governance does emerge in EU cross-border regions and Southeast Asia growth triangles? Italy-Slovenia and Indonesia-Malaysia-Singapore border zones revisited. *Asia Europe Journal, 12*, 365–382.

Novotny, A. (2014). Motivation and success of academic spinoffs: evidence from Hungary. *Annals of the University of Oradea. Economic Science Series*, *23*(1), 1212–1219.

Nsanzumuhire, S. U., & Groot, W. (2020). Context perspective on University-Industry Collaboration processes: A systematic review of literature. *Journal of Cleaner Production, 258*, 120861.

O'Dwyer, M., Filieri, R., & O'Malley, L. (2023). Establishing successful university–industry collaborations: Barriers and enablers deconstructed. *The Journal of Technology Transfer, 48*(3), 900–931.

Oliver, A. L. (2022). Holistic ecosystems for enhancing innovative collaborations in university–industry consortia. *The Journal of Technology Transfer*, 1–17.

Onnerfors, A., Kotzeva, M., & Brandmüller, T. (2019). *Eurostat regional yearbook* (2019th ed.). Publications Office of the European Union.

Owen-Smith, J. (2003). From separate systems to a hybrid order: Accumulative advantage across public and private science at research one universities. *Research Policy, 32*(6), 1081–1104.

Owen-Smith, J., & Powell, W. W. (2001). To patent or not: Faculty decisions and institutional success at technology transfer. *The Journal of Technology Transfer, 26*(1–2), 99–114.

Perkmann, M. (2003). Cross-border regions in Europe: Significance and drivers of regional cross-border cooperation. *European Urban and Regional Studies, 10*(2), 153–171.

Perkmann, M., Salandra, R., Tartari, V., McKelvey, M., & Hughes, A. (2021). Academic engagement: A review of the literature 2011–2019. *Research Policy, 50*(1), 104114.

Perkmann, M., & Sum, N. L. (2002). Globalization, regionalization and cross-border regions: Scales, discourses and governance. *Globalization, regionalization and cross-border regions* (pp. 3–21). Palgrave Macmillan UK.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., & Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy, 42*(2), 423–442.

Perkmann, M., & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews, 9*(4), 259–280.

Perkmann, M., & Walsh, K. (2008). Engaging the scholar: Three types of academic consulting and their impact on universities and industry. *Research Policy, 37*(10), 1884–1891.

Phan, P. H., & Siegel, D. S. (2006). The effectiveness of university technology transfer: Lessons learned from quantitative and qualitative research in the US and the UK. *Foundations and Trends in Entrepreneurship, 2*(2), 77–144.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–903.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management, 12*(4), 531–544.

Polanyi, M. (2000). [1962]). The republic of science: Its political and economic theory. *Minerva, 38*, 1–32.

Polt, W., Gassler, H., Schibany, A., Rammer, C., & Schartinger, D. (2001). Benchmarking industry–science relations: The role of framework conditions. *Science and Public Policy, 28*(4), 247–258.

Ponomariov, B. L. (2008). Effects of university characteristics on scientists' interactions with the private sector: An exploratory assessment. *The Journal of Technology Transfer, 33*(5), 485–503.

Ponomariov, B. L., & Boardman, P. C. (2010). Influencing scientists' collaboration and productivity patterns through new institutions: University research centers and scientific and technical human capital. *Research Policy, 39*(5), 613–624.

Powers, J. B., & McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: A resource-based view of academic entrepreneurship. *Journal of Business Venturing, 20*(3), 291–311.

Raich, S. (1995). *Grenzüberschreitende und interregionale Zusammenarbeit in einem* (pp. 164–183). Baden-Baden: Europa der Regionen, Nomos.

Rippa, P., & Secundo, G. (2019). Digital academic entrepreneurship: The potential of digital technologies on academic entrepreneurship. *Technological Forecasting and Social Change, 146*, 900–911.

Rosell, C., & Agrawal, A. (2009). Have university knowledge flows narrowed?: Evidence from patent data. *Research Policy, 38*(1), 1–13.

Rossoni, A. L., De Vasconcellos, E. P. G., & De Castilho Rossoni, R. L. (2023). Barriers and facilitators of university-industry collaboration for research, development and innovation: a systematic review. *Management Review Quarterly*, 1–37.

Sánchez-Barrioluengo, M., & Benneworth, P. (2019). Is the entrepreneurial university also regionally engaged? Analysing the influence of university's structural configuration on third mission performance. *Technological Forecasting and Social Change, 141*, 206–218.

Santoro, M. D. (2000). Success breeds success: The linkage between relationship intensity and tangible outcomes in industry–university collaborative ventures. *The Journal of High Technology Management Research, 11*(2), 255–273.

Schartinger, D., Rammer, C., Fischer, M. M., & Fröhlich, J. (2002). Knowledge interactions between universities and industry in Austria: Sectoral patterns and determinants. *Research Policy, 31*(3), 303–328.

Schoen, A., van Pottelsberghe de la Potterie, B., & Henkel, J. (2014). Governance typology of universities' technology transfer processes. *The Journal of Technology Transfer*, *39*, 435–453

Schuelke-Leech, B. A. (2013). Resources and research: An empirical study of the influence of departmental research resources on individual STEM researchers involvement with industry. *Research Policy, 42*(9), 1667–1678.

Shane, S. A. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*. Edward Elgar Publishing.

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003). Commercial knowledge transfers from universities to firms: Improving the effectiveness of university–industry collaboration. *The Journal of High Technology Management Research, 14*(1), 111–133.

Siegel, D. S., Wright, M., & Lockett, A. (2007). The rise of entrepreneurial activity at universities: Orga-nizational and societal implications. *Industrial and Corporate Change, 16*(4), 489–504.

Siemsen, E., Roth, A., & Oliveira, P. (2010). Common method bias in regression models with linear, quadratic, and interaction effects. *Organizational Research Methods, 13*(3), 456–476.

Slaughter, S., & Leslie, L. L. (1997). *Academic capitalism: Politics, policies and the Entrepreneurial University*. Johns Hopkins University Press.

Sperrer, M., Müller, C., & Soos, J. (2016). The concept of the entrepreneurial university applied to universities of technology in Austria: Already reality or a vision of the future? *Technology Innovation Management Review, 6*(10), 37–44.

Stephan, P. E., & Levin, S. G. (1992). *Striking the mother lode in science: The importance of age*. Oxford University Press.

Thursby, J., & Thursby, M. (2011). University-industry linkages in nanotechnology and biotechnology: Evidence on collaborative patterns for new methods of inventing. *The Journal of Technology Transfer, 36*(6), 605–623.

Tian, M., Su, Y., & Yang, Z. (2022). University–industry collaboration and firm innovation: An empirical study of the biopharmaceutical industry. *The Journal of Technology Transfer, 47*(5), 1488–1505.

Urbano, D., & Guerrero, M. (2013). Entrepreneurial universities: Socioeconomic impacts of academic entrepreneurship in a European region. *Economic Development Quarterly, 27*(1), 40–55.

Van Looy, B., Ranga, M., Callaert, J., Debackere, K., & Zimmermann, E. (2004). Combining entrepreneurial and scientific performance in academia: Towards a compounded and reciprocal Matthew-effect? *Research Policy, 33*(3), 425–441.

Vivona, R., Demircioglu, M. A., & Audretsch, D. B. (2023). The costs of collaborative innovation. *The Journal of Technology Transfer, 48*(3), 873–899.
Wang, W., & Liu, Y. (2022). Does University-industry innovation community affect firms' inventions? The mediating role of technology transfer. *The Journal of Technology Transfer, 47*(3), 906–935.
Welsh, R., Glenna, L., Lacy, W., & Biscotti, D. (2008). Close enough but not too far: Assessing the effects of university–industry research relationships and the rise of academic capitalism. *Research Policy, 37*(10), 1854–1864.
Wright, M., Clarysse, B., Lockett, A., & Knockaert, M. (2008). Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy, 37*(8), 1205–1223.
Zucker, L. G., & Darby, M. R. (1996). Star scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry. *Proceedings of the National Academy of Sciences*, *93*(23), 12709–12716.

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