Dynamics of university-industry knowledge co-creation:

Coping with economic swings and academic managerialism

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(Cillian Murphy, 2024)

Abstract

Knowledge creation is not only the core of economic growth, but also the basis of social welfare. Knowledge co-creation nowadays relies on extensive collaboration across diverse sectors of society, with a predominant emphasis on collaborative endeavours between universities and industries. Investigating the dynamics of knowledge co-creation and its impact is essential, particularly within a context where corporations are progressively becoming pivotal players in the innovation landscape and its involvement raises doubts regarding business scientific impact and its quality. This level of involvement in R&D present several benefits, but also raises doubts regarding the scientific impact and quality of business-driven research.

The primary objective of this doctoral thesis is to address three sets of research questions. First, to investigate the influence economic growth on firms' scientific knowledge co-creation outputs and its scientific impact. Second, to examine the role of different types of knowledge transfer channels in the relationship of economic growth and scientific impact. The role of *formal channels*, *informal channels*, and *cocreative channels* in particular, is tested. Third, to explore the rise of team-centred motivations to collaborate with industry of co-creators in the context of university management practices, and assessment culture (what we denominate as *managerialism of academia*).

The context of the study is Spanish co-creation of knowledge. Over the period of study from 2000 to 2016, several institutional and socio-economic conditions have changed the dynamics of co-creation between universities and industry. The empirical analysis relies on three main data sources. First, qualitative data from semi-structured interviews with university and industry researchers. Second, a dataset of publications from 15,500 Spanish firms spanning 2000 to 2016. Third, a survey conducted to the 3,338 corresponding authors of these publications.

In general, this thesis fulfils its objective of exploring how aspects of university-industry co-creation and its impact on business science respond to changes in institutional and socio-economic conditions. First, this thesis provides empirical evidence to confirm a university-industry cycle theory, positing that economic growth maintains a curvilinear relationship with firms' co-creation of scientific knowledge

with universities and its scientific impact. Second, it shows a negative effect of informal channels on the scientific impact of collaborative science, and a positive moderating effect of informal and cocreative channels on the relationship between economic growth and scientific impact. Third, it illustrates the impact of academic managerialism on the evolution of self-centred towards team-centred motivations to collaborate with industry among university co-creators.

These findings suggest that knowledge creation and the scientific impact of Spanish firms are vulnerable to economic fluctuations, resulting in an unstable capacity to co-create high-quality scientific knowledge. On the other hand, this thesis highlights the importance of the role of government-driven collaboration programmes in advancing business science. By confirming a positive effect of co-creative channels, it shows that informal channels and joint projects financed by public funds support collaborative science and boost the effects of economic growth on scientific impact. Finally, when exploring the motivations within the context of academic managerialism, the thesis reflects on the risks of excessive control and performativity in certain working conditions within universities, which influence academics' motivations to collaborate with industries.

The conclusions of this thesis offer valuable insights for policymakers and practitioners aiming to optimize strategies for promoting innovation and scientific impact of collaborative research.

Keywords: Scientific production; university-industry interaction; co-authored research publications; knowledge transfer channels; motivations to collaborate with companies; economic growth; economic crisis

Resumen

La creación de conocimiento no solo es el núcleo del crecimiento económico, sino también la base del bienestar social. La cocreación de conocimiento hoy en día depende de una amplia colaboración entre diversos sectores de la sociedad, especialmente en los esfuerzos colaborativos entre universidades e industrias. Investigar la dinámica de la cocreación de conocimiento y su impacto es esencial, especialmente en un contexto donde las empresas están se han convertido en actores clave de la innovación. Este nivel de participación en I+D presenta varios beneficios, pero también plantea dudas sobre el impacto científico y la calidad de la investigación impulsada por empresas.

El objetivo principal de esta tesis doctoral es abordar tres preguntas de investigación. Primero, investigar la influencia del crecimiento económico en los resultados de la cocreación de conocimiento científico de las empresas y su impacto científico. Segundo, examinar el papel de diferentes tipos de canales de transferencia de conocimiento, los canales formales, informales y cocreativos, en la relación entre crecimiento económico y su impacto científico. Tercero, explorar el aumento de las motivaciones centradas en el equipo para colaborar con la industria de los cocreadores en el contexto de las prácticas de gestión universitaria y la cultura de evaluación (lo que denominamos gerencialismo de la academia).

El contexto del estudio es la cocreación de conocimiento en España. Durante el período de estudio, de 2000 a 2016, varias condiciones institucionales y socioeconómicas han cambiado la dinámica de la cocreación entre universidades e industria. El análisis empírico utiliza tres fuentes de datos. Primero, datos cualitativos de entrevistas semiestructuradas con investigadores universitarios e industriales. Segundo, un conjunto de datos de publicaciones de 15,500 empresas españolas que abarcan desde 2000 hasta 2016. Tercero, una encuesta realizada a los 3,338 autores correspondientes de estas publicaciones.

En general, esta tesis explora cómo los aspectos de la cocreación universidad-industria y su impacto responden a los cambios en las condiciones institucionales y socioeconómicas. Primero, se proporciona evidencia empírica para confirmar una teoría del ciclo, que postula que el crecimiento económico mantiene una relación curvilínea con la cocreación de conocimiento científico de las empresas con las universidades y con su impacto científico. Segundo, muestra un efecto negativo de los canales

informales sobre el impacto científico de la ciencia colaborativa, y un efecto moderador positivo de los canales informales y cocreativos en la relación entre el crecimiento económico y el impacto científico. Tercero, ilustra el impacto del gerencialismo académico en la evolución de motivaciones individuales hacia motivaciones centradas en el equipo para colaborar con la industria entre los cocreadores universitarios.

Estos hallazgos sugieren que la creación de conocimiento y el impacto científico de las empresas españolas son vulnerables a las fluctuaciones económicas, lo que resulta en cierta inestabilidad para cocrear conocimiento científico de alta calidad. Por otro lado, esta tesis destaca la importancia del papel de los programas de colaboración impulsados por el gobierno en el avance de la ciencia empresarial. Al confirmar un efecto positivo de los canales cocreativos, muestra que los proyectos conjuntos financiados con fondos públicos apoyan la ciencia colaborativa y potencian los efectos del crecimiento económico en el impacto científico. Finalmente, al explorar las motivaciones en el contexto del gerencialismo académico, la tesis reflexiona sobre los riesgos de un control y una performatividad excesivos en ciertas condiciones laborales dentro de las universidades, que influyen en las motivaciones de los académicos para colaborar con las industrias.

Palabras clave: producción científica; interacción universidad-industria; co-publicaciones; canales de transferencia de conocimiento; motivaciones para colaborar con empresas; crecimiento económico; crisis económica

Resum

La creació de coneixement no només és el nucli del creixement econòmic, sinó també la base del benestar social. La cocreació de coneixement avui dia depèn d'una àmplia col·laboració entre diversos sectors de la societat, amb un èmfasi predominant en els esforços col·laboratius entre universitats i indústries. Investigar la dinàmica de la cocreació de coneixement i el seu impacte és essencial, especialment en un context on les corporacions estan progressivament convertint-se en actors clau en el panorama de la innovació, i la seva implicació planteja dubtes sobre l'impacte científic i la qualitat de la investigació impulsada per empreses. Aquest nivell de participació en R+D presenta diversos beneficis, però també planteja dubtes sobre l'impacte científic i la qualitat de la investigació impulsada per empreses.

L'objectiu principal d'aquesta tesi doctoral és abordar tres conjunts de preguntes d'investigació. Primer, investigar la influència del creixement econòmic en els resultats de la cocreació de coneixement científic de les empreses i el seu impacte científic. Segon, examinar el paper de diferents tipus de canals de transferència de coneixement en la relació entre creixement econòmic i impacte científic. Es prova el paper dels canals formals, informals i cocreatius en particular. Tercer, explorar l'augment de les motivacions centrades en l'equip per col·laborar amb la indústria dels cocreadors en el context de les pràctiques de gestió universitària i la cultura d'avaluació (el que anomenem managerialisme de l'acadèmia).

El context de l'estudi és la cocreació de coneixement a Espanya. Durant el període d'estudi, del 2000 al 2016, diverses condicions institucionals i socioeconòmiques han canviat la dinàmica de la cocreació entre universitats i indústria. L'anàlisi empíric es basa en tres fonts principals de dades. Primer, dades qualitatives d'entrevistes semiestructurades amb investigadors universitaris i industrials. Segon, un conjunt de dades de publicacions de 15.500 empreses espanyoles que abasten des del 2000 fins al 2016. Tercer, una enquesta realitzada als 3.338 autors corresponents d'aquestes publicacions.

En general, aquesta tesi compleix el seu objectiu d'explorar com els aspectes de la cocreació universitat-indústria i el seu impacte en la ciència empresarial responen als canvis en les condicions

institucionals i socioeconòmiques. Primer, aquesta tesi proporciona evidència empírica per confirmar una teoria del cicle universitat-indústria, que postula que el creixement econòmic manté una relació curvilínia amb la cocreació de coneixement científic de les empreses amb les universitats i el seu impacte científic. Segon, mostra un efecte negatiu dels canals informals sobre l'impacte científic de la ciència col·laborativa, i un efecte moderador positiu dels canals informals i cocreatius en la relació entre creixement econòmic i impacte científic. Tercer, il·lustra l'impacte del managerialisme acadèmic en l'evolució de motivacions autocentrades cap a motivacions centrades en l'equip per col·laborar amb la indústria entre els cocreadors universitaris.

Aquests resultats suggereixen que la creació de coneixement i l'impacte científic de les empreses espanyoles són vulnerables a les fluctuacions econòmiques, resultant en una capacitat inestable per cocrear coneixement científic d'alta qualitat. D'altra banda, aquesta tesi destaca la importància del paper dels programes de col·laboració impulsats pel govern en l'avenç de la ciència empresarial. En confirmar un efecte positiu dels canals cocreatius, mostra que els projectes conjunts finançats amb fons públics donen suport a la ciència col·laborativa i potencien els efectes del creixement econòmic en l'impacte científic. Finalment, en explorar les motivacions en el context del managerialisme acadèmic, la tesi reflexiona sobre els riscos d'un control i una performativitat excessius en certes condicions laborals dins les universitats, que influeixen en les motivacions dels acadèmics per col·laborar amb les indústries.

Paraules clau: producció científica; interacció universitat-indústria; publicacions; canals de transferència de coneixement; motivacions per col·laborar amb empreses; creixement econòmic; crisi económica

Chapter 1. General introduction

1.1. Purpose of the study

Knowledge creation is one of the pillars of building a society and is indispensable for constructing well-functioning scientific, innovative and economic systems. Nowadays knowledge creation is characterized by extensive collaboration across diverse sectors of society, with a predominant emphasis on collaborative efforts between universities and industries. Thus, collaboration has become crucial in innovation by creating and developing novel technologies (Campbell & Guttel, 2005; Rothaermel et al., 2007; Ankrah & Omar 2015; Agasisti et al., 2019; Tseng et al., 2020).

The European Commission is committed to boosting this relationship with a steady increase in funding, reinforcing its importance as a regional strategy for economic growth (European Commission, 2018). Following this wave of support to university-industry collaboration, scholars have devoted their efforts to understand the elements, links, attributes and dynamics of these relationships in order to generate a discussion on building successful relationships that yield scientific of knowledge outputs (García-Aracil & Fernández de Lucio, 2008; Ivanova, 2014).

Currently, research on these relationships has focused on exploring the scientific and societal impacts of policies that promote university-industry collaboration (Rau et al., 2018). However, with the rise of collaborative science and the increased interest of companies in research some sceptical scholars raise questions about whether corporate science has significant impacts on science and knowledge generation. They call for more contextualized knowledge regarding the institutional and socio-economic conditions and for more evidence of whether the collaborations with companies are contributing to the generation of quality science and translating into scientific impact and societal benefits (Rau et al., 2018; Hillerbrand & Werker, 2019).

Despite the extensive body of research on university-industry relationships (D'Este & Patel, 2007; Bekkers & Bodas Freitas, 2008; Lauvås & Rasmussen, 2022; Clauss et al., 2024; Rossi et al., 2024), many voices call for studies employ temporal approaches to explore knowledge co-creation (Hmieleski & Powell, 2018; Vick & Robertson, 2018; Skute et al., 2019; Perkmann et al., 2021; Mathisen & Jørgensen, 2021; Barberá-Tomás et al., 2022). Two concrete areas that require additional research are the influence of the socioeconomic changes on knowledge co-creation outputs and channels, including

economic growth and its cycles (Ranga & Etzkowitz, 2012; Vick & Robertson, 2018; Azagra-Caro et al., 2019; Skute et al., 2019; Perkmann et al., 2021, and the evolution of motivations to engage into knowledge co-creation (Hmieleski & Powell, 2018). This thesis takes on these claims to advance understanding in these directions.

This research highlights the changes in institutional and socio-economic conditions reflected in economic growth. By doing so, it aims to contextualize the study and incorporate elements of temporality. Each chapter of this thesis elaborates on one of these elements: first, by analysing the consequences of economic growth on knowledge co-creation outcomes; second, by disentangling the impact of concrete types of knowledge transfer channels on the relationship between economic growth and business science; and lastly, by exploring the role of academic managerialism in the evolution of researchers' motivations to collaborate with businesses over time (see Fig. 1.1).

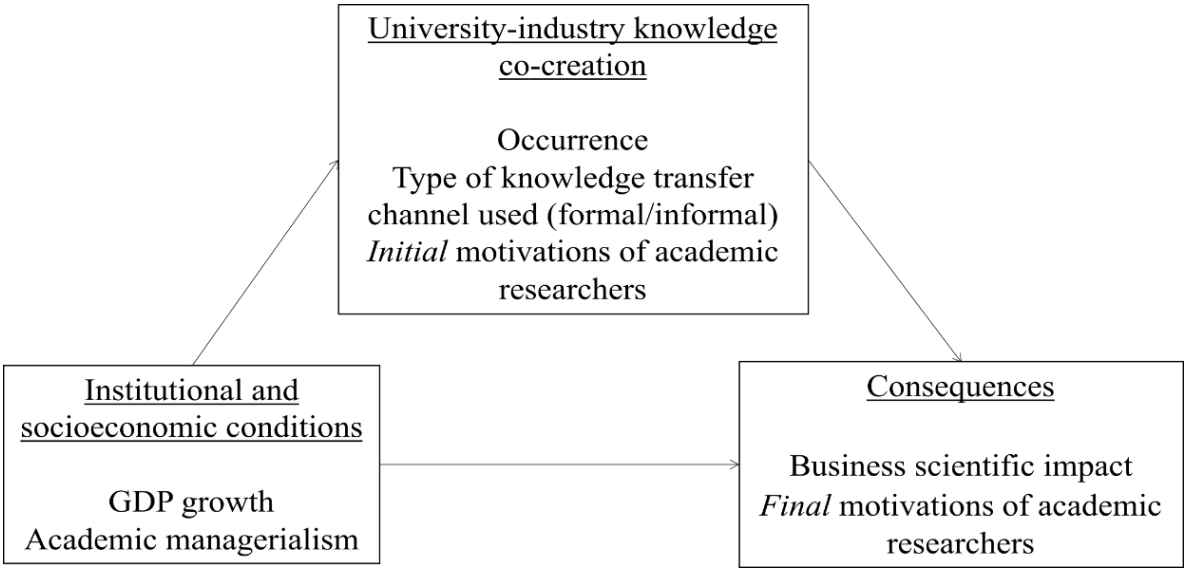

Fig. 1.1. Conceptual framework of the thesis

The research context of this thesis is Spain from 2000 to 2016. This choice is particularly compelling to study economic growth, given the prolonged duration of the Great Recession in Spain that last from 2008 to 2014, extending five years beyond the global recession (2008-2009). Moreover, the dependence of local and national R&D on public funding, coupled with vulnerability to external economic shocks (Salmon, 2017; Ordóñez et al., 2019), renders the Spanish context an insightful case study.

Chapter 2 analyses the influence of economic growth on firms' scientific knowledge co-creation outputs and their scientific impact. Chapter 3 investigates the role of knowledge transfer channels in the relationship between economic growth and business scientific impact. Chapter 4 explores the rise of team-centred motivations to collaborate with industry of co-creators in the context of academic managerialism.

Overall, this thesis provides valuable insights for policymakers and practitioners seeking to understand the evolution of knowledge co-creation in Spain in order to optimize R&D promotion strategies and improve the scientific impact of collaborative research.

In this chapter, we first present the research questions and then explain the research methods. Following that, we describe the contributions of each study. The chapter concludes with an outline of the entire thesis structure.

1.2. Research questions

This dissertation addresses three main research questions:

1. What are the effects of economic growth on business scientific output co-creation and impact?
2. What are the effects of different types of knowledge transfer channels, according to their degree of formalisation, on the relationship between economic growth and scientific impact of business science?
3. What is the impact of managerialism on the evolution of self-centred towards team-centred motivations among university knowledge co-creators for collaborating with industry?

The first question focuses on scientific outputs and attempts to explain how economic growth influences the co-creation of knowledge between universities and businesses, as well as their scientific impact. The literature presents mixed arguments, suggesting that firms may exhibit distinct strategic behaviours towards R&D (Archibugi et al., 2013). On the one hand, economic growth favours firm stability, making them prone to invest in R&D and collaborate with universities. Consequently, this could lead to an increase in knowledge co-creation outputs. On the other hand, economic growth facilitates that companies rely on their resources to develop new products and knowledge internally

(Laursen & Salter, 2006). As a result, they may show less interest in collaborating with universities, thereby decreasing co-creation outputs.

Regarding business scientific impact, the literature points out that in times of low economic growth, firms prioritize boosting R&D despite difficulties, firms are more inclined to pioneer scientific and technological ideas (Köksal & Özgül, 2007), increasing their scientific impact. Conversely, in periods of high economic growth, firms tend to focus on exploitative activities rather than investing in high-quality research (Archibugi et al., 2013), thus decreasing scientific impact.

The second question continues the analysis of business scientific impact by delving deeper into the role of knowledge transfer channels in the relationship between economic growth and business scientific impact. Formal knowledge transfer channels encompass legal instruments such as licenses or royalty agreements, as well as academic-industry collaborations through sustained working relationships. Informal knowledge transfer channels are based on informal communication processes. Co-creative knowledge transfer channels entail setting research priorities through mutual compromise and joint efforts such as competitive R&D projects and research partnerships.

There are reasons to justify both a positive and a negative effect of knowledge transfer channels on scientific impact. Positive effects on scientific impact are argued by several authors. Formal channels can lead to high-impact research due to the type and extent of novelty in the research (Thompson et al., 2018; D'Este et al., 2019). Informal channels enhance the exchange of valuable knowledge and contribute to open science (Beck et al., 2022). Moreover, cocreative channels promote scientific impact by securing funds for infrastructure and research staff (Belderbos et al., 2004; Faems et al., 2005; Banal-Estañol et al., 2015) and allowing researchers to focus on fewer, high-impact projects. However, there are counter arguments suggesting negative effects on scientific impact at any point of time. Formal channels can face issues with access restrictions on research tools and data sharing (Mowery et al., 2014). And a multiple use of informal channels and cocreative channels can reduce the attention devoted to each project, diminishing the quality of high-level research (Banal-Estañol et al., 2015).

The literature indicates a positive moderating effect of formal, informal, and co-creative channels on the relationship between economic growth and the business scientific impact. On the one hand, economic growth can encourage companies to prioritise the most convenient channels to enhance the

scientific impact of their research. On the other hand, governments can intervene in balance collaborative efforts to ensure the optimal use of channels to produce high-quality outputs.

The third question of the thesis focuses on the academic cocreators' motivations to collaborate with companies. The literature has focused on academics' self-centred motivations to collaborate with industry, such as *gold, ribbon, and puzzle* motivations (Lam, 2011). However, for many university knowledge co-creators, benefiting the team is a crucial motivation. Batson (2022) categorized *collectivism-based and principlism-based* motivations to refers to researcher's concerns about their team.

In the study, the concept of managerialism in academia is introduced to identify the features of new management that influence academic co-creation (Glenna et al., 2007). Managerialism might be potentially affecting researchers' motivations to collaborate with companies. Building on this conceptual perspective provides a new angle on the influence of institutional issues such as the evaluation system, working conditions and organisational culture in the study of collaborative motivations.

1.3. Research methods

This doctoral project proposes a mixed method that combines qualitative and quantitative approaches. Since the aim of the thesis was to gain an in-depth understanding of the changing dynamics of co-creation, the mixed method design permits the integration of different methods to fill theoretical and practical gaps as appropriate.

In Chapters 2, the use of mixed methods strengthens the data analysis by allowing distinct types of data to complement each other. Mixed methods research is instrumental in corroborating arguments and validating results obtained through the application of each method individually (Mason, 2006; Tashakkori & Teddlie, 2003). Qualitative data captures the subjective experiences of interviewees (Stange, 2006; Wellman et al., 2023), enriching theory, contextualizing the research, and formulating hypotheses (Teddlie & Tashakkori, 2011). On the other hand, quantitative research facilitates drawing

inferences about a phenomenon and enables the validation of hypotheses, ensuring the generalizability of findings to broader populations.

The chosen methodology for the second chapter adopts a mixed-method approach, integrating both qualitative and quantitative methods to explore the relationships between economic growth and knowledge co-creation with industry, and business scientific impact. The objective was to uncover evidence of connections between these two phenomena throughout different levels of economic growth. The study used qualitative data from semi-structured interviews with five academic researchers and four industry researchers to ground the theoretical framework. Additionally, bibliometric data from Web of Science was employed to test the hypotheses. The empirical analysis was conducted on a dataset comprising publications from 15,500 Spanish firms spanning 2000 to 2016, with normalized citations as a measure of scientific impact.

Chapter 3 utilized information gathered from interviews to inform the design of a survey targeting 3,310 of potential co-authors of firm publications[1], including both academic and non-academic researchers affiliated with Spanish institutions. Contact details for survey participants were extracted from the same scientific publications sourced from the Web of Science database, spanning from 2000 to 2016. A total of 317 responses were obtained, yielding a response rate of 9.68%, which is considered representative of the population of knowledge co-creators in Spain.

Chapter 4 employed a multimethod qualitative approach, combining deductive and inductive analysis to explore researchers' motivations for engaging with industry over time. This methodological approach facilitated a comprehensive understanding of researchers' perspectives, allowing for the exploration of personal and academic experiences (Newby, 2014; Seale, 2004). The selection of participants followed using information-oriented selection principles (Flyvbjerg, 2001). Data from the most productive scientific knowledge co-creators were collected from a database of firms' publications sorted on the Web of Science from 2000 to 2016. Ten paradigmatic cases of top academic co-creators in Spain were

[1] The survey covered subsequent years. However, as we do not have equivalent data on publications for this period, the study limited the analysis to the same period as the previous study presented in Chapter 2, which covers 2000-2016. The number of publications for survey for the subsequent years (2017-2019) was 14,434, with 4,745 potential respondents. Out of these, we received 445 responses, resulting in a response rate of 9.37%.

selected. Data analysis ensued through two distinct phases: firstly, a deductive approach was employed following content analysis guidelines to ascertain the motivations driving collaboration with industry; secondly, an inductive grounded theory approach was utilized to delve into the factors influencing changes in motivation.

The analysis relied on 10 semi-structured interviews conducted from March 2021 to June 2022. These interviews were recorded, transcribed, and underwent consensus agreement. NVIVO software was used for in-depth analysis. Professional details sourced from public sources and university web pages (e.g., curriculum vitae, academic status, statistics on Ph.D. students, funded projects, and overall publications) were also crucial materials used to prepare interviews and for the analysis in the third study.

1.4. Contribution of the thesis

Overall, this thesis fulfils its objective of exploring how aspects of university-industry co-creation and its impact on business science and academic motivations to cooperate with industry respond to fluctuations in the economy and changes in institutional settings. Several theoretical contributions are presented in each chapter.

Chapter 2 fills a gap on the role played by time, particularly the effect of economic growth and business cycles, on both university-industry knowledge co-creation output and firms' scientific impact. The chapter introduces a university-industry cycle theory, suggesting that economic growth maintains a curvilinear relationship with firms' co-creation of scientific knowledge with universities and its scientific impact—negative with high economic growth but positive with low economic growth. Additionally, it identifies that scientific co-creation output with universities enhances firms' scientific impact across all economic phases.

Chapter 3 fills a gap in the literature by theorizing the effect of knowledge transfer channels on scientific impact. This chapter shows a negative effect of informal channels on scientific impact and confirms a positive moderating effect of informal and cocreative channels on the relationship between economic growth and scientific impact. These results highlight that knowledge co-creation through informal channels is less likely to directly improve the scientific impact of business science but can do

so indirectly by enhancing the effect of economic growth on high impact scientific knowledge. Similarly, knowledge co-creation through joint research projects also plays a moderating effect.

Chapter 4 addresses a gap in the literature, which has traditionally focused on static approaches to studying motivations and has mostly developed its theory around egocentric types of motivations. This chapter examines the impact of managerialism on the evolution of self-centred towards team-centred motivations to collaborate with industry among university-based knowledge co-creators. This study expands the existing framework on motivations to collaborate with industry, particularly by incorporating team-centred motivations. The results revealed that an environment of competition and individualism intensified by managerialism in academia. For top academic co-creators there was a shift from self-centred to team-centred motivations in their collaborations with industry.

Specifically, using Lam's (2011) categories to label self-centred motivations, this study showed that academic work's intense control and performativity led to the look for research-based motivations (puzzle motivation) towards collectivism, and inadequate working conditions led to motivations based on reputation and career awards (ribbon motivation) towards collectivism and principlism-based motivations.

1.5. Structure of the dissertation

The remainder of this dissertation consists of four chapters. Chapter 2 analyses how firms' scientific knowledge co-creation output and their scientific impact react to economic growth. Chapter 3 analyses the role of formal channels, informal channels and joint research projects on the relationship between economic growth and scientific impact of business science. Chapter 4 examines team-centred motivations of university knowledge co-creators to collaborate with industry as a reaction to managerialism in public universities. Table 1.1 presents an overview of the contents covered in the three chapters.

These three empirical chapters are intended to be presented as stand-alone research articles. Each chapter follows its own structure: abstract, introduction, literature review, methodology, findings, discussion, and conclusion.

The last chapter of this thesis is Chapter 5, which summarizes the contributions to knowledge of this doctoral research, the implications for science policy, the limitations of the research, and recommendations for further research.

Table 1.1. Research design summary

Studied element of university-industry knowledge co-creation	Chapter 2 Co-creation of knowledge and scientific impact	Chapter 3 Channels of knowledge transfer	Chapter 4 Motivations to collaborate with industry
Research questions	SRQ1. What are the effects of economic growth on business scientific output co-creation and impact?	SRQ2. What are the effects of different types of knowledge transfer channels, according to their degree of formalisation, on the relationship between economic growth and scientific impact of business science?	SRQ3. What is the impact of managerialism on the evolution of self-centred towards team-centred motivations among university knowledge co-creators for collaborating with industry?
Research context	Spain 2000-2016	Spain 2000-2019	Spain 2000-2016
Methodology	Mixed methods Qualitative research (interviews) Quantitative approach (bibliometric and regression analysis)	Survey analysis Quantitative approach (bibliometric and regression analysis)	Qualitative research (interviews, inductive and deductive analysis)
Analytical tools	Stata	Qualtrics Stata	Nvivo
Data	WoS publication data: 7.500 firms' publications Online interviews meetings to 4 industry researchers and 5 university researchers	Survey of correspondent coauthors of research articles published with at least one company. Reference population - 8,055 co-authors, 9.58% response rate.	Semi-structured interviews to top academic coauthors of industry publications Other support documentation: curriculum vitae of participants, lines of research, publications records.
Unit of analysis	Firms' publications (Publication level)	Firms' publications (Publication level merged with individual responses to the survey)	Collaborative researcher (Individual level)
Ethical factors	UPV code of ethics was followed, a letter of informed consent was signed, and data protection was ensured.	Ethical evaluation of research approved by CSIC Ethics Committee To participate in the survey, a letter of informed consent was signed, and data protection was ensured.	UPV code of ethics was followed, a letter of informed consent was signed, and data protection was ensured.
Validity	Robustness checks were done in the quantitative analysis.	Robustness checks were done in the quantitative analysis	Reliability and validity methods were taken into consideration, cross-checking, reflexibility and member checks.
Limitations	Limitations identified and acknowledged	Limitations identified and acknowledged	Limitations identified and acknowledged

Chapter 2. The steady effect of knowledge co-creation with universities on business scientific impact throughout the economic cycle

This chapter is based on this published article:
Gómez-Aguayo, A.M., Azagra-Caro, J.M. & Benito-Amat, C. The steady effect of knowledge co-creation with universities on business scientific impact throughout the economic cycle. *Scientometrics* 129, 2771–2799 (2024), https://doi.org/10.1007/s11192-024-04986-5.

2.1. Introduction

Knowledge creation stands as a foundational element within scientific, innovation, and economic systems, serving as a cornerstone for progress in these domains. Companies play a crucial role in this process by actively contributing to knowledge creation through the dissemination of scientific codified knowledge – a concept we define as business scientific output (McManus et al., 2021). This dissemination not only enhances competitive advantage and attracts qualified scientists but also leads to improved scientific, technological outcomes, and innovation (Tseng et al., 2020; Perkmann et al., 2011; McMillan et al., 2014; Soh & Subramanian, 2014).

Collaborative knowledge creation, particularly through partnerships with universities, is a notable avenue for scientific advancement (Camerani et al., 2018). Such collaborations offer benefits such as a stronger connection with open science, heightened absorptive capacity, and increased business scientific impact (Beck et al., 2022; McKelvey & Rake, 2020; Belderbos et al., 2016; McKelvey & Rake, 2016; Fabrizio, 2009). Business scientific impact, defined as the recognition within a professional community of knowledge producers by firms (D'Este et al., 2018), emerges as a critical aspect of collaborative knowledge creation.

Previous research highlights the influence of individual, organizational, and institutional factors on the output of university-industry scientific knowledge co-creation and the scientific impact of firms (McKelvey & Rake, 2020; Arora et al., 2021). However, a significant research gap exists concerning the role of time, specifically the effect of economic growth and business cycles, on both university-industry knowledge co-creation output and firms' scientific impact (Barberá-Tomás et al., 2021). While some authors within the field of scientometrics have explored the consequences of scientific knowledge creation on economic growth or the effects of scientific impact on economic growth (Azmeh, 2022; Pinto & Teixeira, 2020; Solarin & Yen, 2016; Inglesi-Lotz et al., 2014; Inglesi-Lotz & Pouris, 2013), a void remains in the literature regarding the effects of economic growth on co-creation output and business scientific impact.

This paper seeks to address this gap by examining the influence of economic growth on business scientific output co-creation and impact. Therefore, our research question focuses on understanding the

specific effects of economic growth on these dimensions, shedding light on a heretofore neglected antecedent in the literature.

Our study makes a significant contribution to future scientometrics research by providing insights into the dynamics of university-industry knowledge co-creation and its impact on firms' scientific output, particularly in the context of economic growth. By elucidating how economic cycles affect collaborative knowledge creation and business scientific impact, our findings offer valuable implications for policymakers and practitioners seeking to optimize strategies for fostering innovation and scientific advancement in dynamic economic environments.

Section 2 presents a review of the literature and the hypotheses of the study, supported by interviews with prolific university and industry co-authors of joint publications; Section 3 describes the context of the study; Section 4 presents the data on co-publications made by companies; Section 5 presents the estimations of the effects of economic growth on university-industry knowledge co-creation and firms' scientific impact; and Section 6 concludes by offering policy recommendations and suggestions for future research.

2.2. Theoretical framework, interview protocol and hypotheses

The concept of economic cycles has been a central focus in various schools of economics. Keynes (1936) examined periods of economic expansion and crisis, developing theoretical models to explain the causes of business cycles. He proposed that fluctuations in aggregate demand are the main cause for economic downturns (Vianna, 2023). But the theory of business cycles was further elaborated by Schumpeter (1939). Schumpeter yielded economic cycle theories, pointing out that business cycles are dynamic, and economic fluctuations are changes triggered by innovation or technological waves (Schumpeter, 1939). Business cycles differ in duration: short-term, around 3-6 years, mid-term lasting around 7-15 years; and long-term lasting more than 15 (Grinin et al., 2016).

There are several definitions of a business cycle, in this thesis, it is defined as a series of fluctuations in real gross domestic product (GDP) growth, real personal income, employment and other indicators (NBER, 2008). Fig 2.1 presents an overview of major global economic recessions since the 1960s: the

first oil crisis (1973–1975), the second oil crisis (1978–1981), the 90s recession (1990–1992) and the Great Recession (2008–2014) — the latter being the most recent incident and the object of the empirical study in this research. Cycles are composed of phases of crisis and expansions, as presented in 2.2 in the years corresponding to the Great Recession. They correspond broadly to phases of low and high economic growth, and often a threshold in GDP growth is used to delimitate the two phases, e.g., the International Monetary Fund considered that less than 3 percent GDP growth in 2008 and 2009 would identify the Great Recession (IMF, 2008).

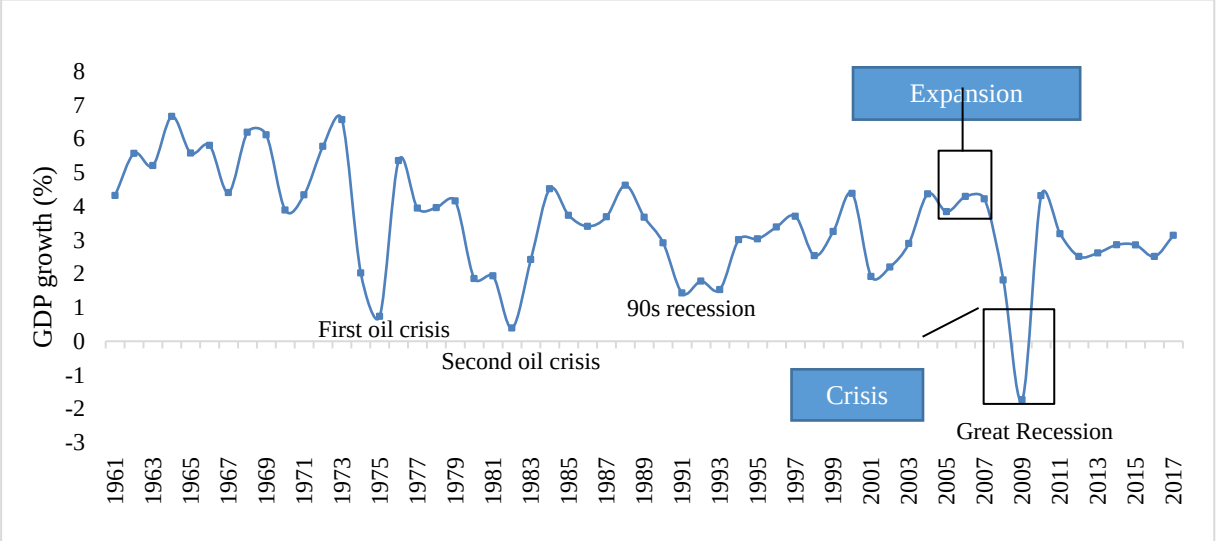

Fig. 2.1. Economic growth and cycles, 1961–2017 (own elaboration based on data from the World Bank dataset).

To establish the foundation for our theoretical contribution regarding the interaction between university-industry scientific knowledge co-creation output and firms' scientific impact in response to economic growth, we conducted interviews with prominent business and university scientific knowledge co-creators. Selection criteria for industry researchers involved identifying one of the most prolific firms from our empirical sample, characterized by over 50 co-publications with universities spanning the analysis period (2008–2016). Interviews were conducted with four researchers from this firm. Additionally, we selected five university researchers who were among the most prolific co-authors of publications with firms, ensuring representation across periods of both low and high growth. Virtual interviews lasting 30–40 minutes were conducted to gather insights. We opted not to include more

researchers as redundancy in the information provided became redundant. Table 2.1. presents anonymized individual data from these interviews.

Table 2.1. Interview data Negative binomial model estimation of scientific impact

Interviewee code	Scientific field	Scientific sub-field	Autonomous Community
Industry researcher 1	Technology	Infrastructures and Robotics	Catalonia
Industry and university researcher 2	Life sciences & Biomedicine	Molecular biology	Valencian Community
Industry researcher 3	Technology	Civil Engineering	Madrid
Industry researcher 4	Technology	Chemical Engineering	Catalonia
University researcher 5	Life sciences & Biomedicine	Animal science	Madrid
University researcher 6	Life sciences & Biomedicine	Marine Ecology	Canary Islands
University researcher 7	Technology	Mechanical Engineering	Catalonia
University researcher 8	Physical sciences	Applied Physics	Basque Country
University researcher 9	Physical sciences	Physical Chemistry	Catalonia

Industry researchers are all in the same company. University researchers are affiliated Spanish public universities. Names of scientific fields are at the first level of aggregation of Web of Science

2.2.1. University-industry knowledge co-creation output and economic growth

The impact of economic growth on university-industry knowledge co-creation output is ambivalent. First, the reasons to expect a positive or negative linear effect will be developed, and then the hypothesis of a curvilinear effect due to growth will be tested.

2.2.1.1. Increasing or decreasing university-industry knowledge co-creation output in economic growth

The scientific knowledge creation output of firms is driven by business R&D (Halperin & Chakrabarti, 1987; Chakrabarti, 1990; Cincera & Dratwa, 2011; Arora et al., 2021). R&D activity has a procyclical behaviour (Barlevy, 2017). Economic growth favours the financial stability of firms, and, therefore, that the cash flow of the company finances investment in R&D (Hall, 1992; Himmelberg & Petersen, 1994; Rafferty & Funk, 2008). The more R&D-intensive that firms are, the higher their absorptive capacity, the more open their external search strategies (Perkmann & Walsh, 2007) and the higher their scientific co-creation output with universities (Vedovello, 1998; Azagra-Caro et al., 2019). This implies a positive relationship between economic growth and firms' scientific co-creation output with universities.

However, opposing arguments can also be found. For some companies to invest time, money and other resources to absorb external knowledge might be risky when the rewards are uncertain. According

to Hess & Rothaermel (2011), when companies participate in formal university collaborations, they may experience a loss in research productivity because of knowledge redundancies and high costs in the management and monitoring of research results (Laursen & Salter, 2006).

Faced with this risk, companies may prefer to rely on their resources and capabilities to develop new products and knowledge internally (Laursen & Salter, 2006). Economic growth endows companies with the ability to self-finance their own R&D projects (Schumpeter & Fels, 1939; Hall, 2002; Hud & Rammer, 2015). Therefore, they may not be interested in collaborating with organisations with different institutional norms, or, if they are, they may have more power to retain intellectual property and not publish the results (Azagra-Caro et al., 2019).

Industry researchers provide evidence of a negative relationship between economic growth and firms' scientific knowledge co-creation output with universities, as the following statement shows:

> *During the first years of the crisis [2008–2010] the company was in the process of creating a knowledge base and researching at a basic level. From 2012 onwards, the company started to have its own knowledge of certain technologies and processes, which it didn't want to share, so it stopped publishing the results of the research.*
>
> (Industry Researcher 2)

There are, therefore, reasons to justify both a positive and a negative effect of economic growth on co-creation output. It will now be argued that one effect or the other will prevail according to the level of economic growth.

2.2.1.2. University-industry knowledge co-creation output: increasing with low economic growth and decreasing with high economic growth

With low economic growth, firms facing financial constraints are likely to reduce their investment in R&D (Schumpeter & Fels, 1939; Freeman, 1987), and the low demand also negatively affects firm's R&D (Shleifer, 1986). The low economic growth has a dual effect on policymaking: on the one hand, the shock affects innovation systems, reducing R&D public budgets; on the other hand, governments increase their efforts to maintain innovation capacity and employment levels (Hud & Hussinger, 2015; Aghion et al., 2012). More specifically, government policies seek to counterbalance the negative effects

of low economic growth by promoting university-industry research cooperation. D'Agostino & Moreno (2018) showed that the positive effects of R&D cooperation on innovation activities were stronger in times of economic turbulence than with high economic growth, and innovation also stimulates cooperation with universities (Azagra-Caro et al., 2014). This makes low economic growth a friendly environment in which companies can innovate (Filippetti & Archibugi, 2011; Pellens et al., 2020).

This postulate coincides with the following statement made by a university researcher during an interview:

> *Normally, when there is low economic growth, companies stop doing research or postpone it; however, the public sector invests money so that companies can receive assistance for doing research in the form of loans of which a percentage is forgivable. Then you suddenly find yourself having greater possibilities for collaboration with companies and projects with companies in which there is mutual interest.*
>
> (University Researcher 7)

Some examples of national government policies that have tackled the effects of low economic growth can be found in Canada, Japan, Argentina and Mexico. In Canada, although federal and local governments reduced education funding due to the 1970s oil crises, they did not stop providing Canadian universities with support and continued developing programmes to promote the university-industry relationship in science and technology (Naimark, 1989; Doutriaux & Baker 1995; Liévana, 2010). Japan, in the 1990s, experienced a "lost decade" due to economic stagnation. The government supported university-industry collaboration by promoting technology transfer in 1998 (Whittaker, 2001). In Argentina, during the crisis of the 1990s, the government promoted a series of plans for research collaboration (Thorn, 2005). Mexico, in 2008 and 2009, was facing the worst moment of the Great Recession. Despite this, the government launched an Incentive Programme for Innovation (2009–2013) that included economic incentives for companies in association with public-private universities or research centres.

A similar response can be found at the supranational level, by the European Community (EC) during the Great Recession. Of the four Specific Programmes under the EC's Seventh Framework Programme

(FP7), the largest budget was for the Cooperation Programme, whose objective was to strengthen research collaboration between universities and firms, especially transnational cooperation (Veugelers & Cassiman, 2005; Szücs, 2018). Policymakers, as a way to minimise "government failures" in the allocation of subsidies and to increase the effectiveness of intersectoral R&D collaboration, follow a "picking-the-winner strategy" (Shane, 2009; Cantner & Kösters, 2009). In so doing, programme agencies select consortia with previous experience and a proven ability to generate results. Evaluators rate the outputs generated in the collaboration process by considering, among other aspects, the number of co-publications and their citation impact. Hence, firms will find that co-publishing with universities revalorises with low economic growth (Azagra-Caro et al., 2019). This view is acknowledged in the following statement from a researcher:

> *[In our company we are] very strong when it comes to project submissions. We were particularly active in the framework of FP7 projects [2007–2013], in which co-publications were associated with these projects.*
>
> (Industry Researcher 4)

In fact, Azagra-Caro et al. (2019) confirm that firms' R&D spending fosters university-industry knowledge co-creation output, but after a certain threshold, the relationship becomes negative; i.e., it follows the shape of an inverted U: increasing with low economic growth (with low business R&D growth), and decreasing during a high economic growth (with high business R&D growth). Such a shape is typical of concomitant phenomena. Laursen & Salter (2006) establish that the benefits of openness are subject to diminishing returns, which indicates that there is a point at which additional research becomes unproductive. This explains how innovation performance can decline after an excessive amount of corporate research (Koput, 1997).

To be precise, the following postulate is made:

Hypothesis 1. The probability of firms' scientific knowledge co-creation output is initially increasing with economic growth, but above a certain point it is negatively related with economic growth.

2.2.2. The scientific impact of firm's co-creation output with universities and economic growth

2.2.2.1. Firms' scientific impact: increasing in low economic growth and decreasing in high economic growth

Scientific impact is measured in terms of the popularity, influence, novelty or usefulness of a research publication (Cohen et al. 2010). In the context of firms, many of these attributes may depend on the level of economic growth. Archibugi et al. (2013) observed that the innovation behaviour of firms follows different patterns in times of low economic growth. Actually, the growth of firms relies significantly on increasing production capacity and workforce with high economic growth, but it relies even more on increasing R&D budgets with low economic growth, despite the difficulties (Köksal & Özgül, 2007). Low economic growth nurtures the innovations that lead to recovery; creative destruction lies beneath growth cycles, and with low economic growth, firms are more likely to pioneer new pathbreaking scientific and technological ideas which will have a potential impact (Schumpeter, 1942). Similarly, firms that seek longer-run, explorative strategies are better suited to face low economic growth (Archibugi et al., 2013). This is compatible with the idea that economic growth will allow firms to develop more science-based innovation, and thus better science, during downturns.

Some extracts from interviews with company researchers on the performance of the scientific impact of firms illustrate how the cycle led to new pathways in their R&D strategy.

> *The company's marketing activities were disrupted by the economic crisis [the Great Recession]. At the innovation level, it also had an impact that, in this case, may have been positive. That is to say, any disruption and any interruption in activity led to a search for new lines of work. In this sense, we were urged to search for alternative routes for process optimisation or the creation of alternative materials that could be used to reduce production costs.*
>
> (Industry Researcher 1)

University researchers emphasised the particular characteristics of research conducted during times of low economic growth that may have positively influenced the scientific impact of the co-publications:

Even though not much research is carried out with low economic growth, that which is tends to be more thorough. The results that arise from this research have a more appealing scope, more time and resources are devoted to refining the work, and their contribution is often highly focused on the social requirements of the context, thereby generating a great deal of interest.

(University Researcher 9)

Hence, with low economic growth, we may expect a positive relationship between economic growth and scientific impact. With high economic growth, this needs not to be true. On the contrary, some reasons suggest a negative relationship. As aforementioned, with high economic growth, the growth of firms relies significantly on increasing production capacity and workforce (Köksal & Özgül, 2007), as well as on exploitative strategies (Archibugi et al., 2013). This will result into lower-quality R&D activities and fewer explorative strategies that would more likely lead to higher scientific impact. Particularly, with the high economic growth after the Great Recession, firms' basic research concentrated in fewer firms, which puts long-run innovation in danger (Krieger et al., 2021), and potentially scientific impact (Bloch et al., 2019). On the other hand, business research is underproductive with high economic growth, because by the time others can benefit from spillovers, the economy is likely to go through low economic growth (Barlevy, 2007). Similarly, business research with low economic growth has high quality and prepares for future situation of low economic growth, whereas business research with high economic growth has lower quality and does not prepare for future low economic growth (Amore, 2015). All these reasons indicate that with high economic growth, economic growth will hamper the scientific impact of business firms.

These reflections allow the next postulate to be made:

Hypothesis 2. Economic growth initially increases the scientific impact of firms' output, but above a certain point, that relationship becomes negative.

2.2.2.2. The scientific impact of firms in collaboration with universities

Scientific co-production with universities may increase the quality of industrial science in three ways. First, university science tends to be more basic, related to general principles and forward looking, which

is likely to broaden the perspective of firms (Frenken et al., 2005; Krieger et al., 2021). Second, scientific production is at the core of the academic profession, much more so than for companies; universities are more familiar with institutions like peer-review and can offer firms an increase in quality by shaping results according to the standards of the scientific circuits. Third, scientific co-production with universities opens up access for firms to new diffusion networks, and thus to enhanced recognition of quality, through conference and workshop presentations, informal discussion with colleagues, preprints, etc. (Goldfinch et al. 2003; Aksnes, 2003). Some of these arguments can be reflected in the statements researchers make on their experience:

> *Universities always endeavour to publish the results of their research with companies, because the CVs of doctoral students, professors and lecturers are supported by the measure of their publications. Therefore, any work done by the company with a university group is bound to boost its quality, in terms of its presentation as well as its analysis, writing and dissemination.*
>
> (University Researcher 7)

Empirical evidence suggests that this is the case. For example, the impact of university–industry scientific publications was higher in Canada (1988–2005) than that of purely university papers and industry papers (Lebeau et al., 2008). Abramo et al. (2020) provide empirical evidence that during the period of 2010–2015, largely coinciding with the Great Recession in Italy, until reaching the start of recovery in 2017, private-public collaboration had a positive effect on the impact of publications. As well as Bloch et al. (2019) in the case of Danish industry publications from the period of 1995-2013, who found that articles in collaboration with university present higher impact than other type of collaboration. Similarly, other works find evidence of the positive effect of co-publications in collaboration with universities in scientific impact of firms (Gielfi et al., 2014; Krieger et al., 2021).

Hence, it can be expected that scientific co-production with universities will have a positive effect on business science.

Hypothesis 3. Scientific co-production with universities increases firms' scientific impact.

2.2.3. The moderating effect of economic growth in the relationship between university co-authorship and the quality of business science

It has been argued that scientific co-production with universities increases firms' scientific impact irrespective of the level of economic growth; i.e. this positive effect is expected at any point in time. However, another situation is expected in which the contribution from universities will be more meaningful. Although little theorising has been made about this aspect, on the one hand, enhanced public support to university-industry cooperation with low economic growth (section 2.2.1) is based on the assumption that universities are *particularly* useful in crisis, with low economic growth. On the other hand, the idea of a more valuable contribution from universities would be compatible with some recommendations stemming from the open innovation paradigm for firms to open up to universities in order to tackle low economic growth (Chesbrough, 2020; Hughes, 2011).

Some statements made by university researchers also suggest that with low economic growth firms are more open to novel ideas from universities, which could have a greater scientific impact, as shown by the following excerpt:

> *Certain issues come into vogue when crisis arises and call certain realities into question. Researchers working on these issues take advantage of the moment to propose solutions that previously may not have been interesting to the company. My research group and the companies with which I collaborated worked on projects with themes that were in vogue. The low economic growth gave rise to innovative ideas that, due to the relevance of the subject matter at that time, had a high impact in publications.*
>
> (University Researcher 7)

If this higher (lower) relevance of universities during economic downturns (upturns) translates into better cooperative science outlets, the following hypothesis could be established:

Hypothesis 4. Economic growth decreases the positive effect of scientific co-creation output with universities on the scientific impact of business science.

2.3. Research context

The above hypotheses will be tested in the context of the Spanish Great Recession. Fig. 2.2 shows how Spain mimicked the world trend; i.e. an economic acceleration (2000–2007) followed by an economic contraction (2008–2009), only that in Spain the contraction lasted longer (till 2014). The world Great Recession began in the United States with the collapse of Lehman Brothers in September 2008, due to failures in economic and financial regulation, and was followed by a financial crisis in the rest of the world (Grusky et al., 2011). Attempting to stabilise their economies, some governments developed bailout policies to save companies from bankruptcy. The world economy recovered between 2010 and 2012. Spain, however, experienced a lower recovery. The Spanish Great Recession started with the collapse of the property bubble in 2008, and it was deepened with the effects of the global financial crisis and by very high levels of unemployment and poverty (Meardi, 2014).

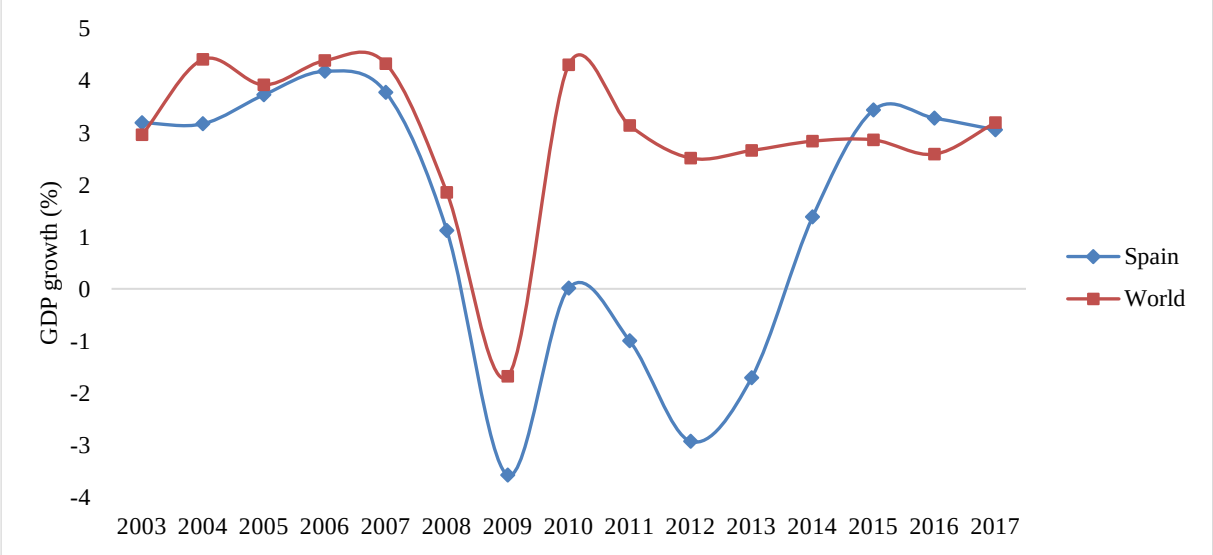

Fig. 2.2. Spanish GDP growth (own elaboration based on data from the World Bank dataset).

The Spanish Great Recession had immediate effects on Spanish science and innovation. On the private side, there was a reduction in the number of firms that introduced technological and non-technological innovations, by 43% and 55%, respectively (COTEC Foundation, 2018). On the public side, government R&D spending stagnated in 2008 and 2009, and in 2010 it decreased heavily (Cruz-Castro & Sanz-Menéndez, 2016), affecting research institutions that depend on public financing such as

universities and public research centres. However, public opinion was more favourable to considering science and technology as a policy priority (Sanz-Menéndez and Van Ryzin, 2015), and some regional governments and specific types of firms could effectively sustain business R&D efforts and collaborations despite the difficulties (García-Sánchez and Rama, 2020; Cruz-Castro et al., 2018).

From 2006 to 2017, the Spanish government instituted three programmes to support business R&D cooperation. Their main objective was to promote public-private alliances by providing direct public funding to universities and other research organisations to develop applied research activities in collaboration with private companies. Fig. 2.4 shows the evolution of the individual budgets of these three collaborative programmes and in terms of the percentage of the total national R&D budget. The National Strategic Consortia for Technical Research (CENIT) programme (2006–2010) was launched as part of the Ingenio 2010 Strategy, funded by the Centre for Industrial Technological Development (CDTI). The launch of this first programme took place in 2006, when the economy was expanding, although this high economic growth phase was about to end. In 2009, a Ministerial order considered CENIT as part of the 2008–2011 Spanish National R&D&I Plan (Orden CIN/1.559/2009). The last two years of the CENIT programme finalised under this framework (2009–2010), although the 2008–2011 Plan already incorporated a reinforced programme for public-private collaboration named *Innpacto*. The launch of this second programme occurred in 2008, when the economy plummeted. The *Innpacto* programme was promoted by the Ministry of Economy and Competitiveness and lasted for three years of the crisis (2010–2012). Fig 2.3 shows that *Innpacto* allocated a higher percentage of collaborative resources than CENIT. The structure of this programme continued from 2013 to 2019 under the name of the Challenges-Collaboration Programme. This third programme started in 2013, when the economy began to recover, with a reduced percentage of collaborative budget compared to *Innpacto*, but still higher than that of CENIT. These data reflect the fact that the percentage of budget allocation to promote business R&D collaboration was significantly higher during the phases of low economic growth than during phases of high economic growth. This is consistent with section 2.1.2 and Hypothesis 1.

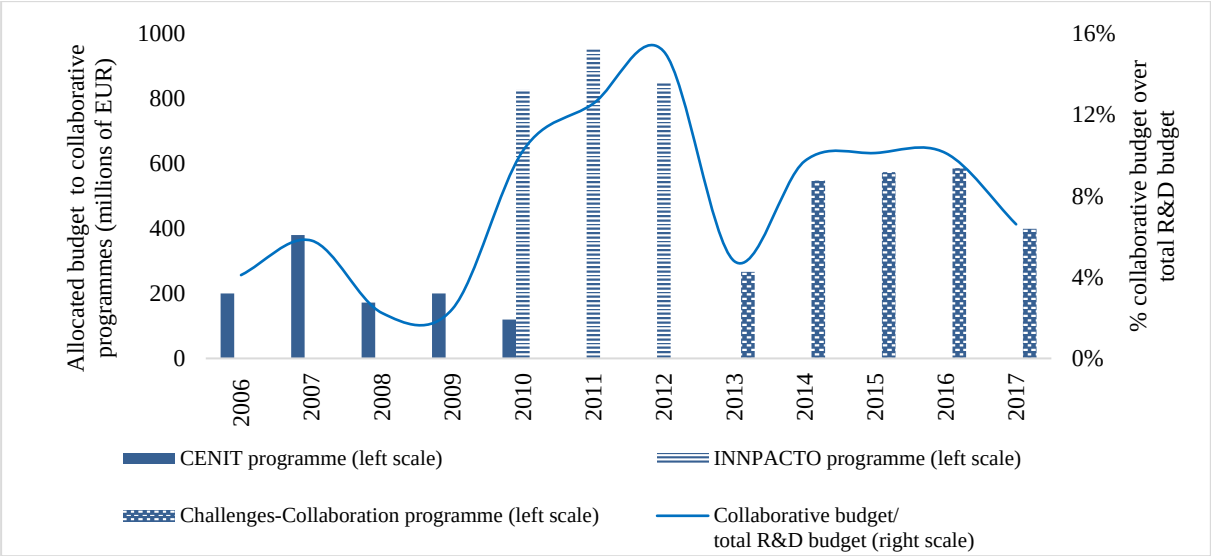

Fig. 2.3. Allocated budget to public-private R&D collaboration programmes in million EUR and % collaborative budget of total R&D budget. Own elaboration based on data from the Spanish Ministry of the Treasury (2018) and the Spanish Official State Gazette (2019).

2.4. Data and methods

Bibliometric data are a way to measure knowledge co-creation output and its scientific impact. In this study, university-industry knowledge co-creation output is measured through data on their co-publications. There is an ongoing debate on the use of university-industry co-publications as a proxy for joint scientific output. For instance, authors such as Lundberg et al. (2006) consider that university-industry co-publications are not a representative indicator of all the scientific output that can be generated from joint collaboration. However, authors such as Calvert & Patel (2003), Tijssen et al. (2009) and Abramo et al. (2009) have validated this approach, arguing that the number of co-publications is related to the occurrence of cooperation in research.

For the purposes of this study, the scientific impact of a publication is measured by the number of citations of the publications from each unit. Despite several criticisms to the use of citation counts, some authors considered it to be an appropriate statistical indicator of quality research (Cole, 1992).

The affiliation data for the authors was collected from the Web of Science records of publications in academic journals between 2000 to 2016 and contributed by any Spanish organisation. The resulting 188,458 Spanish addresses were classified as universities, firms and other organisations (hospital, research centre, joint institute, public organisation, non-profit organisation). The unit of analysis used is

the publication. The sample consists of the publications made by firms and their co-publications with other organisations, which translates into almost 15,500 publications, applying Hadi's (1994) method to exclude citation and team size outliers. If the non-firm organisation is a university, it is a university-industry co-publication. Publications are duplicated if different types of co-authoring organisations exist; however, in the econometric estimations of this study, this will be controlled by weighting the share of the number of organisational affiliations.

Economic growth is measured through the Spanish GDP annual growth rate (source: Spanish National Statistics Institute). To match publication and GDP data, a time-lag of two years has been assumed, since the effect of economic growth on publications is not immediate. The sign and significance of the estimated coefficients in the regression analysis do not change after testing with three-, four- and five-year lags.

Table 2.2. Variable definitions and descriptive statistics

Variable role	Variable name	Description	Mean	Std. Dev.	Min.	Max.
Dependent variables	*University co-authorship*	1 if a Spanish firm publication is co-authored with a university, 0 otherwise.	0.47	0.50	0.00	1.00
	Scientific impact	Citation counts: Number of citations of firm publications	5.49	11.69	0.00	770.00
Independent variables	ΔGDP_{t-2}	Change in Gross Domestic Product	1.45	2.61	-3.50	5.29
	ΔGDP^{2}_{t-2}	Change in Gross Domestic Product squared	8.49	6.91	-3.50	27.98
Control variables	*Firm size*	Number of firm publications, divided by 100	0.29	0.46	0.00	2.02
	Foreign collaboration	Number of foreign organisations	0.64	3.10	0.00	86.00
	Team size	Number of authors	5.53	14.37	1.00	498.00
	Multidisciplinarity	Number of different fields of the firm publication	1.18	0.41	0.00	3.00
	Science field					
	Social sciences	1 if the scientific field of the firm publication is social science, 0 otherwise	0.02	0.13	0.00	1.00
	Physical sciences	1 if the scientific field is physical sciences, 0 otherwise	0.22	0.41	0.00	1.00
	Technology	1 if the scientific field is technology, 0 otherwise	0.22	0.42	0.00	1.00
	Life sciences	1 if the scientific field is life sciences, 0 otherwise	0.72	0.45	0.00	1.00
	Region	18 dummy variables, one per Spanish autonomous community (NUTS-2 regions). Most co-publications located in Madrid (31%) and Catalonia (29%).				

Table 2.2 provides the mean and standard deviations of the sample. A little less than half of the sample are co-publications of firms with universities. Fig. 2.4 and Fig. 2.5 are constructed to provide some descriptive insight into the trend of university co-authorship and firms' scientific impact in the economic cycle.

As Fig. 2.4 shows, university co-authorship increased from 0.29 in 2000 to 0.54 in 2016. The main increase occurred between 2008 and 2009, at the beginning of the Great Recession. Actually, the evolution of university co-authorship exhibits a countercyclical behaviour, it being clearer during the phase of low economic growth, which roughly corresponds to the prediction of Hypothesis 1.

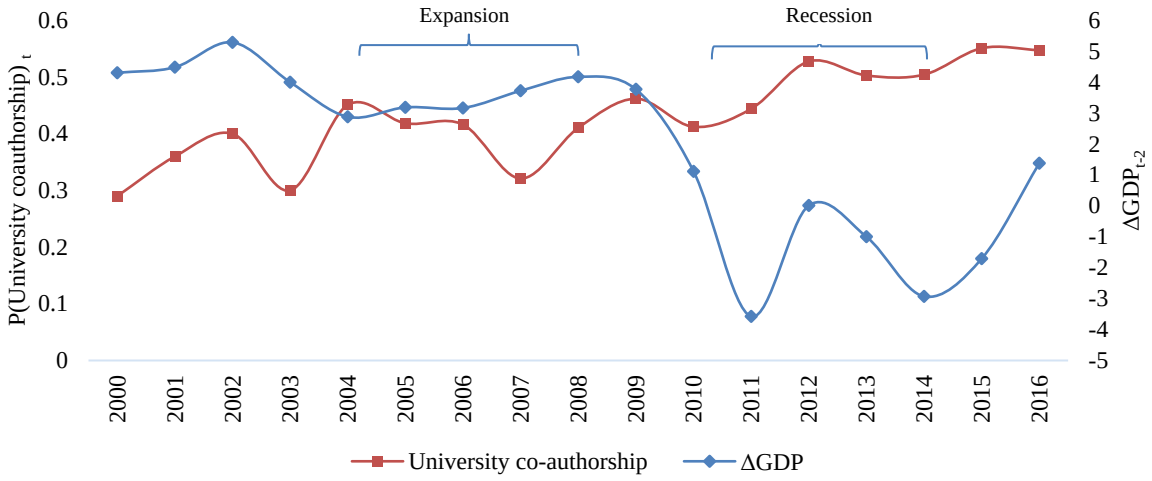

Fig. 2.4. Countercyclical behaviour of university-industry co-creation output.

Fig. 2.5 shows a substantial increase in firms' scientific impact, especially during the expansion. In crisis, stagnation is observed, albeit with fluctuations, before recovering at the end of 2016. Hence, the scientific impact of firms in some way behaves as predicted by Hypothesis 2, it being clearer with high economic growth.

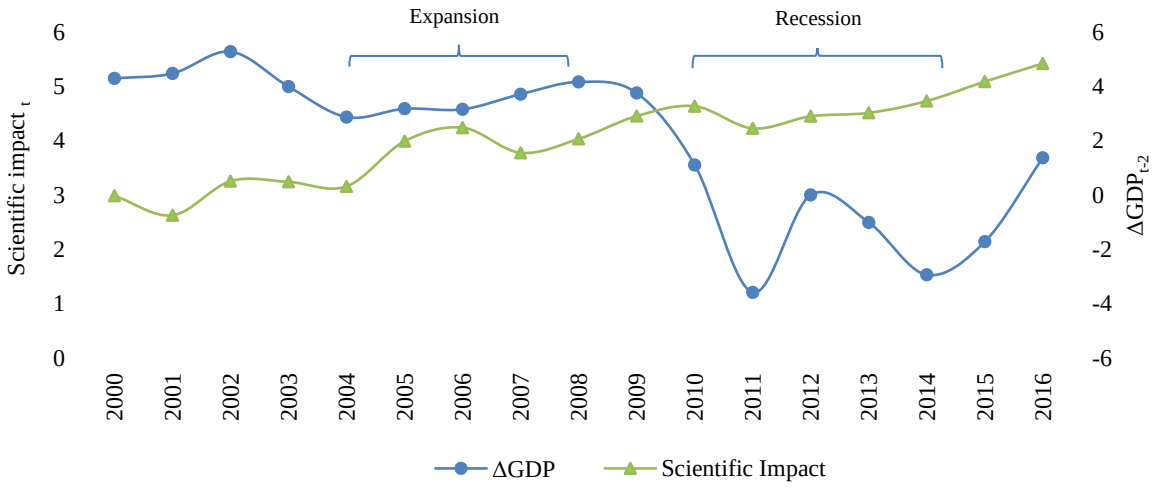

Fig. 2.5. Countercyclical behaviour of scientific impact of firm publications.

The empirical analysis involved two models. First, binary logistic regression was used to estimate the probability of a firm publication in collaboration with universities:

$$P(\text{University co-authorship}_{ijt})=f(\Delta GDP_{t-2}, \Delta GDP^{2}_{t-2}, \theta_{ijt}) \quad (1)$$

The dependent variable, university co-authorship, takes the value of 1 if a Spanish firm publication is co-authored with a university, 0 otherwise; *i* is the publication; *j* the firm; and *t* is time. The independent variables used in both groups of models are ΔGDP and ΔGDP^2, the squared term corresponding to the possibility of non-linearities in the data; and θ includes a set of control variables.

Second, a negative binomial model was used to estimate the scientific impact of the creation output of firms. The dependent variable used is the scientific impact, based on a two-year citation window (publication year and the following two years). This two-year window is imposed by the recency of the data when we created the database: the last publication year analysed was 2016, and citation data was available until 2018. Some may consider this to be a limitation of the study. However, other authors indicated that citation patterns are different for each scientific field (Garfield, 1972; Moed, 2006; Althouse et al., 2009). For example, in life sciences and physical sciences, the citations peak arises two years after publishing, and these are the most abundant fields in the sample used in this study. In addition, several papers have argued that a two-year lapse after publication is useful as an indicator of the long-

term quality and this is a sufficiently robust indicator of scientific impact (Adams, 2005; Dorta-Gonzalez & Dorta-Gonzalez, 2013).

The form of the proposed models is:

$$\text{Scientific impact}_{ijt}=f\big(\Delta GDP_{t-2},\ \Delta GDP^{2}_{t-2},\text{University co-authorship}_{ijt},\ \text{University co-authorship}_{ijt}*\Delta GDP_{t-2},\theta_{ijt}\big) \quad (2)$$

2.5. Results

2.5.1. Probability of university-industry co-publication

The results from the logistic estimation of Equation 1 are shown in Table 2.3. Column 1 includes control variables only, based on previous studies of industry (co-)publications (e.g. Halperin & Chakrabarti, 1987; Carayol & Matt, 2006; McKelvey & Rake, 2016; 2020; Yegros-Yegros et al., 2016; Arora et al., 2021). The control variables generally have the expected results on the full sample, but they vary according to the phase of the cycle. Smaller companies are relatively more eager to co-publish with universities, both pre- and post-crisis. These results probably reflect that small, highly specialised firms have the necessary capacities and resources to acquire public funds for collaborative R&D projects (Wanzenboeck et al., 2014); however, this contrasts with Giunta et al. (2016), who indicate that larger firms co-publish more than smaller ones. The coefficient of foreign collaboration is positive and significant in the full sample and the post-crisis period. The coefficients of team size are not significant in the full sample nor in pre-crisis, but during the phase of low economic growth the effect is negative and significant. The coefficients of multidisciplinarity are positive in the full sample and before the crisis, and they are not significant afterwards.

Column 2 shows that the coefficient of ΔGDP is negative and significant, which means that the probability of firms' co-publications with universities is countercyclical. However, according to the negative and significant coefficient of ΔGDP^2 (Column 3), this occurs after a threshold, and before that the effect of economic growth is positive. To corroborate the presence of an inverted U-shape, the test proposed by Lind and Mehlum (2010) was used, as suggested by Haans et al. (2016). The test verifies

an inverted U-shaped relationship between GDP growth and the probability of co-publication. Hence, the evidence supports Hypothesis 1: economic growth maintains an inverted U-shaped quadratic relationship with university co-authorship. When economic growth decelerates or contracts, the negative relationship between economic growth and university-industry co-publications becomes positive.

Table 2.3. Logistic model estimation of university co-authorship

	1 Full sample	2 Full sample	3 Full sample	4 Pre-crisis (2000-2008)	5 Post-crisis (2009-2016)
ΔGDP_{t-2}		-0.09***	-0.11***	-0.11***	0.05**
		(0.01)	(0.01)	(0.03)	(0.02)
ΔGDP^2_{t-2} (H1)			-0.02***		
			(0.00)		
Firm size	-0.47***	-0.47***	-0.46***	-0.44***	-0.56***
	(0.05)	(0.05)	(0.04)	(0.07)	(0.07)
Foreign	0.04***	0.03**	0.03**	0.01	0.08***
collaboration	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Team size	-0.01	-0.01	-0.01	0.02	-0.07***
	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)
Multidisciplinarity	0.16**	0.14**	0.15**	0.28***	0.01
	(0.07)	(0.07)	(0.07)	(0.10)	(0.10)
Science field	Significant	Significant	Significant	Significant	Significant
Region	Significant	Significant	Significant	Significant	Significant
Constant	-0.04	-0.04	0.12	-0.22	0.71**
	(0.10)	(0.10)	(0.10)	(0.19)	(0.15)
Observations	15,457	15,457	15,457	7,553	7,904
$\chi 2$	883	975	996	463	472
p	0.00	0.00	0.00	0.00	0.00
R2	0.07	0.08	0.09	0.08	0.09
Log-likelihood	-5,079.32	-5,028.74	-5,010.81	-2,618.05	-2, 299.93

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

To obtain a more intuitive understanding of the effect of economic growth in each phase of the cycle, the data is split into pre- and post-crisis periods. Column 4 shows that the effect of GDP growth before the crisis is significant with a negative sign. On the contrary, Column 5 shows that impact of GDP growth rate, during and after the crisis, is significant and positive.

2.5.2. Scientific impact of industry publications

The second group of estimations focuses on the scientific impact of publications. The results of the negative binomial regressions appear in Table 2.4. All estimations include fixed effects for the region and science field. Regarding control variables, Column 1 shows that all of them have positive, significant effects on scientific impact. The positive sign of *firm size* implies the greater the size of firms, the greater the scientific impact of their publications. The positive sign of *foreign collaboration* indicates that international co-publications may be more beneficial than national ones (Goldfinch et al., 2003). *Team size* appears to have a positive effect, probably because there are more authors researching and communicating with other researchers, who subsequently cite them (Frenken et al., 2010; Mckelvey & Rake, 2020). Finally, *multidisciplinarity* indicates a positive effect, probably due to the association of this variable with high-quality research results.

Column 2 shows the negative linear effect of ΔGDP on the scientific impact of firms' creation output; i.e. the overall countercyclical behaviour of this scientific impact. However, the coefficient of ΔGDP^2 is statistically significant and reveals a negative quadratic relationship with scientific impact, as observed in Column 3: that is, with low economic growth, when the economy stagnates and slows down, the scientific impact of firms increases; however, when the economy recovers, the scientific impact of firms decreases. The test by Lind and Mehlum (2010) confirms the presence of an inverted U-shape relationship between GDP growth rate and the scientific impact of firms' creation output. Hence, this result confirms Hypothesis 2.

The effect of knowledge co-creation with universities, university co-authorship, on firms' scientific impact is positive and significant, regardless of whether ΔGDP^2 is excluded (Column 2) or included (Column 3). Hence, co-creation with universities increases scientific impact. This confirms Hypothesis 3.

Column 4 adds an interaction between university co-authorship and ΔGDP. It does not provide a significant result, implying that the economic growth does not moderate the effect of university co-authorship on firms' scientific impact; therefore, Hypothesis 4 is not confirmed. University co-authorship was also studied in interaction with ΔGDP^2 in order to test whether the scientific co-creation

output with universities flattened the curvilinear effect of economic growth on the scientific impact of business science; however, no significant results were obtained. Taken together with the verification of Hypothesis 1, the results suggest that the scientific impact of firms grows with low economic growth because the probability of co-authorship with university increases, not because co-authorship yields better results than with high economic growth.

Table 2.4. Negative binomial model estimation of scientific impact

	1 Full sample	2 Full sample	3 Full sample	4 Full sample	5 Pre-crisis (2000-2008)	6 Post-crisis (2009-2016)
ΔGDP_{t-2}		-0.03***	-0.04***	-0.04***	-0.10***	0.03**
		(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
ΔGDP^2_{t-2} (H2)			-0.01***	-0.01***		
			(0.00)	(0.00)		
University co-authorship (H3)		0.16***	0.15***	0.15***	0.18***	0.12***
		(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
University co-authorship * ΔGDP_{t-2} (H4)				-0.01		
				(0.01)		
Firm size	0.13***	0.16***	0.16***	0.16***	0.13***	0.15***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Foreign collaboration	0.08***	0.08***	0.07***	0.07***	0.11***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Team size	0.06***	0.06***	0.06**	0.06**	0.07***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Multidisciplinarity	0.26***	0.28***	0.29***	0.29***	0.45***	0.19***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.07)	(0.06)
Science field	Significant	Significant	Significant	Significant	Significant	Significant
Region	Significant	Significant	Significant	Significant	Significant	Significant
Constant	0.93***	0.90***	0.99***	0.99***	0.68***	1.23***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.12)	(0.09)
Observations	14,528	14,528	14,528	14,528	6,971	7,557
χ^2	467	545	575	575	403	221
p	0.00	0.00	0.00	0.00	0	0
R^2	0.01	0.02	0.02	0.02	0.02	0.01
Log-likelihood	-18,653.42	-18,614.93	-18597.40	-18,597.33	-8,913.15	-9,626.47

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

The results in columns 5 and 6 break down the sample by period. For the pre-crisis sample, GDP growth rate has a significant and negative effect on firms' scientific impact, whereas for the post-crisis sample, GDP growth rate has a positive significant effect. University co-authorship has a similar positive effect.

2.5.3. Split sample analysis by scientific field

It was determined whether the sign and significance of the coefficients of the independent variables vary across scientific fields in the first level of aggregation of Web of Science subject categories (Life sciences & Biomedicine, Physical sciences, Technology).[2] Table 2.5 Columns 1 to 3 confirm the inverted U-shaped relationship between GDP growth rate and the probability of university co-authorship for every science field. Columns 4 to 6 confirm the negative effect of squared GDP growth rate and the positive effect of university co-authorship on business scientific impact for every science field.

With regard to the interaction between university co-authorship and ΔGDP on firms' scientific impact, Columns 4 and 5 support the original result of the non-effect in the case of Life sciences and Physical sciences; however, in the case of Technology, Column 6 shows that economic growth increases the positive effect of scientific co-creation output with universities on the scientific impact of business science. The significance of the estimated coefficient is weak (less than 10%), but the fact that it contradicts Hypothesis 4 deserves some discussion. A possible explanation of this distinctive feature is that in periods of high economic growth, technologically innovative firms become important drivers of the higher innovation investment (Archibugi et al., 2013). With high economic growth, technological firms are willing to expand innovation though the formalisation of R&D interactions and capitalisation of technological opportunities (Perez, 2003; Archibugi et al., 2013). This upswing in the economy would also lead to an improvement in the impact of business science as the novelty of new technology increases (Foster et al., 2015).

Another explanation, especially in the case of Technology, is that firms' scientific impact may receive greater benefits from scientific co-production with academic partners who provide predominantly basic knowledge, while the research of technological firms focuses mostly on applied activities, which leads to better quality research output (Scandura & Iammarino, 2022).

[2] Social sciences and Arts & Humanities were excluded, due to the small number of observations. This is not surprising, given that data referring to this field are not sufficiently covered by WoS (Hicks, 2004).

Table 2.5. Logistic model estimation of university co-authorship and negative binomial model of scientific impact, by scientific field

	University co-authorship			Scientific impact		
	1 Life sciences	2 Physical sciences	3 Technology	4 Life sciences	5 Physical sciences	6 Technology
ΔGDP_{t-2}	-0.06***	-0.09***	-0.23***	-0.03***	-0.04***	-0.10***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
ΔGDP^2_{t-2} (H1&2)	-0.02***	-0.03**	-0.05***	-0.01***	-0.01**	-0.02***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
University co-authorship (H3)				0.07**	0.17***	0.43***
				(0.03)	(0.05)	(0.07)
University co-authorship*ΔGDP_{t-2} (H4)				-0.00	0.01	0.05**
				(0.01)	(0.02)	(0.03)
Firm size	-0.80***	-0.25***	0.15	0.12***	0.08	0.25***
	(0.07)	(0.09)	(0.13)	(0.03)	(0.05)	(0.07)
Foreign	0.07**	-0.04	0.08	0.05***	0.09***	0.11***
collaboration	(0.01)	(0.03)	(0.08)	(0.01)	(0.02)	(0.03)
Team size	-0.03***	0.01	0.00	0.06***	0.04***	0.06***
	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)
Multidisciplinarity	1.16***	0.14	0.57***	0.28***	-0.03	0.53***
	(0.12)	(0.10)	(0.1)	(0.06)	(0.06)	(0.07)
Science field	Significant	Significant	Significant	Significant	Significant	Significant
Region	Significant	Significant	Significant	Significant	Significant	Significant
Constant	-0.89***	0.96***	-0.09	0.93***	1.45***	0.30**
	(0.17)	(0.20)	(0.20)	(0.09)	(0.12)	(0.14)
Observations	11,144	3,393	3,448	10,584	3,242	3,136
χ^2	724	147	333	330	169	1,909
P	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.10	0.05	0.12	0.01	0.01	0.03
Log-likelihood	3,088.37	1,319.59	-1,395.78	-12,283.95	-5,390.90	-4,897.21

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

2.6. Robustness checks

A set of robustness tests were applied to the findings. First, it was decided to refine the analysis regarding firm size variable. In previous estimations, in order to maintain the number of observations from the full sample, the total number of co-publications from firms was used as a proxy variable for firm size. However, to provide a more precise empirical examination, an additional regression analysis was conducted in which firm size calculation was based on the number of employees and profitability based on the return on investment (ROI) of firms (Hartmann et al., 2006; Kamien & Schwartz, 1978). To this end, the System of Analysis of Iberian Balance Sheets (SABI database), compiled by Bureau van Dijk, was used to control for firm-level data. Information on approximately 30,000 companies was downloaded. Matches were found for 500 firms from 2,426 companies in the total sample by using a company name-matching algorithm and manual review. The results in Table 2.6 confirm previous finding and reinforce the support for Hypotheses 1 to 3, but not 4.

Table 2.6. Logistic model estimation of university co-authorship and negative binomial model estimation of business scientific impact: SABI-matched subsample

	1 University co-authorship	2 Scientific impact
ΔGDP_{t-2}	-0.09***	-0.05***
	(0.02)	(0.01)
ΔGDP^2_{t-2} (H1&2)	-0.02***	-0.01***
	(0.01)	(0.00)
University co-authorship (H3)		0.12***
		(0.05)
University co-authorship * ΔGDP_{t-2}(H4)		-0.02
		(0.02)
Employeest-2	0.00*	-0.00***
	(0.00)	(0.00)
Profitability (ROI) t-2	0.00	-0.01*
	(0.00)	(0.00)
Foreign collaboration	0.02	0.05***
	(0.04)	(0.02)
Team size	0.00	0.06***
	(0.01)	(0.01)
Multidisciplinarity	-0.02	0.19**
	(0.13)	(0.07)
Science field	Significant	Significant
Region	Significant	Significant
Constant	0.01	-0.10*
	(0.19)	(0.04)
Observations	5,320	5,061
$\chi 2$	432	262
p	0.00	0.00
R2	0.14	0.02
Log-likelihood	-1,653.48	-6,594.34

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

Second, a robustness check was performed to overcome the limitations regarding the use of citation counts as an indicator of scientific impact. Frenken et al. (2010) mentioned that this measure does not consider the relative impact or the citation behaviour across disciplines. Therefore, a different specification of the second dependent variable was considered, the Field Normalised Citation Score (FNCS). The indicator aims to normalise citation counts for differences between fields, so that the computation of scientific impact is not influenced by/independent of the subject category of a paper (Rehn et al., 2007). To calculate FNCS, the relative number of citations of a single publication (2-year windows) was divided by the average of citations received by all Spanish papers in the same subject

fields and the same period. Consider the following example: a Spanish paper published in 2016 belongs to two categories: “Biomedicine” and “Physical Sciences”, their FNCS would be the number of citations received in 2016, 2017 and 2018 divided by the average number of citations of all publications in “Biomedicine” in 2016, plus the number of citations received in those same years divided by the average of citations of all publications in “Physical Sciences” in 2016 and divided by 2.

To check the scientific impact of the co-creation of firms using the FNCS indicator the Tobit model was applied, because FNCS presents continuous observations that take values greater than zero, which reflects a censored data distribution. It was noted that the results in both models do not change. The results in Table 2.7, Column 1, support the finding of an inverted U-shaped relationship between ΔGDP and the scientific impact of the creation output of firms. In the pre-crisis sample, a significant and negative effect of GDP growth rate is observed on firms’ scientific impact, whereas for the post-crisis sample, GDP growth rate has a positive significant effect. Moreover, the effect of knowledge co-creation with universities, university co-authorship, on the scientific impact of firms confirms the result that co-creation with universities increases scientific impact.[3]

[3] The results are also robust to the exclusion of the firm size outliers or the exclusion of firm co-publications with joint university-government labs.

Table 2.7. Tobit model estimation of normalised scientific impact

	1 Full sample	2 Pre-crisis (2000-2008)	3 Post-crisis (2009-2016)
ΔGDP_{t-2}	-0.00	-0.10**	0.06**
	(0.01)	(0.04)	(0.02)
ΔGDP^2_{t-2} (H2)	-0.01***		
	(0.01)		
University co-authorship (H3)	0.44***	0.46***	0.48***
	(0.07)	(0.10)	(0.09)
University co-authorship * ΔGDP_{t-2} (H4)	-0.04		
	(0.02)		
Firm size	0.45***	0.40***	0.41***
	(0.07)	(0.12)	(0.09)
Foreign collaboration	0.16***	0.22***	0.11***
	(0.03)	(0.05)	(0.03)
Team size	0.03	0.01	0.07***
	(0.03)	(0.03)	(0.01)
Multidisciplinarity	0.63***	0.80***	0.44***
	(0.11)	(0.16)	(0.14)
Science field	Significant	Significant	Significant
Region	Significant	Significant	Significant
Constant	1.37***	1.33***	1.33***
	(0.22)	(0.30)	(0.20)
Observations	14,544	6,788	7,756
$\chi 2$			
p	0.00	0.00	0.00
R2	0.01	0.01	0.01
Log-likelihood	-15,915.11	-7,816.29	-8,054.86

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

2.7. Conclusions

The literature on university-industry scientific knowledge co-creation output and firms' scientific impact has demonstrated the dependence of both phenomena on individual, organizational, and institutional factors. Concurrently, another line of research has emphasized the role of economic growth in shaping innovation activities. This study bridges these two streams of literature to articulate a theoretical framework regarding how university-industry scientific knowledge co-creation output and firms' scientific impact respond to economic growth. We propose a university-industry cycle theory, positing that economic growth maintains a curvilinear relationship with firms' co-creation of scientific

knowledge with universities and its scientific impact, being negative with high economic growth but positive with low economic growth.

By utilizing a comprehensive database of co-publications by Spanish firms with universities during the Great Recession, we have empirically validated this theoretical framework, confirming the curvilinear behaviour of firms' scientific impact in response to economic growth. Additionally, we have identified that scientific co-creation output with universities amplifies firms' scientific impact across all economic phases.

These contributions hold significant implications for the field of scientometrics. While previous research predominantly focused on the effects of scientific knowledge creation and impact on economic growth (Azmeh, 2022; Pinto & Teixeira, 2020; Solarin & Yen, 2016; Inglesi-Lotz et al., 2014; Inglesi-Lotz & Pouris, 2013), our study shifts the spotlight to university-industry co-creation and impact, elucidating their reactions to economic growth. Moreover, by employing a mixed-methods approach encompassing qualitative insights alongside quantitative analysis, we extend beyond the traditional quantitative-only studies in this domain.

Our findings also carry practical implications. They underscore the need for nuanced public policies tailored to different stages of the economic cycle to reinforce R&D cooperation effectively. During periods of low economic growth, initiatives promoting knowledge co-production should be prioritized, bolstering industry collaboration and expediting the publication of co-creation output. Conversely, in times of high economic growth, support for co-creation efforts becomes crucial to enhancing the quality of firms' scientific output and preparing for potential future economic downturns.

Furthermore, our study reveals distinct implications for different scientific fields. In the Life sciences and Physical sciences, sustaining scientific knowledge co-creation during periods of high economic growth is vital, while in Technology-related fields, high economic growth amplifies the contribution of university co-authorship to firms' scientific impact. This underscores the necessity for tailored policy efforts aligned with the phase of the economic cycle and the specific scientific field.

Despite these contributions, our study has limitations and suggests avenues for future research. While we have contributed to theory by identifying mechanisms between economic growth and scientific co-production or impact, further analysis of these mechanisms is warranted. Additionally, expanding the

dataset to encompass other countries and longer time spans would enhance the generalizability of our findings. Moreover, future research could explore analogous questions pertaining to technological cooperation and impact, as well as conduct robustness tests with longer citation windows. Finally, the effects of the coronavirus pandemic on knowledge co-creation warrant further investigation, as it has introduced unprecedented challenges and opportunities in the economic landscape.

In conclusion, our study underscores the significance of studying economic growth and science co-created by companies and universities in navigating economic fluctuations. The innovative policies governments implement in response to economic shifts will play a pivotal role in leveraging the challenges posed by low economic growth as opportunities for scientific advancement and economic resilience.

Chapter 3. Which university-industry transfer channels foster the effect of economic growth on business scientific impact?

3.1. Introduction

Society has been able to overcome and recover from various shocks and crises thanks to the impact of research conducted through collaboration between universities and industries (Defendi et al., 2021). Although the results of these relationships are often applied to products and development, research knowledge frequently fails to bridge the gap and translate into impactful scientific outcomes. At the same time, it is of relevant importance to explore if the impact of business science might change over time. In this relationship both parts play different roles in having quality science. On the one hand, business science contributes significantly to the impact and quality of innovation (Camerani et al., 2018); on the other hand, university science contributes shaping impactful research outputs (Beck et al., 2022; McKelvey & Rake, 2020; Belderbos et al., 2016). Due to this complementarity collaborative science is expected to provide avenues for scientific advancement.

The impact of business science is defined as the recognition within a professional community of knowledge producers by firms (D'Este et al., 2018). However, to elaborate some arguments in this chapter we also take into account the definition of other scholars such as Cohen et al. (2010), Leimu and Koricheva (2005), and Glänzel and Schubert (2001), who associate scientific impact with characteristics such as popularity, influence, novelty, and the usefulness of research publications.

In Chapter 2, we highlighted that collaborative research with universities increases scientific impact of business science, and elaborated on how economic growth has a positive effect on firms' scientific impact, but, beyond a certain point, this relationship turns negative (Gómez-Aguayo et al., 2024. Despite the importance of these findings, university co-authorship did not moderate the relationship between economic growth and firms' scientific impact. Our results suggest that the influence of universities on the scientific impact of firms in crises is due to the increased probability of co-authorship, rather than co-authorship yielding better results than in expansions. However, we did not explore whether certain knowledge transfer channels might moderate this relationship while others may not. This research gap exists concerning the knowledge transfer channels, specifically on the effect of economic growth and business cycles (Barberá-Tomás et al., 2022), thus, this study aims to address it.

Knowledge transfer channels refer to the mechanisms used to facilitate the transfer of knowledge during interactions between researchers from universities and industries (D'Este & Patel, 2007). The literature proposes several ways to classify these channels, such as bi-directional and unidirectional channels (Meyer-Krahmer & Schmoch, 1998; Azagra-Caro et al., 2006), or academic engagement and commercialization channels (Perkmann et al., 2013).[4] In this study, we use formal and informal classification based on Link et al. (2007), Bradley et al. (2013), Schaeffer et al. (2020) and others. Formal channels involve legal instruments, such as the licensing of patents or the creation of spin-offs (Link et al., 2007; Bradley et al., 2013). Informal channels refer to mechanisms that facilitate the flow of technological knowledge through informal communication such as conferences and knowledge diffusion activities (Brennenraedts et al., 2006; Bekkers & Bodas Freitas, 2008). This classification provides a comprehensive and consistent approach, suited for exploring different forms of knowledge exchange, as it offers a wide range of channels for analysis.

Several studies have explored the potential of formal knowledge transfer channels to enhance scientific outputs and promote high-impact collaborative research (Gulbrandsen & Smeby, 2005; Abreu & Grinevich, 2013). However, less attention has been paid into the relationship between informal channels and scientific impact. The diversity of factors involved in informal processes, along with the challenges in measuring immediate outputs, make direct measurement difficult. To develop this study, it is necessary to rely on two main sources of data. First, bibliometric data will be used to analyse scientific impact of co-creation outputs. Second, survey data will be utilized to explore the use of various knowledge transfer channels. The challenge of this study lies in effectively matching these two data sources to provide comprehensive insights into the relationship between different channels and scientific impact. To the best of our knowledge, this is the first attempt to do so.

The main question we seek to address is 'What are the effects of different types of knowledge transfer channels, according to their degree of formalisation, on the relationship between economic growth and

[4] Bidirectional knowledge transfer associated with collaborative research and unidirectional channels are those that rely on research contracts in which there is a unilateral transfer of knowledge from the universities. Academic engagement includes activities such as collaborative research, contract research and consulting and informal activities. Literally mentioned: "Academic engagement is also sometimes referred to as informal technology transfer" (Link et al., 2007; Perkmann et al., 2013, p. 424)

scientific impact of business science?' Two main objectives would be: (1) to analyse the scientific impact of firms among existing types of knowledge transfer channels, (2) to show the moderation effect of knowledge transfer channels on the effect of economic growth on the scientific impact of collaborative knowledge creation.

The paper is organized as follows. Section 2 offers a conceptual framework detailing the intersections of scientific impact, knowledge transfer channels, and economic growth. Section 3 introduces the dataset, describes the survey sample, outlines the variables, and presents the empirical analysis method. Section 4 presents the results of the econometric analysis. Section 6 provides a discussion of the findings and draws the main conclusions.

3.2. Theoretical framework

3.2.1. Formal, informal and cocreative university-industry knowledge transfer channels

The seminal literature on informal university technology transfer (IUTT) distinguishes two mechanisms for transferring knowledge between university and industry: formal and informal channels (Link et al., 2007, Grimpe & Fier, 2010, Bradley et al., 2013). According to these authors, formal channels are forms of interaction that involve legal instruments, such as the licensing of patents, the agreements for tangible research materials and the creation of spin-offs (Link et al., 2007; Bradley et al., 2013; Schaeffer et al., 2020).[5]

These are 'pure' formal channels (Schaeffer et al., 2020), but there are also other formal channels. Bradley et al. (2013) introduced a new category labelled 'academic-industry collaborations', followed by others (Ranga et al., 2016; Schaeffer et al., 2020).

[5] Another conception of formal and informal linkages is suggested by Vedovello (1997, 1998). She grouped university-industry linkages into formal and informal categories, focusing on merely contractual aspects of formal linkages and the structure of the partnership. Other authors who classify linkages between university and industry according to this approach of formality include, Fritsch and Schwirten (1999), Schartinger et al. (2002), D'Este and Patel (2007), Romero (2007), Wright et al. (2008), Perkmann and Walsh (2009), Eun (2009), Cassiman et al. (2010), and Leisyte (2011). Vedovello's contractual approach to formal channels includes mechanisms that we do not take into account because they do not imply sustain long-term collaboration. The focus of this research is to explore the channels that maintain collaborations over time.

Link et al. (2007) and Bradley et al. (2013) define informal channels as those mechanisms that facilitate the flow of technological knowledge through informal communication processes such as technical assistance, sharing facilities, provision of technical or advisory services, and consulting work. According to Schaeffer et al. (2020), informal channels encompass additional mechanisms of informal communication, such as conferences, training activities for companies (presentations, occasional talks). Knowledge diffusion activities, sometimes considered non-formal knowledge transfer channels, also fit into this category (Azagra-Caro et al., 2020). We also consider an informal channel the participation in non-academic networks (associations, joint initiatives) that involve contractual arrangements. It includes certain features of sustained partnerships characterized by a continued working relationship through academic–industry collaboration, e.g. channels like research contracts, supervision of industrial PhDs, and creation of joint research centres.

The IUTT literature includes joint publications as an informal channel, but we consider it a miscategorisation. Joint publications are rather a scientific codified output of interactions, so a transfer mechanism must precede a joint publication. Otherwise, the publication would not exist and would not produce scientific impact, which is what we try to link to specific transfer channels. Hence, in the context of our research, we consider joint publications a transfer output and not a channel.

Curiously, the categorization of the most intuitive channel leading to joint publications, joint research projects, remains one of the most contentious in the IUTT literature. While Link et al. (2007) consider joint research projects as an informal mechanism facilitating the flow of technological knowledge, Bradley et al. (2013) argue that such projects do not correspond to the informal category. Shaffer categorizes joint research as a formal interactive channel, arguing that it represents a form of sustained long-term collaboration involving continuous interaction. Given the lack of consensus on categorizing joint research projects, we turned to the categorization proposed by D'Este et al. (2019). They introduce a cocreative knowledge transfer channel as a form of university-industry collaboration that emphasizes on collaborative knowledge production. It involves establishing research priorities through mutual compromise and requires joint efforts to tackle diverse challenges. Co-creation includes competitive R&D projects and research partnerships. Table 3.1 summarizes the above information and synthesizes the concepts used in this study.

Table 3.1. Knowledge transfer types according to the formalization of their basic contents

Knowledge transfer type	Description	Basic contents	Related transfer channels
Formal knowledge transfer	Formal technology transfer mechanisms encompass legal instruments such as licenses or royalty agreements, plus academic-industry collaborations through sustained working relationships	Allocation of property rights, disclosure to TTO, or a formal process that relies on long-lasting interaction	Licensing of patents Agreement for tangible research materials Creation of spin-offs Research contracts or agreements
Informal knowledge transfer	An informal technology transfer mechanism is one facilitating the flow of technological knowledge through informal communication processes	Communication processes, no disclosure to TTO, exchange of ideas	Joint publications* Conferences Technical assistance and sharing facilities Provision of technical or advisory services Consulting work Training activities for companies (presentations, occasional talks) Knowledge diffusion activities Supervision of industrial PhDs Joint research centres Participation in non-academic networks (associations, joint initiatives)
Cocreative knowledge transfer	Co-creation mode in university-industry interaction entails setting research priorities through mutual compromise and joint efforts to address challenges.	Knowledge co-creation through collaborative research projects	Joint research projects

Own elaboration based on Link et al. (2007), Grimpe and Fier (2010), Bradley et al. (2013), D'Este et al. (2019), Schaeffer et al. (2020) and Azagra-Caro et al. (2020). * In the context of our research, joint publications are a transfer output, so we do not include them among transfer mechanisms/channels in the empirical part.

3.2.2. Formal, informal and cocreative university-industry knowledge transfer channels and scientific impact of business science

The relationship between the type of channels, according to their degree of formalization, and their effect on business scientific impact is not developed in existing literature. Although some studies have partially explored this relationship in the case of universities and public research organisations, their findings remain ambivalent even in that case. All in all, taken together there is no clear indication of the effect of formal or informal channels on business scientific impact. Below, we elaborate on the reasons for expecting either a positive or negative linear effect based on the type of channels.

Formal channels. A first line of reasoning suggests a positive effect of formal channels on scientific impact in the case of universities and public research organisations. Collaborations with technology companies often focus on applied activities, leading to higher quality research output (Scandura & Iammarino, 2022). For instance, spin-off and firm creation activities are recognized as effective means to foster research novelty (Arza, 2010; Drivas et al., 2014) and are positively associated with the impact of scientific contributions (D'Este et al., 2019). Moreover, licensing academic patents has been shown to positively influence citations in related scientific publications (Mowery et al., 2014; Thompson et al., 2018).

However, in particular cases licensing, spin-offs can negatively impact scientific output due to issues of restricted access to research tools such as materials or data sharing. For example, licensing involving material transfer agreements have been observed to decrease citations in scientific publications due to restriction on sharing practices of universities during license negotiations that limit the sharing of research tools (Mowery et al., 2014).

Hence, there are reasons to justify both a positive and a negative effect of formal channels on scientific impact.

Informal channels. Although there is a lack of literature theorizing the effect of informal channels on scientific impact in the case of universities and public research organisations, it is possible to identify arguments anticipating a positive impact of informal channels.

Studies on informal channels limited to suggest that these channels can enhance both the quantity and quality of research outcomes (Siegel et al., 2003). However, these studies have not empirically examined this assertion (Perkmann et al., 2021).

The first line of reasoning is that informal channels increase the likelihood of exchanging valuable knowledge (McKelvey & Rake, 2016). These channels act as mechanisms that contribute to open science, thereby increasing the impact of research outputs. For example, knowledge diffusion that occurs through conferences, training activities for companies, and technical assistance helps to share results with a wide audience in academia or industry, receive peer feedback and spark new research ideas (García-Aracil & Fernández de Lucio, 2008; Friesike et al., 2014, Gerbin & Drnovsek, 2016; Beck et

al., 2022) and cross-check and verify previous knowledge (McKelvey & Rake, 2016). However, these channels have not been studied in relation to scientific impact.

The second line of reasoning follows the idea that the impact of informal channels on science is a matter of time. Informal channels stimulate formal channels, and long-term efforts will nurture new ideas and knowledge inputs to address major scientific challenges. For example, some studies argue that consulting work and advisory services contribute to scientific impact (De Fuentes & Dutrénit, 2012). These activities provide funding for the laboratory or department of the consulting scientist (Ortega-Argilés et al., 2009; Rentocchini et al., 2011). Although consultancy and advisory services are not direct sources of new scientific or technological knowledge, they can facilitate technical innovation and contribute to challenges from large science and technology-intensive firms (Rentocchini et al., 2014). Informal channels could potentially increase scientific impact due to the involvement of industry researchers in academic culture. Similar to the effects of collaboration with other innovation actors, the theoretical framework suggests that involvement in firm networks can enhance research quality (Liao, 2011; Li et al., 2013). Furthermore, the supervision of industrial PhDs might ensure the quality of research through the involvement of a university supervisor, whose role is to enhance the research quality (Schartinger et al., 2001).

On the contrary, informal channels are associated to applied activities focused on solving industry problems and are often linked to lower levels of scientific impact. Moreover, multiple informal interactions over time may have the opposite effect, resulting in less scientific valuable (Perkmann & Walsh, 2009) and a reduced ability to focus on a particular topic.

Cocreative channels. Cocreative channels are particularly beneficial for academics involved in these projects, enabling them to focus on researching and generating high-quality outputs (Callaert et al., 2015) and fostering novelty and academic value in the resulting outputs (Perkmann & Walsh, 2009; Arza, 2010; Vega-Jurado et al., 2017). Joint research can boost research output for several reasons. First, industrial research ideas can be refined by testing practical and theoretical concepts (Banal-Estañol et al., 2015). Second, it secures funds for infrastructure and research staff (Belderbos et al., 2004; Faems et al., 2005; Banal-Estañol et al., 2015). Third, researchers can be more selective and focus on fewer, more challenging projects (Banal-Estañol et al., 2015).

However, there is a risk of a decline in the quality of research when academics are involved in multiple projects, as this could reduce the time and attention they can dedicate to each project, potentially impacting the quality of high-level research (Banal-Estañol et al., 2015).

Overall, we have used studies on the effects of knowledge transfer channels on the scientific impact of universities and public research organisations to gain insights into the case of business scientific impact. It is difficult to predict whether these three types of channels will have a positive or negative effect on scientific impact, particularly on business scientific impact. Our arguments suggest that formal and informal channels have mixed effects, both positive and negative, while cocreative channels are expected to have a positive effect. However, there is little theory to support clear hypotheses. Therefore, it is necessary to continue analysing the three types of channels using an exploratory approach to address our research question.

3.2.3. Moderating effects of university-industry knowledge transfer channels on the relationship between economic growth and business scientific impact

The impact of economic growth on the scientific impact of business output is ambivalent. In a previous study we confirmed the presence of an inverted U-shape relationship between GDP growth rate and the scientific impact of firms' science (Gómez-Aguayo et al., 2024). To identify the moderating effect, we argue that formal, informal, and cocreative channels can increase the effect of economic growth on firms' scientific impact. However, this effect is influenced by different factors depending on the type of knowledge transfer channel.

Moderating role of formal channels. Several studies show that economic growth enhances firms' ability to fund R&D projects through formal agreements (Perez, 2003; Archibugi et al., 2013; Hottenrott & Lawson, 2014). Under this situation, firms are more willing to engage with universities through formal interactions for three reasons. First, economic growth increases firms' desire for formal contracts to enhance research performance due to lower costs in the management and monitoring of research results (Laursen & Salter, 2006). Second, economic growth encourages firms to invest resources to absorb external knowledge from universities through formal agreements with universities (Mueller, 2006;

Barjak et al., 2015). Third, economic growth prompts firms to be more willing to engage in formal channels for undertaking risky activities, thereby minimizing uncertainty (Powers & McDougall, 2005).

Additionally, economic growth leads to an increase in public support to formal knowledge transfer channels, thus, enhancing firms' innovation capacity (Hud & Hussinger, 2015; Franco & Haase, 2015; Perkmann et al., 2021). This support shapes firms' innovative performance, translating into higher scientific capabilities to generate better science (Satta et al., 2016). Therefore, formal knowledge transfer channels can play an important role in moderating the relationship between growth and firms' scientific impact.

Moderating role of informal channels. Economic growth leads industries to rely more on informal channels. Firms are prone to use informal channels to provide quick and practical solutions to their technical problems (Bozeman & Boardman, 2013). For instance, firms may need to create an entirely new product or application before their competitors. Hence, informal channels offer the short-term answers that will benefit firms in their technological race (De Fuentes & Dutrénit, 2012) and the scientific impact of such collaborations is expected to be higher, as the use of informal channels is indispensable when dealing with innovative research.

Economic growth also influences government actions to incentivise the use of informal channels to generate complementarities with other channels and to develop strong long-term links in future collaborations (Santoro & Gopalakrishnan, 2001).

Moderating role of cocreative channels. Economic growth stimulates governments to increase efforts to promote university-industry collaboration through competitive calls for joint projects. Companies participating in these projects are expected to gain higher levels of public funding for their research, enabling access to valuable resources (Belderbos et al., 2004; Faems et al., 2005) and improving the efficiency gains in research productivity and the quality of research outputs (Bolli et al., 2016; Álvarez-Bornstein & Bordons, 2021). Economic growth facilitates competitive projects associated with exploratory research and early-stage inventions, which leads to novel science. Moreover, these competitive projects are align with open science strategies, enhancing the visibility of publications and increasing scientific impact (Ali-Khan et al., 2017).

Overall, we point out the positive moderation effect of formal, informal and cocreative knowledge transfer channels on the relationship between economic growth and scientific impact of business science. However, little theory to support clear hypotheses, so an exploratory analysis is needed to clarify the effects of each channel on this relationship.

3.3. Methods

3.3.1. Data collection and sample characteristics

There are two main sources of data for this study. First, 29,934 firm co-publications from Web of Science database, encompassing articles published between 2000 and 2019 — part of this sample between 2000 and 2016 constituted firm co-publications with universities used in Chapter 2. Second, a survey to the 8,121 corresponding authors of these co-publications. We chose corresponding authors because they are the main contributors to a scientific paper (Mattsson et al., 2011). The sample included researchers affiliated to Spanish universities, firms or other Spanish organisations. Table 3.2 includes the survey fiche.

The survey was tailored to individual co-authors matching with one of their publications. For those with multiple publications, one paper was randomly selected to reduce respondent fatigue. The questions in the survey were then aligned with the selected co-publication. The survey was deployed using the Qualtrics XM platform (see Appendix 3A), and the research protocol received approval from the Ethics Committee of the Spanish National Research Council (CSIC) (see Appendix 3B). Confidentiality was assured in the invitation email, which included a letter of institutional support requesting participation. The questionnaire was distributed in November 2023, followed by three reminders sent in late November and December, and the survey was closed in January 2024.

A total of 772 responses were collected, yielding a response rate of 9.58%. Despite the small number size, this is, to the best of our knowledge, the first match between university-industry co-publication data and individual author responses on the specific knowledge transfer channels involved in the co-publication, so we expect it to be insightful. In any case, the representativeness of the sample, calculated

using simple random sampling, required a sample size of n = 291. This was calculated by $\frac{Z^2 p(1-p)}{e^2}$, where ρ = 0.50, with a 5.5% error bound, and Z = 1.96 for a 95% confidence interval. [6]

Among the 772 respondents, 326 were university or firm authors and 446 had other affiliations. Our target was the 326 university or firm authors.

In coherence with Chapter 2, the unit of analysis used is a multiple count of publications, i.e. a publication duplicated if different types of co-authoring organisations exist. The duplication rate in the sample was 2.50, so the resulting number of observations is 646. In the econometric estimations of this study, this duplication will be controlled by weighting the share of the number of organisational affiliations.

Table 3.2. Sample construction

	Details of sample and sub-samples
Number of publications for survey	29,934
Number of corresponding authors	9,819
Number of invalid e-mails	1,698
Number of corresponding authors with valid e-mails	8,121
Number of non-consenting authors	63
Number of potential respondents	8,055
Number of responses	772
Response rate	9.58%
Number of responses from university or industry authors	326
Number of responses from other authors	446
Average number of institutional sectors per publications	2.50
Number of multiple-counted each publication	646

The following Table 3.3 compares the distribution of the full sample from Chapter 2 with the sub-sample of this study, by year. The sub-sample is not uniform relative to the larger population; this heterogeneity affects the comparability across all years and thus requires careful interpretation of the survey results by period. Notably, the inclusion of the years 2017-2019 –a period marked by rapid GDP

[6] The survey covered co-publications of subsequent years (2017-19), but we do not have equivalent data on the affiliation type of publications. Therefore, we must limit our analysis to the same period of Chapter 2. The number of co-publications for survey for the subsequent years (2017-2019) was 14,434, with 4,783 corresponding authors with valid e-mails. Out of these, we received 445 responses, resulting in a response rate of 9.37%.

growth– implies that the results may be less representative of periods characterised by slow or negative growth.

Table 3.3. Sample comparison with Chapter 2

1 Publication year	2 ΔGDP_{t-2}	3 Frequency distribution of publications in Chapter 2 Original sample (n=14,544)	4 Frequency distribution of matched publications in this chapter (n=646)	5 Frequency difference (3)-(4)
2000	4.30	4.4%	0.7%	3.6%
2001	4.48	2.1%	0.0%	2.1%
2002	5.29	2.7%	0.4%	2.3%
2003	4.00	2.6%	0.0%	2.6%
2004	2.87	4.6%	1.5%	3.1%
2005	3.18	4.1%	2.2%	0.4%
2006	3.16	4.9%	2.2%	2.4%
2007	3.72	6.8%	3.0%	1.2%
2008	4.17	5.4%	2.6%	2.3%
2009	3.76	5.6%	2.6%	4.2%
2010	1.11	6.4%	3.0%	2.4%
2011	-3.57	6.8%	3.3%	2.3%
2012	0.01	7.5%	4.4%	2.0%
2013	-0.99	7.7%	4.1%	2.7%
2014	-2.92	9.0%	4.8%	2.7%
2015	-1.70	9.4%	6.6%	1.1%
2016	1.37	10.1%	6.3%	2.8%
2017	3.43	-	16.2%	-6.9%
2018	3.28	-	19.6%	-9.5%
2019	3.05	-	16.6%	-16.6%
Total		100%	100%	

3.3.2. Construction of variables

For the empirical analysis, we employed the Tobit model. The form of the proposed models is as follows:

$$\text{Scientific impact}_{it} = f\big(\Delta GDP_{t-2}, \Delta GDP^{2}_{t-2}, \overline{knowledge\ transfer\ channel\ type}_{it},$$

$$\overline{knowledge\ transfer\ channel\ type}_{it} * \Delta GDP_{t-2}, \theta_{it}\big) \quad (3)$$

The dependent variable is measured using Field Normalised Citation Score (FNCS) of unit's publications, based on a two-year citation window (publication year and the following two years) [7]. *i* is

[7] This two-year window is imposed by the recency of the data: the last publications year analysed is 2019 and citation data was available until 2021. Some may consider this a limitation of the study. However, two-year lapse after publication is useful as an indicator of the long-term quality and this is a sufficiently robust indicator of scientific impact (Adams, 2005; Dorta-Gonzalez & Dorta-Gonzalez, 2013).

the co-publication; *t* is time. The independent variables are ΔGDP and ΔGDP^2, the squared term corresponding to the possibility of non-linearities in the data, assuming a time-lag of two years; *cocreative channels*, takes the value of 1 is a publication used a joint project as a knowledge transfer channel, 0 otherwise; *formal channels* and *informal channels* represent the total number of formal and informal knowledge transfer channels used for each co-publication (*i)*; and θ includes a set of control variables.

As in Chapter 2, we include GDP growth and its square values as independent variables. Economic growth is assessed using the annual growth rate of Spanish GDP, as reported by the Spanish National Statistics Institute. To match publication and GDP data, a time-lag of two years has been assumed, since the effect of economic growth on publications is not immediate.

The main independent variable in this study is a vector of knowledge transfer channels which, according to our factor analysis, leads to three variables. The survey contained an instrument on the use of 14 knowledge transfer channels. After presenting university and industry respondents with one of their co-publications with industrial/university co-authors, they were asked, 'In order to develop this co-publication, could you please indicate which channels you used?' They could confirm whether the publication belonged to them, and subsequently select the channels used for that specific publication, so the resulting variable takes value 1 if the channel was used in that publication and 0 otherwise.

The frequency distribution appears in Table 3.5. The most common channel is joint research projects, indicating that 57% of the co-publications were the result of this channel. A formal channel, research contracts or agreements ranks second (40% of the cases) and informal channels, conferences, ranks third (24%).

An exploratory factor analysis was conducted using the principal component extraction method with Varimax (variation maximization) rotation. All analyses were performed using Stata version 14.2. Following the literature on informal university technology transfer which distinguishes two types of knowledge transfer channels (see section 2.3), we imposed an initial two-factor structure. The results matched largely the theoretical literature, as can be seen in Table 3.4. Even more, joint research projects

did not load on any factor, consistently with the ambiguity of this literature (see section 2.3), so we consider them a separate variable, in line with D'Este et al. (2019).[8]

The first factor identifies activities related to informal channel such as provision of technical or advisory services, technical assistance and sharing facilities, conferences, consulting work, educational and knowledge diffusion activities. The second factor comprises variables related to creation of spin-offs, licensing of patents, research contracts or agreements, joint research centres and agreement for tangible research materials.

We examined Cronbach's alpha to estimate the internal consistency of our factors. Factor 1 (formal channels) had an alpha of 0.45, while factor 2 (informal channels) had an alpha of 0.59. A Cronbach's alpha value >0.5 is considered as acceptable level of reliability (Griethuijsen et al., 2015; Taber, 2018), indicating that our factors have acceptable internal consistency values for Cronbach's alpha. Some authors suggest that Cronbach's alpha values are not a strict standard (Taber, 2018). Authors like Lee and Bozeman (2005) reported an acceptable Cronbach's alpha of 0.54 in their study on research collaboration, and its impact on scientists' productivity. Similarly, Nehring et al. (2015) reported an alpha reliability of 0.55 for a conceptual knowledge test. In some cases, a Cronbach's alpha of 0.45 was considered acceptable for a pre-test in some studies in science education (Berger & Hänze, 2015). Griethuijsen et al. (2015) also reported a cross-national study on student interests in science, with some alpha values around 0.50 and lower values of 0.44 other factors. In these cases, a limited number of test items were used, so higher scores were not reached. These authors argue that slightly increasing the number of items would lead to higher alpha values.

[8] We explored alternative factor structures. An unrestricted four-factor solution or a 3-factor restricted solution did not relate to existing taxonomies nor provided additional insights.

Table 3.4. Factor analysis of the types of interaction by firms. Rotated component matrix (n = 646)

Components	Frequency distribution	(1) Formal channels	(2) Informal channels
Joint research projects	0.57		
Research contracts or agreements	0.40	0.27	
Conferences	0.24		0.63
Provision of technical or advisory services	0.20		0.42
Technical assistance and sharing facilities	0.19		0.36
Training PhD students	0.10		0.21
Educational activities	0.10		0.45
Knowledge diffusion activities	0.09		0.49
Consulting work	0.09		0.44
Licensing of patents	0.07	0.57	
Creation of spin-offs	0.06	0.55	
Professional networks	0.05		0.23
Agreement for tangible research materials	0.04	0.38	
Joint research centres	0.02		

Values for each type of interaction: 0 ‘No interaction’, 1 ‘At least one interaction’. Method: Principal factors. Rotation method: Varimax with Kaiser normalization. Explained variance: 0.91%. Loadings of <0.2 were removed from the table.

To construct the variables for the regressions, we used the factor loadings for each type of channel obtained from factor analysis. We control by university and industry characteristics (co-authorship, firm size, foreign collaboration, team size, region, science field, region).

To examine the potential moderator effect of university-industry interaction variables on the relationship between economic growth and scientific impact, we extend the equation model by incorporating interaction terms.

Table 3.5. Variable definitions and descriptive statistics (n = 646)

Variable role	Variable name	Description	Mean	Std. Dev.	Min.	Max.
Dependent variables	Scientific impact	FNCS: relative number of citations of a single publication divided by the average of citation number within the same research field.	1.40	1.77	0.00	11.07
Independent variables	ΔGDP_{t-2}	Change in Gross Domestic Product	2.11	2.07	-3.57	5.28
	ΔGDP^{2}_{t-2}	Change in Gross Domestic Product squared	8.74	4.41	0.00	27.9
	Cocreative channels	1 if a publication used cocreative channel, 0 otherwise.	0.58	0.49	0.00	1.00
	Informal channels	Number of informal channels	1.13	1.40	0.00	6.00
	Formal channels	Number of formal channels	0.57	0.78	0.00	4.00
	University co-authorship	1 if a Spanish firm publication is co-authored with a university, 0 otherwise.	0.57	0.50	0.00	1.00
	Firm size	Number of firm publications, divided by 100	0.15	0.35	0.00	1.73
	Foreign collaboration	Number of foreign organisations	0.46	1.13	0.00	6.00
	Team size	Number of authors	7.21	3.32	1.00	18.00
	Multidisciplinarity	Number of different fields of the firm publication	1.27	0.45	1.00	3.00
	Science field					
	Social sciences	1 if the scientific field of the firm publication is social science, 0 otherwise	0.02	0.15	0.00	1.00
	Physical sciences	1 if the scientific field is physical sciences, 0 otherwise	0.33	0.47	0.00	1.00
	Technology	1 if the scientific field is technology, 0 otherwise	0.47	0.49	0.00	1.00
	Life sciences	1 if the scientific field is life sciences, 0 otherwise	0.45	0.49	0.00	1.00
	Region	18 dummy variables, one per Spanish autonomous community (NUTS-2 regions). Most co-publications located in Madrid (20%) and Catalonia (17%).				

3.4. Results

Descriptive results, as illustrated in Fig. 3.1, highlight the variations in the average scientific impact associated with different types of knowledge transfer channels. The use of formal channels does not show a significant difference in scientific impact compared to their non-use within our sample. In contrast, publications resulting from using informal channels demonstrate a lower scientific impact, suggesting that avoiding informal channels could enhance co-publications' impact. Finally, we find that

cocreative channels yield the highest scientific impact among the channels, indicating that co-creative channels are effective for co-publications to achieve higher scientific impact. However, this must be tested in an appropriate regression setting, controlling for other confounding factors, as we do next.

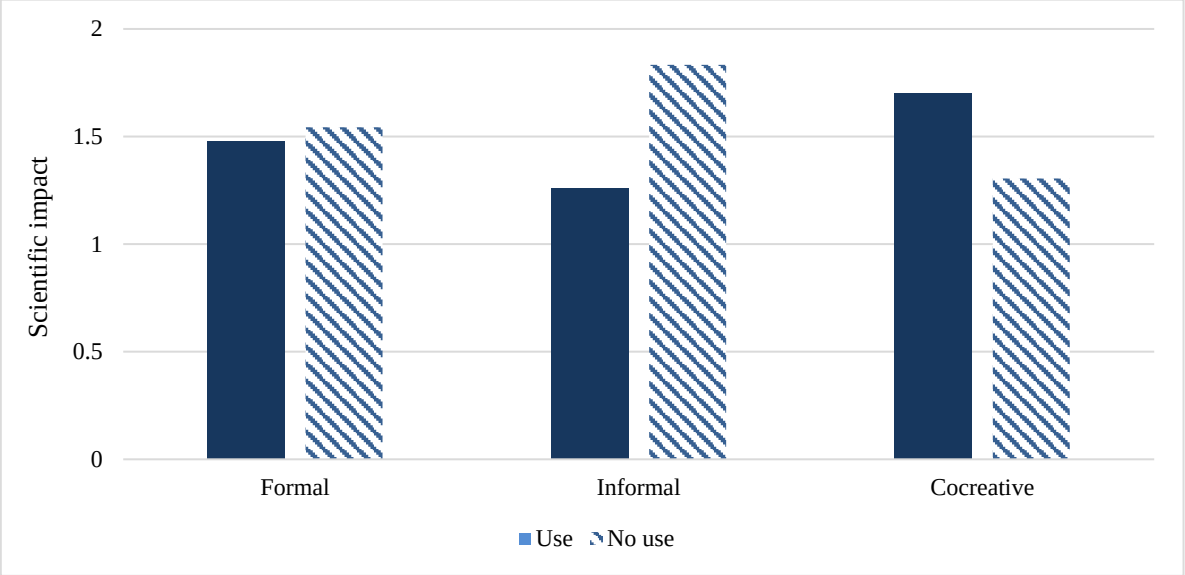

Fig. 3.1. Type of knowledge transfer channels (use and no use) related to scientific impact of business science. (Number of responses from university or industry authors = 326)

Table 3.6 presents the results of two model estimations. First, we apply the Tobit model to estimate the scientific impact of firm's co-creation with universities, because our variable FNCS presents continuous observations that take values greater than zero, reflecting a censored data distribution. Second, we employ the stepwise regression model to reduce collinearity and verify if the results are robust to the elimination of non-significant variables. This model identifies the significant effects of the covariates while simultaneously adjusting for other covariates in the regression model.

Columns 1-2 show a negative effect of ΔGDP on the scientific impact of collaborative publications, consistent with findings from our previous study (Chapter 2/Gómez-Aguayo et al., 2024). However, squared GDP growth does not have a significant effect, inconsistent with that study, which reported a negative effect. The reason is that, as mentioned in the previous section, the sample is overrepresented by recent years of fast GDP growth.

Columns 3-4 further elaborate on each type of knowledge transfer channels. All estimations include fixed effects for the region and science field. One out of our three predictor variables, informal channels,

is significant with a negative sign, that is, it diminishes the scientific impact of collaborative science. The coefficient of formal channels is not statistically significant, indicating that formal channels are not associated with scientific impact of business science. Also, cocreative channels do not seem to exert a significant direct effect on business scientific impact. Then, the direct effects of formal and cocreative knowledge transfer channels are not confirmed.

All in all, these estimations fulfil our first objective of analysing the scientific impact of firms among existing types of knowledge transfer channels. The results show that informal channels are negatively associated with the scientific impact.

Columns 5-6 present interactions between ΔGDP and each of our predictor variables. None provides a significant result, indicating that there are not any moderation effects of knowledge transfer channels on the relationship between economic growth and scientific impact.

Regarding control variables, *Multidisciplinarity* has a positive effect, in line with other findings associating multidisciplinarity with high-quality research outputs (Yegros-Yegros et al., 2015). The lack of significance of the control variable firm size, foreign collaboration, and team size is consistent across the columns.

Table 3.6. Tobit model estimation of scientific impact of firm co-publications with universities

	1 Tobit	2 Stepwise	3 Tobit	4 Stepwise	5 Tobit	6 Stepwise
ΔGDP_{t-2}	-0.21	-0.13**	-0.22	-0.12**	-0.22*	-0.12*
	(0.12)	(0.06)	(0.12)	(0.06)	(0.12)	(0.06)
ΔGDP^2_{t-2}	-0.03		-0.04		-0.04	
	(0.03)		(0.03)		(0.03)	
University co-authorship	-0.65**	-0.68**	-0.66**	-0.70**	-0.66**	-0.70**
	(0.25)	(0.24)	(0.24)	(0.24)	(0.25)	(0.24)
Firm size	0.22		0.23		0.18	
	(0.37)		(0.36)		(0.36)	
Foreign collaboration	-0.04		-0.05		-0.04	
	(0.11)		(0.11)		(0.12)	
Team size	0.04		0.03		0.03	
	(0.04)		(0.04)		(0.04)	
Multidisciplinarity	0.48	0.57**	0.50	0.58*	0.58	0.58*
	(0.35)	(0.26)	(0.35)	(0.26)	(0.36)	(0.26)
Cocreative channels			0.00		0.02	
			(0.21)		(0.21)	
Informal channels			-0.16**	-0.14*	-0.15**	-0.14*
			(0.07)	(0.07)	(0.06)	(0.07)
Formal channels			-0.04		-0.04	
			(0.15)		(0.14)	
Cocreative channels* ΔGDP_{t-2}					0.13	
					(0.10)	
N. informal* ΔGDP_{t-2}					0.04	
					(0.03)	
N. formal * ΔGDP_{t-2}					0.02	
					(0.08)	
Science field	Included	Included	Included	Included	Included	Included
Region	Included	Included	Included	Included	Included	Included
Constant	0.81	0.73*	0.87	0.69*	0.81	0.69*
	(0.50)	(0.32)	(0.49)	(0.33)	(0.51)	(0.33)
Observations	635	635	635	635	635	635
P	0.00	0.00	0.00	0.00	0.00	0.00
R2	0.03	0.02	0.03	0.02	0.03	0.02
Log-likelihood	-522.74	-528.52	-521.20	-527.74	-520.25	-527.74

* $p<0.05$, ** $p<0.01$. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

In the former estimations, whereas the variables *formal* and *informal* channels express *variety* in the type of channels used, the variable *cocreative* channels expresses the use (yes or no) of a single channel. To take it into account, we will check the robustness of our results, with an alternative measure for the types of knowledge transfer channels (formal, informal, cocreative). We created dummy regressors to capture a group-level effect. Each dummy variable takes the value 1 if at least one observation within the group of channels was used in a publication, and 0 if none of the channels from that group were used. We also include in the model interaction terms between the dummy variables and other covariates.

In Table 3.7, Columns 1-2, the effect of GDP growth is still negative and lineal. In Columns 3-4, GDP growth has a negative quadratic relationship with scientific impact, as in Chapter 2, which increases the consistency between chapters.

The coefficients of informal channels (dummy variable) is not statistically significant, indicating that the mere fact of using one of these channels is not associated with scientific impact of business science (vis-à-vis Table 3.6, where the number of informal channels used had a significant negative effect). The use of formal and cocreative channels does not seem to exert a significant direct effect on scientific impact.

Columns 3 and 4 add the interactions between our predictor variables and GDP growth in order to test whether the knowledge transfer channels moderate the curvilinear effect of economic growth on the scientific impact of business science. In Table 3.6, the coefficient of informal channels is significant, but in Table 3.7 the coefficient loses significance when including the interaction with economic growth. The results support the idea that the use of informal and cocreative channels –not their number–, at different levels of economic growth will have a positive effect on scientific impact of business science.

Table 3.7. Tobit model estimation of scientific impact of firm co-publications with universities

	1 Tobit	2 Stepwise	3 Tobit	4 Stepwise
ΔGDP_{t-2}	-0.22	-0.13*	-0.27*	-0.24*
	(0.11)	(0.06)	(0.12)	(0.11)
ΔGDP^2_{t-2}	-0.04		-0.06*	-0.05
	(0.03)		(0.03)	(0.03)
University co-authorship	-0.68**	-0.68**	-0.69**	-0.72**
	(0.24)	(0.24)	(0.25)	(0.25)
Firm size	0.21		0.17	
	(0.35)		(0.38)	
Foreign collaboration	-0.06		-0.05	
	(0.12)		(0.11)	
Team size	0.03		0.04	
	(0.04)		(0.04)	
Multidisciplinarity	0.46	0.57*	0.51	0.75**
	(0.35)	(0.26)	(0.35)	(0.28)
Dummy cocreative channels	-0.05		-0.06	
	(0.21)		(0.20)	
Dummy informal channels	-0.34		-0.30	
	(0.23)		(0.22)	
Dummy formal channels	-0.32		-0.31	
	(0.23)		(0.23)	
Cocreative channels* ΔGDP_{t-2}			0.24*	0.21*
			(0.10)	(0.10)
Dummy informal* ΔGDP_{t-2}			0.38**	0.34**
			(0.11)	(0.11)
Dummy formal * ΔGDP_{t-2}			0.16	0.19
			(0.11)	(0.11)
Science field	Included	Included	Included	Included
Region	Included	Included	Included	Included
Constant	1.47*	0.73*	2.00**	2.03**
	(0.65)	(0.32)	(0.14)	(0.14)
Observations	635	635	635	635
P	0.00	0.00	0.00	0.00
R^2	0.03	0.02	0.04	0.03
Log-likelihood	-521.68	-528.52	-515.86	-521.09

* $p<0.05$, ** $p<0.01$. Robust standard errors in brackets. No multicollinearity according to VIF. Weighting variable: share of number of organisational affiliations.

3.5. Discussion and conclusions

The evidence we provide contributes to the literature on university-industry knowledge transfer in several ways. Our study is the first matching between university-industry co-publication data and individual author responses on the specific knowledge transfer channels involved in the co-publication, and also responds to the calls for greater focus on scientific impact of business science and knowledge co-creation. This chapter delivers two main insights. First, we offer empirical evidence of a negative relationship between informal channels and scientific impact. Second, we demonstrate a positive

moderating effect of informal and cocreative knowledge transfer channels on the relationship between economic growth and scientific impact.

Our study analysed the effects of different types of knowledge transfer channels, according to their degree of formalisation, on the relationship between economic growth and scientific impact of business science. To examine the influence of knowledge transfer channels on the scientific impact, we expanded the list of channels offered by seminal authors (Link et al., 2007; Grimpe & Fier, 2010; Bradley et al., 2013, D'Este et al., 2019; Schaeffer et al., 2020) to propose three types of knowledge transfer, formal, informal and cocreative channels.

The main results suggest that high levels of informal channels have a negative effect on scientific impact of business science. This negative relationship provides support for arguing that knowledge creation through many informal channels is less likely to directly improve scientific impact of business science. We propose two reasons for this relationship. First, that informal channels are often used for conducting applied activities that meet industry requirements rather than generating new knowledge. Second, as Perkmann & Walsh (2009) suggested, many informal interactions may result in less scientific valuable outputs because they reduce scientists' ability to focus on a single topic.

Additionally, our results suggest that informal and cocreative channels increase the effect of economic growth on firms' scientific impact of business science. We propose three reasons for this result. First, economic growth provides firms and universities with access to resources, fostering informal collaborations and funding joint projects that promote novel research. Second, economic growth encourages governments to allocate resources to cocreation projects, enabling firms to pursue more exploratory research and develop early-stage inventions with high impact research. Third, economic growth facilitates the adoption of open science strategies by firms, increasing the visibility and impact of their collaborative research (Ali-Khan et al., 2017).

We found no evidence of a significant effect of either formal or cocreative channels on business scientific impact. We suggest that this is due to the type of knowledge associated to those channels. Formal and cocreative channels are often used in applied research, which may have restricted access to research tools and limited sharing practices. Despite these results, there is the possibility that informal channels are stimulating these types of channels in the long run, which has to be further researched.

The insights presented here are valuable for policymakers to promote specific knowledge transfer channels more strategically. On the one hand, governments should encourage researchers who use formal and cocreative channels to promote open science and data sharing in their collaborations, in particular in publicly funded research collaborations. These practices would increase visibility and would generate a robust basis for other high impact studies. On the other hand, while the use of informal channels is crucial for interdisciplinary research collaboration and to make the research team more dynamic for giving practical solutions to firms, it is essential to limit the use of informal channels in certain collaborations with firms where increasing scientific impact is a priority.

Non-significant results also provide valuable information for policymakers, suggesting that collaborations set by formal and cocreative channels should reflect their success through high scientific impact contributions, especially when formal channels are incentivised by public funding. The observed decline in average scientific impact in recent years, coupled with the lack of direct effect of formal and co-creative channels in our findings, aligns with other studies suggesting that disruptive science has been diminished in recent years (Park et al., 2023). These results reflect a shifting landscape in scientific research. Current university-industry collaboration strategies, such as *The Transfer and Collaboration Plan: Science and Innovation at the Service of Society*, illustrate how science has transitioned towards new Mission-Oriented approaches, incorporating diverse dynamics of collaboration with multiple actors. Research conducted within these frameworks calls for alternative channels of knowledge transfer and innovative methods for measuring scientific impact.

This study presents limitations, including a small sample size and that the empirical evidence derived from a single country, which may limit the generalizability of the findings. Moreover, the process of matching personal answers and publication data resulted in data loss. Finally, the sample exhibits a disproportionately high percentage of researchers from recent years who participated in the survey, while responses from previous years are relatively fewer.

Future work could focus on exploring the complementarities between channels, specifically interaction between informal channels and other formal and cocreative channels of knowledge transfer. The implications of the results should be updated with more recent data and include in the analysis other

firm collaborations with organisations such as hospitals, research centres, joint institutes, public organisations, non-profit organisations.

Chapter 4. Academic managerialism and team-centred motivations of top university-industry knowledge co-creators

4.1. Introduction

University-industry relationships have been at the forefront of academic and policy debates for at least two decades (Owen-Smith & Powell, 2001; Renault, 2006; Laredo, 2007; Hayter et al., 2018). While some authors argue that their benefits are fundamental to economic growth (Castiaux, 2007), others raise questions about the impact of such relationships on scientific knowledge creation (Kleinman & Vallas, 2001; Fowler-Davis, et al., 2009; McKelvey & Holmén, 2010). Some academic researchers manage to cocreate scientific knowledge with industry, which alleviates the tension between knowledge creation and transfer, since they contribute actively to open science and their co-publications with industry signal successful research collaborations (Fecher & Friesike, 2014; Yegros-Yegros et al., 2016; McKelvey & Rake, 2020). The motivations of university knowledge co-creators to collaborate with industry are key to understanding this conflict alleviation (Beck et al., 2022). However, the literature on university-industry motivations presents three gaps.

First, most studies have focused on understanding the key drivers of researchers' motivation to collaborate with companies from a static perspective (Bekkers & Bodas Freitas, 2008; Giuliani et al., 2010; D'Este & Perkmann, 2011; Haeussler & Colyvas, 2011). Since academics, like any other type of worker, experience changes in the conditions of their work during their career, motivations to collaborate with industry may depend on factors such as change in work conditions (Ranga et al., 2016; De Silva et al., 2023), and evaluation of performance (Tartari & Breschi, 2012) but also internal factors such as change of position, and career status (Zhao et al., 2023).

Second, academic motivations to collaborate with industry have not been discussed within a context of change of institutional settings. Over the last decades there has been major institutional changes, such as the introduction of New Public Management (NPM) in evaluation systems and working conditions with the aim of assessing the performance and research direction of academic scientists (Smeenk et al., 2009; Muller, 2022). These changes are suggested to have had a direct impact on academics' knowledge production (Cañibano et al., 2018; Thomas et al., 2020, Glenna et al., 2007). Hence, changes in managerialism may have an impact on the motivations of academics to collaborate with industry.

Third, the literature has focused on academics' self-centred motivations to collaborate with industry. Notably, Lam's (2011) framework distinguishes between *gold, ribbon, and puzzle* motivations to collaborate, which all refer to individual self-benefit. However, for many university knowledge co-creators, benefiting the team is a crucial motivation. For example, Batson (2022) categorized *collectivism-based and principlism-based* motivations (discussed below) for individual researcher's concerns about their team.

To cover these gaps, the objective of this study is to analyse the impact of managerialism on the evolution of self-centred towards team-centred motivations to collaborate with industry among university-based knowledge co-creators.

Our analysis relies on 10 semi-structured interviews complemented by the professional details of some of the most productive scientific knowledge co-creators in Spain, all of whom are professors at prestigious public universities and carry out their research in departments of applied sciences.

This chapter is structured as follows. Section 2 provides a literature review of previous studies on researchers' motivation, as well as an explanation of the role of managerialism in the university sector. Section 3 and 4 describe the methodology and data analysis. Section 5 presents the findings and elaborates on the influence of managerialism on motivations to collaborate. In section 6, the article concludes with a discussion of the effects of academic managerialism on co-creators motivation to collaborate and offers some final observations and policy implications.

4.2. Theoretical background

4.2.1. Managerialism in academia

Inspired by the new public management (NPM) narrative, the concepts of efficiency and maximisation have been introduced into university culture (Clarke & Knights, 2015; Morley & Crossouard, 2016; Steinþórsdóttir et al., 2019). Universities have moved towards becoming organisations managed through paradigms of efficiency and productivity typically applied in the private sector (Hagen, 2002; Blackmore, 2002; Deem & Brehony, 2005; Olssen & Peters, 2005). There is no unified concept of managerialism, but it refers to adopting business principles and practices to administer and manage

public universities by incorporating notions of efficiency and accountability in university governance (Olssen & Peters, 2005; Lynch, 2014; Ese, 2019; Muller, 2022). In particular, this study focuses on features of managerial evaluation and auditing techniques to assess the performance and research direction of academic scientists (Smeenk et al., 2009; Muller, 2022).

Previous research has emphasized evaluation systems as one factor influencing knowledge production and researchers' performance (Cañibano et al., 2018; Thomas et al., 2020), but this literature is fragmented and in university-industry collaboration studies *managerialism* remains unexplored.

Specifically, we argue that the evaluation system is not the sole factor changing researchers' behaviour, but also that other dimensions impact directly on academics' welfare understood as work conditions and organizational culture. There is literature in higher education studies that suggested that *performativity culture* in academia, as a part of managerialism strategy, makes academics take responsibility for their performance, inducing them to increase their scientific production and intensifying competition (Ball, 2003, 2012; Deem et al., 2007; Keisu & Carbin, 2014; Kalfa & Taksa, 2017). From a management studies perspective, critical studies have taken into account the situational context of academic labour in knowledge production (Alvesson & Sveningsson, 2011). It is argued that labour conditions in academia are precarious and full of uncertainties, with rising concerns about the consequences for science (Leišytė, 2016; Steinþórsdóttir et al., 2018; Rogler, 2019; Ferris, 2021; Willson, 2022; Hinostroza-Paredes, 2023).

However, existing studies do not take into consideration the full managerialism phenomena and the implications for knowledge production and co-creation, perhaps because it has an implicit ideological component (Glenna et al., 2007). Being highly critical of neoliberal logic, it can be difficult to argue with advocates of university-industry collaboration.

One of the aims of this study is to identify which factors are influencing academics motivations to engage with companies. Accordingly, we propose to identify features of managerialism that we describe as: (a) control and performativity culture in academia, and (b) uncertain working conditions.

Despite the lack of literature bridging both frames of literature, we can expect that managerialism in academia will shape the motivations of academic co-creators for two reasons. First, the motivations of academics are influenced by changes in institutional characteristics (D'Este & Patel, 2007). Second, the

motives to continue collaborations with industries change when the benefits gained from those collaborations—such as social, economic, or institutional advantages—influence their research and foster their careers (Ankrah & Omar, 2015). Thus, it is reasonable to propose that managerialism may influence academics' motivations to engage with companies.

4.2.2. Motivations of academic's collaboration with industry: lack of dynamic approaches

Schunk and DiBenedetto (2020) defined *motivation* as the process that initiates and supports goal-directed activities and motivations have been studied not only in the field of psychology but also in education studies, health sciences, and economics. The literature distinguishes between two types of motivations: intrinsic motivation, driven by an inherent interest for joy, and extrinsic motivation is tied to actions motivated by external rewards (Deci & Ryan, 1985). Based on this framework, some scholars in the field of innovation studies have delved deeper into the motivations of academics to collaborate with industry (Azagra-Caro et al., 2008; Lam, 2011; Arzenšek et al., 2014). These studies have found that academics are motivated by both intrinsic and extrinsic factors. Academics' intrinsic motivations include scientific curiosity, a desire to learn, seeking feedback from practice, and problem-solving (Meyer-Krahmer & Schmoch, 1998; Welsh et al., 2008; D'Este & Perkmann, 2011). Extrinsic motivation is to secure resources for research (Welsh et al., 2008; Perkmann & Walsh, 2009; D'Este & Perkmann, 2011; Ankrah et al., 2013). One of the most popular categorizations – the one we adopt in this study – is Lam's (2011). She categorized those motivations as 'gold, ribbon, and puzzle' motivations. Gold represents extrinsic motivations driven by the self-interest to obtain financial rewards, ribbon pertains to motivations associated with reputation and career awards, and puzzle denotes the intrinsic satisfaction derived from doing research (Lam, 2011).

Most of the studies of academics' motivations to collaborate with industry are 'static', in the sense that they capture a picture of motivation at a specific moment in time. However, motivation is inherently a dynamic process (Schunk & DiBenedetto, 2020) that evolves as individuals progress both personally and professionally. Scholars such as Hmieleski and Powell (2018), Balven et al. (2018) and Barberá-Tomás et al. (2022) all, advocate for adopting dynamic approaches when studying academic's

motivations. They argue that studying the continuity and change of scientists' motivations contributes to a deeper understanding of researchers' entrepreneurial behaviour. In one of the very few empirical papers that have studied motivations from a dynamic perspective, it was found that during periods characterized by enhanced access to resources for academics, researchers' motivations shifted to being determined by 'pull' factors (De Silva et al., 2023). Hence, there is evidence that motivations may change over time.

4.2.3. Motivations of academic's collaboration with industry: self-centred versus team-centred

The conceptualization of motivations to collaborate with industry has predominantly adopted a self-centred perspective. This is exemplified by the prevalent use of self-determination theory (Deci & Ryan, 1985), which characterizes motivations based on individual needs. For instance, Lam's concepts, focusing on the desire for different outcomes individuals obtain from collaborations, also align with this self-centred approach. However, these models do not offer alternatives that connect collective outcomes from intrinsic rewards (Shamir, 1990). Lam's categories proposed in 2011, 'gold, ribbon, and puzzle' can be conceptualized as self-centred because they are based on the self-interest of pursuing a concrete goal.

In the study, Lam suggests expanding this view to encompass a broader perspective on motivations, one that includes a mix of motives beyond the pragmatism of extrinsic rewards, towards an expanded perspective incorporating social and affective aspects related to other forms of intrinsic motivation, such as the desire to devote effort to benefit others (Lam, 2011: p. 1365).

Some authors have expanded the study of team-centred motivations in the context of academic and entrepreneurial science, such as Grant (2008), who studies prosocial motivation as a particular form of intrinsic motivation based on the will to look after the welfare of others and society. Other authors in the fields of work psychology and organizational behavior emphasize prosocial motivations and beneficiary impact linked to the collective entities of which they are part (Vallerand, 1997; Grant, 2008; Azagra-Caro & Llopis, 2018; Batson, 2022; Lu et al., 2022).

The categorization we adopt in this study is Batson's (2022), who suggested a framework of collectivistic work motivations drawing on Kurt Lewin's conceptual analysis (Lewin, 1944/1951), classifying them into collectivism and principlism-based motivations. Collectivism-based motivations are those characterized by the overarching goal of enhancing the welfare of the group, and principlism-based motivations are those driven by the ultimate goal of advocating for specific principles, moral standards, or ideals. Additional scholars who have delved into this conceptual approach include Shah and Gardner (2008), Eisenberg et al. (2016), and Lu et al. (2022).

In accordance with Batson's categories, we conceptualize *team-centred motivation* as a researcher's intention to benefit one or more people in their research team. A research team is defined as a group of individuals united by mutual objectives, employing their diverse skills, expertise, and viewpoints to advance knowledge within a research project (Little et al., 2017; Beck et al., 2022). Such teams often comprise Master's students, junior doctoral-level faculty, and technical staff (Mazumdar et al., 2015).

4.3. Methods

4.3.1. The context of university-industry research collaboration in Spain

Scientific knowledge co-creation between university and industry has undergone a gradual turn as a response to the implementation of University Reform Law in 1986 (Jiménez-Contreras et al., 2003). Since the 1990s, academic incentives to increase university outputs have led to more pressure to acquire external funding. Moreover, after the Organic Law of Universities of 2001, evaluation of the research activity of teaching staff became relevant. A strong evaluation system was established focusing on scientific production and innovation results (Torrado & Duque-Calvache, 2023). At the same time, many European countries suffered from a reduction in public funding due to the economic crisis that started in 2008 (Martínez-Campillo & Fernández-Santos, 2020). In this context, academics searched for private funding and competitive private-public funds by orienting science toward the market sector and to the priorities of funding agencies (Slaughter & Cantwell, 2012). There is evidence that collaborations in Spain increased over the last two decades, following the implementation of the National Strategic Consortia for Technical Research (CENIT) in 2006 and *Innpacto* programme in 2010 sponsored by the

Centre for the Development of Industrial Technology (CDTI) in Spain, and through the 7th Framework Programme, (FP7) from 2007 and 2013and the European Commission Horizon 2020 funded by the European Commission (Crespi & Leone 2006; Primeri & Reale, 2012; Testa et al., 2019). In such a context, it is important to observe on a broader scale how since the implementation of different mechanisms to promote university-industry collaboration, academics' behaviour towards joint work may have changed. Not only considering the allocation of resources as a determinant, but also how institutional settings have influenced co-creators of scientific knowledge motivations to collaborate with non-academic actors in Spain (Ramos-Vielba, et al., 2016; Gerbin & Drnovsek, 2016; García-Aracil et al., 2017). In particular it is important to analyse this from the perspective of universities, as the organisations facing the changes in institutional rules and regulations and having to adapt to altered research policy settings.

4.3.2. Data collection

Ten semi-structured interviews with leading university scientific knowledge co-creators were conducted from March 2021 to June 2022. The selection of cases in exploratory qualitative studies has no strict rule-based criteria (Flyvbjerg, 2001). We selected these leading cases of scientific knowledge co-creators because they are paradigmatic cases (Flyvbjerg, 2001) of successful academics who balance activities of research and knowledge transfer. It made sense to focus on paradigmatic cases both to maximise the usefulness of the information obtained and to unfold phenomena along a time trajectory (Yin, 2013). An information-oriented selection (Flyvbjerg, 2001) was thus made of co-creators who have been consistently involved in knowledge co-creation with companies in Spain (Henkel, 1997; Deem, 1998).

The identification of elite cases was done using the Web of Science database, encompassing articles published between 2000 and 2016. We identified corresponding authors exhibiting a higher frequency of co-publications. Specifically, we selected individuals who occupied top positions in authorship, demonstrating a consistent pattern of co-publication throughout the entire period. This consistency was defined as approximately one publication every two years or a steady distribution across either of the two intervals, spanning from 2000 to 2007 and 2008 to 2016.

We obtained a list of 20 academics and contacted them via email. Ten participants agreed to participate, six did not reply to the invitation and four decline to participate. After completing the ten interviews we decided not to repeat our selection process and invite more participants, as we considered this round of interviews had saturated the information necessary for the research objective (Strauss & Corbin, 1998).

The interviews were conducted online through the Microsoft Teams virtual platform, with an average duration of 40 minutes. Participants provided written informed consent on the day of the interview, and they were reassured of the confidentiality of their responses (see Appendix 4A). All interviews were recorded. For the transcriptions we used Tactiq, a Chrome browser extension for automatically generating live transcriptions. Transcripts were then manually verified and corrected. Table 4.1 summarizes the professional details of participants. Interviwees were pseudonymized to safeguard the personal information of participants. These pseudonyms are used when referring to the interviewees.

Table 4.1. Summary of participants, affiliation, field and academic status.

Interviewee code	Scientific field	Scientific sub-field	Autonomous Community
Antonio	Life sciences & Technology	Agronomy	Madrid
Adrián	Life sciences & Technology	Ecology	Canary Islands
Jordi	Technology	Mechanical engineering	Catalonia
María	Life sciences & Technology	Molecular biology	Valencian Community
Mikel	Physical sciences	Applied Physics	Basque Country
Manuel	Biomedicine	Biomedicine	Catalonia
Amadeu	Biomedicine	Chemistry and pharmacology	Catalonia
Juliana	Life sciences & Technology	Agri-food science and technology	Catalonia
José	Life sciences & Biomedicine	Animal science	Catalonia
Ángel	Technology	Civil engineering	Asturias

Names of scientific fields are at the first level of aggregation of Web of Science

The interviews were based on a semi-structured interview protocol that was adjusted as the interviews progressed (see Appendix 4B for the interview guide). A series of initial open-ended questions was posed, exploring participants' interactions with companies throughout their careers, their motivations for initiating engagement with the industry at the outset of their academic journey, and the evolution of their research in collaboration with companies. Special attention was given to recent collaborations,

particularly those that have taken place since the 2000s. Participants were requested to provide detailed descriptions of their experiences, focusing specifically on the initial projects they engaged in collaboratively with a firm. A subsequent set of questions inquired about the influence of research collaborations on scientific knowledge co-creation, with a particular emphasis on the period from 2000 to 2016. Concluding the interview, participants were prompted to articulate the benefits derived from their collaborations and elucidate their present motivations for engaging with companies.

To mitigate potential memory bias, participants were presented with a timeline depicting their publications with firms since 2000. They were consistently prompted to validate the chronology of events utilizing dates and charts, while also cross-verifying secondary data. Gläser and Laudel (2015, p. 310) state that graphical 'research trail' representations contribute, on several levels, to the informational yield from interviews: they demonstrate the efforts made by the interviewer and help to build trust; they contribute to creating a favourable atmosphere by confronting the interviewee with a new perspective on his or her work (i.e. the interviewer is not only asking for information but also is providing some); and they favour 'graphic elicitation', that is, they prompt narratives about the content of research, and trigger memories. Interviews concerning events which occurred several years earlier can be difficult if interviewees are unable to recall the events. Prior to the interviews, we compiled their publication records using Web of Science and bibliometric materials, facilitating contact with researchers and interview preparation. Professional details were procured in advance from publicly available sources and university web pages (e.g., curriculum vitae, academic status, PhD students' statistics, funded projects, and overall publications) (see Fig. 4.1).

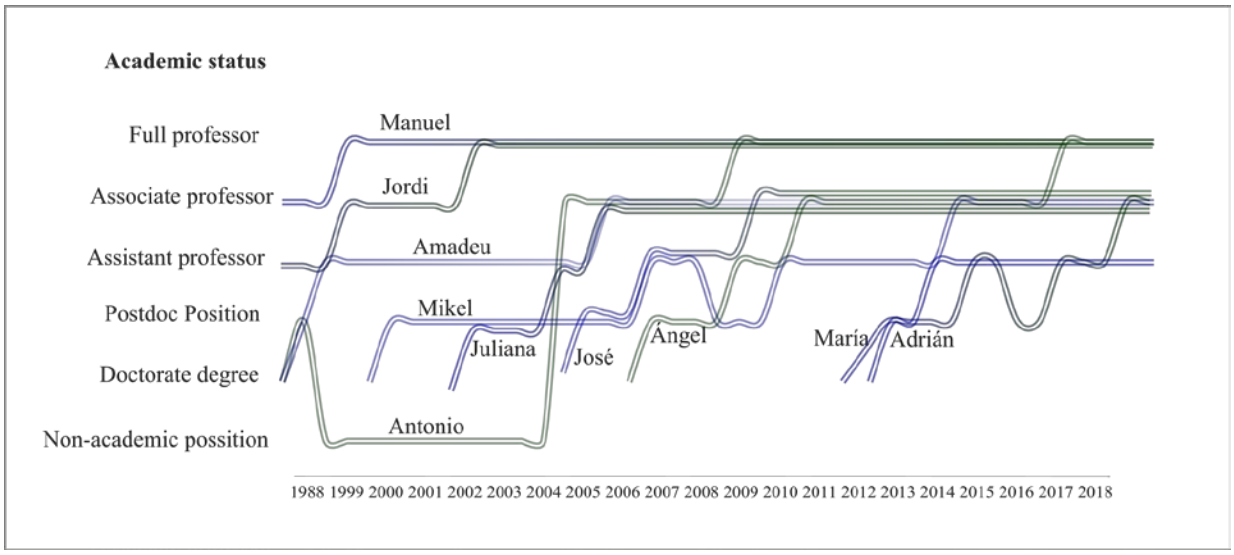

Fig. 4.1. Academic track of participants

4.4. Data analysis

Due to the limited theoretical basis underpinning the wide range of reasons of why the motivations of academics might change in complex contexts (De Silva et al., 2023), we adopted a mixed method data analysis, using a hybrid of deductive and inductive approach. We applied deductive analysis to identify motivations over the years, and used inductive analysis to answer *why* questions, and enrich knowledge about processes and behavioural interactions (Glaser & Strauss, 1967; Edmondson & McManus, 2007). NVIVO software was used for data coding and organisation to assist in-depth analysis.

4.4.1. Identification of motivations of top university knowledge co-creators to collaborate with industry

Deductive techniques require pre-determined themes identified in the conceptual framework of motivations from a previous literature review. Data were reviewed and coded according to the identified categories proposed by Lam (2011): gold, ribbon, and puzzle motivations. We selected this categorization as it specifically elaborates on entrepreneurial scientists, a group that closely resembles academic knowledge co-creators. These themes were considered part of an aggregate dimension that we termed self-centred motivations.

During the analysis, we identified new codes that do not fit with established categories (Table 4.2). These codes captured a social dimension of motivations not previously addressed by Lam (2011) or any other studies on scientists' motivations. Team-centred motivations were acknowledged and, based on Batson et al. (2022), classified into two themes: collectivism-based and principlism-based motivations.

Table 4.2. Coding structure of co-creators' motivations to collaborate with firms

Open Codes	Themes	Themes definition	Aggregate dimensions
Access to private and public funding Access to information on industry problems Acquire infrastructure for research	Gold motivations	Refers to financial gains	Self-centred motivations
Transcending their research Building and networking	Ribbon motivations	Associated with fame career advancements and building a reputation. It includes the seek for research funding	
Feedback from industry Applicability/transfer of knowledge Dedicate more time to research Robust testing of research outcomes	Puzzle motivations	Refers to the satisfaction related to the research itself, including the creation of new knowledge or solving problems	
Strengthen the research team Prepare the research team for the potential impacts of a crisis	Collectivism-based	Motivation with the ultimate goal of increasing a group's welfare	Team-centred motivations
Employ the team's researchers in projects with firms Provide formal contracts to the research team Fix careers of research team	Principlism-based motivation	Motivation with the ultimate goal of promoting some principle, moral standard, or ideal	

(1) 'Self-centred motivations' refer to researcher motivation to collaborate with industry, based on the self-interest of pursuing a professional goal. Second-order themes ('gold, ribbon and puzzle') are based on Lam's (2011) framework.

(2) 'Team-centred motivations' refer to a researcher's motivation to collaborate with industry with the intention of benefiting one or more people in his or her research team. The second-order themes ('collectivism and principlism') are based on Batson et al.'s (2022) framework.

4.4.2. Dimensions of managerialism that influence motivations of top university knowledge co-creators to collaborate with industry

We adopted the Gioia approach for inductive coding, as outlined by Magnani and Gioia (2023). We coded responses that referred to researchers' perceptions, attitudes, and expectations regarding collaboration within the university environment. The open coding process was cyclical, i.e., coding was iterative until no new themes emerged. We identified some features that played a pivotal role in co-creators' willingness to collaborate with companies. We identified the first-order codes, those that were found repeatedly in several cases. Once first-order codes were established, we proceeded to organize them into groups based on logical relationships, exploring both similarities and differences among them. Through iterative examination of transcripts and emerging categories, we undertook axial coding to identify second-order codes. Six themes surfaced as perceptions held by academics regarding contemporary academia. We subjected these themes to multiple reviews for refinement. Subsequently, following the same strategy with second-order codes, we created three aggregate dimensions (selective coding). This procedure was done multiple times until we got a refined theme. We found two general dimensions —control and performativity culture in academia and working conditions of researchers. At this point, as we observed organizational considerations during the analysis, we engaged with literature on higher education studies and organisational studies to elaborate a concept that put the themes all together in a broader concept and that helped to interpret our findings (Table 4.3).

Table 4.3. Coding structure of dimensions of managerialism that influence the behaviour of top scientific knowledge co-creators at university

First-order codes	Second-order themes	Aggregate dimensions
Expectations to reach a tenured position Strong pressure in reaching publication targets Fictitious system of evaluation focus on quantity Omission in valuing and rewarding teaching endeavours	Performance evaluation focus on assessing researchers productivity	Control & performativity culture
Perception of academic bureaucracy Audits, public reports and funding justifications	Inefficiency, bureaucracy and cumbersome administrative procedures	
Researchers' perceptions of endogamic academia Fictitious and perverse ecosystem of evaluation of academic work Competitive environment between researchers	Strong competition among researchers	
Strong pressure to publish articles Pressure to achieve high numbers of publications Scientists are highly self-motivated	Focus on intensive production of knowledge	
Low salaries for researchers and job flexibilization Perceived job insecurity for early-career researchers	Lack of employment contracts for researchers	Uncertain working conditions
No overtime, theses supervised, tutorials or other results generated are unpaid Lack spans of time for teaching and research	Inadequate salaries for Researchers	

4.5. Results

Deductive analysis revealed the emergence of team-centred motivations to collaborate with industry. We observed that self-centred motivations do not disappear, but give rise to team-centred motivations and then coexist with them.

To thoroughly understand this finding, we delve into the outcomes derived from the inductive analysis. The results reveal two general dimensions: (i) the culture of control and performativity in academia and (ii) the working conditions of researchers, which are characteristics observed in academia that might be associated with the emergence of team-centred motivations. Both aspects converge to impose constraints on individuals to develop their careers, but unintendedly they might be fuelling the emergence of team-centred motivations (section 4.2).

The interviews suggest that control and performativity in academia and inadequate working conditions for researchers have an impact on motivations. Specifically, they prompt top academic co-creators to utilize team-centred motivations to support their pursuit of the puzzle and the ribbon. Fig. 4.2 illustrates the influence of managerialism in the relationship between self-centred and emergent team-centred motivations to collaborate with industry.

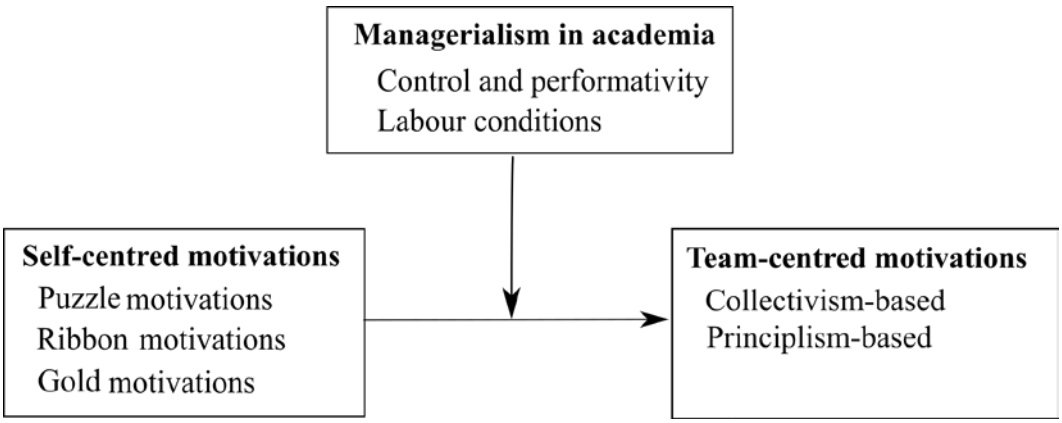

Fig. 4.2. The influence of managerialism in the emergence of team-centred motivations of top university knowledge co-creators to collaborate with industry.

4.5.1. Control and performativity in academia leads puzzle motivation towards collectivism

Evaluation systems are crafted to exert control over academic work and to enhance researchers' performance (Smeenk et al., 2009). However, when the control becomes overly stringent, it elevates the pressure on researchers. An example is the case of young researchers, particularly non-tenured postdoctoral researchers.

Increasing managerialism does not contribute to researchers performing better science or engaging in research addressing societal challenges. Instead, it creates pressure on individuals to perform, shifting the focus from the scientific outcomes to individuals' performance.

This outcome is recurrently observed during the interviews:

> *There are some standards for evaluation, which I think are nonsense. Evaluation criteria for academic activity that penalise you if you publish in second quartile journals* [control and performativity]*... Sometimes the same research* [meaning "research of the same quality"] *has been published in a first or second quartile journal. But if you publish your article in a second quartile, that penalises you. This is wrong; it is a lapse in the evaluation system...*
>
> (Jordi)

Top co-creators are discontent with how academia assesses their performance but understand the need for an indicator to measure their scientific contributions. They agree with the principle that individual publication citation should count more than journal impact factors in research evaluation (Cagan, 2013). Some authors elaborate on this matter. Ball (2012) and Ese (2019) argue that the excessive control of academics increases the individualization of academic work and competition. The pursuit of academics to ensure high levels of knowledge production can lead to forms of performativity culture, as expressed by several authors (Deem et al., 2007; Paradeise & Thoenig, 2013; Kenny, 2018). This statement is confirmed by the interviewees, for instance, one of them emphasized:

> *The academic system has become a fictitious ecosystem. We all play this system, in which you become a bit competitive. I know it's not good, but I am there... The competitiveness of students and professors, as well as the rankings that give you money, create an ecosystem that we have to*

stop to lower the pressure. In other words, the academic system sucks you in, in such a way that you have to compete. Who can resist it? Well, one's personality and one's values. There are times when I publish in journals out of habit... and you are pushed to publish in certain journals... This is looking like a whole debacle. In the end, you feel that there may be some negative impact on science, not because of the collaboration with firms, but because of academia itself.

(Amadeu)

Despite the competitive environment in academia, where the emphasis is on individualism, our findings reveal that academic top co-creators might develop a certain type of collectivism-based motivation. It happens when they are motivated to collaborate with the industry to strengthen the research team.

We observed two key factors influencing this shift in motivation: the leadership role taken by professors within the academic team and their intrinsic drive for recognition and reputation (Beck et al., 2022). This shift of role is exemplified by top co-creators who prioritize group cohesion and the collective well-being of the team. Statements like *"I don't have a team; we are a team in the sense that I am just one more"* (José) or *"we have to stop talking in the first-person singular and start talking in the first-person plural*" (Amadeu) underscore a team-centred mindset. Additionally, the composition of academic teams is illustrated by José's description of his research group.

In this group, we are two senior researchers, two technicians, three interns, and an industrial doctorate working on coronaviruses. Now, we need another PhD student to open another line of research on standby: two full-time and one part-time postdocs. We also have two research technicians. We are talking about a relatively small group, so sometimes you need the help of researchers from other centres.

(José)

The inclination towards a team-centred motivation roots in the aim of top researchers to strengthen the team by providing opportunities for young researchers (PhD students in particular) to establish themselves within the collaborating company. This goal comes from a concern for the well-being of

these students who may not have secure job positions, by providing opportunities for future jobs outside academia or the chance to replicate their success through collaborations with companies.

At the same time, top co-creators extend the pursuit of the ribbon motivation (e.g. reputation and recognition) to enhance the team's funding and reputation. They revealed their aim to position their team's colleagues within the companies they collaborate with to build strong teamwork and, simultaneously, the closest collaboration (collectivism-based motivation). This strategy would facilitate future collaborations with the company or entrepreneurial opportunities for the team, as Lee (2000) and Agrawal and Henderson (2002) suggested. It is a common motivation for researchers to keep collaborating with industry, as they mentioned:

> *I refer to the students who have completed their PhD with me and are now working in the same company where we conducted research as 'professionals'. I have to say that more than 50% of them* [PhD students], *were already employed before finishing their PhD. This is unique […]. It is not because I am very clever, it is because I have been there* [in the company], *working closely with them.*
>
> (Antonio)

> *… Usually, I have consultancy contracts with companies, aiming to involve a student in the project. Ultimately, my team counts with one person who conducts research at the university, and another who conducts research at the company. Both PhD students work together on the research* [collectivism-based].
>
> (Antonio)

4.5.2. Uncertain working conditions drive ribbon motivation towards collectivism and principlism-based motivation

Our results suggest that one of the main motivations for working with industry is to obtain resources as a way to support the pursuit of reputation and career rewards (ribbon motivation). In the case of top co-creators they also seek external research funding as a means to strengthen the research team (Ramos-

Vielba et al., 2016). We consider the willingness to benefiting their research groups as collectivism-based motivation. Several testimonies confirm this statement, as Juliana stated:

> *The funding that you get with the collaboration with companies helps to make the team more dynamic* [ribbon motivation]*, which means that there are more students, some PhDs or doctoral students*
>
> (Juliana)

Lam (2011) mentioned that other extrinsic rewards might derive from ribbon motivation as the increase the access to research resources. However, top co-creators considered are prone to collaborate with companies in their intent to use the research resources to provide certainty and stability regarding work remuneration to other researchers in their group, e.g., research fellows, doctoral students, and post-doctoral researchers[9]. Our results reveal that the desire to provide adequate working conditions or collocate researchers in the industry underscores principlism-based motivation. According to the literature on responsible research and innovation, team members' sense of responsibility triggers a response that upholds the principles of fairness and equity in an academic environment (Beck et al., 2022). This is acknowledged in the following excerpts:

> *To give you an idea of how important it is to work with companies, I now have 14 students, 5 master students, 9 PhD students. All of them are working and are paid with money from the projects I run with companies.*
>
> (Antonio)

> *Collaboration in consortia with companies promotes the incorporation of doctoral researchers in the companies. In other words, at one time when we had projects, four people who finished their theses with us joined the consortium's companies. So, it was useful...*
>
> (Juliana)

[9] Precarious employment in early-career researchers is frequent. These include informal agreements, part-time work, fixed-term contracts and delayed entry into permanent positions within universities (Kehm, 2006; Muñoz-Rodríguez & Ortega, 2017; Lafuente & Bergal-Mirabent, 2019; Torrado & Duque-Calvache, 2023).

Top co-creators were questioned about their collaborations and motivation to collaborate, specifically in the period from 2008 to 2014, the Great Recession in Spain. They emphasized the limitations they faced in universities during turbulent times. Top co-creators consider that the dependence of Spanish universities on public funding, particularly in periods of crisis, harms academic research. Therefore, collaborating with companies can be a strategy to secure resources for researchers within teams, especially for researchers with less stability. This result aligns with the findings of Ramos-Vielba et al. (2016), suggesting that seeking additional funds is not only to obtain extra income but for teams to continue pursuing research activities. Certainly, firm' propensity to coproduce scientific knowledge increased during the Great Recession (Azagra-Caro et al., 2019; Gómez-Aguayo et al., 2024) One top co-creator discussed their struggles sustaining the team over time:

> *The situation of research in Spain depends on political ups and downs, which is a major drawback, because for most of us as researchers, we cannot ask for projects lasting more than four years, which is the duration of a political leader's term*
>
> (Adrián)

> *During the crisis, there were a lot of cutbacks at the university that left* research departments *without staff, and universities had to look for funding for experimental work, they had to look for more collaborations with companies as a way to get more funding.*
>
> (María)

These academics actively pursue collaborations with companies to preserve resources and protect collective interests in the event of constraints within the university.

Top co-creators narrated their experience in the crisis and how collaboration with the industry is essential to maintaining the research team, and they attached great importance to the group's interests. The top co-creators expressed positive sentiments about their decision to collaborate with companies as a proactive measure to safeguard the research team against potential crises. The last findings of this study support Grant's (2008) idea that seeking funding (ribbon) might be transformed into a more forward-looking and team-centred motivation rather than one purely driven by self-interest. At times, team-centred motivations stem from an individual's inherent desire to enhance the well-being of others.

In contrast, in other cases, they arise as instrumental objectives —serving as a means to support one's ultimate goals.

4.6. Discussion and conclusion

This study examines the evolving motivations of top academic co-creators, characterised as successful academics who balance their research and knowledge transfer activities through joint scientific production with companies. This work intends to contribute to the body of literature on motivations theory and link it to higher education literature. By analysing the evolution of motivations within cocreators our research expands the existing framework on motivations to collaborate with industry, particularly by incorporating team-centred motivations. It highlights the importance of exploring researchers' perceptions of university management and assessment culture, revealing that these perceptions can drive motivations in response to academic managerialism.

The results revealed that an environment of competition and individualism intensified by managerialism in academia had unintended positive consequences for top academic co-creators. For them, there was a shift from self-centred to team-centred motivations in their collaborations with industry. Specifically, this study showed that academic work's intense control and performativity led to puzzle motivation towards collectivism, and inadequate working conditions led to ribbon motivation towards collectivism and principlism-based motivations. In the narrative, we observed a lower inclination towards gold motivations among top academics.

Managerialism has had an unintended positive consequence for top academic co-creators. For them, the negative circumstances affecting other researchers increased their interest in supporting their research teams, leading to a shift from self-centred to team-centred motivations in their collaborations with industry.

The findings reveal the need to understand managerialism in academia, not only as a management strategy that supports performance maximisation from the university setting, but also as an ideological framework that uses control and performativity as tools to shape academic work towards scientific production goals (Grey, 1994; Alvesson et al., 2008).

Academics repeatedly argued that firms were open to publishing their results, a positive aspect that has changed over time and was compatible with the increase of managerialism in academia. However, for the individual, the collected narratives underlined that the combination of control and performativity and uncertain working conditions create dependencies in researchers' work. Researchers feel compelled to generate knowledge to meet academic criteria. These findings led to ethical dilemmas for universities about the environment in which researchers create knowledge (Henkel, 1997; Hey, 2001; Boni & Lozano, 2007; Slaughter & Cantwell, 2012; Llopis & Foss, 2016).

Based on some answers of top academics, it appears that managerialism may have a direct negative impact on certain groups of researchers. This issue needs to be further studied to better align university management strategies with broader policies at European level that seek to increase knowledge transfer to society with an attractive and stable scientific career that improves conditions for research (Ministry of Science, Innovation and Universities, 2024).

Knowledge creation, including co-creation with industry, has an immanent relevance in constructing a society (Foucault, 1980). Therefore, all stakeholders should shoulder responsibility for these findings. Our results also have some practical implications:

First, policymakers must direct their efforts towards fostering the advancement of scientific knowledge, adopting coordinated policies, and implementing mechanisms that assure the quality and impact of research outcomes, benefiting both academic institutions and industry partners. Moreover, the discourse surrounding university-industry collaborations should avoid perpetuating instrumentalisation, which may divert the focus of scientists towards commercial interests and the agendas of funding bodies.

Second, universities could rely more on the openness of companies to conduct research to consolidate university-industry collaborations and team science, which aligns with the Open Science strategies. By capitalising on the increasing motivation for team-centred approaches, universities can promote the formation of research groups, thereby strengthening collaborative research.

Third, accreditation agencies should actively seek alternatives to traditional academic evaluation methods. For example, new practices for research evaluation that incorporate additional values in research beyond mere productivity targets. This will align evaluation systems with the objectives of broader strategic programmes where researchers are encouraged to engage in Mission-Oriented research

and Governance for transformative change. Reducing pressure on academic metrics could reorient academics' research towards more ambitious collaborative and interdisciplinary, which are often fostered through such partnerships.

4.7. Limitations and recommendations for future research

While this study sheds light on the influence of managerialism in academia on the motivations of scientific knowledge co-creators to engage in collaborative efforts with companies, it is essential to acknowledge its limitations: First, the results of this study cannot be generalised, as the cases studied are exclusively on prominent academic co-creators of public universities in Spain. These cases do not represent all academics nor the leading cases of collaboration. However, they provide evidence regarding the experiences of knowledge co-creators, which may indicate shared experiences among other groups of academics. Future research should study additional cases of collaboration and other academic populations, including graduate students, PhD students, and post-doc researchers.

Second, the interviewees are top academics that belong to hard sciences in top public universities. Researchers should extend this research to soft sciences and other universities, including private ones.

Third, the findings were based on critical cases, and a small sample was considered not representative of the academic community, which could be just the tip of the iceberg. Therefore, our results are exploratory and require further empirical investigation through large-scale surveys that could provide information about team-centred motivations, effects of managerialism on academic behaviour and impacts on knowledge development. Future research should continue exploring the relationship between motivations to collaborate with industry and managerialism in academia, offering deeper understanding of how these relationships shape new forms of academic-industry collaborations.

Chapter 5. General conclusions

The objective of this thesis consisted in explaining how some aspects of university-industry co-creation and its impact on business science respond to changes in institutional and socio-economic conditions. The dissertation emphasizes the importance of temporal approaches in exploring knowledge co-creation and the motivations behind engaging in such processes. It also highlights the need for further research on how socio-economic changes affect the outputs and channels of knowledge co-creation, including economic growth and its cycles. This research delves into the role of formal, informal and cocreative knowledge transfer channels on scientific impact of business science, particularly in response to economic growth. Additionally, it focuses on understanding the motivations of academic knowledge co-creators, exploring the rise of team-centred motivations to collaborate with industry within the context of academic managerialism.

This chapter provides an overview of the main theoretical and methodological contributions, practical implications, principal limitations, and avenues for future research.

5.1. Research contributions

The three studies that constitute this thesis contribute to future research by offering insights into the dynamics of knowledge co-creation between universities and industry. The first study, outlined in Chapter 2, underscores the importance of universities and economic growth on firms' scientific output. The theoretical contribution of this study presents a sort of university-industry cycle theory, suggesting that economic growth enhances the likelihood of firms' scientific knowledge co-creation and their scientific impact, until reaching an inflection point, after which those relationships become negative, and reveals that collaboration with universities is always needed for increasing business scientific impact.

The results of the second study lead to a more in-depth examination of co-authorship and understanding of the knowledge transfer channels. This study, presented in Chapter 3, advances the discussion of business scientific impact further by considering knowledge transfer channels among its antecedents. This study points to the tailored use and importance of knowledge transfer channels, showing that informal and publicly funded joint projects, so-called cocreative channels, are not only the

most common transfer channel but also have a positive impact on the relation between economic growth and business scientific impact. Moreover, the study shows that there is a negative relationship between informal channels and business scientific impact, suggesting that the use of many informal channels leads to lower scientific impact of business science.

The third study, discussed in Chapter 4, examines university knowledge co-creators' motivations to collaborate with industry. It reveals that co-creators follow self-centred motivations at the onset of collaboration, but over time, these motivations tend to shift towards team-centred orientations. This study contributes to observe that the emergence of team-centred motivations is partly due to the influence of the increasing academic managerialism, which entails excessive control and performativity in certain working conditions. Our research joins for the first time two streams of literature —academic managerialism and university-industry interaction— literature and highlights the need for a comprehensive approach to studying the behaviour of academics.

5.2. Practical implications

The findings of this thesis offer valuable insights for policymakers and practitioners aiming to optimize strategies for promoting scientific impact of collaborative research.

Given that the empirical analysis is centred on the effects of economic growth on knowledge co-creation outcomes, we are well-positioned to provide general insights for the establishment of specific policies to promote impactful knowledge co-creation. Chapter 2 shows that economic conditions are determinant in advancing business science, particularly in terms of research outcomes and scientific impact. Therefore, R&D programmes should focus on strengthening long-term university-industry collaborations, ensuring that both industry and university research capacities and performances are enhanced. Government support during periods of economic growth should be robust enough to lay the foundation for future research benefits, even when the economy stagnates. This is especially useful for universities as it allows them to respond with autonomy and focus on high-impact research.

Chapter 3 indicates the effects of three type of knowledge transfer channels on scientific impact. First, it shows that the use and the variety of informal channels have a negative effect on scientific impact of

business science. Therefore, policymakers are advised to control and limit the use of informal channels in certain collaborations to ensure the scientific impact of collaborative research. Second, the chapter demonstrates that the use of informal and cocreative channels, at different levels of economic growth will have a positive effect on scientific impact of business science. Thus, policymakers should act strategically promoting cocreative channels, for example, the participation of universities and industries in joint research programmes, especially in periods of economic growth. Third, although in this chapter we found no evidence of a significant effect of formal channels on business science impact, the findings still offer valuable insights. Policymakers are encouraged to develop mechanisms to enhance the impact of business science through co-creation conducted via formal channels. This can be achieved by incentivising firms to access research tools, promoting sharing practices, and engaging in open science activities.

Chapter 4 extends the existing framework on motivations for collaborating with industry by introducing team-centred motivations. This chapter provides qualitative evidence that academic managerialism influences top co-creators, shifting their motivations from self-centred to team-centred motivations to collaborate with industry. It also highlights researchers' perceptions of university management and assessment culture, revealing how these perceptions can shape motivations in response to academic managerialism. These findings have specific implications for practitioners and university managers.

Universities should capitalize on the openness of companies to engage in collaborative research, thus strengthening university-industry collaborations and fostering team science. Accreditation agencies should consider alternatives to traditional evaluation methods that reduce the pressure on academics and encourage collaborative research. Additionally, they should balance the control of academics' performance with ensuring adequate working conditions, creating a supportive environment and reducing opportunistic behaviour of academics.

Overall, the findings of this thesis also aim to rise some concerns regarding discrepancies between specific university policies and national priorities, which could hinder the attainment of overarching goals. The government should review policy settings to further encourage collaboration without creating firm dependence on public funding and minimising universities dependence on private funding.

Additionally, such policies should encourage collaborations in which power is balanced and the sharing of their benefits from interaction is equitable between universities and firms. The government should also ensure that academics have adequate working conditions for academics and the autonomy needed to work effectively within the university setting.

5.3. Limitations and further research

The scope of this thesis is to explore changes in university-industry knowledge co-creation from different theoretical and methodological approaches. Although specific limitations are presented in each chapter, the thesis also presents general limitations. First, the thesis focuses specifically on "scientific knowledge co-creation and impact", meaning that equivalent questions regarding technological co-creation and impact are not addressed. Moreover, while it delves into university-industry collaboration, it does not explore collaboration with non-academic entities such as non-profit and civil society organizations, which constitute the basis of a new academic engagement with society (Boni & Gasper, 2012).

Second, the empirical evidence in this thesis is based on data from a single country. Including data from multiple countries and covering a more extended period would strengthen the robustness of the findings and allow for a more comprehensive validation of the theoretical framework. In addition, the bibliometric evidence relies only on national co-publication data, excluding international co-publications and collaborations. Therefore, expanding the studies on a broader scale would be beneficial.

Third, the focus is limited to the hard sciences. Despite efforts to ensure comprehensive analysis across scientific fields, limitations of the WoS publication data source resulted in the exclusion of humanities and social sciences from the study. Future research could replicate this study to examine the evolution of knowledge co-creation in these disciplines.

Finally, there are certain limitations specific to chapter 4. The results presented in this chapter are exploratory and require further empirical investigation through large-scale surveys. Moreover, it would be valuable to include perceptions regarding managerialism from other academic groups, such as graduate students, doctoral candidates, postdoctoral researchers, and non-academic researchers.

In conclusion, this thesis demonstrates that knowledge co-creation in the context of university-industry collaboration is at the core of innovation processes and, therefore, a line of research that needs to be addressed. The limitations presented in this section open up new questions and new possibilities for further research, especially today, where the economic development depends on actors committed to technological change and mission-driven policies that focused on societal challenges. There is much work to be done to develop congruent policies that achieve balanced and sustainable collaborations between universities and industry, where both parties share a mutual commitment to expand scientific frontiers.

References

Abramo, G., D'Angelo, C. A., Di Costa, F., & Solazzi, M. (2009). University-industry collaboration in Italy: A bibliometric examination. *Technovation*, *29*(6), 498–507.

Abramo, G., D'Angelo, C. A., & Di Costa, F. (2020). The relative impact of private research on scientific advancement. arXiv preprint arXiv:2012.04908.

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.

Adams, J. (2005). Early citation counts correlate with accumulated impact. *Scientometrics*, 63(3), 567–581.

Agasisti, T., Barra, C., & Zotti, R. (2019). Research, knowledge transfer, and innovation: The effect of Italian universities' efficiency on local economic development 2006− 2012. *Journal of Regional Science*, *59*(5), 819-849.

Aghion, P., Askenazy, P., Berman, N., Cette, G., & Eymard, L. (2012). Credit constraints and the cyclicality of R&D investment: Evidence from France. *Journal of the European Economic Association*, 10(5), 1001–1024.

Agrawal, A., & Henderson, R. (2002). Putting Patents in Context: Exploring Knowledge Transfer from MIT. *Management Science* 48, 44–60. https://doi.org/10.1287/mnsc.48.1.44.14279

Aksnes, D. W. (2003). Characteristics of highly cited papers. *Research evaluation*, *12*(3), 159–170.

Ali-Khan, S. E., Harris, L. W., & Gold, E. R. (2017). Motivating participation in open science by examining researcher incentives. *Elife*, *6*, e29319.

Althouse, B. M., West, J. D., Bergstrom, C. T., & Bergstrom, T. (2009). Differences in impact factor across fields and over time. *Journal of the American Society for Information Science and technology*, 60(1), 27–34.

Álvarez-Bornstein, B., & Bordons, M. (2021). Is funding related to higher research impact? Exploring its relationship and the mediating role of collaboration in several disciplines. *Journal of Informetrics*, 15(1), 101102.

Alvesson, M., Lee Ashcraft, K., & Thomas, R. (2008). Identity matters: Reflections on the construction of identity scholarship in organization studies. *Organization* 15, 5–28.

Alvesson, M., & Sveningsson, S. (2011). Management is the solution: Now what was the problem? On the fragile basis for managerialism. *Scandinavian Journal of Management* 27, 349–361. https://doi.org/10.1016/j.scaman.2011.08.002

Amore, M. D. (2015). Companies learning to innovate in recessions. *Research Policy*, 44(8), 1574-1583.

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, 50–65.

Ankrah, S., & Omar, A. T. (2015). Universities–industry collaboration: A systematic review. *Scandinavian journal of management*, 31(3), 387-408.

Archibugi, D., Filippetti, A., & Frenz, M. (2013). Economic crisis and innovation: is destruction prevailing over accumulation?. *Research Policy*, *42*(2), 303-314.

Archibugi, D., Filippetti, A., & Frenz, M. (2013). The impact of the economic crisis on innovation: Evidence from Europe. *Technological Forecasting and Social Change*, 80(7), 1247-1260.

Arora, A., Belenzon, S., & Sheer, L. (2021). Knowledge spillovers and corporate investment in scientific research. *American Economic Review*, *111*(3), 871-98.

Arza, V. (2010). Channels, benefits and risks of public—private interactions for knowledge transfer: conceptual framework inspired by Latin America. *Science and Public Policy*, 37(7), 473-484.

Arzenšek, A., Košmrlj, K., & Širca, N. T. (2014). Slovenian young researchers' motivation for knowledge transfer. *Higher education*, *68*, 185-206.

Azagra-Caro, J. M., Archontakis, F., Gutiérrez-Gracia, A., & Fernández-de-Lucio, I. (2006). Faculty support for the objectives of university–industry relations versus degree of R&D cooperation: The importance of regional absorptive capacity. *Research Policy*, 35(1), 37-55.

Azagra-Caro, J. M., Aznar-Marqez, J., & Blanco, J. M. (2008). Interactive vs. non-interactive knowledge production by faculty members. *Applied Economics*, *40*(10), 1289-1297.

Azagra-Caro, J. M., Pardo, R., & Rama, R. (2014). Not searching, but finding: how innovation shapes perceptions about universities and public research organisations. *The Journal of Technology Transfer*, 39(3), 454–471.

Azagra-Caro, J. M., & Llopis, O. (2018). Who do you care about? Scientists' personality traits and perceived impact on beneficiaries. *R&D Management*, *48*(5), 566-579.

Azagra-Caro, J. M., Tijssen, R. J. W., Tur, E. M., & Yegros-Yegros, A. (2019). University-industry scientific production and the Great Recession. *Technological Forecasting and Social Change*, *139*, 210–220.

Azagra-Caro, J. M., Fernández-Mesa, A., & Robinson-García, N. (2020). 'Getting out of the closet': Scientific authorship of literary fiction and knowledge transfer. *The Journal of Technology Transfer*, *45*(1), 56-85.

Azmeh, C. (2022). Quantity and quality of research output and economic growth: empirical investigation for all research areas in the MENA countries. *Scientometrics*, 127(11), 6147-6163.

Ball, S.J. (2003). The teacher's soul and the terrors of performativity. *Journal of Education Policy* 18, 215–228.

Ball, S.J. (2012). Performativity, Commodification and Commitment: An I-Spy Guide to the Neoliberal University. *British Journal of Educational Studies* 60, 17–28.

Balven, R., Fenters, V., Siegel, D. S., & Waldman, D. (2018). Academic entrepreneurship: The roles of identity, motivation, championing, education, work-life balance, and organizational justice. *Academy of Management Perspectives*, *32*(1), 21-42.

Banal-Estañol, A., Jofre-Bonet, M., & Lawson, C. (2015). The double-edged sword of industry collaboration: Evidence from engineering academics in the UK. *Research Policy*, 44(6), 1160-1175.

Barberá-Tomás, D., Azagra-Caro, J. M., & D'Este, P. (2022). Dynamic perspectives on technology transfer: introduction to the special section. *The Journal of Technology Transfer*, 1-9.

Barjak, F., Es-Sadki, N., & Arundel, A. (2015). The effectiveness of policies for formal knowledge transfer from European universities and public research institutes to firms. *Research Evaluation*, 24(1), 4-18.

Barlevy, G. (2007). On the cyclicality of research and development. *American Economic Review*, 97(4), 1131-1164.

Batson, C.D. (2022). Prosocial motivation: A Lewinian approach. *Motivation Science* 8, 1–10.

Beck, S., Bergenholtz, C., Bogers, M., Brasseur, T. M., Conradsen, M. L., Di Marco, D., ... & Xu, S. M. (2022). The Open Innovation in Science research field: a collaborative conceptualisation approach. *Industry and Innovation*, 29(2), 136-185.

Beck, S., LaFlamme, M., Bergenholtz, C., Bogers, M., Brasseur, T. M., Conradsen, M. L., ... & Xu, S. M. (2021). Examining Open Innovation in Science (OIS): what Open Innovation can and cannot offer the science of science. *Industry and Innovation*, 1-15.

Bekkers, R., & Freitas, I. M. B. (2008). Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter?. *Research policy*, 37(10), 1837-1853.

Belderbos, R., Carree, M., & Lokshin, B. (2004). Cooperative R&D and firm performance. *Research policy*, 33(10), 1477-1492.

Belderbos, R., Gilsing, V. A., & Suzuki, S. (2016). Direct and mediated ties to universities: "Scientific" absorptive capacity and innovation performance of pharmaceutical firms. *Strategic Organization*, *14*(1), 32–52.

Belderbos, R., Sleuwaegen, L., Somers, D., & De Backer, K. (2016). Where to locate innovative activities in global value chains: does co-location matter?

Berger, R., & Hänze, M. (2015). Impact of expert teaching quality on novice academic performance in the jigsaw cooperative learning method. *International Journal of Science Education*, 37(2), 294-320.

Blackmore, J. (2002). Globalisation and the restructuring of higher education for new knowledge economies: New dangers or old habits troubling gender equity work in universities? *Higher education quarterly*, *56*(4), 419-441.

Bloch, C., Ryan, T. K., & Andersen, J. P. (2019). Public-private collaboration and scientific impact: An analysis based on Danish publication data for 1995–2013. *Journal of Informetrics*, 13(2), 593-604.

Bolli, T., Olivares, M., Bonaccorsi, A., Daraio, C., Aracil, A. G., & Lepori, B. (2016). The differential effects of competitive funding on the production frontier and the efficiency of universities. *Economics of Education Review*, 52, 91-104.

Boni, A., & Lozano, J. F. (2007). The generic competences: an opportunity for ethical learning in the European convergence in higher education. *Higher Education*, 54, 819-831.

Boni, A., & Gasper, D. (2012). Rethinking the quality of universities: How can human development thinking contribute? *Journal of Human Development and Capabilities*, 13(3), 451-470.

Bozeman, B., & Boardman, C. (2013). An evidence-based assessment of research collaboration and team science: patterns in industry and university-industry partnerships. *In Workshop on Institutional and Organizational Supports for Team Science.*

Bradley, S. R., Hayter, C. S., & Link, A. N. (2013). Models and methods of university technology transfer. *Foundations and Trends® in Entrepreneurship*, 9(6), 571-650.

Brennenraedts, R., Bekkers, R., & Verspagen, B. (2006). ECIS Working Paper Series. In *The Different Channels of University-Industry Knowledge Transfer: Empirical Evidence from Biomedical Engineering*. Technische Universiteit Eindhoven Eindhoven, The Netherlands.

Buheji, M., & Ahmed, D. (2020). Foresight of Coronavirus (COVID-19) opportunities for a better world. *American Journal of Economics*, 10(2), 97–108.

Cagan, R. (2013). The San Francisco Declaration on Research Assessment. *Disease Models & Mechanisms*, 6, 869-870.

Callaert, J., Landoni, P., Van Looy, B., & Verganti, R. (2015). Scientific yield from collaboration with industry: The relevance of researchers' strategic approaches. *Research Policy*, 44(4), 990-998.

Calvert, J., & Patel, P. (2003). University-industry research collaborations in the UK: bibliometric trends. *Science and Public Policy*, *30*(2), 85–96.

Camerani, R., Rotolo, D., & Grassano, N. (2018). Do firms publish? A multi-sectoral analysis. *A Multi-Sectoral Analysis (October 2018). SWPS*, 21.

Campbell, D. F., & Guttel, W. H. (2005). Knowledge production of firms: research networks and the" scientification" of business R&D. *International Journal of Technology Management*, 31(1-2), 152-175.

Cañibano, C., Vilardell, I., Corona, C., & Benito-Amat, C. (2018). The evaluation of research excellence and the dynamics of knowledge production in the humanities: The case of history in Spain. *Science and public policy*, *45*(6), 775-789.

Cantner, U., & Kösters, S. (2009). *Picking the winner? Empirical evidence on the targeting of R&D subsidies to start-ups* (No. 2009, 093). Jena economic research papers.

Carayol, N., & Matt, M. (2006). Individual and collective determinants of academic scientists' productivity. *Information Economics and Policy*, 18(1), 55–72.

Cassiman, B., Di Guardo, M. C., & Valentini, G. (2010). Organizing links with science: Cooperate or contract?: A project-level analysis. *Research Policy*, *39*(7), 882-892.

Castiaux, J. H. A. (2007). Knowledge Creation through University-Industry Collaborative Research Projects. *Electronic Journal of Knowledge Management*, *5*(1), pp43-54.

Chakrabarti, A. K. (1990). Scientific output of small and medium size firms in high tech industries. *IEEE Transactions on Engineering Management*, *37*(1), 48–52.

Chesbrough, H. (2020). To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective. *Industrial Marketing Management*, *88*, 410–413.

Cincera, M., & Dratwa, D. (2011). Determinants of scientific production: an empirical study of the world's top R&D companies. *Bruxelas, Bélgica.: Université Libre de Bruxelles.*

Clarke, C.A., & Knights, D. (2015). Careering through academia: Securing identities or engaging ethical subjectivities? *Human Relations* 68, 1865–1888.

Clauss, T., Kesting, T., & Franco, M. (2024). Innovation generation through formalisation and fairness in university–Industry collaboration. *Technovation*, 134, 103049.

Cohen, M. Z., Alexander, G. L., Wyman, J. F., Fahrenwald, N. L., Porock, D., Wurzbach, M. E., ... & Conn, V. S. (2010). Scientific impact: Opportunity and necessity. *Western journal of nursing research*, 32(5), 578–590.

Cole, S. (1992). Making science: Between nature and society. *Harvard University Press*.

COTEC Foundation (2018). Informe Cotec 2018. Madrid: Fundación Cotec para la Innovación Tecnológica. ISBN: 9788492933396

Crespi, F. & Leone, C. (2006) Seventh Framework Programme COTEC Position Paper. Analysis of FP6 Italian Results for The Definition Of FP7 Research Priorities (Rome, COTEC Fondazione per l'Innovazione Tecnologica).

Cruz-Castro, L., & Sanz-Menéndez, L. (2016). The effects of the economic crisis on public research: Spanish budgetary policies and research organizations. *Technological Forecasting and Social Change*, *113*, 157–167.

Cruz-Castro, L., Holl, A., Rama, R., & Sanz-Menéndez, L. (2018). Economic crisis and company R&D in Spain: do regional and policy factors matter? *Industry and Innovation*, 25(8), 729-751.

D'Agostino, L. M., & Moreno, R. (2018). Exploration during turbulent times: an analysis of the relation between cooperation in innovation activities and radical innovation performance during the economic crisis. *Industrial and Corporate Change*, 27(2), 387-412.

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, 316–339.

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., Ramos-Vielba, I., Woolley, R., & Amara, N. (2018). How do researchers generate scientific and societal impacts? Toward an analytical and operational framework. *Science and Public Policy*, 45(6), 752-763.

De Fuentes, C., Dutrénit, G., 2012. Best channels of academia–industry interaction for long-term benefit. *Research Policy*, 41, 1666–1682. https://doi.org/10.1016/j.respol.2012.03.026

De Silva, M., Al-Tabbaa, O., & Pinto, J. (2023). Academics engaging in knowledge transfer and co-creation: Push causation and pull effectuation?. *Research Policy*, *52*(2), 104668.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of research in personality*, *19*(2), 109-134.

Deem, R. (1998). 'New managerialism' and higher education: The management of performances and cultures in universities in the United Kingdom. *International Studies in Sociology of Education*, 8(1), 47-70.

Deem, R., & Brehony, K.J. (2005). Management as ideology: the case of 'new managerialism' in higher education. *Oxford Review of* Education 31, 217–235. https://doi.org/10.1080/03054980500117827

Deem, R., Hillyard, S., Reed, Michael, & Reed, Mike (2007). *Knowledge, Higher Education, and the New Managerialism: The Changing Management of UK Universities*. OUP Oxford.

Defendi, H. G. T., da Silva Madeira, L., & Borschiver, S. (2021). Analysis of the COVID-19 vaccine development process: an exploratory study of accelerating factors and innovative environments. *Journal of Pharmaceutical Innovation*, 1-17.

Dorta-Gonzalez, P., & Dorta-González, M. I. (2013). Impact maturity times and citation time windows: The 2-year maximum journal impact factor. *Journal of Informetrics*, 7(3), 593–602.

Doutriaux, J., & Baker, M. (1995). University & industry in Canada: report on a complicated relationship.

Drivas, K., Lei, Z., & Wright, B. D. (2017). Academic patent licenses: Roadblocks or signposts for nonlicensee cumulative innovation?. *Journal of Economic Behavior & Organization*, *137*, 282-303.

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. *Academy of management review*, 32(4), 1246-1264.

Eisenberg, N., VanSchyndel, S.K., & Spinrad, T.L. (2016). Prosocial Motivation: Inferences From an Opaque Body of Work. *Child Development* 87, 1668–1678. https://doi.org/10.1111/cdev.12638

Ese, J. (2019). *Defending the university?: Academics' reactions to managerialism in Norwegian higher education* (Doctoral dissertation, Karlstads universitet).

Eun, J. H. (2009). Chinas horizontal university-industry linkage: where from and where to. *Seoul Journal of Economics*, *22*(4), 445-466.

European Commission Directorate-General for Education (2018). Youth, Sport and Culture. *The state of university-business cooperation in Europe: final report.* Office for Official Publications of the European Communities https://data.europa.eu/doi/10.2766/676478

Fabrizio, K. R. (2009). Absorptive capacity and the search for innovation. *Research Policy*, *38*(2), 255-267.

Faems, D., Van Looy, B., & Debackere, K. (2005). Interorganizational collaboration and innovation: Toward a portfolio approach. *Journal of product innovation management*, 22(3), 238-250.

Fecher, B., & Friesike, S. (2014). *Open science: one term, five schools of thought* (pp. 17-47). Springer International Publishing.

Ferris, G. (2021). Undermining resilience: how the modern UK university manufactures heightened vulnerability in legal academics and what is to be done. *The Law Teacher*, *55*(1), 24-41.

Filippetti, A., & Archibugi, D. (2011). Innovation in times of crisis: National Systems of Innovation, structure, and demand. *Research Policy*, *40*(2), 179–192.

Flyvbjerg, B. (2001). *Making social* science matter: Why social inquiry fails and how it can succeed again. Cambridge university press.

Foster, J. G., Rzhetsky, A., & Evans, J. A. (2015). Tradition and innovation in scientists' research strategies. *American Sociological Review*, 80(5), 875–908.

Foucault, M. (1980). Power/knowledge, ed. *C. Gordon. New York: Pantheon*, *90*.

Fowler-Davis, S. (2009). Knowledge exchange: capacity building in a small university. *Education+ Training*, *51*(8/9), 682-695.

Franco, M., & Haase, H. (2015). University–industry cooperation: Researchers' motivations and interaction channels. *Journal of Engineering and technology Management*, 36, 41-51.

Freeman, C. (1987). Technical innovation, diffusion, and long cycles of economic development. In *The long-wave debate* (pp. 295–309). Springer, Berlin, Heidelberg.

Frenken, K., Hölzl, W., & Vor, F. de. (2005). The citation impact of research collaborations: The case of European biotechnology and applied microbiology (1988–2002). *Journal of Engineering and Technology Management*, *22*(1), 9–30.

Frenken, K., Ponds, R., & Van Oort, F. (2010). The citation impact of research collaboration in science-based industries: A spatial-institutional analysis. *Papers in regional science*, *89*(2), 351–271.

Friesike, S., Widenmayer, B., Gassmann, O., & Schildhauer, T. (2015). Opening science: towards an agenda of open science in academia and industry. *The journal of technology transfer*, 40, 581-601.

Fritsch, M., & Schwirten, C. (1999). Enterprise-university co-operation and the role of public research institutions in regional innovation systems. *Industry and innovation*, *6*(1), 69-83.

García-Aracil, A., & Fernández de Lucio, I. (2008). Industry–university interactions in a peripheral European region: an empirical study of Valencian firms. Regional Studies, 42(2), 215-227.

García-Aracil, A., Castro-Martínez, E., Azagra-Caro, J. M., D'Este, P., & de Lucio, I. F. (2017). 11 University technology transfer. *University Technology Transfer: The globalization of academic innovation*, 253.

García-Sánchez, A., & Rama, R. (2020). Foreign ownership and domestic cooperation for innovation during good and harsh economic times. *International Journal of Multinational Corporation Strategy*, *3*(1), 4-25.

Garfield, E. (1972). Citation analysis as a tool in journal evaluation. *Science*, 178(4060), 471–479.

Gerbin, A., & Drnovsek, M. (2016). Determinants and public policy implications of academic-industry knowledge transfer in life sciences: A review and a conceptual framework. *The Journal of Technology Transfer*, *41*, 979-1076.

Gielfi, G. G., Furtado, A. T., & Campos, A. L. S. (2014) University-Industry Collaboration in the Brazilian Oil Industry: A Bibliometric examination. *12th Globelics International Conference.*

Giuliani, E., Morrison, A., Pietrobelli, C., & Rabellotti, R. (2010). Who are the researchers that are collaborating with industry? An analysis of the wine sectors in Chile, South Africa and Italy. *Research Policy* 39, 748–761.

Giunta, A., Pericoli, F. M., & Pierucci, E. (2016). University–industry collaboration in the biopharmaceuticals: The Italian case. *The Journal of Technology Transfer*, *41*(4), 818–840.

Glänzel, W., & Schubert, A. (2001). Double effort= double impact? A critical view at international co-authorship in chemistry. *Scientometrics*, 50(2), 199-214.

Glaser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory: Strategies for grounded theory. *New Brunswick und London: Aldine Transaction*.

Gläser, J., & Laudel, G. (2015). A bibliometric reconstruction of research trails for qualitative investigations of scientific innovations. *Historical Social Research*, 40(3), 299-330.

Glenna, L.L., Lacy, W.B., Welsh, R., & Biscotti, D. (2007). University Administrators, Agricultural Biotechnology, and Academic Capitalism: Defining the Public Good to Promote University–Industry Relationships. *The Sociological Quarterly* 48, 141–163.

Goldfinch, S., Dale, T., & DeRouen, K. (2003). Science from the periphery: Collaboration, networks and "Periphery Effects" in the citation of New Zealand Crown Research Institutes articles, 1995–2000. *Scientometrics*, *57*(3), 321–337.

Gómez-Aguayo, A. M., Azagra-Caro, J. M., & Benito-Amat, C. (2024). The steady effect of knowledge co-creation with universities on business scientific impact throughout the economic cycle. *Scientometrics*, 1-29.

Grant, A.M. (2008). Does intrinsic motivation fuel the prosocial fire? Motivational synergy in predicting persistence, performance, and productivity. *Journal of Applied Psychology* 93, 48–58.

Grey, C. (1994). Career as a project of the self and labour process discipline. *Sociology* 28, 479–497.

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.

Grinin, L., Tausch, A., & Korotayev, A. (2016). *Economic cycles, crises, and the global periphery*. Springer.

Grossman, G. M., & Helpman, E. (1991). Trade, knowledge spillovers, and growth. *European economic review*, 35(2-3), 517-526.

Grusky, D. B., Western, B., & Wimer, C. (2011). *The great recession*. Russell Sage Foundation.

Gulbrandsen, M., & Smeby, J. C. (2005). Industry funding and university professors' research performance. *Research policy*, 34(6), 932-950.

Haans, R. F., Pieters, C., & He, Z. L. (2016). Thinking about U: Theorizing and testing U-and inverted U-shaped relationships in strategy research. *Strategic management journal*, *37*(7), 1177-1195.

Hadi, A. S. (1994). A modification of a method for the detection of outliers in multivariate samples. *Journal of the Royal Statistical Society Series B: Statistical Methodology*, 56(2), 393-396.

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.

Hagen, S. (2008). From tech transfer to knowledge exchange: European universities in the marketplace. *Wenner-Gren International Series*, *84*, 103-117.

Hall, B. H. (1992). *Investment and research and development at the firm level: does the source of financing matter?* (No. w4096). National bureau of economic research.

Hall, B. H. (2002). The financing of research and development. *Oxford review of economic policy*, *18*(1), 35–51.

Halperin, M. R., & Chakrabarti, A. K. (1987). Firm and industry characteristics influencing publications of scientists in large American companies. *R&D Management*, *17*(3), 167–173.

Hartmann, G. C., Myers, M. B., & Rosenbloom, R. S. (2006). Planning your firm's R&D investment. *Research-Technology Management*, 49(2), 25–36.

Hayter, C. S., & Link, A. N. (2018). Why do knowledge-intensive entrepreneurial firms publish their innovative ideas? *Academy of Management Perspectives*, *32*(1), 141-155.

Henkel, M. (1997). Teaching Quality Assessments: Public Accountability and Academic Autonomy in Higher Education. *Evaluation* 3, 9–23. https://doi.org/10.1177/135638909700300102

Hess, A. M., & Rothaermel, F. T. (2011). When are assets complementary? Star scientists, strategic alliances, and innovation in the pharmaceutical industry. *Strategic Management Journal*, *32*(8), 895–909.

Hey, V. (2001). The construction of academic time: sub/contracting academic labour in research. *Journal of Education Policy* 16, 67–84. https://doi.org/10.1080/02680930010009831

Hicks, D. (2004). The four literatures of social science. *Handbook of quantitative science and technology research*, 473–496.

Hillerbrand, R., & Werker, C. (2019). Values in university–industry collaborations: The case of academics working at universities of technology. *Science and Engineering Ethics*, 25, 1633-1656.

Himmelberg, C. P., & Petersen, B. C. (1994). R & D and internal finance: A panel study of small firms in high-tech industries. *The review of economics and statistics*, 38–51.

Hinostroza-Paredes, Y. (2023). Reflexivity and agency in university-based teacher educators: a critical realist analysis. *Teaching in Higher Education*, *28*(8), 1918-1936.

Hmieleski, K. M., & Powell, E. E. (2018). The psychological foundations of university science commercialization: A review of the literature and directions for future research. *Academy of Management Perspectives*, *32*(1), 43–77.

Hottenrott, H., & Lawson, C. (2014). Research grants, sources of ideas and the effects on academic research. *Economics of Innovation and New Technology*, *23*(2), 109-133.

Hud, M., & Hussinger, K. (2015). The impact of R&D subsidies during the crisis. *Research policy*, 44(10), 1844-1855.

Hud, M., & Rammer, C. (2015). Innovation Budgeting Over the Business Cycle and Innovation Performance. *SSRN Electronic Journal*.

Hughes, A. (2011). Open innovation, the Haldane principle and the new production of knowledge: science policy and university–industry links in the UK after the financial crisis. *Prometheus*, 29(4), 411–442.

IMF (2008). *World Economic Outlook 2008*. Washington: International Monetary Fund.

Inglesi-Lotz, R., & Pouris, A. (2013). The influence of scientific research output of academics on economic growth in South Africa: An autoregressive distributed lag (ARDL) application. *Scientometrics*, 95, 129-139.

Inglesi-Lotz, R., Balcilar, M., & Gupta, R. (2014). Time-varying causality between research output and economic growth in US. *Scientometrics*, 100, 203-216.

Ivanova, I. (2014). Quadruple helix systems and symmetry: a step towards helix innovation system classification. *Journal of the Knowledge Economy*, 5, 357-369.

Jiménez-Contreras, E., de Moya Anegón, F., & López-Cózar, E.D. (2003). The evolution of research activity in Spain: The impact of the National Commission for the Evaluation of Research Activity (CNEAI). *Research Policy* 32, 123–142.

Kalfa, S., & Taksa, L. (2017). Employability, managerialism, and performativity in higher education: a relational perspective. *Higher Education* 74, 687–699.

Kamien, M. I., & Schwartz, N. L. (1978). Self-Financing of an R and D Project. *The American Economic Review*, 68(3), 252–261.

Kehm, B. M. (2006). Doctoral education in Europe and North America: A comparative analysis. *Wenner Gren International Series*, 83, 67.

Keisu, B. I., & Carbin, M. (2014). Administrators or critical cynics? A study of gender equality workers in Swedish Higher Education. *NORA-Nordic Journal of Feminist and Gender Research*, *22*(3), 204-218.

Kenny, J. (2018). Re-empowering academics in a corporate culture: an exploration of workload and performativity in a university. *Higher Education* 75, 365–380.

Kleinman, D.L., & Vallas, S.P. (2001). Science, Capitalism, and the Rise of the "Knowledge Worker": The Changing Structure of Knowledge Production in the United States. *Theory and Society* 30, 451–492.

Köksal, M. H., & Özgül, E. (2007). The relationship between marketing strategies and performance in an economic crisis. *Marketing Intelligence & Planning*, 25(4), 326-342.

Koput, K. W. (1997). A chaotic model of innovative search: some answers, many questions. *Organization Science*, *8*(5), 528–542.

Krieger, B., Pellens, M., Blind, K., Gruber, S., & Schubert, T. (2021). Are firms withdrawing from basic research? An analysis of firm-level publication behaviour in Germany. *Scientometrics*, 126(12), 9677-9698.

Lafuente, E., & Berbegal-Mirabent, J. (2019). Contract employment policy and research productivity of knowledge workers: an analysis of Spanish universities. *The International Journal of Human Resource Management*, 30(16), 2360-2386.

Lam, A. (2011). What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'? *Research Policy*, 40, 1354–1368.

Laredo, P. (2007). Revisiting the Third Mission of Universities: Toward a Renewed Categorization of University Activities? *Higher Education Policy* 20, 441–456.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic management journal*, 27(2), 131-150.

Lauvås, T., & Rasmussen, E. (2022). University-industry collaboration: drivers and barriers. *In Handbook of Technology Transfer* (pp. 124-137). Edward Elgar Publishing

Lebeau, L. M., Laframboise, M.-C., Larivière, V., & Gingras, Y. (2008). The effect of university–industry collaboration on the scientific impact of publications: The Canadian case, 1980–2005. *Research Evaluation*, *17*(3), 227–232.

Lee, S., & Bozeman, B. (2005). The impact of research collaboration on scientific productivity. *Social studies of science*, 35(5), 673-702.

Lee, Y.S. (2000). The Sustainability of University-Industry Research Collaboration: An Empirical Assessment. *The Journal of Technology Transfer* 25, 111–133.

Leimu, R., & Koricheva, J. (2005). Does scientific collaboration increase the impact of ecological articles? *BioScience*, 55, 438–443.

Leisyte, L. (2011). University commercialization policies and their implementation in the Netherlands and the United States. *Science and public policy*, *38*(6), 437-448.

Leišytė, L. (2016). New public management and research productivity–a precarious state of affairs of academic work in the Netherlands. *Studies in Higher Education*, *41*(5), 828-846.

Lewin, K. (1944/1951). Constructs in field theory. In K. Lewin (Ed.), Field theory in social science: Selected theoretical papers (pp. 30 – 42). Harper. (Original work published 1944)

Li, E. Y., Liao, C. H., & Yen, H. R. (2013). Co-authorship networks and research impact: A social capital perspective. *Research Policy*, *42*(9), 1515-1530.

Liao, C. H. (2011). How to improve research quality? Examining the impacts of collaboration intensity and member diversity in collaboration networks. *Scientometrics*, *86*(3), 747-761.

Liévana, C. M. (2010). The Relationship between industry and universities. *Cuadernos de estudios empresariales*, *20*(1), 81–105.

Lind, J. T., & Mehlum, H. (2010). With or without U? The appropriate test for a U-shaped relationship. *Oxford bulletin of economics and statistics*, *72*(1), 109–118.

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.

Little, M. M., St Hill, C. A., Ware, K. B., Swanoski, M. T., Chapman, S. A., Lutfiyya, M. N., & Cerra, F. B. (2017). Team science as interprofessional collaborative research practice: a systematic review of the science of team science literature. *Journal of Investigative Medicine*, 65(1), 15-22.

Llopis, O., & Foss, N. J. (2016). Understanding the climate–knowledge sharing relation: The moderating roles of intrinsic motivation and job autonomy. *European Management Journal*, 34(2), 135-144.

Lu, Y., Zheng, L., Zhang, B., & Li, W. (2022). Configuration of prosocial motivations to enhance employees' innovation behaviors: From the perspective of coupling of basic and applied research. *Frontiers in Psychology*, *13*, 958949.

Lundberg, J., Tomson, G., Lundkvist, I., Skår, J., & Brommels, M. (2006). Collaboration uncovered: Exploring the adequacy of measuring university-industry collaboration through co-authorship and funding. *Scientometrics*, 69(3), 575–589.

Lynch, K. (2014). New managerialism, neoliberalism and ranking. *Ethics in science and environmental politics*, *13*(2), 141-153.

Magnani, G., & Gioia, D. (2023). Using the Gioia Methodology in international business and entrepreneurship research. *International Business Review* 32, 102097.

Martínez-Campillo, A., & Fernández-Santos, Y. (2020). The impact of the economic crisis on the (in)efficiency of public Higher Education institutions in Southern Europe: The case of Spanish universities. *Socio-Economic Planning Sciences* 71, 100771.

Mason, J. (2006). Mixing methods in a qualitatively driven way. *Qualitative research*, 6(1), 9-25.

Mathisen, L., & Jørgensen, E. J. (2021). The significance of knowledge readiness for co-creation in university industry collaborations. *Innovation*, 23(4), 534-551.

Mattsson, P. (2011). *European knowledge transfer reflected by research collaboration and patent citations indicators.* Karolinska Institutet (Sweden).

Mazumdar, M., Messinger, S., Finkelstein, D. M., Goldberg, J. D., Lindsell, C. J., Morton, S. C., ... & Parker, R. A. (2015). Evaluating academic scientists collaborating in team-based research: a proposed framework. *Academic Medicine*, 90(10), 1302-1308.

McKelvey, M., & Holmén, M. (2010). *Learning to compete in European universities: From social institution to knowledge business*. Edward Elgar Publishing.

McKelvey, M., & Rake, B. (2016). Product innovation success based on cancer research in the pharmaceutical industry: co-publication networks and the effects of partners. *Industry and Innovation*, 23(5), 383-406.

McKelvey, M., & Rake, B. (2020). Exploring scientific publications by firms: what are the roles of academic and corporate partners for publications in high reputation or high impact journals? *Scientometrics*, *122*(3), 1323-1360.

McManus, C., Baeta Neves, A. A., & Prata, A. T. (2021). Scientific publications from non-academic sectors and their impact. *Scientometrics*, 126(11), 8887-8911.

McMillan, G. S., Mauri, A., & Casey, D. L. (2014). The scientific openness decision model: "Gaming" the technological and scientific outcomes. *Technological Forecasting and Social Change*, 86, 132-142.

Meardi, G. (2014). Employment relations under external pressure: Italian and Spanish reforms during the Great Recession. *Comparative political economy of work, London, Palgrave*, 332–350.

Meyer-Krahmer, F., & Schmoch, U. (1998). Science-based technologies: university–industry interactions in four fields. *Research policy*, 27(8), 835-851

Minister of the Treasury (2018). General State Budget for 2018. Retrieved 15 January 2021, from https://www.hacienda.gob.es

Ministry for Science and Innovation (2019). *State R&D Program Oriented to the Challenges of the Society*. Retrieved 23 March 2021, from https://www.aei.gob.es/programa/programa-estatal-idi-orientada-retos-sociedad

Ministry of Science, Innovation and Universities (2024). *State Plan for Scientific and Technical Research and Innovation* (PEICTI). Retrieved 18 October 2024, from https://www.ciencia.gob.es/en/Estrategias-y-Planes/Planes-y-programas/PEICTI.html

Moed, H. F. (2006). *Citation analysis in research evaluation* (Vol. 9). Springer Science & Business Media.

Morley, L., & Crossouard, B. (2016). Gender in the neoliberalised global academy: the affective economy of women and leadership in South Asia. *British Journal of Sociology of Education* 37, 149–168.

Mowery, D. C., Thompson, N. C., & Ziedonis, A. A. (2014). Does university licensing facilitate or restrict the flow of knowledge and research inputs among scientists?. *In Arbeitspapier präsentiert am Workshop "Beyond spillovers*.

Mueller, P. (2006). Exploring the knowledge filter: How entrepreneurial and university-industry relationships drive economic growth. *Research Policy*, 35(10), 1499–1508.

Muller, S. M. (2022). From accountability to managerialism and incentives. In *The Incentivised University: Scientific Revolutions, Policies, Consequences* (pp. 95-112). Cham: Springer International Publishing.

Muñoz-Rodríguez, D., & Ortega, A. S. (2017). Las" cárceles del capital humano": trabajo y vidas precarias en la juventud universitaria. *Recerca. Revista de pensament i anàlisi*, (20), 59-78.

Naimark, A. (1989). Is there a crisis in university research funding? In *University research and the future of Canada: proceedings of the national conference held in Edmonton, Alberta, 26–29 April 1988* (p. 60). University of Ottawa Pr.

NBER's Recession Dating Procedure. (2008). Nber.org. Retrieved 14 August 2016, from http://www.nber.org/cycles/jan08bcdc_memo.html

Nehring, A., Nowak, K. H., zu Belzen, A. U., & Tiemann, R. (2015). Predicting students' skills in the context of scientific inquiry with cognitive, motivational, and sociodemographic variables. *International Journal of Science Education*, 37(9), 1343-1363.

Newby, P. (2014). *Research methods for education*. Routledge.

Olssen, M., & Peters, M.A. (2005). Neoliberalism, higher education and the knowledge economy: from the free market to knowledge capitalism. *Journal of Education Policy* 20, 313–345.

Ordóñez, J., Monfort, M., & Cuestas, J. C. (2019). Oil prices, unemployment and the financial crisis in oil-importing countries: *The case of Spain. Energy*, 181, 625-634.

Ortega-Argilés, R., Vivarelli, M., & Voigt, P. (2009). R&D in SMEs: a paradox?. *Small business economics*, 33, 3-11.

Owen-Smith, J., & Powell, W. W. (2001). Careers and contradictions: Faculty responses to the transformation of knowledge and its uses in the life sciences. In *The transformation of work* (pp. 109-140). Emerald Group Publishing Limited.

Paradeise, C., & Thoenig, J. C. (2013). Academic institutions in search of quality: Local orders and global standards. *Organization studies*, *34*(2), 189-218.

Park, M., Leahey, E., & Funk, R. J. (2023). Papers and patents are becoming less disruptive over time. *Nature*, 613(7942), 138-144.

Pellens, M., Peters, B., Hud, M., Rammer, C., & Licht, G. (2020). Public R&D investment in economic crises. *ZEW-Centre for European Economic Research Discussion Paper*, (20–088).

Perez, P. J., Osborn, D. R., & Sensier, M. (2007). Business cycle affiliations in the context of European integration. *Applied Economics*, 39(2), 199-214.

Perez, C. (2003). *Technological revolutions and financial capital*. Edward Elgar Publishing.

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. (2009). The two faces of collaboration: impacts of university-industry relations on public research. *Industrial and Corporate Change* 18, 1033–1065. https://doi.org/10.1093/icc/dtp015

Perkmann, M., Neely, A., & Walsh, K. (2011). How should firms evaluate success in university–industry alliances? A performance measurement system. *R&D Management*, *41*(2), 202–216.

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

Pinto, T., & Teixeira, A. A. (2020). The impact of research output on economic growth by fields of science: a dynamic panel data analysis, 1980–2016. *Scientometrics*, *123*(2), 945-978.

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.

Primeri, E., & Reale, E. (2012). How Europe shapes academic research: Insights from participation in European union framework programmes. *European Journal of Education*, 47(1), 104-121.

Rafferty, M., & Funk, M. (2008). Asymmetric effects of the business cycle on firm-financed R&D. *Econ. Innov. New Techn.*, *17*(5), 497–510.

Ramos-Vielba, I., Sánchez-Barrioluengo, M., & Woolley, R. (2016). Scientific research groups' cooperation with firms and government agencies: motivations and barriers. *The Journal of Technology Transfer*, *41*, 558-585.

Ranga, M., & Etzkowitz, H. (2012). Great expectations: An innovation solution to the contemporary economic crisis. *European Planning Studies*, 20(9), 1429-1438.

Ranga, M., Perälampi, J., & Kansikas, J. (2016). The new face of university–business cooperation in Finland. *Science and Public Policy*, 43(5), 601-612.

Ranga, M., Temel, S., Ar, I. M., Yesilay, R. B., & Sukan, F. V. (2016). Building technology transfer capacity in Turkish universities: A critical analysis. *European Journal of Education*, 51(1), 90-106.

Rau, H., Goggins, G., & Fahy, F. (2018). From invisibility to impact: Recognising the scientific and societal relevance of interdisciplinary sustainability research. *Research Policy*, 47(1), 266-276.

Rehn, C., Kronman, U., & Wadskog, D. (2007). Bibliometric indicators—definitions and usage at Karolinska Institutet. *Karolinska Institutet*, 13, 2012.

Renault, C. S. (2006). Academic capitalism and university incentives for faculty entrepreneurship. *The Journal of Technology Transfer*, *31*, 227-239.

Rentocchini, F., Manjarrés Henrìquez, L., D'Este, P., & Grimaldi, R. (2011). The effect of academic consulting on research performance: evidence from five Spanish universities. *Pablo and Grimaldi, Rosa, The Effect of Academic Consulting on Research Performance: Evidence from Five Spanish Universities (May 10, 2011).*

Rentocchini, F., D'Este, P., Manjarrés-Henríquez, L., & Grimaldi, R. (2014). The relationship between academic consulting and research performance: Evidence from five Spanish universities. *International Journal of Industrial Organization*, *32*, 70-83.

Rogler, C. R. (2019). Insatiable greed: performance pressure and precarity in the neoliberalised university. *Social Anthropology*, *27*, 63-77.

Romero, F. (2007, August). University-industry relations and technological convergence. *In PICMET'07-2007 Portland International Conference on Management of Engineering & Technology* (pp. 233-240). IEEE.

Rossi, F., De Silva, M., Pavone, P., Rosli, A., & Yip, N. K. (2024). Proximity and impact of university-industry collaborations. A topic detection analysis of impact reports. *Technological Forecasting and Social Change*, 205, 123473.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: a taxonomy of the literature. *Industrial and corporate change*, 16(4), 691-791.

Salmon, K. (2017). A decade of lost growth: Economic policy in Spain through the great recession. *South European Society and Politics*, 22(2), 239-260.

Santoro, M. D., & Gopalakrishnan, S. (2001). Relationship dynamics between university research centers and industrial firms: Their impact on technology transfer activities. *The Journal of Technology Transfer*, 26(1), 163-171.

Sanz-Menéndez, L., & Van Ryzin, G. G. (2015). Economic crisis and public attitudes toward science: A study of regional differences in Spain. *Public Understanding of Science*, *24*(2), 167-182.

Satta, G., Parola, F., Penco, L., & Esposito de Falco, S. (2016). Insights to technological alliances and financial resources as antecedents of high-tech firms' innovative performance. *R&D Management*, 46(S1), 127-144.

Scandura, A., & Iammarino, S. (2022). Academic engagement with industry: the role of research quality and experience. *The Journal of Technology Transfer*, *47*(4), 1000-1036.

Schaeffer, V., Öcalan-Özel, S., & Pénin, J. (2020). The complementarities between formal and informal channels of university–industry knowledge transfer: a longitudinal approach. *The Journal of Technology Transfer*, 45, 31-55.

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.

Schartinger, D., Schibany, A., & Gassler, H. (2001). Interactive relations between universities and firms: empirical evidence for Austria. *The Journal of Technology Transfer*, *26*(3), 255-268.

Schumpeter, J. (1942). Creative destruction. *Capitalism, socialism and democracy*, *825*, 82–85.

Schumpeter, J. A., & Fels, R. (1939). *Business cycles: a theoretical, historical, and statistical analysis of the capitalist process* (Vol. 2, pp. 1958–65). New York: McGraw-Hill.

Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social cognitive theory. *Contemporary educational psychology*, *60*, 101832.

Seale, C. (2004). *Social Research Methods: A Reader*. Psychology Press.

Shah, James Y., and Wendi L. Gardner, eds. *Handbook of motivation science*. Guilford Press, 2008.

Shamir, B. (1990). Calculations, values, and identities: The sources of collectivistic work motivation. *Human relations*, *43*(4), 313-332.

Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small business economics*, *33*(2), 141–149.

Shleifer, A. (1986). Implementation cycles. *Journal of Political Economy*, *94*(6), 1163–1190.

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.

Skute, I., Zalewska-Kurek, K., Hatak, I., & de Weerd-Nederhof, P. (2019). Mapping the field: A bibliometric analysis of the literature on university–industry collaborations. *The Journal of Technology Transfer*, *44*(3), 916–947.

Slaughter, S., & Cantwell, B. (2012). Transatlantic moves to the market: the United States and the European Union. *Higher Education* 63, 583–606. https://doi.org/10.1007/s10734-011-9460-9

Smeenk, S., Teelken, C., Eisinga, R., & Doorewaard, H. (2009). Managerialism, organizational commitment, and quality of job performances among European university employees. *Research in Higher Education*, *50*, 589-607.

Soh, P. H., & Subramanian, A. M. (2014). When do firms benefit from university–industry R&D collaborations? The implications of firm R&D focus on scientific research and technological recombination. *Journal of Business Venturing*, *29*(6), 807–821.

Solarin, S. A., & Yen, Y. Y. (2016). A global analysis of the impact of research output on economic growth. Scientometrics, 108, 855-874.

Stange, K. C., Crabtree, B. F., & Miller, W. L. (2006). Publishing multimethod research. *The Annals of Family Medicine*, 4(4), 292-294.

Steinþórsdóttir, Finnborg S., et al. "New managerialism in the academy: Gender bias and precarity." *Gender, Work & Organization* 26.2 (2019): 124-139. https://doi.org/10.1111/gwao.12286

Stoll, J. D. (2020). Crisis has jump-started America's innovation engine: What took so long. *The Wall Street Journal, April*, 10.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research techniques*. Thousand Oaks, CA: Sage Publications Ltd.

Szücs, F. (2018). Research subsidies, industry–university cooperation and innovation. *Research Policy*, *47*(7), 1256–1266.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in science education*, 48, 1273-1296.

Tartari, V., & Breschi, S. (2012). Set them free: scientists' evaluations of the benefits and costs of university–industry research collaboration. *Industrial and Corporate Change*, *21*(5), 1117-1147.

Tashakkori, A., & Teddlie, C. (2003). Issues and dilemmas in teaching research methods courses in social and behavioural sciences: US perspective. *International journal of social research methodology*, 6(1), 61-77.

Teddlie, C., & Tashakkori, A. (2011). Mixed methods research. *The Sage handbook of qualitative research*, *4*, 285-300.

Testa, G., Szkuta, K., & Cunningham, P. N. (2019). Improving access to finance for young innovative enterprises with growth potential: Evidence of impact of R&D grant schemes on firms' outputs. Research Evaluation, 28(4), 355-369.

Thomas, D. A., Nedeva, M., Tirado, M. M., & Jacob, M. (2020). Changing research on research evaluation: A critical literature review to revisit the agenda. *Research Evaluation*, *29*(3), 275-288.

Thompson, N. C., Ziedonis, A. A., & Mowery, D. C. (2018). University licensing and the flow of scientific knowledge. *Research Policy*, *47*(6), 1060-1069.

Thorn, K. (2005). Science, technology and innovation in Argentina. *A profile of issues and practices*.

Tijssen, R. J. W. (2012). Co-authored research publications and strategic analysis of public-private collaboration. *Research Evaluation*, *21*(3), 204–215.

Tijssen, R. J. W., van Leeuwen, T. N., & van Wijk, E. (2009). Benchmarking university–industry research cooperation worldwide: performance measurements and indicators based on co-authorship data for the world's largest universities. *Research Evaluation*, *18*(1), 13–24.

Torrado, J. M., & Duque-Calvache, R. (2023). University and precariousness: origins and consequences of the labour model of the Spanish Public University in the 21st century. *Educación XX1*, 26(1), 47-69.

Tseng, F. C., Huang, M. H., & Chen, D. Z. (2020). Factors of university–industry collaboration affecting university innovation performance. *The Journal of Technology Transfer*, 45, 560-577.

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In *Advances in experimental social psychology* (Vol. 29, pp. 271-360). Academic Press.

Van Griethuijsen, R. A., van Eijck, M. W., Haste, H., Den Brok, P. J., Skinner, N. C., Mansour, N., ... & BouJaoude, S. (2015). Global patterns in students' views of science and interest in science. *Research in science education*, 45, 581-603.

Vedovello, C. (1997). Science parks and university-industry interaction: geographical proximity between the agents as a driving force. *Technovation*, *17*(9), 491-531.

Vedovello, C. (1998). Firms' R&D activity and intensity and the university–enterprise partnerships. *Technological forecasting and social change*, *58*(3), 215-226.

Vega-Gomez, F. I., & Miranda-Gonzalez, F. J. (2021). Choosing between formal and informal technology transfer channels: determining factors among Spanish academicians. *Sustainability*, 13(5), 2476.

Vega-Jurado, J., Kask, S., & Manjarrés-Henriquez, L. (2017). University industry links and product innovation: cooperate or contract?. *Journal of technology management & innovation*, 12(3), 1-8.

Veugelers, R., & Cassiman, B. (2005). R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization*, *23*(5–6), 355–379.

Vianna, M. T. (2023). Business cycle theories after Keynes: A brief review considering the notions of equilibrium and instability. *Structural Change and Economic Dynamics*, 64, 134-143.

Vick, T. E., & Robertson, M. (2018). A systematic literature review of UK university–industry collaboration for knowledge transfer: A future research agenda. *Science and Public Policy*, *45*(4), 579–590.

Wanzenboeck, I., Scherngell, T., & Brenner, T. (2014). Embeddedness of regions in European knowledge networks: a comparative analysis of inter-regional R&D collaborations, co-patents and co-publications. *The Annals of Regional Science*, 53(2), 337–368.

Wellman, N., Tröster, C., Grimes, M., Roberson, Q., Rink, F., & Gruber, M. (2023). Publishing multimethod research in AMJ: A review and best-practice recommendations. *Academy of Management Journal*, 66(4), 1007-1015.

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.

Whittaker, D. H. (2001). Crisis and Innovation in Japan: A New Future through Technoentrepreneurship? In W. W. Keller & R. J. Samuels (Eds.), *Crisis and Innovation in Asian Technology* (pp. 57–85). Cambridge: Cambridge University Press.

Willson, R., Stewart-Robertson, O., Julien, H., & Given, L. (2022). Academic casualization, precarity, and information practices: A scoping review. *Proceedings of the Association for Information Science and Technology*, *59*(1), 833-836.

World Bank. (2019). *World development indicators*. Retrieved 13 January 2021, from https://data.worldbank.org/country/ES

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.

Yegros-Yegros, A., Rafols, I., & D'este, P. (2015). Does interdisciplinary research lead to higher citation impact? The different effect of proximal and distal interdisciplinarity. *PloS one*, 10(8), e0135095.

Yegros-Yegros, A., Azagra-Caro, J. M., López-Ferrer, M., & Tijssen, R. J. (2016). Do university–industry co-publication outputs correspond with university funding from firms? *Research Evaluation*, 25(2), 136-150.

Yin, R. K. (2013). Validity and generalization in future case study evaluations. *Evaluation*, *19*(3), 321-332.

Zhao, Y., Zhang, Z., Lu, Y., & Ding, M. (2023). Standing in others' shoes: The role of leader prosocial motivation in facilitating employee creativity. *Creativity and Innovation Management*, *32*(1), 58-69.

Appendices

Appendix 3A: Survey script

Canales de interacción entre la universidad y la empresa, ciclos económicos y coproducción de conocimiento

Estimado/a investigador/a:

Le enviamos esta encuesta por ser autor/a de al menos una publicación científica (en este sentido le llamamos investigador/a, aunque esa no sea su ocupación principal). Como habrá tenido ocasión de leer en el correo previo, este estudio se enmarca en un proyecto de investigación apoyado por la Generalitat Valenciana. El proyecto tiene como objetivo principal estudiar los canales de interacción entre la universidad y otros actores sociales durante las distintas fases de los ciclos económicos y sus efectos en la coproducción de conocimiento.

Conocer su opinión y experiencia nos resultará de enorme utilidad para alcanzar dicho objetivo. Su participación es voluntaria, y podrá desistir en cualquier momento, revocando su consentimiento, sin que ello tenga repercusión negativa alguna para usted. Si usted lo desea (y así lo podrá hacer constar al final de la encuesta), se le proporcionará un informe privado, comparando sus respuestas con la media, e información sobre posibles contribuciones académicas.

En cumplimiento de lo establecido en la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales, le garantizamos la confidencialidad de las respuestas y el tratamiento anonimizado de las mismas. Los datos solicitados no incluyen información personal que permitan identificar al encuestado, como nombre, apellidos, números de identificación personal o de teléfono. Los datos serán encriptados desde el momento mismo de su recogida, y se conservarán en el servidor de INGENIO, sin acceso público, con cortafuegos y sistemas de seguridad contra accesos no autorizados. En ningún caso se comunicará o cederá dicha información a terceros. Asimismo, le informamos de la posibilidad que tiene de ejercer los derechos de acceso, rectificación, cancelación y oposición de sus datos de carácter personal mediante escrito dirigido a INGENIO.

El medio empleado para realizar la encuesta será Qualtrics y el tiempo estimado para la realización de la encuesta será de aproximadamente 20 minutos. Puede abandonar la encuesta y retomarla posteriormente en el punto donde la ha dejado. Muchas gracias por su valiosa colaboración.

CONSENTIMIENTO INFORMADO

Declaro que he leído la información anterior en calidad de participante, he contado con tiempo suficiente para ello, se me ha brindado la oportunidad de realizar preguntas, aclarar dudas, y he recibido suficiente información sobre las condiciones de mi participación en esta investigación, por parte de Ana María Gómez y Joaquín M.ª Azagra Caro (Investigador Principal del proyecto). Asimismo, se me ha asegurado el tratamiento confidencial de mis datos.

Doy mi consentimiento para participar en la encuesta sobre canales de interacción, ciclos económicos y coproducción del conocimiento.

Sí
No

A. CARACTERÍSTICAS PROFESIONALES

1. ¿Cuál es su situación laboral actual?

1. Trabaja
2. Emérito/a o ad honorem
3. Jubilado/a
4. No trabaja (anteriormente no ha trabajado)

2. (SI JUBILADO/A). Las siguientes preguntas están redactadas en presente. Por favor, entiéndalas como si usted se encontrara en su anterior situación laboral.

5. De acuerdo, lo he entendido

3. ¿En qué tipo de organización trabaja usted, principalmente (XXX A PARTIR DE AHORA)?

6. Universidad
7. Centro no universitario de educación superior (escuela de negocios, escuela superior de arte, conservatorio superior de música…)
8. Organismo Público de Investigación de la Administración General del Estado (CSIC, ISCIII, CIEMAT, INIA, IEO, IGME, INTA, IAC)
9. Otro organismo de investigación
10. Establecimiento sanitario (centro de salud, hospital…)
11. Empresa
12. Organización sin fines de lucro (movimiento de bases, ONG, fundación, asociación, mutua, cooperativa...)
13. Administración pública (ministerio, consejería, diputación, ayuntamiento...)
14. Otro tipo de organización (especificar)
15. Trabaja por cuenta propia

4. (SI XXX = UNIVERSIDAD, CENTRO NO UNIVERSITARIO, OTRO ORGANISMO DE INVESTIGACIÓN, ESTABLECIMIENTO SANITARIO, EMPRESA, ORGANIZACIÓN SIN FINES DE LUCRO U OTRO TIPO DE ORGANIZACIÓN) ¿Cuál es el régimen de propiedad de su organización?

16. Público
17. Privado
18. Semipúblico/semiprivado

5. ¿En qué campo de conocimiento de la Clasificación UNESCO realiza principalmente sus investigaciones actuales o más recientes?

19. Lógica
20. Matemáticas
21. Astronomía y Astrofísica
22. Física
23. Química
24. Ciencias de la Vida
25. Ciencias de la Tierra y el Espacio
26. Ciencias Agronómicas
27. Ciencias Médicas
28. Ciencias Tecnológicas
29. Antropología
30. Demografía

31. Ciencias Económicas
32. Geografía
33. Historia
34. Ciencias Jurídicas y Derecho
35. Lingüística
36. Pedagogía
37. Ciencia Política
38. Psicología
39. Ciencias de las Artes y las Letras
40. Sociología
41. Ética
42. Filosofía
43. Otro campo de conocimiento (especificar)

6. (SI XXX = EMPRESA) ¿En qué actividad económica se clasifica su organización?

44. Agricultura, ganadería, silvicultura y pesca
45. Industrias extractivas
46. Industria manufacturera
47. Suministro de energía eléctrica, gas, vapor y aire acondicionado
48. Suministro de agua, actividades de saneamiento, gestión de residuos y descontaminación
49. Construcción
50. Comercio al por mayor y al por menor; reparación de vehículos de motor y motocicletas
51. Transporte y almacenamiento
52. Hostelería
53. Información y comunicaciones
54. Actividades financieras y de seguros
55. Actividades inmobiliarias
56. Actividades profesionales, científicas y técnicas
57. Actividades administrativas y servicios auxiliares
58. Administración pública y defensa; seguridad social obligatoria
59. Educación
60. Actividades sanitarias y de servicios sociales
61. Actividades artísticas, recreativas y de entretenimiento
62. Otros servicios
63. Actividades de los hogares como empleadores de personal doméstico; actividades de los hogares como productores de bienes y servicios para uso propio

7. (SI XXX = ESTABLECIMIENTO SANITARIO) ¿De qué tipo de establecimiento sanitario se trata?

64. Hospital universitario
65. Hospital no universitario
66. Centro de salud
67. Otro tipo de establecimiento sanitario (especificar)

8. ¿En qué país se encuentra su organización (donde va usted a trabajar)?

68. España
69. Otro país de la Unión Europea
70. Un país no perteneciente a la Unión Europea

9. (SI PAÍS = ESPAÑA) ¿En qué comunidad o ciudad autónoma se encuentra situada su organización (donde va usted a trabajar)?

71. Andalucía	
72. Aragón	
73. Asturias	
74. Baleares	
75. Canarias	
76. Cantabria	
77. Castilla y León	
78. Castilla-La Mancha	
79. Cataluña	
80. Comunidad Valenciana	
81. Extremadura	
82. Galicia	
83. La Rioja	
84. Madrid	
85. Murcia	
86. Navarra	
87. País Vasco	
88. Ceuta	
89. Melilla	

10. ¿En qué año empezó a trabajar usted en este tipo de organización (XXX), aunque fuera una organización distinta de la actual? (AÑO 000 A PARTIR DE AHORA)

90. Año de inicio	

11. ¿Cuál es su categoría profesional actual? (MOSTRAR SOLO LAS OPCIONES QUE TENGAN SENTIDO A RAÍZ DE LA RESPUESTA A LA PREGUNTA 3).
(SI XXX=UNIVERSIDAD, CNUES, OPI-AGE O ESTABLECIMIENTO SANITARIO)

91. Categoría	□
92. Catedrático/a contratado/a o laboral	□
93. Catedrático/a de escuela universitaria	□
94. Catedrático/a de universidad	□
95. Profesor/a adjunto/a	□
96. Profesor/a agregado/a	□
97. Profesor/a asociado/a	□
98. Profesor/a ayudante doctor/a	□
99. Profesor/a ayudante no doctor/a	□
100. Profesor/a colaborador/a de universidad	□
101. Profesor/a contratado/a doctor/a	□
102. Profesor/a de universidad privada	□
103. Profesor/a lector/a	□
104. Profesor/a pleno/a	□
105. Profesor/a titular de escuela universitaria	□
106. Profesor/a titular de universidad	□
107. Científico/a titular	□
108. Investigador/a científico/a	□
109. Investigador/a distinguido/a	□
110. Profesor/a de investigación	□

111. Profesor/a de investigación ICREA	□
112. Profesor/a de investigación IKERBASQUE	□
113. Colaborador/a docente	□
114. Facultativo/a	□
115. Personal no facultativo (excluye personal de administración y servicios)	□
116. Doctorando/a	□
117. Investigador/a posdoctoral contratado con fondos públicos (Juan de la Cierva, Ramón y Cajal, Marie Curie, con cargo a proyecto, etc.)	□
118. Investigador/a contratado/a con fondos privados (de universidad privada o centro privado de investigación)	□
119. Personal de administración y servicios	□
120. Profesor/a visitante	□
121. Técnico/a medio/a de investigación	□
122. Técnico/a superior de investigación	□

(SI XXX<>UNIVERSIDAD, CNUES, OPI-AGE O ESTABLECIMIENTO SANITARIO)

123. Respuesta libre

12. ¿Desde qué año disfruta de su categoría profesional actual?

124. Año de inicio

B. INTERACCIÓN CON EL ENTORNO EN FASES DE AUGE Y DECLIVE DE LA ECONOMÍA

13. ¿A qué tipos de organización distintos del suyo pertenecen las personas con las que usted ha interactuado en materia de investigación* desde que empezó a trabajar en XXX, en 000? (YYY A PARTIR DE AHORA; EXCLUIR EL SUYO PROPIO)

** Por interacción en materia de investigación, entendemos el uso de canales de interacción como contratos, convenios, proyectos colaborativos, licencias de derechos de propiedad intelectual, creación de spin-off, etc.*

125. Universidad
126. Centro no universitario de educación superior
127. Organismo Público de Investigación de la Administración General del Estado
128. Otro organismo de investigación
129. Establecimiento sanitario (centro de salud, hospital…)
130. Empresa
131. Organización sin fines de lucro (movimiento de bases, ONG, fundación, asociación, mutua, cooperativa...)
132. Administración pública (ministerio, consejería, diputación, ayuntamiento...)
133. Otro tipo de organización (especificar)
134. Ninguno

(NOTA: SI ESCOGE “NINGUNO” SALTAR A LA SECCIÓN E)

14. De entre los tipos de organización escogidos, ¿a cuáles pertenecen las personas con las que usted ha interactuado a lo largo de los siguientes periodos? (SOLO TIPOS ESCOGIDOS EN LA ANTERIOR PREGUNTA; PRIMER AÑO DEL PERIODO: 000; SOLO COLUMNAS DESDE ESE AÑO. SI EL PRIMER INTERVALO NO ESTÁ COMPLETO, NO PASA NADA)

Tipos de organización	Periodo de auge antes de la Gran Recesión (2004-2007)	Durante la Gran Recesión (2008-2014)	Periodo de auge entre la Gran Recesión y la Recesión por la pandemia de COVID-19 (2015-2019)	Durante la Recesión por la pandemia de COVID-19 (2020)	Periodo de auge tras la Recesión por la pandemia de COVID-19 (2021-hoy)
135. Universidad	□	□	□	□	□
136. Centro no universitario de educación superior	□	□	□	□	□
137. Organismo Público de Investigación de la Administración General del Estado	□	□	□	□	□
138. Otro organismo de investigación	□	□	□	□	□
139. Establecimiento sanitario (centro de salud, hospital…)	□	□	□	□	□
140. Empresa	□	□	□	□	□
141. Organización sin fines de lucro (movimiento de bases, ONG, fundación, asociación, mutua, cooperativa...)	□	□	□	□	□
142. Administración pública (ministerio, consejería, diputación, ayuntamiento...)	□	□	□	□	□
143. Otro tipo de organización (especificar)	□	□	□	□	□
144. Ninguno	□	□	□	□	□

(NOTA: SI ESCOGE “NINGUNO”, SALTAR A LA SECCIÓN F)

15. (SI HA INTERACTUADO EL MÁXIMO NÚMERO DE PERIODOS CON MÁS DE UNA ORGANIZACIÓN). Si ha seleccionado un solo tipo de organización, por favor, confirme su elección. Si ha seleccionado más de un tipo de organización, escoja aquel con el que haya interactuado más tiempo, o el más importante para usted.

145. Repetir listado de escogidos

16. ¿Qué canales de interacción con YYY ha utilizado desde 000?

Canales de interacción	
146. Participación en proyectos de investigación conjuntos, concedidos mediante convocatorias públicas	□
147. Creación de empresas “spin-off”	□
148. Dirección de tesis industriales o empresariales	□
149. Prestación de servicios técnicos o de asesoramiento	□
150. Asistencia técnica y trabajo compartido en laboratorios vivientes o espacios comunes de investigación	□
151. Licencia de patentes u otras formas de protección de la propiedad industrial o intelectual	□
152. Participación en contratos o convenios de investigación	□
153. Creación de centros conjuntos de investigación	□
154. Contrato de acuerdo de transferencia de material de investigación tangible	□
155. Asistencia o ponencia en conferencias	□
156. Asesoramiento externo en respuesta a consultas puntuales (ocasional)	□
157. Participación en redes profesionales no exclusivamente académicas (asociaciones, iniciativas mixtas)	□
158. Participación en actividades docentes (presentaciones, charlas ocasionales)	□
159. Actividades no académicas de difusión de conocimiento (ferias, jornadas, exposiciones)	□
160. Otros canales (especificar)	□

(NOTA: SI ESCOGE “NINGUNO”, SALTAR A LA SECCIÓN F)

17. ¿Qué canales de interacción con YYY ha utilizado a lo largo de los siguientes periodos? (SOLO EL TIPO DE ORGANIZACIÓN CON EL QUE HA ACTUADO MÁS PERIODOS, O EL ESCOGIDO EN LA PREGUNTA 7; SOLO PERIODOS EN LOS QUE HA INTERACTUADO; PRIMER AÑO DEL PERIODO: 000; SOLO COLUMNAS DESDE ESE AÑO. SI EL PRIMER INTERVALO NO ESTÁ COMPLETO, NO PASA NADA)

Canales de interacción	Periodo de auge antes de la Gran Recesión (2004-2007)	Durante la Gran Recesión (2008-2014)	Periodo de auge entre la Gran Recesión y la Recesión por la pandemia de COVID-19 (2015-2019)	Durante la Recesión por la pandemia de COVID-19 (2020)	Periodo de auge tras la Recesión por la pandemia de COVID-19 (2021-hoy)
161. Canal 1-W1	□	□	□	□	□

18. En una escala de 1 a 7, donde 1 es poco importante y 7 es muy importante, ¿cuál es el grado de importancia que usted le concede a los siguientes canales de interacción con YYY para mejorar el impacto científico de su investigación (SOLO CANALES QUE HA USADO)?

Canales de interacción	**1**	**2**	**3**	**4**	**5**	**6**	**7**
162. Canal 1-W1	□	□	□	□	□	□	□

19. ¿Podría indicar en qué períodos se han dado en mayor medida las siguientes situaciones? (PRIMER AÑO DEL PERIODO: 000; SOLO COLUMNAS DESDE ESE AÑO. SI EL PRIMER INTERVALO NO ESTÁ COMPLETO, NO PASA NADA)

	En periodos de crisis más que en periodos de auge	En periodos de auge más que en periodos de crisis	En periodos de crisis y de auge por igual	No sé
163. Las YYY se ha apoyado en las ideas científicas que han surgido de XXX	□	□	□	□
164. Las XXX han tenido voluntad de interactuar en materia de investigación con YYY	□	□	□	□
165. Las administraciones públicas han fomentado las interacciones en materia de investigación de XXX con YYY mediante subvenciones de I+D+i	□	□	□	□

C. INTERACCIÓN CON EL ENTORNO Y COPUBLICACION CIENTÍFICA

20. ¿Ha publicado usted artículos científicos con autores de YYY?

166. Sí
167. No

21. (SI RESPONDE “SI” EN LA PREGUNTA 20 ENTRESACAR AUTOMÁTICAMENTE LOS CANALES ELEGIDOS EN LAS PREGUNTAS 17 y 18. ¿En qué medida los canales de interacción que usted ha usado han contribuido a copublicar artículos científicos con YYY?

	Nada	Poco	Algo	Bastante	Mucho
168. Canal 1-W1	□	□	□	□	□

22. (SI RESPONDE QUE “SI” EN LA PREGUNTA 20; Y SI RESPONDE MÁS QUE “NADA”, ENTRESACAR AUTOMÁTICAMENTE LOS CANALES ELEGIDOS EN LA PREGUNTA 15) ¿En qué medida los canales de interacción que usted ha usado han contribuido al impacto científico de sus copublicaciones con YYY?

	Nada	Poco	Algo	Bastante	Mucho
169. Canal 1-W1	□	□	□	□	

23. ¿En qué medida considera usted importante la copublicación de los resultados de sus investigaciones con ese tipo de organización (YYY) para su promoción profesional?

	Nada importante	Poco importante	Algo importante	Bastante importante	Muy importante
170.	□	□	□	□	□

24. ¿Podría indicar cómo influyen los siguientes factores en la decisión de copublicar artículos científicos con YYY?

	Muy negativamente	Negativamente	De forma neutra	Positivamente	Muy positivamente
171. Confianza en la persona investigadora de YYY	□	□	□	□	□
172. Novedad en las metodologías utilizadas por la persona investigadora de YYY	□	□	□	□	□
173. Reputación de la persona investigadora de YYY	□	□	□	□	□
174. Reputación de la organización a la que pertenece la persona investigadora de YYY	□	□	□	□	□
175. Contar con estudiantes de doctorado y posdoctorado contratados a cargo de YYY	□	□	□	□	□
176. Que la proyección de la colaboración sea de corta duración (menor o igual a 2 años)	□	□	□	□	□
177. Que la proyección de la colaboración sea de larga duración (de más de 2 años)	□	□	□	□	□

25. ¿Cómo cree que influyen los siguientes factores en el **impacto científico*** de las copublicaciones realizadas con YYY?

** Por impacto científico, entendemos la repercusión sobre la carrera profesional, la reputación entre los colegas y pares científicos, el número de citas recibidas por las copublicaciones, el factor de impacto de las revistas en que han sido publicadas, etc.*

	Muy negativamente	Negativamente	De forma neutra	Positivamente	Muy positivamente
178. Profundidad en la temática	□	□	□	□	□
179. Novedad en la temática	□	□	□	□	□
180. Riesgo para abordar ideas rompedoras en la investigación	□	□	□	□	□
181. Tiempo para dedicar a la publicación	□	□	□	□	□
182. Recursos económicos y materiales disponibles para desarrollar la investigación	□	□	□	□	□
183. Libertad para publicar los resultados	□	□	□	□	□
184. Recursos para publicar el artículo en una revista en acceso abierto	□	□	□	□	□
185. Que la proyección de la colaboración sea de corta duración (menor o igual a 2 años)	□	□	□	□	□
186. Que la proyección de la colaboración sea de larga duración (de más de 2 años)	□	□	□	□	□

26. ¿Considera que la copublicación de artículos científicos con YYY al finalizar una investigación puede indicar que la colaboración, a nivel científico es:

Muy fallida	Fallida	Ni exitosa ni fallida	Exitosa	Muy exitosa
□	□	□	□	□

D. COPUBLICACIÓN DE ARTÍCULOS CIENTÍFICOS CON COAUTORES DE YYY (SOLO SI XXX=Universidad o empresa y YYY=Empresa o universidad)

27. Usted es autor de la siguiente o siguientes copublicaciones entre XXX y YYY:

187. ZZZ1…ZZZN

28. (SI N>2) Por favor, de entre todas esas copublicaciones, elija la que a su juicio ha contribuido de manera más significativa al conocimiento (ZZZR)

188. Repetir listado

29. Para desarrollar esta copublicación (ZZZR), ¿podría indicar qué canales de interacción **usó**?

189. Participación en proyectos conjuntos, concedidos mediante convocatorias públicas
190. Creación de empresas “spin-off”
191. Dirección de tesis industriales o empresariales
192. Prestación de servicios técnicos o de asesoramiento
193. Asistencia técnica y trabajo compartido en laboratorios vivientes o espacios comunes de investigación
194. Licencia de patentes u otras formas de protección de la propiedad industrial o intelectual
195. Participación en contratos o convenios de investigación
196. Creación de centros conjuntos de investigación
197. Contrato de acuerdo de transferencia de material de investigación tangible
198. Asistencia o ponencia en conferencias
199. Asesoramiento externo en respuesta a consultas puntuales (ocasional)
200. Participación en redes profesionales no exclusivamente académicas (asociaciones, iniciativas mixtas)
201. Participación en actividades docentes (presentaciones, charlas ocasionales)
202. Actividades no académicas de difusión de conocimiento (ferias, jornadas, exposiciones)
203. Otras actividades (especificar)

30. Para desarrollar esta copublicación (ZZZR), ¿cuál fue la fuente de financiación principal?

204. Financiación institucional
205. Financiación pública regional
206. Financiación pública nacional
207. Financiación pública de la Unión Europea
208. Otra financiación pública internacional
209. Financiación privada con fines comerciales (p.ej. de empresas)
210. Financiación privada sin ánimo de lucro (p.ej. de fundaciones y organizaciones no gubernamentales)
211. Autofinanciación

31. (SI RESPONDE “Financiación pública nacional” o “Financiación pública de la UE”) Por favor, ¿podría especificar cuál fue el programa de financiación?

E. PERFIL DE LA PERSONA ENTREVISTADA

Para terminar, le agradeceríamos que nos pudiera facilitar información sociodemográfica y, en un solo caso, psicológica, sobre usted, de interés solo a efectos estadísticos y con fines académicos.

32. Año de nacimiento:

212. Año

33. Sexo:

213. Masculino
214. Femenino
215. Intersexual
216. Prefiero no contestar

34. Nacionalidad:

217. Española
218. Española y otra
219. Otra

35. (SI NACIONALIDAD <> ESPAÑOLA) ¿Con cuál de estas áreas geográficas se corresponde la nacionalidad no española?

220. Europea no española
221. Africana
222. Norteamericana
223. Sudamericana
224. Asiática
225. Oceánica

36. Lengua materna:

226.	Española
227.	Española y otra
228.	Otra

37. (SI LENGUA<>ESPAÑOLA) ¿Qué otra lengua materna posee usted (si es de más de una, por favor escoja la que usted considere)?

229.	Lista desplegable de lenguas https://es.wikipedia.org/wiki/ISO_639-1
230.	(añado también “valenciano” de forma exenta)

38. ¿Dispone de título de doctor/a?

231.	Sí
232.	No

39. Número de menores de 18 años a su cargo:

233.	Número de menores (no desplegable)

40. Cuando se habla de política se utilizan normalmente las expresiones “izquierda” y “derecha”. En este eje hay una serie de valores que van de izquierda a derecha. ¿En qué valor del eje se colocaría usted?

234.	Ida. 1…10 Dcha.
235.	Prefiero no decirlo

41. ¿De qué manera cree usted que afronta las situaciones?

	Totalmente en desacuerdo	Algo en desacuerdo	Ni de acuerdo ni en desacuerdo	Algo de acuerdo	Totalmente de acuerdo
236. Cuando tengo problemas, cuento con personas que me pueden ayudar	□	□	□	□	□
237. Mi familia y amigos/as son un gran apoyo para mí	□	□	□	□	□
238. En situaciones difíciles, puedo gestionar mis emociones	□	□	□	□	□
239. Puedo dominar mis emociones negativas	□	□	□	□	□
240. Cuando me enfrento a un problema por lo general puedo encontrar una solución	□	□	□	□	□
241. Cuando tengo un problema, conozco a personas que serán capaces de ayudarme	□	□	□	□	□
242. Generalmente puedo resolver los problemas que ocurren	□	□	□	□	□
243. Puedo controlar mis emociones	□	□	□	□	□
244. Normalmente puedo encontrar la forma de superar los problemas	□	□	□	□	□
245. Puedo encontrar familiares y amigos/as que me atiendan cuando los necesite	□	□	□	□	□
246. Cuando tengo un problema, puedo encontrar la manera de solucionarlo	□	□	□	□	□
247. Puedo manejar mis emociones	□	□	□	□	□

RETROALIMENTACIÓN

42. ¿Le gustaría recibir información sobre los resultados de este estudio?

248. Sí
249. No

43. Para recibir la información de resultados del estudio, introduzca su dirección de correo electrónico para recibir información.

250. Correo electrónico

(NOTA: Esta respuesta se codificará y encriptará de modo que no se relacione el correo electrónico con el resto de respuestas del cuestionario)

44. Si desea realizar algún comentario sobre este cuestionario, por favor escríbalo a continuación.

251. Comentario

Appendix 3B: Ethics approval letter

MINISTERIO
DE CIENCIA
E INNOVACIÓN

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

COMITÉ DE ÉTICA

INFORME DE EVALUACIÓN BIOÉTICA/BIOSEGURIDAD

Evaluados los aspectos bioéticos de la investigación propuesta (Investigación con la participación de seres humanos, el manejo de sus muestras y/o datos que requieren protección) y, según los términos definidos en el proyecto, el Comité de Ética del CSIC declara que no existen objeciones que puedan constituir impedimento alguno para su desarrollo.

Para que conste a los efectos oportunos, se expide el presente informe de evaluación en Madrid, a veintinueve de abril de dos mil veintidós.

Datos del Investigador principal

Nombre	AZAGRA CARO, JOAQUÍN MARÍA
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Datos de la Investigación propuesta

Título	"Encuesta sobre canales de interacción entre la universidad y la empresa, ciclos económicos y coproducción de conocimiento", contemplada en el proyecto titulado "La calidad de la coproducción de conocimiento de las empresas y la sociedad con las universidades: la Gran Recesión y la Recesión por COVID-19"
Convocatoria	Generalitat Valenciana – Subvenciones para grupos de investigación consolidados
Referencia	AICO/2021/021

Evaluación

FAVORABLE
Código interno: 077/2022

CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS * COMITÉ DE ÉTICA CSIC

Víctor Ramón Velasco Rodríguez
Presidente del Comité de Ética del CSIC

Este informe solo tiene validez para la investigación propuesta y en las condiciones en ella descritas. Cualquier cambio que afecte a las implicaciones bioéticas y/o de bioseguridad de la misma, invalida este informe y deberá ser puesto en conocimiento del Comité de Ética del CSIC para su valoración.

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Appendix 4A: Informed consent

Consentimiento Informado del Participante

Impreso CEI_UPV_A1

Yo, ……. en adelante, la Participante habiendo sido suficientemente informado/a por Dª-Nombre Ana María Gómez Aguayo, declaro haber sido informado sobre:
a) los objetivos del Proyecto de investigación:" Los resultados de la investigación universidad-empresa y la crisis económica código CSO2016-79045-C2-2-R", que se realiza en el Instituto, INGENIO CSIC-UPV, así como de la tecnología y metodología a utilizar en el mismo.
b) de las tareas a realizar por el Participante y condiciones de las mismas.
c) del uso que se le va a dar a la información obtenida mediante la colaboración del Participante.
d) de que los datos obtenidos serán tratados y custodiados con respeto a la intimidad del Participante, de forma anónima y confidencial y acorde a la vigente normativa de protección de datos, en concreto, conforme al Reglamento (UE) 2016/679 del Parlamento Europeo y del Consejo, de 27 de abril de 2016, relativo a la protección de las personas físicas en lo que respecta al tratamiento de datos personales y a la libre circulación de estos datos.
e) de que sobre estos datos me asisten los derechos de acceso, rectificación, cancelación y oposición que podré ejercitar mediante solicitud ante el investigador responsable en la dirección de contacto que figura en este documento, sin que ello afecte a la licitud del tratamiento basado en el consentimiento previo a su retirada.
f) los datos personales obtenidos en el estudio objeto del proyecto no serán empleados en otros estudios diferentes. La gestión de datos es anónima y los datos serán destruidos tras la extracción de resultados y conclusiones, es decir, que estos datos no podrán ser cedidos sin mi consentimiento expreso y no lo otorgo en este acto.
g) que me asiste el derecho a presentar una reclamación sobre el uso de estos datos, ante una autoridad de control.

Declaro, que mi participación es totalmente voluntaria.

Declaro, además, que he leído y conozco el contenido del presente documento, comprendo los compromisos que asumo y los acepto expresamente. Por ello, firmo este consentimiento informado, por duplicado, de forma voluntaria para manifestar mi deseo de participar en este estudio relacionado con el Proyecto de investigación.

Al firmar este consentimiento no renuncio a ninguno de mis derechos. Recibiré una copia de este consentimiento para guardarlo y poder consultarlo en el futuro.

Firma del participante:	Fecha:

En caso de utilizar necesariamente datos personales y no estar éstos anonimizados:
Datos de contacto del delegado de protección de datos de la UPV:
Email: dpd@upv.es
Dirección: Secretaría General, Universitat Politécnica de València, Camí de Vera, s/n. - 46022-València.

Plazo de conservación de los datos: 18 meses.

El Participante tiene derecho a solicitar al responsable del tratamiento el acceso a los datos personales relativos al interesado, y su rectificación o supresión, o la limitación de su tratamiento, o a oponerse al tratamiento, así como el derecho a la portabilidad de los datos.

Firma del investigador	Fecha:

Appendix 4B: Interview guide

Date:

Gender: M/F

ID interviewee:

1 General

1.1 Current role in the organisation?

1.2 Seniority and position in the university (in status)

1.3 Experience in University - Industry collaboration (in years)

2 Motivations

2.2 Could you tell me about your relationships with companies throughout your career, and if they have changed over time?

2.3 Who took the first step in the collaboration, what motivated you at the very beginning?

2.4 Could you tell me how your research with companies has evolved over the course of those collaborations, and whether it has changed over time, with a focus on 2000-2019?

2.5 Does the search for funding play a role in defining the scope of your research with business?

2.6 I would like to ask you about the quality of the research output with companies, how they evolved over the course of your career, and has it changed over time?

2.7 I would like to ask you about the co-creation of knowledge (scientific papers production) with companies, how they evolved over the course of your career, and has it changed over time?

3 Research team

3.1 How is the team set up to develop collaborations with companies?

3.2 What benefits do the research team and staff derive from collaborations with companies?

3.3 What motivates you now to seek and continue those collaborations nowadays?