UNIVERSITY-BUSINESS COOPERATION:

A LOOK AT THE ORGANISATIONAL CONTEXT-RELATED FACTORS THAT SHAPE COOPERATION ACTIVITIES IN BASQUE MANUFACTURING SMES

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Statement of originality

Hereby I, María Vivar Simón, declare that this PhD thesis is original, the result of my personal work, and that it has not been previously submitted to obtain another professional title or qualification. All ideas, formulations, images, illustrations taken from external sources have been duly cited and referenced.

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Lorpen bat, izatez, nahiak batzearen emaitza da.

Un logro es siempre, de forma natural, una suma de voluntades.

Any achievement is always, naturally,a sum of intentions.

-José María Arizmendiarrieta-

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Abstract

The importance acquired by university-business cooperation (UBC) in R&D and innovation policies (Vick and Robertson, 2018) has led to the vast majority of the literature on UBC being analysed from this perspective (e.g. Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Rosendo-Ríos, Ghauri and Zhang, 2016; Santos *et al.*, 2020). However, cooperation between universities and business is manifest in a wide range of activities in relation to the three missions of the university: education, research and entrepreneurship (Galán-Muros and Plewa, 2016). For this reason, the almost exclusive focus of the literature on UBC towards R&D has biased existing knowledge about the organisational context-related factors that determine it. This limitation calls for the development of empirical studies that analyse UBC from a holistic perspective.

In order to address this research gap, this quantitative study identifies and explores the organisational factors that (i) differentiate cooperating from non-cooperating manufacturing SMEs, (ii) determine the likelihood of manufacturing SMEs' cooperation universities, and (iii) determine the levels of cooperation in different UBC activities.

Applying a questionnaire to a sample of 332 manufacturing SMEs located in the Autonomous Community of the Basque Country, the impact is analysed of organisational context-related factors – general business characteristics, business openness, R&D, lifelong learning, absorptive capacity (AC), innovation, and UBC willingness and support – on 14 types of UBC activities, identified and classified in the fields of education, research, valorisation and management (Davey *et al.*, 2018).

Specifically, the study analyses the following UBC activities: (i) education: student mobility, curriculum co-design and co-delivery, dual education and lifelong learning; (ii) research: joint R&D, consultancy and staff mobility; (iii) valorisation: commercialisation of R&D results, academic entrepreneurship and student entrepreneurship; and (iv) management: governance, shared resources and support.

Due to the key role of AC, both in the literature on UBC and in the various fields related to knowledge and technology transfer (Cohen and Levinthal, 1990; Zahra and George, 2002; Jansen, Van Den Bosch and Volberda, 2005; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018), the study places special emphasis on clarifying the role of AC in the various UBC activities.

The data obtained has been analysed using several different statistical techniques, including logistic regression models, linear regression models and structural equation models.

The organisational context-related factors that determine both the probability and the levels of cooperation in the various UBC activities differ, with the importance of both the relationship aspects and the knowledge base and cognitive proximity of the companies to the university being noteworthy.

Key words: University-Business Cooperation, Knowledge and technology transfer, Absorptive capacity, Small and medium-sized enterprises, Manufacturing industry

Resumen

La importancia adquirida por la cooperación universidad-empresa (CUE) en las políticas de I+D e innovación (Vick and Robertson, 2018) ha influido en que la gran mayoría de la literatura acerca de la CUE haya sido analizada desde esta perspectiva (p. ej. Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Rosendo-Ríos, Ghauri and Zhang, 2016; Santos *et al.*, 2020). Sin embargo, la cooperación entre las universidades y las empresas se hace patente en un amplio abanico de actividades en relación a las tres misiones de la universidad; la educación, la investigación y el emprendimiento (Galán-Muros and Plewa, 2016). Por esta razón, el enfoque casi exclusivo de la literatura de la CUE hacia la I+D ha sesgado el conocimiento existente acerca de los factores organizacionales que la determinan. Esta limitación hace una llamada al desarrollo de estudios empíricos que analicen la CUE desde una perspectiva holística.

Con la finalidad de responder a este vacío de investigación, el presente estudio cuantitativo identifica y explora los factores organizacionales que (i) diferencian a las pymes manufactureras cooperantes de las no cooperantes, (ii) determinan la probabilidad de cooperación de las pymes manufactureras con la universidad, y (iii) determinan los niveles de cooperación en las distintas actividades de cooperación. Tras la aplicación de un cuestionario a una muestra de 332 pymes manufactureras ubicadas en la Comunidad Autónoma del País Vasco, se analiza el impacto de los factores organizacionales relacionados con las características generales de la empresa, su apertura al conocimiento externo, la I+D, la formación continua, su capacidad de absorción (CA), la innovación, y su predisposición y apoyo a la CUE, en 14 tipos de actividades de cooperación, identificadas y clasificadas en los ámbitos de la educación, la investigación, la valorización y la gestión (Davey *et al.*, 2018). Concretamente, el estudio analiza las siguientes actividades de cooperación (i) educación: movilidad de estudiantes, codiseño y coimpartición del curriculum universitario, participación en programas de formación dual y formación continua, (ii) investigación: desarrollo conjunto de proyectos de I+D, consultoría y movilidad de personal, (iii) valorización: comercialización de resultados de I+D, emprendimiento académico y emprendimiento estudiantil, y (iv) gestión: participación en gobernanza, disposición de recursos compartidos y patrocinios.

Debido al rol clave de la CA, tanto en la literatura de la CUE como en diversos campos relacionados con la transferencia del conocimiento y de la tecnología (Cohen and Levinthal, 1990; Zahra and George, 2002; Jansen, Van Den Bosch and Volberda, 2005; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018), el estudio hace especial hincapié en esclarecer el papel de la CA en las diversas actividades de cooperación en función de su operacionalización.

Los datos obtenidos han sido analizados mediante diversas técnicas estadísticas, entre las que se incluyen modelos de regresión logística, modelos de regresión lineal y modelos de ecuaciones estructurales.

Como resultado del presente estudio se observa que los factores organizacionales que determinan tanto la probabilidad como los niveles de cooperación en las diversas actividades varían, siendo destacable la importancia que adoptan tanto los aspectos relaciones como la base de conocimiento y la cercanía cognitiva de las empresas respecto a la universidad.

Palabras clave: Cooperación Universidad-Empresa, Transferencia de conocimiento y de tecnología; Capacidad de absorción, Pequeña y mediana empresa; Industria manufacturera

Laburpena

I+Gko eta berrikuntzako politiketan unibertsitateen eta enpresen arteko lankidetzak (UEL) hartu duen garrantziak (Vick and Robertson, 2018) eragin du UELari buruz idatzi den gehiena ikuspegi horretatik aztertu izana (adibidez, Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Rosendo-Ríos, Ghauri and Zhang, 2016; Santos *et al.*, 2020). Hala ere, unibertsitateen eta enpresen arteko lankidetza agerian geratzen da unibertsitatearen hiru misioei -hezkuntza, ikerketa eta ekintzailetza- lotutako jarduera sorta zabal batean (Galán-Muros and Plewa, 2016). Horregatik, UELari buruzko literaturak fokua ia modu esklusiboan I+Gan jarri izanak egin du lankidetza hori baldintzatzen duten antolaketa faktoreei buruzko ezagutza arlo horretara lerratua egotea. Mugapen hori dela eta, beharrezkotzat jotzen da UELa ikuspegi holistikotik aztertuko duten azterketa enpirikoak garatzea.

Ikerketa hutsune horri erantzuteko, azterlan kuantitatibo honekin jakin dezakegu zer antolaketa faktore diren (i) manufakturako ETE kooperanteak eta ez-kooperanteak bereizten dituztenak, (ii) manufaktura-ETEek unibertsitatearekin lankidetzan aritzeko duten probabilitatea zehazten dutenak, eta (iii) lankidetza jardueretako lankidetza mailak zehazten dituztenak, faktore horiek identifikatu eta aztertzen dituelako. Euskal Autonomia Erkidegoan dauden manufakturako ETE-en lagin bati (332 ETE) galdetegi bat aplikatu ondoren, aztertu da zer inpaktu duten enpresaren ezaugarri orokorrekin, kanpoko ezagutzara irekitzearekin, I+G arloarekin, etengabeko prestakuntzarekin, xurgatzeko gaitasunarekin, berrikuntzarekin eta UELarekiko jarrera eta laguntzarekin lotura duten antolaketa faktoreek hezkuntzaren, ikerketaren, balorizazioaren eta kudeaketaren esparruetan identifikatutako eta sailkatutako 14 lankidetza jardueratan (Davey *et al.*, 2018). Zehazki, azterlanak honako lankidetza jarduera hauek aztertzen ditu: (i) hezkuntzan: ikasleen mugikortasuna, unibertsitateko curriculuma lankidetzan diseinatzea eta lankidetzan irakastea, prestakuntza dualeko eta etengabeko prestakuntzako programetan parte hartzea, (ii) ikerketan: I+Gko proiektuak batera garatzea, aholkularitza eta langileen mugikortasuna, (iii) balorizazioan: I+Gko emaitzen merkaturatzea, ekintzailetza akademikoa eta ikasleen ekintzailetza, eta (iv) kudeaketan: gobernantzan parte hartzea, partekatutako baliabideak izatea eta babesak.

Xurgatzeko gaitasunak UELaren literaturan zein ezagutzaren eta teknologiaren transferentziarekin lotura duten hainbat eremurekin duen funtsezko zeregina dela eta (Cohen and Levinthal, 1990; Zahra and George, 2002; Jansen, Van Den Bosch and Volberda, 2005; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018), ikerketak bereziki azpimarratzen du argitu beharra dagoela xurgatzeko gaitasunak lankidetza jarduera guztietan duen zeregina, operazional izateko duten ahalmenaren arabera.

Lortutako datuak hainbat teknika estatistikoren bidez aztertu dira; besteak beste, erregresio logistikoko ereduak, erregresio linealeko ereduak eta ekuazio estrukturalen ereduak.

Azterlan honen ondorioz, jardueretako lankidetza probabilitatea eta lankidetza mailak zehazten dituzten antolaketa faktoreak aldatu egiten dira, eta nabarmentzekoa da harremanek, ezagutza oinarriak eta enpresek unibertsitatearekiko duten hurbiltasun kognitiboak hartzen duten garrantzia.

Hitz gakoak: Unibertsitatearen eta enpresaren arteko lankidetza, Ezagutzaren eta teknologiaren transferentzia; Xurgatzeko gaitasuna, Enpresa txiki eta ertaina; Manufakturako industria

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Glossary of acronyms

AC: Absorptive Capacity

AVE: Average Variance Extracted

CFA: Confirmatory Factor Analysis

CFI: Comparative Fit Index

CNAE: National Classification of Economic Activities

CR: Composite Reliability

EFA: Exploratory Factor Analysis

GDP: Gross Domestic Product

GFI: Goodness of Fit

GVA: Gross Value Added

HEI: Higher Education Institution

IC: Innovation Capacity

ICT: Information and Communication Technologies

ID: Innovation Degree

IP: Intellectual Property

LLL: Lifelong Learning

LMT: Low-medium Technological Industries

LR: Likelihood Ratio

NIH: “Not invented here”

NUTS: Nomenclature of Territorial Units for Statistics

OECD: Organisation for Economic Co-operation and Development

OR: Odds Ratio

PAC: Potential Absorptive Capacity

RAC: Realised Absorptive Capacity

RBV: Resource-based View

RMSEA: Root Mean-Square Error of Approximation

RTO: Research Transfer Office

R&D: Research and Development

SDB: Social Desirability Bias

SEM: Structural Equation Modelling

SME: Small and Medium-sized Enterprise

TLI: Tucker-Lewis Index

TTO: Technology Transfer Office

UBC: University-Business Cooperation

VIF: Variance Inflation Factors

WIL: Work Integrated Learning

Chapter 1

Introduction

1. Introduction

1.1. Relevance of University-Business Cooperation

Industry is the backbone of the European economy and has a profound impact on regions, in terms of socio-economic development, innovation and job creation (Muller, Robin, Wesley, *et al.*, 2019; European Commission, 2020b, 2021b). Given its importance, cooperative agreements between industrial companies and knowledge partners, including universities, are considered essential to address current and future socio-economic challenges (Agrawal, 2001; Bekkers and Bodas Freitas, 2008; Ankrah and Al-Tabbaa, 2015; Bouncken, Pesch and Reuschl, 2016; BusinessEurope, 2017; Ghobakhloo, 2018).

University-business cooperation (hereinafter UBC) can be understood as an interaction between any parts of a higher education system and a business sphere, with the principal aim of fostering knowledge and technology exchange (Siegel, Waldman and Link, 2003; Bekkers and Bodas Freitas, 2008). UBC is increasingly recognised as a driver of innovation and competitiveness of firms (Faems, Looy and Debackere, 2005; Hewitt-Dundas, 2013; Ankrah and Al-Tabbaa, 2015; Markuerkiaga *et al.*, 2017). Nevertheless, as Galán-Muros and Plewa (2016) state, UBC is not only essential for companies but also for all the stakeholders involved in the innovation system.

In spite of its emergence in the last decades, UBC is not something new. Academics and industry have been cooperating for centuries with the aim of transferring knowledge and combining forces both for self-interest and social benefit (Etzkowitz, 1998; Galán-Muros, 2015). However, the concept of a more organised and formal cooperation between university and business spheres is currently emerging (Wissema, 2009; Guerrero *et al.*, 2016; Galvao *et al.*, 2019).

Many governments and policy-makers trust universities as socio-economic development main actors (Uyarra, 2010), and UBC has become a priority area in R&D and innovation policies in the vast majority of countries (Kitagawa and Lightowler, 2013; Vick and Robertson, 2018). Nonetheless, there are several and diverse reasons and needs driving both universities and businesses to cooperate beyond R&D-related issues such as improving the skills of employees through training (Davey *et al.*, 2018), accessing and screening potentially valuable recruits (Faulkner and Senker, 1995; Perkmann, Neely and Walsh, 2011; Davey *et al.*, 2018; Ferrández-Berrueco and Sánchez-Tarazaga, 2020) or jointly developing the curriculum of the university programmes (Davey *et al.*, 2018). These converging university and business need make it clear that (i) the university needs the business sphere and, by the same token, the latter needs the former (KPMG, 2016), and that (ii) it is not possible to conceive a world without UBC (Davey *et al.*, 2011).

Despite the multiple benefits of UBC, this cooperation faces multiple barriers (i.e. differing motivations, differing time-horizons, lack of funding, lack of absorptive capacity, etc.) (Perkmann, Neely and Walsh, 2011; Richard, Howells and Ramlogan, 2012; Plewa, Korff, Johnson, *et al.*, 2013; Galán-Muros and Plewa, 2016; Biedenbach, Marell and Vanyushyn, 2018), and levels of cooperation remain low (Davey *et al.*, 2018). Therefore, identifying the factors that shape UBC (Geisler and Rubenstein, 1989; Bekkers and Bodas Freitas, 2010; Bruneel, D´Este and Salter, 2010; Galán-Muros and Plewa, 2016) and advancing research in the field is vital to promote and support it (Skute *et al.*, 2017; Mascarenhas *et al.*, 2018).

This study seeks to contribute to the UBC literature, with the dual aim of generating empirical evidence to understand the UBC phenomenon, as well as generating inputs for the development of mechanisms and policies for its promotion and support.

1.2. Structure of the document

The research study presented in this document has been structured into the following ten chapters to improve its readability and understanding (see Table 1). The first chapter introduces and emphasises the importance of the field of study. Then, the second chapter provides an extensive literature review, which leads to a holistic view of the UBC phenomenon and its determinants. Afterwards, the research framework that guides the empirical research is described in the third chapter. Subsequently, the fourth chapter deals with the definition of the research objectives, research questions and hypotheses addressed by this study. Moving on to the fifth chapter, the research methodology, research design and methods applied for the achievement of the present study are described and justified. Later, the sixth chapter describes the process followed to assess the distribution of the data, together with the validity of the latent constructs included in the study. Hereafter, the statistical analyses carried out to address the research questions, specific objectives and hypotheses determined for the study are described in the seventh chapter. Next, the eight chapter offers a discussion of the results obtained in the study, while simultaneously drawing conclusions deriving from said results. This chapter also focuses on the limitations and future lines arising from the study, and summarises its theoretical and practical contributions. Finally, the last two chapters detail the bibliographic references and appendices, respectively.

Chapter	Title	Objective
1	Introduction	Introduce and emphasise the importance of the field of study
2	Literature review	Offer a comprehensive understanding of the UBC phenomenon and its determinants
3	Research framework	Provide a critical analysis of the UBC literature review Define research gaps
4	Research objectives, research questions and hypotheses	Define the research objectives, research questions, purpose and hypothses
5	Research methodology	Describe and justify the research methodology, research design and methods applied
6	Data and measurement assessment	Describe the process followed to assess the distribution of the data, together with the validity of the latent constructs
7	Data analysis and results	Describe the statistical analyses carried out to address the research questions and specific objectives
8	Conclusions and recommendations	Contrast and discuss the results obtained with the literature, and conclusions drawn Describe the limitations and the future lines of research identified Summarise the theoretical and practical contributions of the study
9	References	Gather and cite the bibliographical references used
10	Appendices	Collect the supplementary material and evidences necessary for understanding and verification of the empirical research

Table 1. Structure of the document

1.3. Summary

This chapter introduced and emphasised the importance of the field of study, UBC. In turn, it described the 10-chapter structure of the document, which was designed to improve its readability and understanding.

Chapter 2

Literature review

2. Literature review

2.1. Introduction

The following chapter seeks to offer a comprehensive understanding of the UBC phenomenon and its determinants through the synthesis of an in-depth literature review. The chapter consists of three main sections: (i) an introduction to the topic, (ii) a comprehensive view of UBC and (iii) a compilation of UBC's determining factors from a business perspective.

The first introductory section deals with: (i) an opening sub-section on the importance of external knowledge acquisition and cooperation with universities for companies in the knowledge-based society; (ii) an explanation of the transformation of a university into an entrepreneurial university and the appearance of the "Triple Helix" theory; and (iii) a discussion on the emergence and relevance of UBC.

The second section seeks to provide a comprehensive understanding of UBC. To this end, the section includes: (i) a review of UBC definitions and an approximation of UBC as a process; (ii) an overview of informal interactions and UBC activities; and (iii) an explanation of the dynamic nature of UBC.

The third section focuses on UBC's determining factors, its sub-sections addressing: (i) UBC's drivers and barriers; and (ii) the business' characteristics, resources and capabilities that can have an impact on UBC.

2.2. Knowledge, the most valued asset in an ever-changing context

As Heraclitus said (c. 500 BCE), "*the only constant is change*" and, centuries later, companies are facing a crisis that has aggravated the challenges that arose previously from technology development, globalisation, green transition and demographic change (OECD, 2020).

Fast and constant technological changes led to the emergence of highly uncertain and disruptive markets (OECD, 2018) driven by a knowledge-based economy (OECD, 2013b; Lundvall, 2016). This paradigm change forced businesses to shorten product life cycles (Snyder and Blevins, 1986) and to increase industry "clockspeed" (MacCarthy *et al.*, 2016). Moreover, the appearance of a "global village" (Archibugi and Iammarino, 2002) turned products and services into "made in the world" (European Commission, 2017). These new scenarios offer both opportunities and challenges, but regions and companies from all around the world must be ready to learn and adapt to them if they are to remain competitive (European Commission, 2017). Companies cannot rely exclusively on efficiency and cost reduction, as innovation, and more specifically technological innovation, is recognised as the critical factor for the long-term survival of firms (Tidd and Bessant, 2013). Firms must be innovative and flexible (OECD, 2018). Being innovative means as having the capacity to commercialise both radical innovations and incremental innovations (Rothwell and Gardiner, 1985; Bessant and Tidd, 2013). As for being flexible, this refers to the capacity to adapt quickly and at minimum cost to demands and external changes (Lundvall, 2016).

Business capacity building is important not only for companies themselves but also for governments since the way in which businesses develop these abilities will define regional competitiveness (OECD, 2007).

Many studies recognise that organisational knowledge[1] is the essential element for the development of these abilities (Foray and Hargreaves, 2002; Easterby-Smith, Lyles and Tsang, 2008; Lundvall, 2016). Consequently, the extent to which companies are able to generate and apply knowledge is imperative and represents the main factor in economic growth (Agrawal, 2001). Nevertheless, globalisation and fast technology development means that the generation and application of knowledge is becoming more complex. Product and technology life cycle shortening has forced businesses to develop and introduce innovative products and services faster than their global competitors (Bessant and Tidd, 2013) and, in the face of this situation, networking plays a determining role.

Although internal R&D was considered to be a key asset of the firm some decades ago, external context evolution has driven today's companies to rethink the way in which they generate and commercialise knowledge, innovation and new ideas (Chesbrough, 2007). Businesses are not able to generate all the required knowledge to remain competitive by themselves, so they are increasingly approaching various external agents, such as customers, suppliers, universities, research centres and so on with the aim of acquiring such knowledge (Laursen and Salter, 2006). Under these circumstances, knowledge and technology transfer has acquired great importance for business competitiveness (Bekkers and Bodas Freitas, 2008; Bouncken, Pesch and Reuschl, 2016). Consequently, the number of alliances has increased over the last decades, helping businesses to spread the cost and risk involved in innovation development, in addition to acquiring knowledge and technology.

Knowledge alliances can range from more simple to more complex agreements such as technology-sharing or joint development arrangements (Mowery, Oxley and Silverman, 1996). In this fashion, the early Schumpeterian model of the lone entrepreneur that introduces innovations into the market through a "creative destruction" (Schumpeter, 1942) is shifted towards a new scenery where different actors are developing together an iterative process of trial and error with a view to generating successful commercial ideas (Laursen and Salter, 2006). However, knowledge transfer alliances are not always successful and this can be explained by the diversity in knowledge acquisition capacity among businesses (Tsai, 2001). Companies diverge in their ability to assimilate and replicate knowledge obtained from external sources since organisations require access to external knowledge but also an internal capacity to learn from it (Cohen and Levinthal, 1990). Furthermore, getting access to outer sources does not guarantee success, as networking efforts are also needed (Tsai, 2001).

Networks provide businesses with access to knowledge, resources, markets and technology (Inkpen, 2005). This in turn encourages businesses to develop a capacity for learning from others, a critical skill when it comes to tackling the increased pace of competition (Easterby-Smith, Lyles and Tsang, 2008). A high learning capacity allows businesses to apply or replicate new knowledge (Tsai, 2001). In this connection, the role and commitment of management is equally as important as its learning capacity (Harrigan, 1988). Managers have to learn to use cooperative strategies in order to deliver adequate value to customers, renew

[1] It is necessary to point out that there is an interchangeably use of "knowledge" and "technology" in the literature (Agrawal, 2001).

their skill base and maintain their ability to increase long-term shareholder value (Harrigan, 1988). Thus, the primary task of management is establishing the coordination necessary for this knowledge integration (Grant, 1996).

Knowledge transfer could be defined as a process in which an organisation learns from the experience of another, giving rise to the generation of new knowledge and to an improvement of the ability to innovate (Szulanski, 2000; Easterby-Smith, Lyles and Tsang, 2008). Even though it seems to be a straightforward linear process that simply requires the availability of the necessary knowledge to be performed, this is easier said than done. Knowledge transfer is a complex phenomenon and even in the relatively simplest case of transferring, such as an intraorganisational transfer case, it turns out to be rather complicated (Easterby-Smith, Lyles and Tsang, 2008). What is more, it must be considered as a process of knowledge reconstruction rather than a process of transfer and reception (Szulanski, 2000). Several studies have tried to identify the main variables that influence success in transfer processes (Mowery, Oxley and Silverman, 1996), concluding that the nature of the knowledge and the capacity to learn are the main pillars (Tsai, 2001).

Knowledge may be classified as explicit or tacit (Asheim and Coenen, 2005). Explicit knowledge can be codified and written and thus easily transferred (Liebeskind *et al.*, 1996), whereas tacit knowledge cannot be transferred easily. On many occasions, knowledge happens to be “sticky” and difficult to spread (von Hippel, 1994; Szulanski, 2000). Due to the differences between tacit and explicit knowledge, learning and innovation can be developed in two ways. The first one is linked to the generation and use of codified scientific and technological knowledge STI (scientific and technologically-based innovation) and the other one is linked to learning by doing, using and interacting DUI (innovation based on learning-by-doing, by-using, and by-interacting) (Jensen *et al.*, 2007). Regardless of the way in which it is developed, knowledge generation and transfer is a joint process in which, besides innovation, the learning and skills acquired throughout the process are also an output. As a result, organisations can be referred to as “learning organisations”(Lundvall, 2016). This step towards learning organisations implies changes not only in the internal organisation of firms but also in interfirm relationships (Lundvall, 2016). When businesses establish an alliance, they exchange and combine tacit and explicit knowledge, applying social processes that involve communication, interaction, cooperation and dialogue which generate new knowledge (Kane and Alavi, 2007).

Knowledge transfer and innovation literature acknowledge interorganisational cooperation as essential in supplementing the internal innovative capacity and performance of organisations (Faems, Looy and Debackere, 2005). In this vein, businesses can enhance their innovative abilities by developing interorganisational cooperation with a different range of partners. These cooperations can be carried out with different agents such as:

- Suppliers and customers (Shaw, 1994),
- Potential lead users (Quinn, 1985; Hippel, Thomke and Sonnack, 1999),
- Universities and research centres (Santoro and Gopalakrishnan, 2000; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Hewitt-Dundas, 2013),
- Potential or existing industry competitors (Dogson, 1993),

And all of them are relevant (Faems, Looy and Debackere, 2005).

Within this wide range of possible knowledge partners, universities are commonly accepted as an interesting option as they are an important source of knowledge, especially in the areas of science and technology (Agrawal, 2001). The results of a quantitative[2] research developed by Kaufmann and Tödtling (2001) demonstrated that partners from science are more important than firms' customers for the introduction of products new to the market. Cooperation and knowledge exchange between universities and businesses is increasingly perceived as an engine towards innovation (Ankrah and Al-Tabbaa, 2015). For this reason, this cooperation has become a priority area in R&D and innovation policies across most countries (Kitagawa and Lightowler, 2013; Vick and Robertson, 2018).

Although the original goal of university was to provide education through its knowledge basis, universities' missions and roles are constantly expanding (Breznitz and Feldman, 2012; Guerrero and Urbano, 2017), in the same way that society and economy do (Chatterton and Goddard, 2000; Etzkowitz *et al.*, 2000; Etzkowitz, 2004; Gunasekara, 2006a). Accordingly, the emerging role of a modern entrepreneurial university focuses also both on innovation and entrepreneurship, giving rise to competitiveness and economic growth (Guerrero *et al.*, 2016). Current universities, entrepreneurial universities, are expected to contribute to regional development through different actions (Gunasekara, 2006b) such as:

- Training graduates (providing them with the required skills and competences for both local and global markets),
- Undertaking research (basic and applied) that will spill through to society via technology transfer or cooperations,
- Involving academics in the business sphere and public sector by means of broader community engagement,
- Working together with regional policy-makers to improve the benefits of spillover impacts.

As can be seen, this evolution has led to the addition of knowledge generation and transfer-related activities through which socio-economic development is achieved (Etzkowitz, 2004; Breznitz and Feldman, 2012; Guerrero and Urbano, 2012). This evolution has raised huge interest among a large number of scholars who seek to discover the extent to which current universities and scientific research are contributing to socio-economic development, and fulfilling their third mission without comprising education and research activities (Veugelers and Rey, 2014; Benneworth and Cunha, 2015; Coccia, 2018; Eizaguirre *et al.*, 2020). The evolution of university towards entrepreneurship has brought about a direct change in the way in which university and businesses cooperate, and it is therefore essential to have a comprehensive understanding of how this process has been developed.

[2] Quantitative studies are used to consolidate beliefs (logically formulated in a theory or theoretical framework) and establish accurate patterns of behaviour in a population (Hernández Sampieri, Fernández and Baptista Lucio, 2014).

2.2.1. The entrepreneurial university

The university, a long-established institution, has evolved and survived over time by adopting new roles and functions (Antonelli, 2008). Despite only reaching a national elite of politicians, industrialists, the clergy and civil servants in its origins, in the 20th century its service was widened to a larger part of the population (Chatterton and Goddard, 2000), thereby increasing its direct contribution to society and economy (Breznitz and Feldman, 2012; Audretsch, 2014).

Although the original goal of university was to provide education through its knowledge base, an academic revolution transformed it from being a knowledge silo into a knowledge generator (Etzkowitz, 2004). In this way, the modern university, which combined teaching and research, emerged in the early 19th century (Etzkowitz and Leydesdorff, 1997). Under this "pure" academic pattern, the university was assumed to simply fulfil high-level research and transmission of knowledge (Laukkanen, 2003). However, within advanced economies a general worry emerged that teaching and research were not enough to cope with economic and social objectives (Chatterton and Goddard, 2000). Hence, universities started to be increasingly expected to play a major role in regional development (Laukkanen, 2003). This led to a second academic revolution, which integrated a third university mission in pursuit of socio-economic development. This shifted the traditional training and research university into an "Entrepreneurial University" (Etzkowitz, 2004) or a "Third Generation University, 3GU" (Wissema, 2009, p.xii). This emergence was accompanied by important modifications in universities' policy environments owing to initiatives such as the Bayh–Dole Act (1980) and the abandonment of the 'professor's privilege' in most European regions (Baldini, Grimaldi and Sobrero, 2006; Lissoni, Llerena and Mckelvey, 2008; Grimaldi *et al.*, 2011). In this new scenario, academia is seen as a key provider of new technologies and business ventures, turning into a regional development engine (Markuerkiaga *et al.*, 2017). This change drove the "extension of knowledge" towards the "capitalisation of knowledge" as universities establish strong ties with knowledge users, and the university itself becomes an economic actor (Etzkowitz, 1998). This new paradigm entails a normative change in science (Etzkowitz, 1998) as the entrepreneurial university should be in opposition to the concept of an "ivory tower" academic model (Etzkowitz, 2004).

Universities in developed countries started to become increasingly more entrepreneurial (Mowery and Sampat, 2005; Phan and Siegel, 2006; Rothaermel, Agung and Jiang, 2007) undertaking different activities, such as joint ventures with private companies, spin-off firm formation, patenting and licensing, contract research, cooperative research, industry training courses, consulting and joint publishing (Thursby and Kemp, 2002; Friedman and Silberman, 2003; Laukkanen, 2003; Shane, 2004; Philpott *et al.*, 2011). These entrepreneurial activities, a result of the interaction between university and business, established stronger ties between both parties whilst contributing to economic development and employment creation (Robles and Ballina, 2012). Many academics have shown considerable evidence of the importance of this third mission as a mechanism for generating technological spillovers (D´Este and Patel, 2007).

Until the emergence of the entrepreneurial university, university and industry were mainly separate spheres. Thus, the development of cooperation activities has been one of universities' main challenges as they have had to evolve from individual non-interconnected activities to more structured and systemically required ones (Markuerkiaga *et al.*, 2017). Since the appearance of the entrepreneurial university, both universities and companies have started to assume tasks that were largely the province of the other (Etzkowitz and Leydesdorff, 1997). This gives rise to some concern as to whether excessive orientation towards industry in research might result in a loss of freedom to the university, turning its research activity from a long-term perspective into a short term one (Blumenthal *et al.*, 1997). This shift in the economy also led to changes in parts of the knowledge infrastructure. Prior to the entrepreneurial university, exchange across institutional boundaries was organised through arms-length transactions, mediated by organisations such as non-profit organisations (Gieryn, 1983). Under this previous scenario, informal arrangements were the norm, such as consulting ties between companies and individual professors in tacit exchange for fellowship and departmental research funds (Etzkowitz and Leydesdorff, 1997). Nevertheless, in this new entrepreneurial scenario, while universities are increasingly viewed as key players in national and regional innovation systems, distinct boundaries are blurred and replaced by a tie network (Etzkowitz and Leydesdorff, 1997). This has had an impact not only on the relationship between university and business, but also on the interaction between university, government and business spheres as science and technology gains great importance for socio-economic development (Etzkowitz and Leydesdorff, 1997). The analysis of this triadic interaction led to the "Triple Helix" theory, postulating that interaction among university-industry-government is the key to improving conditions for innovation in a knowledge-based society (Etzkowitz, 2004).

2.2.2. UBC's emergence and relevance

Within the "Triple Helix" framework, the analysis of cooperation between universities and the business sphere, known as university-business cooperation (UBC), has received a great deal of attention for being a major territorial competitiveness driver in knowledge-based economies and societies (Skute *et al.*, 2019). Universities are acknowledged as the main providers of the knowledge and human capital required by businesses (Harrison and Turok, 2017), and UBC is therefore essential for regional socio-economic development (Plewa, Korff, Johnson, *et al.*, 2013).

UBC is conceived as a tool for companies (including small and medium-sized enterprises, SMEs[3]) to generate and acquire higher-level knowledge. If companies are able to absorb and to transform this knowledge into innovations, these will be able to generate competitive advantage (Bercovitz and Feldman, 2006). Consequently, UBC is recognised as an essential tool for increasing the innovative potential and competitiveness of firms (Faems, Looy and Debackere, 2005). In turn, this cooperation is not only essential for businesses and universities. As Snyder and Blevins stated in 1986, the promotion of UBC is equally vital for consumers, who benefit from the results of such cooperation. In this connection, Galán-Muros and Plewa (2016) state that UBC is also essential for all the stakeholders involved in the broader innovation system.

[3] Companies with more than 10 and fewer than 250 employees and a turnover of less than 50€ million, or a balance sheet total of less than 43€ million (European Commission, 2015)

Despite its emergence in the last decades, UBC is not something new. In the 17th century, pharmaceutical field scientists developed entrepreneurial activities in Germany (Etzkowitz, 1998). Universities and businesses have been cooperating for centuries with the aim of transferring knowledge and combining forces both for their self-interest and social benefit (Galán-Muros, 2015). Nevertheless, the conception of a more organised and formal cooperation between university and business spheres is currently emerging (Wissema, 2009; Guerrero *et al.*, 2016; Galvao *et al.*, 2019).

There are multiple reasons and needs driving both university and business spheres to cooperate. This variety of reasons includes: the need for external knowledge and technology, skilled workforce, funding for research, product quality improvement, curriculum development, among many others (Snyder and Blevins, 1986; D´Este and Perkmann, 2011; Looy *et al.*, 2011; Perkmann, King and Pavelin, 2011; Bozeman, Fay and Slade, 2013; Perkmann *et al.*, 2013). Owing to the importance of UBC in addressing such critical issues, it is not possible to conceive a world without this cooperation; a world in which students are trained without being aware of business reality or in which businesses receive neither new knowledge nor appropriately skilled human resources from the university system (Davey *et al.*, 2011).

It is clear that the university needs the business sphere and, by the same token, the latter needs the former (KPMG, 2016). On account of this, governments and policy-makers trust universities as regional socio-economic development key players (Zahra and George, 2002; Uyarra, 2010; Veugelers and Rey, 2014) and there is currently a great deal of evidence which reflects their commitment to fostering UBC (Ranga, Mroczkowski and Araiso, 2017). To give an example, the Basque Government is pushing hard for UBC through the development and implementation of the “I University-Business Basque Strategy 2022” (Basque Government, 2017) which includes, among other initiatives, an increase in the quantity of dual training undergraduate and master degrees, the establishment of business-university classrooms and a joint research project development.

In the European context, UBC is considered a relevant key to solving issues such as:

- Decreasing public funding for universities,
- Businesses’ constant need to innovate,
- High unemployment rates,
- Lack of global competitiveness (Davey *et al.*, 2018).

Thus, the European Commission supports UBC with the aim of strengthening the Knowledge Triangle (education-research-innovation) through diverse mechanisms, actions and initiatives, such as the “European University-Business Forum” (Bertram *et al.*, 2017). These mechanisms reflect the commitment of governments towards UBC. At the same time, this also shows the importance of the aforementioned triadic university- industry-government relationship, “Triple Helix”, wherein UBC seeks to contribute to economic and social development (Ranga and Etzkowitz, 2013).

UBC is increasing globally even though it is more common in developed countries, where universities are more sophisticated, research-focused and interconnected (Teixeira and Mota, 2012). Nonetheless, cooperation levels remain low (Davey *et al.*, 2018) and unused cooperation potential still exists (Lambert, 2003).

The assessment and operationalisation of UBC through different transfer channels has given rise to considerable interest among researchers (Anderson, Daim and Lavoie, 2007; Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, 2010; Looy *et al.*, 2011; Healy *et al.*, 2014; Salimi and Rezaei, 2016; Benneworth *et al.*, 2017; Jonkers *et al.*, 2018). This school of thought assesses elements such as cooperation results, frequency or the intensity and efficiency of technology transfer (Siegel *et al.*, 2001; Tijssen, 2006; Anderson, Daim and Lavoie, 2007; Perkmann, Neely and Walsh, 2011). With this aim in mind, some studies have tried to assess UBC by means of the employment of economic indicators, such as sales index, or participants' satisfaction (Cukor, 1992). On the one hand, regarding sales index, since many factors influence sales performance, this is not a reliable proxy (Healy *et al.*, 2014). On the other hand, evaluation through satisfaction also remains subjective. Thus, it requires a mix of several tools to obtain an approximate result (Perkmann, Neely and Walsh, 2011). However, this is not the only matter of concern since several issues, such as the analysis of transfer channels, the role played by agents and intermediaries, the motivations for establishing UBC or drivers and barriers to cooperate, and a long etcetera have gained the attention of academics and political authorities alike (Teixeira and Mota, 2012).

2.3. A comprehensive understanding of UBC

2.3.1. UBC definitions and process

UBC can be understood as an interaction between any parts of a higher education system and a business sphere, with the principal aim of fostering knowledge and technology exchange (Siegel, Waldman and Link, 2003; Bekkers and Bodas Freitas, 2008; Ankrah and Al-Tabbaa, 2015). Nevertheless, it is necessary here to clarify that most UBC studies have been focused on industrial sector businesses, which are closely linked to research (Hicks *et al.*, 2001). Thus, the term "University-Industry Cooperation (UIC)" is also used indistinctly. Notwithstanding, UBC embraces more activities than research and it must be understood in a broader sense (Davey *et al.*, 2011, 2018). Therefore, UBC can be defined as all types of direct and indirect cooperative interactions between universities and any public or private organisation for mutual benefit (Davey *et al.*, 2011). This latter definition uses the term "business" as an umbrella for all kinds of organisations external to a university (Clauss and Kesting, 2017). Dobson and Matthes (1971) started supporting these broader view decades ago through their article on the relevance of university-agribusiness cooperation.

Due to the great interest generated by UBC among academics, this interaction has been defined in multiple ways, such as:

- A partnership between one or several academics or research institutions, and one or several firms operating in industrial markets focused on cooperative R&D activities (Perkmann and Walsh, 2007; Petruzzelli, 2011; Bozeman, Fay and Slade, 2013).
- A relationship in flux, reflecting issues specific to the transition from an industrial to a knowledge society (Ranga *et al.*, 2013).
- "Bi-directional linkages between the university and industry entities, established to enable the diffusion of creative ideas, skills and people with the aim of creating mutual value over time" (Plewa, Korff, Johnson, *et al.*, 2013, p.23).

- An interorganisational relationship that involves engagement between universities and organisations from the business sector to exchange tangible (e.g. fund, materials, and equipment) and intangible (e.g. technology and data) resources (Perkmann *et al.*, 2013).
- A process that seeks knowledge generation, where created knowledge is new for both parts (Mowery, Oxley and Silverman, 1996; Hardy, Phillips and Lawrence, 2003).

These different definitions are a mere reflection of the multiple ways in which the interaction between university and business can be undertaken, varying from the acquisition of a licensing of university intellectual property for commercial purposes to the development of joint R&D activities (Gulbrandsen, Mowery and Maryann, 2011).

In order to understand the complexity of UBC it is worth highlighting that UBC can be depicted as a process of constant learning and evolution (Ritter and Gemünden, 2003; Calcagnini *et al.*, 2015; Galán-Muros and Davey, 2017). However, rather than being a straightforward and linear knowledge transfer process, UBC is a sophisticated and complex phenomenon (Perkmann and Walsh, 2007). Galán-Muros and Davey (2017) employed the Basic Logic Model (Wholey, 1987), one of the most commonly used analytical frameworks that depicts the basic structure of how a process is expected to work under certain environmental conditions (W.K. Kellogg Foundation, 2004). This model fragments and explains the connection between the elements interacting in the process. The circular UBC process (see Figure 1) defined by Galán-Muros and Davey, (2017) distinguished the following elements:

- *Inputs:* resources employed to carry out UBC activities,
- *Activities:* different actions in the domains of education, research, valorisation and management that are selected and carried out depending on the expected objectives,
- *Outputs:* products, services or other properties that are delivered as a direct result of UBC activities,
- *Outcomes:* result from outputs, these can be positive or negative for the stakeholder, tangible or intangible, and experienced directly or indirectly in a broad range of time,
- *Impacts:* social, economic, civic and/or regional consequences, changes or aftermath of the UBC outcomes, intentional or unintentional.

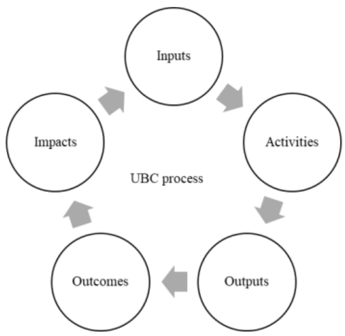

Figure 1. UBC process (Galán-Muros and Davey, 2017)

As these authors stated, three types of conditioning factors determine the UBC process' elements:

i. *Supporting mechanisms:* procedures in the form of strategic, structural, operational and policy mechanisms, which give support to UBC,
ii. *Circumstances:* variables that can have an impact on UBC but may be modified in the short/medium term, and classified as barriers, motivators or facilitators, according to whether they act negatively or positively,
iii. *Context:* individual, corporate and environmental characteristics that can have a positive or negative effect on UBC and cannot be modified in the medium term.

These elements and determining factors exist both in university and business spheres although there might well be differences in how they perceive factors such as barriers, motivators or facilitators (Galán-Muros and Davey, 2017).

2.3.2. Informal interactions and UBC activities

As the UBC process shows, UBC is developed through the execution of different activities that are selected based on the objective with which the relationship was born. UBC activities refer to cooperative interactions developed between university and business spheres with the aim of transferring or exchanging knowledge, technology or other properties based on a contract. Prior to delving into the different types of cooperative activities that universities and businesses can undertake, it is essential to understand the difference between "informal" and "formal" university-business interactions.

In UBC literature, interactions between universities and businesses can be either 'formal' or 'informal', depending on the presence or absence of a contract (Bonaccorsi and Piccaluga, 1994). Notwithstanding this distinction, many authors have stated that UBC often relies on both informal and formal interactions (Faulkner and Senker, 1995; D´Este and Patel, 2007; Perkmann *et al.*, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). Faulkner and Senker (1995) stated that a temporal continuity among formal and informal knowledge transfer channels exists and informal links can be either a precursor or successor of formal interactions (Plewa, Korff, Johnson, *et al.*, 2013). Accordingly, Rappert, Webster and Charles (1999) showed that informal interactions can create the necessary trust for formal engagement. Table 2 below summarises the different informal interaction types found in the literature:

Authors	Informal interactions
Cohen, Nelson and Walsh (2002)	Public meetings or conferences
Perkmann and Walsh (2007)	Formation of social relationships and networks at conferences, etc.
D´Este and Patel (2007)	Attendance at industry-sponsored meetings Attendance at conferences with industry and university participation
Bekkers and Bodas Freitas (2008)	Personal informal contacts
Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros (2010)	Personal interactions between individuals
Plewa, Korff, Johnson, *et al.* (2013)	Open forums such as conferences, workshops and symposiums
Azagra-Caro *et al.* (2017)	Personal contacts between academic and industry researchers Attendance at conferences

Table 2. Informal interaction types

While the effect of informal interactions on local industry is well recognised (Breschi and Lissoni, 2001; Singh, 2005), little literature has taken into account the possible relationship between informal and formal interactions. The temporally unfolding dynamic relationship among informal and formal knowledge transfer channels has received less attention than other issues such as the impact of proximity (Azagra-Caro *et al.*, 2017). Since informal interactions often depend on personal communication and social connections among academics and practitioners, some studies analysed and confirmed the effect of proximity on these (e.g. Breschi and Lissoni, 2001; Singh, 2005).

As regards formal interactions, which this study considers as activities, these vary significantly on account of their diverse nature (Bekkers and Bodas Freitas, 2008) and are related to the three main missions of university (Galán-Muros and Davey, 2017). Even though patents, licenses and academic entrepreneurship have been some of the most studied and known UBC activities (Agrawal and Henderson, 2002; Laukkanen, 2003; Shane, 2004; O´Shea *et al.*, 2005; Phan and Siegel, 2006; Rothaermel, Agung and Jiang, 2007; Isaksen and Karlsen, 2010; Lehmann and Menter, 2016), UBC goes beyond the research approach of the university (Davey *et al.*, 2018). Education-based activities such as the area of work-integrated learning (WIL), which includes undergraduate students in UBC, are increasing in importance. Education-related activities are essential, since these (i) provide graduates with the necessary business experience to innovate successfully, (ii) enable the transition from academic environment to work practice and, (iii) diminish the differences between universities and firms (Rampersad, 2015).

According to the literature, the selection of a UBC activity is determined by the nature of knowledge[4] (Bekkers and Bodas Freitas, 2008) and the extent to which a firm is capable of effectively using university knowledge to its own benefit (Agrawal, 2001; Hewitt-Dundas, 2013). In turn, as Bekkers and Bodas Freitas (2008) noted, the effort required by businesses to undertake UBC activities will vary. For instance, guest lecturing or curriculum co-delivery is a shorter and easier cooperation activity associated with an earlier cooperation stage than the development of joint R&D projects, which requires greater commitment and a more established relationship (De Man, 2004). Alunurm, Rõigas and Varblane (2020) supported this statement, arguing that education-related UBC activities require less commitment than UBC activities related to R&D, commercialisation and management.

The identification and classification of the different types of UBC activities has attracted intense academic interest (Benneworth *et al.*, 2017; Sharma, 2020). Some academics classify them as “soft” activities (consultancy, industry training, production of highly qualified graduates), closer to the traditional academic paradigm of training and research, or “hard” initiatives, such as patenting, licensing and spin-off activities (Perkmann and Walsh, 2007; Philpott *et al.*, 2011).

Table 3 below shows the classification and compilation proposed by Davey *et al.* (2018), including the most recognised UBC activities by the literature. These activities are classified by the fields of education, research, valorisation and management, which are related to entrepreneurial university’s missions.

[4] Knowledge nature refers to the extent to which knowledge can be codified or the degree to which it is related to early or close-to-market research (D´Este and Patel, 2007).

UBC domains	UBC activities
Education	- Mobility of students (e.g. student internships/placements) - Curriculum co-design (e.g. business employers involved in curricula design with universities) - Curriculum co-delivery (e.g. guest lectures) - Dual education programmes (e.g. part academic, part practical) - Lifelong learning for people from business (e.g. executive education, industry training and professional courses)
Research	- Joint R&D (incl. joint funded research) - Consultancy for business (e.g. contract research) - Mobility of staff (i.e. temporary mobility of academics to business and of business people to universities)
Valorisation	- Commercialisation of R&D results (e.g. licencing/patenting) - Academic entrepreneurship (e.g. spin-offs) - Student entrepreneurship (e.g. start-ups)
Management	- Governance (e.g. participation of academics on business boards and business people participation in HEI board) - Shared resources (e.g. infrastructure, personnel, equipment) - Industry support (e.g. endowments, sponsorship and scholarships)

Table 3. UBC activity classification by domain (Davey et al., 2018)

2.3.3. UBC evolution stages and dynamics

It is essential to stress that UBC has a dynamic nature and, despite starting cooperation as an isolated activity, it may well increase to higher cooperation levels (Plewa, Korff, Baaken, *et al.*, 2013; Azagra-Caro *et al.*, 2017). Once UBC interaction starts, cooperation becomes more fluid and paths for cooperation open up (Davey *et al.*, 2018). This was seen in the case study of Harper Adams University and Dairy Crest (Davey *et al.*, 2018). This relationship started out as a research consultancy and student placement, evolved into a longer-term research cooperation, and ended up with the establishment of an innovation centre as a shared facility. This evolution towards a more comprehensive level flourished thanks to joint goals, clear benefits on both sides and the promise of future benefits as the cooperation matured (Davey *et al.*, 2018) .

Marketing and networking literature, which take into account the complex, dynamic nature of relationships, offer several conceptual models to describe the evolution of buyer-seller relationships (Plewa, Korff, Johnson, *et al.*, 2013). Interactions between universities and businesses can also fit this buyer-seller categorisation as these represent a provider-customer relationship, cooperating towards mutually beneficial results (Plewa, Korff, Johnson, *et al.*, 2013). As previously seen in the case of Harper Adams University and Dairy Crest, it can be said that partnerships established by virtue of UBC evolve and change over time (Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). Ongoing involvement is thus expected to change the nature of interactions between partners. However, current contributions insist on the complexity of UBC and it is widely acknowledged that the evolution of relationships do not follow one single pattern (Thune, 2007). Besides, it must be taken into account that not only do a partner's characteristics, actions and goals evolve but, as previously stated, there are also continuous changes in the environment in which UBC is developed (Plewa, Korff, Johnson, *et al.*, 2013; Galán-Muros and Davey, 2017; Davey *et al.*, 2018). In spite of the importance of UBC's dynamic nature, it must be said that there is little research into UBC relationship evolution and management (Santoro and Gopalakrishnan, 2000; Bruneel, D´Este and Salter, 2010; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013; Al-Tabbaa and Ankrah, 2016; Estrada *et al.*, 2016; Azagra-Caro *et al.*, 2017; Mascarenhas *et al.*, 2018; Skute *et al.*, 2019).

With regard to the elements that can have an impact on the dynamics of university-business relationships, time has been one of the most relevant dimensions in networking and relationship theories (Halinen, Medlin and Törnroos, 2012). Nevertheless, different scholars have stated that the effect of time on the evolution of a relationship can be both positive and negative (Plewa, Korff, Johnson, *et al.*, 2013). On the one hand, relationship duration can have a positive influence on interaction effectiveness through increased experience and familiarity but, on the other hand, time could increase the negative effects on outcomes or lower trust levels (Plewa, Korff, Johnson, *et al.*, 2013). As the meta-analysis developed by Palmatier *et al.* (2006) shows, it is not possible to confirm relationship length as a driver for strong relationships. The results of this study showed that length had no significant influence on factors related to trust, commitment or satisfaction. Variance in levels of relational drivers may affect the stage of relationship evolution, rather than its duration. This implies a need to carry out research into relationship stages, together with the influence of relational factors within and between stages (Plewa, Korff, Johnson, *et al.*, 2013). To this end, Plewa, Korff, Johnson, *et al.* (2013) developed a qualitative[5] study on the different stages of research cooperation and each stage's respective measures of success. Even if data were not clear and each UBC should be individually considered, the following overall stages were identified (see Table 4):

Stage	**Definition**	**Measures of success**
Pre-linkage stage	This stage takes place through informal interactions, such as conferences, workshops and symposiums, referrals from colleagues or internet searches, among others. It refers to the identification of potential research partners (individuals or teams) and the analysis of how and whether it is possible to cooperate. This involves uncertainty, lack of experience between partners and undefined cooperation cost and benefits. Factors such as persons involved, reputation, and existing network can determine any UBC initiation. This stage concludes with a discussion relative to a specific project and can be summarised as awareness, screening and meeting potential partners.	Leading to an agreement to work together
Establishment (Stage 1)	This stage refers to the discussion of interests and determination of a mutual agreement. These discussions are usually face-to-face and seek to identify strengths, needs and interests, along with likely deliverables from this first cooperation project. This stage can be summarised as interactions that lead to an agreement.	Leading to a contract
Engagement (Stage 2)	This stage begins when partners start working together. This involves the development of processes and mechanisms that enable the establishment of a cooperative, trusting working environment. The accomplishment of this stage is dependent on the scope and timeframe of the initial UBC project between the partners, such as its delivery.	Leading to delivery of a project
Advancement (Stage 3)	Transition from stage 2 to stage 3 occurs when partners start feeling part of a team and they engage in value creation beyond the originally defined project. These long-term relationships often involve multiple formal projects and related outcomes. Informal value also contributes to the success of the relationship and its continuance.	Leading to an ongoing partnership and word of mouth
Latent stage	A latent stage can occur after stage 1 or stage 3. Relationship is paused, but formal working relationship exists. This can nurture the potential for future cooperations.	Potential future cooperation should a suitable project arise

Table 4. Evolution of UBC stages and measures of success (Plewa, Korff, Johnson, et al., 2013)

[5] Whilst quantitative studies build on previous research, qualitative studies are primarily self-driven. Qualitative studies are used for researchers to form their own beliefs about the phenomenon under study, such as a unique group of people or a particular process (Hernández Sampieri, Fernández and Baptista Lucio, 2014)

Nonetheless, despite the fact that these stages present an apparent linearity, it is not possible to assume a linear evolution of UBC as barriers may appear that pause the development of a relationship, even if an initial project is successfully completed (stage 1), relational structures are developed (stage 2) and further engagement is achieved (stage 3) (Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). Cooperation barriers might be lack of funding, lack of a relevant continuing project, or simply an unwillingness to continue working together (Plewa, Korff, Johnson, *et al.*, 2013). When this happens, the relationship goes through a latent stand-by phase that nurtures the potential for future cooperations. It is worth noting that a relationship can enter a latent phase after stage 1 or stage 3, depending on the particular circumstances of each interaction.

2.4. UBC's determining factors

2.4.1. UBC drivers and barriers

As interorganisational relationship theory states, interaction between different organisations is a complex process which becomes even more difficult if interacting organisations belong to different sectors (e.g., private and public) (Ankrah and Al-Tabbaa, 2015). This theory depicts the case of the partnership between university and businesses (Muscio and Vallanti, 2014).

Although the nexus between science and industry seems something natural and flowing, there are multiple barriers that appear in knowledge transfer processes (Veugelers and Rey, 2014). As previously stated, even though several studies have shown the positive effect of UBC on a company's capacity to develop innovations, UBC faces multiple challenges (Bruneel, D´Este and Salter, 2010), and therefore, cooperation is not always successful (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004). Identifying influencing factors is essential for all UBC stakeholders (Bayona Sáez, García Marco and Arribas Huerta, 2002) and, thus, several studies have tried to identify UBC barriers and drivers (e.g. Snyder and Blevins, 1986; Geisler and Rubenstein, 1989; Bekkers and Bodas Freitas, 2010; Bruneel, D´Este and Salter, 2010).

UBC barriers are understood as cooperation inhibitors (obstacles) (Bruneel, D´Este and Salter, 2010; Galán-Muros, 2015; Galán-Muros and Davey, 2019) while drivers are the factors that facilitate and engage partners in cooperation (D´Este and Perkmann, 2011; Galán-Muros, 2015; Galán-Muros and Davey, 2019). Drivers can be classified as both facilitators, providing the capability to do something, and motivators, pushing partners to undertake UBC activities (Galán-Muros, 2016; Davey *et al.*, 2018).

The following sub-section focuses on the description of the main UBC drivers and barriers found in the literature review.

2.4.1.1. UBC drivers

UBC motivators

Behind each UBC there is a strategic purpose or motivation (Davey *et al.*, 2018; Guerrero, Urbano and Herrera, 2019) that shapes the way in which universities and businesses interact (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004). Being motivated is essential to engage in cooperation (Proulx, Hager and Klein, 2014) and this motivation is targeted towards a certain action or aim.

Although universities and businesses seek different objectives and face different constraints, these differences enhance the value of this cooperation (Rybnicek and Königsgruber, 2019). Besides, regardless of their individual objectives, partners have common goals (e.g. create impact by providing solutions for society's problems) that drive their interest towards cooperation (Ankrah and Al-Tabbaa, 2015).

Table 5 below summarises the main motivators that drive companies to cooperate with universities:

Authors	**UBC motivators**
Davey *et al.* (2018)	Improve their business reputation
Ankrah and Al-Tabbaa (2015); Davey *et al.* (2018)	Resolve a technical problem or obtain a customised solution
Bercovitz and Feldman (2006); Bekkers and Bodas Freitas (2008); Davey *et al.* (2018)	Develop innovative products and services and improve their innovation capacity
Faulkner and Senker (1995); Perkmann, Neely and Walsh (2011); Davey *et al.* (2018); Ferrández-Berrueco and Sánchez-Tarazaga (2020)	Access and benefit from highly qualified human resources such as researchers or students and screen potentially valuable recruits
Davey *et al.* (2018)	Improve the skills of employees through training
Davey *et al.* (2018); Ferrández-Berrueco and Sánchez-Tarazaga (2020)	Have a positive impact on society
Barnes, Pashby and Gibbons (2002); Perkmann, Neely and Walsh (2011)	Gain access to new technology and knowledge and enhance their knowledge bases
Lee (2000); Davey *et al.* (2018)	Gain access to new discoveries at an early stage and cutting-edge research
Etzkowitz and Leydesdorff (2000); Ankrah and Al-Tabbaa (2015)	Share access to research infrastructure
Davey *et al.* (2018)	Obtain funding or financial resources

Table 5. UBC motivators for businesses

It is worth stating that when businesses undertake UBC with the aim of developing innovations, this action is driven less by the possibility of obtaining short-term commercial returns and more with a view to obtaining access to specialist knowledge and expertise, research findings, research techniques, and so on (Cohen, Nelson and Walsh, 2002). In this line, the European-level survey developed by Davey *et al.* (2018) shows that, the main motivators for cooperation in Europe are driven by organisational resource development, such as access to new technologies and knowledge, improving their innovation capacity and accessing new discoveries at an early stage. Thus, it can be stated that European companies are motivated to engage in UBC for reasons related to longer-term innovation capability (Davey *et al.*, 2018).

UBC facilitators

UBC literature has addressed several studies whose aim was to identify the factors that facilitate or impede cooperation (e.g. Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Bekkers and Bodas Freitas, 2010; Bruneel, D´Este and Salter, 2010; Perkmann, Neely and Walsh, 2011; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Galán-Muros and Davey, 2015; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018). Nonetheless, in general, much of this literature has been more focused on barriers than on drivers (Galán-Muros and Plewa, 2016).

Connected with UBC, literature on strategic alliances has given rise to several questions regarding the success of cooperation relationships. This literature mainstream, which seeks to analyse factors affecting success in alliances, initially focused its analysis from a resource-based view of the company (RBV) (Wernerfelt, 1984; Barney, 1991). Academics took into account factors related to company's capabilities (Hagedoorn, 1993), partners' resources (Barney, 1991) and funding potentially gained through alliance (Brouthers, Brouthers and Wilkinson, 1995). Nonetheless, this context merely offered a partial view as a social component was lacking (Zunkin and DiMaggio, 1990). Thus, some scholars started undertaking research into the effect of social contexts on alliances (Zunkin and DiMaggio, 1990). These studies considered factors like initial awareness and contacts (Gulati, 2007), organisational similarities (Zaheer and Venkatraman, 1995) and extant relationships (Dyer and Singh, 1998). In the same fashion, factors such as trust, commitment, shared goals and interrelationships have been considered as UBC drivers (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013; Al-Tabbaa and Ankrah, 2016; Galán-Muros and Plewa, 2016; Rosendo-Ríos, Ghauri and Zhang, 2016; Rajaeian, Cater-steel and Lane, 2018).

According to the study developed by Davey *et al.* (2018), the existence of mutual trust, a shared goal, funding and a prior relationship with the university partner are the most important facilitators perceived by European businesses. This result falls in line with the results obtained by Mora-Valentín, Montoro-Sánchez and Guerras-Martín (2004), who stated that relational factors alone are insufficient to achieve relationship success, since it is necessary to have available resources and alliance competence. Therefore, UBC facilitators can be classified as relational and orientation-related drivers.

Below the main relational and orientation facilitators found in the literature review are described and developed, following in turn the classification developed by Davey *et al.* (2018).

Relational facilitators

Flexibility: Flexibility can be defined as a willingness to respond to changes satisfying partners as needs arise. As competitive environments pressurise companies to re-align and change, these need universities to be flexible in order to adapt cooperation to environmental changes (Plewa, 2009). In the same way, flexibility is required to smooth the hindrance that UBC bureaucracy can lead to (Siegel, Waldman and Link, 2003).

Short geographical distance: The creation of new knowledge results not only from the transfer of codified knowledge but also tacit knowledge which is facilitated by personal interactions and is sensitive to increasing distance. Empirical research on external knowledge sourcing shows that there is a strong geographical dimension to UBC or knowledge spillovers (Hewitt-Dundas, 2013).

Trust: Given the risks arising from the development of cooperative R&D projects and the unfamiliar processes that UBC can mean for businesses, trust is considered a key element for UBC relationship maintenance and success (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Plewa, 2005; Bruneel, D´Este and Salter, 2010; Galán-Muros and Plewa, 2016).

Commitment: Mutual commitment is recognised as one of the most important factors in R&D cooperation success and satisfaction (Barnes, Pashby and Gibbons, 2002; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Rosendo-Ríos, Ghauri and Zhang, 2016; Davey *et al.*, 2018). This factor can involve several aspects such as the volume of resources contributed by partners, support from senior executives and involvement of personnel who participate directly in the relationship (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004). The existence of a mutual commitment supports UBC (Attia, 2015), and the commitment of the top management in particular is a crucial factor in that regard (Ankrah and Al-Tabbaa, 2015) since partners (and their leaders) will not share resources when they are not committed to a cooperation (Barnes, Pashby and Gibbons, 2002; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Ankrah and Al-Tabbaa, 2015; Attia, 2015; Rosendo-Ríos, Ghauri and Zhang, 2016; Davey *et al.*, 2018).

Shared goals: Shared goals are acknowledged as a main UBC relationship driver (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Davey *et al.*, 2011). Establishing a shared goal helps to mitigate possible problems arising from differences in cooperation expectations (Barnes, Pashby and Gibbons, 2002; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Bekkers and Bodas Freitas, 2008; Bruneel, D´Este and Salter, 2010). As seen in Bekkers and Bodas Freitas (2008) differences in objectives, incentives and research focus may result in problems to UBC (Dasgupta *et al.*, 1994). Shared goals also help to build trust between academics and industrial practitioners (Bruneel, D´Este and Salter, 2010). This relationship factor is considered by European businesses to be one of the most important UBC drivers (Davey *et al.*, 2018).

Prior relation: Previous experience of working together can be important for successful cooperation as some of the barriers are already overcome (Muscio and Pozzali, 2013). Thanks to their prior relationship, partners establish personal bonds[6] that lead to communication (Barnes, Pashby and Gibbons, 2002; Plewa, Korff, Johnson, *et al.*, 2013) and consequently to understanding. This can reduce transaction costs and improve the ease of knowledge transfer (Plewa, Korff, Johnson, *et al.*, 2013). Relational success factors depend greatly on the interrelationship among individuals (Santoro and Chakrabarti, 2002; Plewa, Korff, Baaken, *et al.*, 2013). Good personal relationships are the basis for enabling vital links between companies and universities (Barnes, Pashby and Gibbons, 2002). As seen in the studies carried out by Plewa, Korff, Johnson, *et al.* (2013) and Galán-Muros (2016), interrelationship between partners is one of the most important factor in facilitating UBC.

Orientation facilitators

Commercial orientation of the university: As Davey *et al.* (2011) state, the more commercial the orientation of the university is, the more likely the cooperation could be. The commercial orientation of the university is a UBC facilitator since this implies proximity in relation to knowledge (Davey *et al.*, 2018).

Interest of the university in accessing company knowledge: As well as the interest of businesses in accessing scientific knowledge (Davey *et al.*, 2011), another important element for the development of the UBC is the interest of the university in the scientific knowledge of companies (Davey *et al.*, 2018).

Scientific orientation of the company: As previously stated, universities focus on generating and disseminating new basic knowledge whereas businesses usually seek directly applicable knowledge to provide short-term economic value (Dasgupta *et al.*, 1994; Henderson, McAdam and Leonard, 2006; Bruneel, D´Este and Salter, 2010). Academic science tends to be oriented towards long-term, curiosity-driven research while businesses are interested in short- and medium-term outcomes (Perkmann, Neely and

[6] Personal bonds refer to the interplay between individuals involved in cooperation (Plewa, Korff, Baaken, *et al.*, 2013).

Walsh, 2011). On account of these differences, the scientific orientation of the company will facilitate cooperation with universities since it diminishes these disparities (Davey *et al.*, 2011, 2018).

Existence of funding: A lack of resources and funding to undertake cooperation is a well-known hindrance to cooperation (Richard, Howells and Ramlogan, 2012). Government funding, grants or tax credits play a key role in the promotion of UBC (Ankrah and Al-Tabbaa, 2015). The provision of these resources represents an important driver of UBC (Davey *et al.*, 2011, 2018; García-Pérez-de-Lema *et al.*, 2017).

R&D facilities access: In addition to the availability of funding, resource availability such as access to R&D facilities is known to be a UBC driver (Davey *et al.*, 2011; Galán-Muros, 2016).

Attractive IP conditions: As the UBC literature states, conflicts with regard to intellectual property (IP) arise between companies and universities when research projects finish (Hall, Link and Scott, 2001). As Bruneel, D´Este and Salter (2010) observe, companies try to take ownership of the entire results for their commercialisation and this may involve a conflict of interests. Attractive IP conditons for companies are viewed as UBC facilitators (Davey *et al.*, 2011, 2018).

UBC barriers

Differing motivations, lack of people with business knowledge within universities, differing time-horizons, lack of government funding and bureaucracy are some of the most important UBC barriers for European companies (Davey *et al.*, 2018). One of the most common assumptions in the UBC literature is that once barriers are overcome, cooperation happens. However, removing a barrier does not necessarily invite UBC but rather it makes possible (Davey *et al.*, 2018). Therefore, one of the most essential keys for UBC success is the identification and knocking down of barriers (Muscio and Vallanti, 2014; Galán-Muros and Plewa, 2016).

Identification of UBC barriers has caught the attention of several scholars, giving rise to multiple analyses regarding barriers from both the business and university side (e.g. Bekkers and Bodas Freitas, 2010; Bruneel, D´Este and Salter, 2010; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018). Barriers faced by companies are diverse and as shown previously, the impact of these on UBC also varies depending on the relationship stage and the UBC activity type (Plewa, Korff, Johnson, *et al.*, 2013; Al-Tabbaa and Ankrah, 2016; Estrada *et al.*, 2016; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018).

Recent studies have classified UBC barriers according to their nature. Example of these are the classifications proposed by Lopes and Lussuamo (2020) and Davey *et al.* (2018). Whilst Lopes and Lussuamo (2020) differentiated (i) barriers imposed by the business sector, (ii) appropriation of research results, (iii) asymmetry of information and (iv) cultural differences, Davey *et al.* (2018) classified (i) awareness, (ii) funding and resources, (iii) internal, (iv) results and (v) cultural barriers.

Below the main UBC barriers found in the literature review are described and developed, following in turn the classification developed by Davey *et al.* (2018).

Awareness barriers

As well as any other strategic alliance, UBC starts with an initial process in which invididuals and organisations become aware of each other and their offering, identify a potential partner and develop preliminary discussions prior to obtaining an agreement (Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). Awareness of the possibilities offered by engaging in UBC and having connections and appropriate initial contact persons are essential to establish an initial approach (Davey *et al.*, 2012, 2018; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). UBC studies have recognised awareness as one of the most important barriers to UBC (Muscio and Pozzali, 2013; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018).

Funding and resources

Another major barrier found in the literature is the lack of resources to undertake cooperation regardless of where or when financial constraints appear (Richard, Howells and Ramlogan, 2012). Several authors acknowledge own or government's lack of resources/funding as a main barrier for UBC (Carayol, 2003; Laukkanen, 2003; Bercovitz and Feldman, 2006; Perkmann, Neely and Walsh, 2011; van Der Sijde, 2012; Plewa, Korff, Johnson, *et al.*, 2013; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018).

Results barriers

Discrepancies regarding targeted results of the cooperation can be a hindrance to UBC (Davey *et al.*, 2018). The focusing approach on producing scientific outcomes (e.g. papers) by universities can move businesses away from cooperation. This approach can generate conflicts regarding publication of the research results (Tennenhouse, 2004; Davey *et al.*, 2011, 2012, 2018). A lack of absorptive capacity on the business side is also considered a result barrier since businesses need to be able to acquire, assimilate, transform and exploit university knowledge (Cohen and Levinthal, 1989; Zahra and George, 2002; Biedenbach, Marell and Vanyushyn, 2018).

Internal barriers

Some UBC barriers are related to businesses' internal characteristics. As Galán-Muros and Plewa (2016) indicated, the internal and external bureaucratic processes that businesses have to face in order to cooperate with universities can hinder cooperation. UBC bureaucracy processes may include rules and regulations taxed by universities or governments (Perkmann, Neely and Walsh, 2011), and an extensive inflexible bureaucracy holds up cooperation (Siegel, Waldman and Link, 2003). Another obstacle related to internal barriers is the lack of continuity in business research strategies or a high staff turnover (Davey *et al.*, 2012, 2018; Muscio and Vallanti, 2014). High staff turnover by university or companies is a major impediment to cooperation as it interrupts or slows down cooperation processes.

Cultural barriers

Many scholars have identified cultural barriers as one of the main obstacles to undertake UBC (Siegel *et al.*, 2001; Bruneel, D´Este and Salter, 2010; Perkmann, Neely and Walsh, 2011; Bouncken, Pesch and Reuschl, 2016; Davey *et al.*, 2018). Each partner has their own values, norms, principles and beliefs (Al-Tabbaa and Ankrah, 2016), thus differences between these institutional aspects can create disagreement between partners (Muscio and Vallanti, 2014). Factors such as different time horizons and communication styles (universities and businesses do not share the same language) are elements that differ between both parties (Galán-Muros and Plewa, 2016). As seen in Rosendo-Ríos, Ghauri and Zhang (2016), communication is one of the most important elements in both UBC satisfaction and long-term relationships.

Thus, frequent communication, and the development of common knowledge platforms and an understanding of each other's aims (Thune, 2011) creates the foundation for successful UBC (Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004). Finding an appropriate 'language' suitable for both partners is essential since academics and business professionals may employ different languages, which can lead to misunderstandings (Baba, Shichijo and Sedita, 2009).

Although universities have evolved towards an entrepreneurial university stage (Etzkowitz, 1998; Guerrero and Urbano, 2012; Eizaguirre *et al.*, 2020), there are still differences in their aims and motivations with regard to UBC (Ankrah *et al.*, 2013; Muscio and Vallanti, 2014; Davey *et al.*, 2018; Lopes and Lussuamo, 2020). Universities focus on generating and disseminating new basic knowledge whereas businesses usually seek directly applicable knowledge to provide short-term economic value (Dasgupta *et al.*, 1994; Henderson, McAdam and Leonard, 2006; Bruneel, D´Este and Salter, 2010). Academic science tends to be oriented towards long-term, curiosity-driven research while businesses are interested in short- and medium-term outcomes (Bayona Sáez, García Marco and Arribas Huerta, 2002; Perkmann, Neely and Walsh, 2011). Therefore, the conception of time regarding goals, deadlines and results is frequently different and a likely point of conflict (Santoro and Chakrabarti, 2002; van Der Sijde, 2012). Nevertheless, some businesses take a long-term approach to their innovation efforts (Perkmann, Neely and Walsh, 2011), thereby decreasing the difference in time horizons, which is considered a crucial barrier (Phan and Siegel, 2006; Muscio and Vallanti, 2014).

With regard to cultural barriers, it should be also noted that a lack of people with business knowledge within universities and a lack of people with scientific knowledge within companies can also curb cooperation (Muscio and Vallanti, 2014; Davey *et al.*, 2018).

2.4.1.2. Dynamic nature of UBC drivers and barriers

As indicated above, one of the most important characteristics of UBC is its dynamic nature and the wide range of activities in which it can be developed. These nuances make UBC drivers and barriers behave in different ways depending on the developed UBC activity type (Galán-Muros and Plewa, 2016) and the relationship stage (Plewa, Korff, Johnson, *et al.*, 2013).

With regard to the broad range of UBC activity types, the study[7] carried out by Galán-Muros and Plewa, (2016) showed that UBC drivers significantly affected the development of curriculum co-design and co-delivery, lifelong learning, student mobility, staff mobility, R&D, entrepreneurship and commercialisation whilst barriers had more diverse effects on them.

As regards UBC's dynamic nature, Plewa, Korff, Baaken, *et al.* (2013) studied the impact of relational drivers, such as communication, trust, mutual understanding and interrelationship between individuals on cooperation performance across three stages of evolution. The study showed that only communication was

[7] The study included *connections*, *funding*, *organisational culture* and *internal characteristics* as UBC barriers and *resource availability a*nd *relationships* as UBC drivers.

a consistent predictor of success across all the stages. Similarly, Estrada *et al.* (2016) analysed the changing effect of interpartner dissimilarities[8] in cooperation success. The findings obtained revealed that interpartner dissimilarities are not problematic at start-up stage, whereas these complicate the execution stage. This result was sustained with the results obtained by Al-Tabbaa and Ankrah (2016) who analysed the changing dynamics of social capital dimensions during the preformation and postformation stages of UBC. Their results showed that the impact and interaction of social capital dimensions were not static but varied rather over time.

2.4.2. Organisational context-related factors

The resource-based view of the firm (RBV) (Wernerfelt, 1984; Barney, 1991), based on the seminal work of Penrose (1959), took on an inward-looking view of the business that conceptualised companies as heterogeneous entities composed of idiosyncratic resources (Lavie, 2006). Resources are understood as any type of tangible or intangible asset, such as organisational processes, knowledge capabilities and other potential sources of competitive advantage that are owned or controlled by the firm (Barney, 1991).

The RBV highlights the heterogeneity of companies, the role of internal attributes in business strategy and establishes that what a firm possesses will determine what it accomplishes (Das and Teng, 2000). According to the RBV, companies' resources are good indicators of the likelihood of firms entering into strategic alliances since businesses engage if there is a fit between one organisation's resource need and another's resource provision (Das and Teng, 2000; Miotti and Sachwald, 2003). Under the RBV approach, each partner will bring valuable resources and the type of resources that firms contribute are key to predicting the structure of the alliance.

Alliance literature notes that there must be a resource alignment among partners in order to engage in cooperation. Highly compatible goals and a shared understanding of the business rationale can achieve this alignment, bringing similar or dissimilar resources. Complementary alignment brings something new and non-redundant to the alliance and it is critical to the success of alliances (Das and Teng, 2000; Miotti and Sachwald, 2003). Based on the RBV theory, companies engage in specific alliances in order to acquire the complementary resources that they cannot achieve on their own (Das and Teng, 2000).

As Miotti and Sachwald (2003) stated, the RBV can answer three main questions: Why do business cooperate? Who does and with whom? Notwithstanding, Gulati (1999) and Lavie (2006) stated that traditional perspectives on RBV cannot explain how firms gain competitive advantage in an environment where firms maintain continuous and multiple cooperative relationships with alliance partners. Therefore, these authors suggested extending the RBV (firms and their resources) with the social network theory (the value of external ties) with the aim of considering the network as a resource itself. As Gulati (1999) stated, rather than inherent to the firm, network resources reside in the networks in which firms are placed.

[8] The study differentiated between routine-based dissimilarities (differences in partners' behaviours) and orientation-based dissimilarities (differences in partners' aims and expectations).

The RBV and the social network theory are one of the cornerstones of the analysis of UBC in management literature (Miotti and Sachwald, 2003; Vega-Jurado *et al.*, 2010). Drawing on this theory, companies engage in a specific UBC activity type depending on their characteristics, capacities and resources, which determine in turn, the objective of cooperation (Miotti and Sachwald, 2003; Vega-Jurado *et al.*, 2010).

As previously stated, corporate characteristics, capacities and resources are considered UBC determinant contextual elements (Galán-Muros and Davey, 2017) since these can shape businesses' engagement and cooperation levels (Davey *et al.*, 2011, 2018; Perkmann, Neely and Walsh, 2011; Muscio and Vallanti, 2014; Galán-Muros and Plewa, 2016). As seen so far, innovation (Perkmann, Neely and Walsh, 2011) and absorptive capacity (Davey *et al.*, 2011, 2018; Muscio and Vallanti, 2014; Galán-Muros and Plewa, 2016) are among the most frequently discussed. However, as was observed in the literature review, a large number of corporate characteristics, capacities, and resources may determine cooperation with universities (see Table 6).

Category	**Factor**	**Authors**
General business characteristics	Industry	Meyer-Krahmer and Schmoch (1998); Salter and Martin (2001); Schartinger *et al.* (2002); Cohen, Nelson and Walsh (2002); Belderbos *et al.* (2004); Giuliani and Bell (2005); Balconi and Laboranti (2006); Fontana, Geuna and Matt (2006); D´Este and Patel (2007); Bekkers and Bodas Freitas (2008); Gilsing *et al.* (2011); Verbano, Crema and Venturini (2015); Parmentola, Ferretti and Panetti (2020)
	Location	Breschi and Lissoni (2001); Singh (2005); D´Este and Patel (2007); Eom and Lee (2010); Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, (2010); Davey *et al.* (2011), (2018); Hervas-Oliver, Albors-Garrigos and Baixauli (2011); Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano (2015); Galán-Muros (2016); Skute (2019); Alpaydın and Fitjar (2020); Sharma (2020)
	Legal form	Davey *et al.* (2018)
	Headquarters	Lopes and Lussuamo (2020)
	Business group	Belenzon and Berkovitz (2010); Ferrer-Lorenzo, Abella-Garcés and Maza-Rubio (2017); Komera, Jijo Lukose and Sasidharan (2018)
	Age	Autio, Sapienza and Almeida (2000); Gopalakrishnan, Scillitoe and Santoro (2008); Merchán Hernández (2010); García-Pérez-de-Lema *et al.* (2017); Davey *et al.* (2018)
	Size	Acosta Ballesteros and Modrego Rico (1998); Agrawal (2001); Bayona Sáez, García Marco and Arribas Huerta (2002); Abramovsky *et al.* (2009); Arza and López (2011); Hervas-Oliver, Albors-Garrigos and Baixauli (2011); De Fuentes and Dutrénit (2012); Hewitt-Dundas (2013); González-Benito, Muñoz-Gallego and García-Zamora (2016); Davey *et al.* (2018); Alunurm, Rõigas and Varblane (2020)
	Turnover	Ortega-Argilés, Vivarelli and Voigt (2009); Hervas-Oliver, Albors-Garrigos and Baixauli (2011)
	Exports	Soete (1987); Grossman and Helpman (1995); Autio, Hameri and Nordberg (1996); Sousa, Martínez-López and Coelho (2008); Rodil, Vence and Sánchez (2016); Alunurm, Rõigas and Varblane (2020)
	Technological level	Laursen and Salter (2004); Heidenreich (2009); Santamaría, Nieto and Barge-Gil (2009); Hervas-Oliver, Albors-Garrigos and Baixauli (2011); Vanhaverbeke and Cloodt (2014); Hirsch-Kreinsen (2015a), (2015b); Verbano, Crema and Venturini (2015); Parmentola, Ferretti and Panetti (2020)
	Employees' qualification	Cohen and Levinthal (1990); Keller (1996); Veugelers (1997); Cassiman and Veugelers (2002); Singh (2005); Bishop, D'Este and Neely (2011); Hervas-Oliver, Albors-Garrigos and Baixauli (2011); García-Pérez-de-Lema *et al.* (2017); Kobarg, Stumpf-Wollersheim and Welpe (2018)
	Gender	Gilligan (1993); Azagra-Caro (2007); Perkmann and Walsh (2007); Goktepe-Hulten (2010); Carli and Eagly (2016); Zhang, Yuan and Wang (2019)
Business openness	External search breadth	Laursen and Salter (2004), (2006); Arza and López (2011); De Fuentes and Dutrénit (2012); Guerrero, Urbano and Herrera (2019)
	Cluster association	D'Este, Guy and Iammarino (2013); Alpaydın and Fitjar (2020)
	Informal interactions	Rappert, Webster and Charles (1999); Cohen, Nelson and Walsh (2002); Perkmann and Walsh (2007); Bruneel, D´Este and Salter (2010); Plewa, Korff, Johnson, *et al.* (2013); Azagra-Caro *et al.* (2017); García-Pérez-de-Lema *et al.* (2017); Mascarenhas *et al.* (2018)

Table 6. Classification of the organisational context-related factors that may have an impact on UBC

Category	Factor	Authors
Research and development	R&D intensity	(Veugelers, 1997; Schartinger *et al.*, 2002; Miotti and Sachwald, 2003; Mohnen and Hoareau, 2003; Laursen and Salter, 2006; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Grimpe and Sofka, 2009; Bekkers and Bodas Freitas, 2010; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; De Fuentes and Dutrénit, 2012; Bodas Freitas, Geuna and Rossi, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018; Rõigas, Mohnen and Varblane, 2018)
	R&D continuity	Narula (2001); Miotti and Sachwald (2003); Mohnen and Hoareau (2003); Hanel and St-Pierre (2006); Laursen and Salter (2006); Hervas-Oliver, Albors-Garrigos and Baixauli (2011); De Fuentes and Dutrénit (2012); Ritala and Hurmelinna-Laukkanen (2013); Kobarg, Stumpf-Wollersheim and Welpe (2018)
	R&D program knowledge and participation	Veugelers (1997); Cassiman and Veugelers (2002); Mohnen and Hoareau (2003); Negassi (2004); Fontana, Geuna and Matt (2006); Abramovsky *et al.* (2009); Barge-Gil (2010); Bekkers and Bodas Freitas (2010); De Fuentes and Dutrénit (2012); Guerrero, Urbano and Herrera (2019)
Lifelong learning (LLL)	LLL commitment	Cohen and Levinthal (1990); Gatignon and Xuereb (1997); Sinkula, Baker and Noordewier (1997); Freel (2005); Santamaría, Nieto and Barge-Gil (2009); Eshlaghy and Maatofi (2011); Hirsch-Kreinsen (2015a); Khalil and Mehmood (2018); Kobarg, Stumpf-Wollersheim and Welpe (2018); Carrasco-Carvajal and García-Pérez-De-Lema (2020)
Absorptive capacity (AC)	AC	Cohen and Levinthal (1989), (1990); Mowery, Oxley and Silverman (1996); Tsai (2001); Zahra and George (2002); Lane, Koka and Pathak (2006); Easterby-Smith, Lyles and Tsang (2008); Bruneel, D´Este and Salter (2010); Hervas-Oliver, Albors-Garrigos and Baixauli (2011); Hewitt-Dundas (2013); Peer and Penker (2014); Veugelers and Rey (2014); Lehmann and Menter (2016); García-Pérez-de-Lema *et al.* (2017); Biedenbach, Marell and Vanyushyn (2018); Kobarg, Stumpf-Wollersheim and Welpe (2018)
Innovation	Innovation capacity	Laursen and Salter (2004); Eom and Lee (2010); Arza and López (2011); De Fuentes and Dutrénit (2012); Samson and Gloet (2014); Carrasco-Carvajal and García-Pérez-De-Lema (2020)
	Innovation degree	Hagedoorn (1993); Green, Gavin and Aiman-Smith (1995); Kaufmann and Tödtling (2001); Belderbos *et al.* (2004); Laursen and Salter (2006); Eom and Lee (2010); Perkmann, Neely and Walsh (2011); Janeiro, Proença and Gonçalves (2013); Vega-Jurado, Kask and Manjarrés-Henriquez (2017); Lin (2017); Guerrero, Urbano and Herrera (2019)
UBC willingness and support	UBC willingness and support	Fontana, Geuna and Matt (2006); Lai (2011); Qiao and Li (2015); Galán-Muros *et al.* (2017); Davey *et al.* (2018)

Table 6. (cont.) Classification of the organisational context-related factors that may have an impact on UBC

The following sub-section deals with the description of the business characteristics, capacities and resources that can determine cooperation with universities and their participation in the different UBC activities. Throughout the study, these factors are referred to as *organisational context-related factors.* Due to the large number of factors found in the literature review, these were grouped as follows according to their nature:

1. *General business characteristics*
2. *Business openness*
3. *Research & Development*
4. *Lifelong learning*
5. *Absorptive capacity*
6. *Innovation*
7. *UBC willingness and support*

2.4.2.1. General business characteristics

The resources and capabilities of businesses determine their ability to achieve competitive advantage. The key innovation challenges that companies face are liabilities associated with business characteristics such as age and size (Guerrero, Urbano and Herrera, 2019). Business characteristics can also determine UBC, since certain characteristics of business are likely to limit cooperation with universities (Galán-Muros, 2016). The following sub-sections describe the general characteristics of the companies that may determine cooperation with universities.

Industry

Despite industrial companies are more prone to cooperate with universities than other kind of companies, due to their closeness with R&D (Hicks *et al.*, 2001), differences appear between industrial sectors (Pavitt, 1984; Meyer-Krahmer and Schmoch, 1998; Salter and Martin, 2001; Schartinger *et al.*, 2002; Cohen, Nelson and Walsh, 2002; Belderbos *et al.*, 2004; Giuliani and Bell, 2005; Balconi and Laboranti, 2006; Fontana, Geuna and Matt, 2006; D´Este and Patel, 2007; Bekkers and Bodas Freitas, 2008; Gilsing *et al.*, 2011; Parmentola, Ferretti and Panetti, 2020).

As several authors indicate, industries vary in relation to their learning patterns and technological development, causing differences in relation to UBC levels and activities developed (Pavitt, 1984; Salter and Martin, 2001; Belderbos *et al.*, 2004; Bekkers and Bodas Freitas, 2008;Verbano, Crema and Venturini, 2015). With regard to UBC activities, existing studies have observed that:

- Mechanical engineering companies tend to cooperate in research and consulting activities (Meyer-Krahmer and Schmoch, 1998; Schartinger *et al.*, 2002),
- Engineering companies are likely to cooperate in activities regarding contract research, cooperative research and mobility of students (Bekkers and Bodas Freitas, 2008),
- Aeroespace, mechanical, manufacturing, material engineering companies are prone to cooperate in cosultancy and joint research (D´Este and Patel, 2007),
- Electrical and electronic companies seem to be more prone to cooperate in activities regarding mobility of students (Balconi and Laboranti, 2006),
- Chemical, materials and pharmaceutical companies mainly cooperate in patenting (Elliot, Levin and Meisel, 1988; Cohen, Nelson and Walsh, 2002),
- Biotechnological and pharmaceutical companies are predominant in publications (Cohen, Nelson and Walsh, 2002).

Even though companies in fast-developing technological sectors seem to be more prone to cooperate with universities, since these need to be active in the exploration of diverse technologies (Belderbos *et al.*, 2004), as seen in Bekkers and Bodas Freitas (2008, p.1839) “a weak science linkage of a technology (i.e. technological proximity between university research and technology development in the industry) does not necessarily imply a low university-industry interaction” (Meyer-Krahmer and Schmoch, 1998). Accordingly, Parmentola, Ferretti and Panetti (2020) observe that UBC does not follow a sectoral pattern.

Location

The regional environment: its characteristics, resources and support mechanism are essential in the development of UBC (Galán-Muros, 2015). The region in which the company is located can shape the likelihood of the company to cooperate. Factors such as geographical proximity between universities and businesses (Breschi and Lissoni, 2001; Singh, 2005; Davey *et al.*, 2011, 2018; Galán-Muros, 2016; Sharma, 2020), knowledge industrialisation (Eom and Lee, 2010) and industry concentration (D´Este and Patel, 2007; Sharma, 2020) are considered key determinants of UBC. In turn, the importance of regional context is also highlighted by the relevance of regional UBC support structures that seek to foster cooperation between both spheres (Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, 2010; Davey *et al.*, 2018).

As the literature notes, universities in regions with a favourable economic situation are more prone to cooperate with businesses (Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano, 2015). UBC success stories such as Route 128 or Silicon Valley in the USA, Cambridge in the UK, or Oulu in Finland (Laukkanen, 2003) have occurred in regions with high-tech industries, well reputed universities and other research infrastructures (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011).

Legal form

The European-level study on the state of UBC developed by Davey *et al.* (2018) showed that, the most likely business co-operators in Europe were large and publicly-owned businesses. Although there is no clear evidence, the legal form of the company could condition cooperation.

Headquarters

As Lopes and Lussuamo (2020) stated, companies whose headquarters are located outside the region under study can influence cooperation negatively. Whether the company is a headquarter or not could determine UBC.

Business group

Business groups constitute a high percentage of companies in Europe and group affiliates are more innovative than standalones (Belenzon and Berkovitz, 2010). As the literature states, companies belonging to business groups feel more protected and have better access to competitive resources, including technology, innovation and funding (Ferrer-Lorenzo, Abella-Garcés and Maza-Rubio, 2017). The study carried out by Komera, Jijo Lukose and Sasidharan (2018) showed that affiliation to a business group has positive influence on firms' R&D activities. Since companies belonging to a business group have greater resources and more R&D activity, affiliation with a business group may imply greater cooperation with universities.

Age

As Autio, Sapienza and Almeida (2000) indicated, business age can influence knowledge acquisition and exploitation. In turn, Gopalakrishnan, Scillitoe and Santoro (2008) stated that a higher capacity and ability to change characterise younger firms. With regard to UBC, the study developed by García-Pérez-de-Lema *et al.* (2017) demonstrated the existence of differences between young and mature companies. In this study, authors observed that younger firms were characterised by having relational relationships (interpersonal links of trust) that promoted to a higher extent contractual relationships with universities. However, Merchán Hernández (2010) showed that old and consolidated companies showed more intensive strategies for cooperation with universities than younger ones. In the case of the study undertaken by Davey *et al.* (2018), the authors did not find a clear pattern. On the one hand, the authors saw that as the company gets older, it is more prone to cooperate with businesses at higher levels in education. On the other hand, they observed that newer business cooperated more than older ones in valorisation-related activities.

Size

SMEs are seen as vital to economic development (Birchall and Giambona, 2007) and thus, Autio, Hameri and Nordberg (1996) suggested that cooperation with universities in R&D should not be limited to large companies. The study developed by Acosta Ballesteros and Modrego Rico (1998) showed that size did not predict the participation of a company in public-funded joint R&D projects. Nevertheless, the results of the study undertaken by Bayona Sáez, García Marco and Arribas Huerta (2002) showed that large companies are more prone to cooperate in R&D projects with universities. This finding is supported by Hervas-Oliver, Albors-Garrigos and Baixauli (2011), who indicated that large companies have a greater capacity to absorb knowledge from universities and have easier access to participating in public cooperative programmes.

SMEs have to face resource, funding and time limitations (Bayona Sáez, García Marco and Arribas Huerta, 2002; Gray and Mabey, 2005; González-Benito, Muñoz-Gallego and García-Zamora, 2016). In the same fashion, this type of company has fewer opportunities for technological training and development, and fewer management skills than larger organisations (Birchall and Giambona, 2007). Besides, they lack knowledge about how and where to acquire the necessary competences (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). As Bayona Sáez, García Marco and Arribas Huerta (2002) indicated, the reasons why small enterprises do not cooperate in funded joint R&D projects may relate to a lack of information and excessive bureaucracy in the procedures. From an RBV perspective, these constraints can have an impact on cooperation with universities. The studies developed by Davey *et al.* (2018), González-Benito, Muñoz-Gallego and García-Zamora (2016) and Abramovsky *et al.* (2009) showed that the way in which companies cooperate with universities was conditioned by business size. As Davey *et al.* (2018) stated, as companies get larger, long-term cooperation in the areas of education and management is more likely. Along these lines, the study undertaken by Abramovsky *et al.* (2009) showed that in Spain, particularly in the manufacturing sector, larger firms were more likely to engage in cooperative R&D projects in order to overcome financial constraints and excessive perceived economic risk. Nevertheless, this study also found that in other European countries there was no significant relationship between size and R&D cooperation.

As regards business size, it must be highlighted that the study developed by Hewitt-Dundas (2013) showed that smaller companies were more likely to cooperate with regional universities than larger ones. As the authors stated, as cognitive proximity increases, the dependency on co-location in knowledge transfer activities decreases.

Turnover

As Hervas-Oliver, Albors-Garrigos and Baixauli (2011) indicate, investment in R&D projects by SMEs can be limited due to problems of restricted cash flow or the inability to spend the minimum amount required to generate results. Business size appears to be correlated with the availability and stability of internally-generated funds (Ortega-Argilés, Vivarelli and Voigt, 2009). A lack of financial resources limits the ability of small companies to withstand unfavourable market conditions and this may hinder UBC.

Exports

Even though large companies are more likely to cooperate with universities, small companies with strategic goals to internationalise their business activities are potential candidates for cooperation (Autio, Hameri and Nordberg, 1996). Exporting[9] companies need to improve the quality of their products in order to expand (Grossman and Helpman, 1995), making them more likely to cooperate with universities for R&D or innovation development. Internationalisation literature has shown the existing causality between R&D and innovation with exports (Soete, 1987; Sousa, Martínez-López and Coelho, 2008; Rodil, Vence and Sánchez, 2016). In addition, exporting companies may present higher innovation and absorptive capacity levels due to the "learning-by-exporting" effect. Exporting firms acquire overseas experience, know-how and technology in the global markets (Grossman and Helpman, 1995), leading to the development of their capacities (Rodil, Vence and Sánchez, 2016) and an increased likelihood of their cooperating with universities. Although the vast majority of the references found in the literature indicated a positive relationship between exporting and UBC, the study carried out by Alunurm, Rõigas and Varblane (2020) showed a contradictory result. As these latter authors stated, small-export oriented companies may not find competences in higher education institutions (HEIs). Consequently, they are less likely to engage with them.

Technological level

One of the main motivators for businesses to cooperate with universities is to gain access to new technology and knowledge, thereby enhancing their knowledge bases (Davey *et al.*, 2018). Friedman and Silberman (2003) noted that technology transfer is higher in regions close to a concentration of high-tech firms. Consequently, the vast majority of studies that seek to analyse knowledge search patterns are mostly focused on medium-high and high-tech industries (Katila and Gautam, 2002).

As Laursen and Salter (2004) stated, the technological capacity of the firm (measured as the internal R&D investment) is related to the use of universities as a source of knowledge for innovation. Moreover, Verbano, Crema and Venturini (2015) showed that it is important to differentiate between low-tech and high-tech SMEs since their cooperation approach varies. In this vein, open innovation was initially associated with high-tech industries where technological breakthroughs are an important form of innovation (Vanhaverbeke and Cloodt, 2014). However, as the literature notes, there is no reason to believe that medium-low and low-tech companies are less likely to be able to face open innovation challenges than R&D intensive firms are (Bender and Laestadius, 2005). As Santamaría, Nieto and Barge-Gil (2009) indicated, innovation in low-medium technology companies is not usually based on the latest scientific or technological knowledge but these firms depend on non-formal R&D activities and the use of external knowledge. Given their lack of R&D resources, the innovation process in low-medium technology industries is characterised by being primarily based on practical experience and knowledge that is implicit to their manufacturing processes (Heidenreich, 2009; Hirsch-Kreinsen, 2015a).

[9] As Azar and Ciabuschi (2017) stated, exporting is one of the most common ways of entering international markets, enabling companies to increase profits and ensure survival in a highly globalised market place.

Employees' qualification

Employees' qualification level and training can determine the absorptive capacity of companies, what is considered to be closely related to UBC (Cohen and Levinthal, 1990; Keller, 1996; Veugelers, 1997; Cassiman and Veugelers, 2002; Kobarg, Stumpf-Wollersheim and Welpe, 2018). In this line, the study undertaken by Hervas-Oliver, Albors-Garrigos and Baixauli (2011) pointed out that human resources are the core drivers of cooperation engagement with universities in R&D. As García-Pérez-de-Lema *et al.* (2017) noted, SME's R&D cooperation strategies depend on two main factors: (i) companies' absorptive capacity and (ii) their ability to develop personal relationships within their environments (Singh, 2005; Bishop, D'Este and Neely, 2011). In the case of UBC, the availability of employees with a higher education degree can also facilitate these relational aspects, since having a prior relationship with university partners is one of the most important drivers for cooperation (Davey *et al.*, 2018).

Gender

As seen in Liao, Zhang and Wang (2019), the feminist caring theory states that females in general have a stronger tendency toward altruism (Gilligan, 1993), are more concerned with the ethics of "relationships and responsibilities" and may be more concerned about the relationship between firms and stakeholders due to "empathy and care" (Carli and Eagly, 2016). However, the analysis of the academic engagement with companies shows that males are more prone to cooperate than female (Azagra-Caro, 2007; Goktepe-Hulten, 2010). As the literature states, this predisposition is especially given in commercialisation, informal knowledge transfer and entrepreneurial activities (Perkmann and Walsh, 2007). Notwithstanding, no references have been found in the literature review about the impact of gender on UBC from a business perspective; therefore, the role of gender is unclear.

2.4.2.2. Business openness

In addition to the strategic needs of firms, social opportunities and informal interactions can also shape alliance formation (Eisenhardt and Schoonhoven, 1996; Plewa, Korff, Johnson, *et al.*, 2013). Several studies have noted that networks and interpersonal relationships play a pivotal role in the cooperative strategies of companies (Singh, 2005; Bishop, D'Este and Neely, 2011; Ceci and Iubatti, 2012). Besides, a firm's openness also plays a key role, since a greater openness culture to external ideas has a positive influence on a company's R&D performance while moderating cooperation (Fey and Birkinshaw, 2005).

Social interactions, networks and a firm's openness are essential in the current paradigm of "open innovation" (Chesbrough, 2003), a paradigm involving UBC (Perkmann and Walsh, 2007). Given this importance, the following sub-section focuses on the business characteristics that represent a company's openness. These characteristics are summarised below.

External search breadth

"Open innovation" (Chesbrough, 2003) has become increasingly popular both in academic research and industry practice (Chesbrough and Bogers, 2014). As Ceci and Iubatti (2012) stated, companies belonging to networks are more innovative than isolated ones. Companies are frequently investing considerable amounts of time, money and other resources in the external search for new innovative opportunities. And these investments improve the ability of companies to create, use and recombine new and existing knowledge (Ceci and Iubatti, 2012).

Laursen and Salter (2006) pointed out that a combination of partners supports innovation performance and enables sustainable competitive advantage. A combination of commercial and technical (scientific) skills reduces market uncertainty (Laursen and Salter, 2006) and, as Guerrero, Urbano and Herrera (2019) stated, cooperation with several partners simultaneously helps companies to be competitive and innovative while sharing potential challenges and risks. A diversified cooperation enables an effective exploration/exploitation of innovation.

In their research, Flor, Cooper and Oltra (2018) reported that access to a broad knowledge facilitates the understanding of new information and a market's potential changes. Cooperation with a wide range of partners enhances a firm's ability to detect technological or market opportunities, allowing companies to be flexible to adapt to unpredictable changes and develop radical innovations (Chesbrough, 2003; Ferreras-Méndez *et al.*, 2015; Ferreras-Méndez, Fernández-Mesa and Alegre, 2016; Flor, Cooper and Oltra, 2018). Some empirical studies (e.g. Laursen and Salter, 2006; Ceci and Iubatti, 2012) have shown that a company's search strategy can determine its innovative performance. Business search strategy can be defined by two main components: (i) external search breadth and (ii) external search depth. On the one hand, search breadth represents the number of external sources or search channels that firms involve in their innovation activities. On the other hand, external search depth refers to the extent to which firms draw deeply from the different external sources or search channels (Laursen and Salter, 2006; Flor, Cooper and Oltra, 2018). However, as mentioned in previous chapters, the presence of valuable external sources of knowledge does not mean that the flow of external new ideas and knowledge into firms is automatic or a simple process (Vanhaverbeke and Cloodt, 2014). Potential absorptive capacity (the ability to acquire and assimilate external knowledge) and realised absorptive capacity (the ability to transform and exploit external knowledge) (Jansen, Van Den Bosch and Volberda, 2005) are both required.

As Flor, Cooper and Oltra (2018) found out in their study, there is a positive effect between absorptive capacity and open innovation. In turn, some studies have remarked that open innovation is an antecedent of absorptive capacity (Ferreras-Méndez *et al.*, 2015; Ferreras-Méndez, Fernández-Mesa and Alegre, 2016). Hence, based on these theoretical underpinnings, it is estimated that companies with a greater external search breadth are more likely to cooperate with universities to a higher extent.

Cluster association

Under the definition of Porter (1998), a cluster is like a geographic concentration of interconnected companies and institutions in a particular field. Clusters group an array of linked industries such as suppliers of specialised inputs, e.g. components, machinery and services, and providers of specialised infrastructure. In addition, clusters also extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies, or common inputs. As the author stated, many clusters include governmental and other institutions, among which universities should be highlighted, that provide specialised training, education, information, research, and technical support.

The benefits of industrial clustering are focused on localised spillovers (Iammarino and McCann, 2006), that is, the advantage that diverse actors within the cluster acquire from accessing and using knowledge that another co-located actor spills over. Universities are generally considered to be key actors in the generation of this type of externality. Besides, since UBC stimulates the growth of such industrial clusters, university-business relationships are frequently associated with specialised spatial concentrations of firms (D'Este, Guy and Iammarino, 2013) and therefore, businesses belonging to cluster associations.

Informal interactions

Social opportunities and networks lead to the development of informal interactions between companies and universities. The performance of these non-formal links is essential for UBC since these connections can be a precursor of formal interactions (Plewa, Korff, Johnson, *et al.*, 2013). As Rappert, Webster and Charles (1999) showed, informal interactions between both spheres can create the necessary trust for formal engagement. In this fashion, it was observed that the development of informal interactions can reduce information asymmetry problems[10] in SMEs (García-Pérez-de-Lema *et al.*, 2017).

The participation of companies in public meetings, conferences or workshops and symposiums with university participation can generate the personal and professional links that lead to the development of formal cooperation activities (Cohen, Nelson and Walsh, 2002; Perkmann and Walsh, 2007; Plewa, Korff, Johnson, *et al.*, 2013; Azagra-Caro *et al.*, 2017).

2.4.2.3. Research and development

Development and investment in R&D is a highly relevant way of generating the inputs required for the innovation process (Kirner, Kinkel and Jaeger, 2009; Santamaría, Nieto and Barge-Gil, 2009). The key role of private R&D investment has been recognised as a main engine for productivity growth at both macro- and microeconomic levels (Ortega-Argilés, Vivarelli and Voigt, 2009). Accordingly, the acquisition of university knowledge has increased notably in recent years (Ankrah and Al-Tabbaa, 2015) since cooperation with universities in R&D projects not only complements internal R&D competences at lower cost, but also offers companies opportunities to conduct groundbreaking research in the long-term (Takanashi and Lee, 2019).

Given the importance of UBC for the development of R&D, governments in most developed economies have provided significant funding with the aim of fostering it (López, 2008). Consequently, joint R&D is one of the principal UBC activities (De Fuentes and Dutrénit, 2012). As previously noted, UBC literature has been focused mainly from the R&D perspective and the vast majority of the analysis has considered large companies with R&D departments (Ramos-Vielba, Fernández-Esquinas, & Espinosa-de-los-Monteros, 2010). However, R&D cooperation is crucial to maintain the competitiveness of all kinds of companies under the pressure of fast technological change (Lin and Yang, 2020).

[10] When universities are better informed about some issues of the knowledge exchange than companies, information asymmetry problems appear (Heide, 2003; García-Pérez-de-Lema *et al.*, 2017).

Despite the importance of cooperative R&D, notable differences emerge with respect to companies' and universities' R&D priorities (Lee, 2014) and for SMEs, universities can be a challenging partner to work with (Steinmo and Rasmussen, 2016). Hence, it is broadly recognised that companies do not see universities as a primary source for R&D partners (Schultz, Gretsch and Kock, 2020). Nevertheless, research-related UBC activities can vary from basic research projects to contract research projects, whose aim is an incremental improvement and therefore requires a different approach (Schultz, Gretsch and Kock, 2020). Consequently, cooperation can be adapted to different kinds of companies.

Due to the R&D approach acquired historically by UBC and the consequent governmental efforts made in this direction, it is implicit that companies undertaking R&D activities are more likely to cooperate with universities than those that do not carry out any kind of R&D activity. Notwithstanding, the way in which companies carry out R&D activities and the resources they have available for it may determine cooperation (Lin and Yang, 2020). The following sub-sections summarise and synthesise the R&D features that can have an impact on UBC engagement and activity development.

R&D intensity

R&D intensity and absorptive capacity have been closely linked (Laursen and Salter, 2006; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008). Therefore, the literature has analysed the effects of a company's R&D intensity on the exploitation of external knowledge sources (Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008). Generally speaking, the intensity of a firm's R&D activities strengthen its technological stock and make it more receptive to external knowledge (Veugelers, 1997).

Companies with high levels of R&D intensity are more able to exploit search channels (Laursen and Salter, 2006; Kobarg, Stumpf-Wollersheim and Welpe, 2018) and consequently, some studies (e.g. Laursen and Salter, 2006; Grimpe and Sofka, 2009) have highlighted R&D investment as a key determinant of a company's external knowledge search strategy Hervas-Oliver, Albors-Garrigos and Baixauli (2011). Veugelers (1997) noted that the companies that invest the most in internal R&D are more likely to engage in R&D cooperation. Accordingly, the study undertaken by Laursen and Salter (2006) showed a substitution effect between the magnitude of openness of a firm's external search strategy and R&D intensity.

As Miotti and Sachwald (2003) stated, companies that engage the most in R&D cooperation are high profile innovators. These kinds of companies invest heavily in R&D and use close-to-science sources of knowledge in their innovative process. Furthermore, these authors noted that R&D intensive companies cooperated with universities to complement resources at the technological frontier. Research obtained from cooperative projects complements, rather than replaces, R&D by collaborating firm (Hanel and St-Pierre, 2006).

As opposed to this perspective, the research undertaken by Mohnen and Hoareau (2003) showed that R&D-intensive firms and radical innovators tend to source knowledge from universities but not to cooperate directly with them. In this line, Hervas-Oliver, Albors-Garrigos and Baixauli (2011) showed that R&D expenditure was not a driver of the probability to engage in cooperation agreements with universities. Related to this last aspect, Kobarg, Stumpf-Wollersheim and Welpe (2018) highlighted that a high intensity of R&D may have negative aspects towards external cooperation. Issues such as organisational path dependence as well as secretiveness and reduced incentives for cooperation can slow down cooperation.

R&D continuity

The internal capabilities of companies, among which it is worth highlighting the continuity with which they carry out R&D activities, may determine their search for external knowledge (Miotti and Sachwald, 2003; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). As seen in Kobarg, Stumpf-Wollersheim and Welpe (2018), companies can be classified into the following categories according to the continuity of their R&D activities: (i) companies that do not carry out internal R&D, (ii) companies that carry out R&D activities irregularly and (iii) companies with a continuously staffed internal R&D department.

The study carried out by Hervas-Oliver, Albors-Garrigos and Baixauli (2011) asserted that companies which did not conduct in-house R&D and that had a minimum level of absorptive capacity in terms of non-R&D activities tried to search for external knowledge from the universities with the aim of complementing their own resources. This result is supported by the statement of Narula (2001), who noted that the lack of resources forced small companies to seek external knowledge, as they do not have choice if they wish to survive. In turn, Narula also hinted that some in-house capacity was required to make use of the externally acquired knowledge and use non-internal sources as substitutes for internal R&D. As opposed to these statements and from a tighter perspective, Mohnen and Hoareau (2003) noted that only companies that perform in-house R&D are able to extract knowledge from universities. This statement is contrary to the results of Hervas-Oliver, Albors-Garrigos and Baixauli (2011) who noted that companies developing internal R&D activities did not need to search for knowledge in universities since these can substitute university knowledge for their own in-house R&D effort. Under this same rationale, Ritala and Hurmelinna-Laukkanen (2013) suggested that a high absorptive capacity may generate concern about the benefits of cooperation, decreasing the willingness for knowledge share and transfer.

Large absorptive capacity is characterised by a large stock of internal knowledge and a strong internal R&D. When companies perceive their internal R&D to be strong, they do not perceive the value of cooperation (Kobarg, Stumpf-Wollersheim and Welpe, 2018). Besides, in these cases, the Not Invented Here (NIH) (Katz and Allen, 1987; Huston and Sakkab, 2006; Laursen and Salter, 2006; Lichtenthaler and Lichtenthaler, 2009; Kobarg, Stumpf-Wollersheim and Welpe, 2018) syndrome may confront internal resistance from at least some of the company's technical staff. As Kobarg, Stumpf-Wollersheim and Welpe (2018) noted, a higher internal R&D intensity and a continuously staffed internal R&D department has a negative effect if cooperation seeks an incremental innovation. As other authors indicate, this effect can be caused by the substitution effect (West and Bogers, 2014), a prevalence of path dependence (Atuahene-Gima, 2005) and the NIH phenomenon (Cohen and Levinthal, 1990; Lichtenthaler and Lichtenthaler, 2009). Nonetheless, as Laursen and Salter (2006) stated, if knowledge spillovers are perceived as valuable, this kind of company will value cooperative R&D.

R&D program knowledge and participation

Several scholars have highlighted the positive effect of public funding aimed at fostering R&D activities and cooperation (Veugelers, 1997; Cassiman and Veugelers, 2002; Negassi, 2004; Fontana, Geuna and Matt, 2006; Abramovsky *et al.*, 2009). However, as seen in Guerrero, Urbano and Herrera (2019) and Barge-Gil, (2010), it is noted that only a limited number of companies have access to information about public funding programs. Mohnen and Hoareau (2003) pointed out that differences between business and basic research institutions distance both institutions unless governments establish or force a link. As these latter authors stated, direct cooperation with universities is a characteristic of companies that receive government support for innovation.

2.4.2.4. Lifelong learning

According to Galán-Muros and Davey (2017) lifelong learning (LLL) is understood as the provision of adult education, permanent education and/or continuing education by universities to people employed in external organisations. LLL includes continuing education for business people and specific courses that respond to business needs (European Commission, 2009).

Despite LLL's still being an emerging activity (Galán-Muros and Davey, 2017), universities play a key role as a source of company training (Etzkowitz and Klofsten, 2005). Employees of companies can enrol in university courses, that can be adapted to regional skill needs (Gunasekara, 2006b), or specific in-house training programmes (Caniëls and Van den Bosch, 2011). This is essential since current markets require companies with a strong commitment to learning[11] (Calantone, Tamer and Yushan, 2002). A company's commitment to learning is the degree to which the company values and promotes learning. The more an organisation values learning, the more likely it is that learning will occur (Sinkula, Baker and Noordewier, 1997) and, therefore, the greater the investment will be in training and external cooperation. The commitment of companies with regard to LLL can determine cooperation with universities. The following sub-section describes the most significant characteristics related to LLL in companies that may have an impact on UBC.

LLL commitment

As seen in Carrasco-Carvajal and García-Pérez-De-Lema (2020), companies that have a commitment to learning develop technologies (Gatignon and Xuereb, 1997) and create new knowledge that favours innovation capability (Khalil and Mehmood, 2018). In addition, Sinkula, Baker and Noordewier (1997) and Eshlaghy and Maatofi (2011) noted that business' commitment to learning influenced the innovation capability of companies and Freel (2005) stated that the most innovative firms train staff more.

LLL is not limited to a specific kind of company (Leiponen, 2005). Given its importance, Laestadius, Pedersen and Sandven (2005) proposed a new system of innovation indicators that, in addition to measuring R&D intensity, included skill intensity as a measure related to the qualifications of staff and ongoing training. In a later study, Santamaría, Nieto and Barge-Gil (2009) reasserted that non-R&D activities, such as training, are crucial to understanding the innovation process of any firm. In this line, Hirsch-Kreinsen (2015a) highlighted that employee training is essential for innovation in non-R&D intensive low-medium technological companies.

As with the intensity or continuity of R&D, training and updating staff's knowledge is also linked to business absorptive capacity (Cohen and Levinthal, 1990; Santamaría, Nieto and Barge-Gil, 2009; Kobarg,

[11] This value influences whether an organisation is likely to promote a learning culture (Sinkula, Baker and Noordewier, 1997).

Stumpf-Wollersheim and Welpe, 2018). Hence, companies with a greater commitment to learning may be more able to cooperate more with universities.

Absorptive capacity

The role of universities in regional socio-economic development is increasingly acknowledged (Benneworth *et al.*, 2017). Nevertheless, it is essential to bear in mind that universities do not foster regional development autonomously since their regional effectiveness will be dependent on the regional absorptive capacity (hereafter AC) (Peer and Penker, 2014). Without absorptive and innovative capacity in the business sector, the ability to capitalise on opportunities arising from public research will be limited (Veugelers and Rey, 2014). As Lehmann and Menter (2016) stated, the AC of a region is a necessary condition for developing close UBC.

Cohen and Levinthal introduced the concept of AC for the first time[12] in 1989. AC is defined as the ability of companies to identify, assimilate, and apply new knowledge to commercial ends, with the aim of generating opportunities for profit (Cohen and Levinthal, 1989, 1990). As Cohen and Levinthal (1989) stated, the ability of a firm to continually acquire new external knowledge, in order to create a competitive advantage, is dependent on its organisational AC. Consequently, variations in businesses' AC levels can explain differences in knowledge transfer effectiveness among companies (Cohen and Levinthal, 1990; Zahra and George, 2002). Given its importance, the role of AC has not only been assessed in interorganisational knowledge transfer (Mowery, Oxley and Silverman, 1996; Easterby-Smith, Lyles and Tsang, 2008), it has also been analysed in intraorganisational cases, where knowledge transfer among business units has been studied (Hansen, 1999; Tsai, 2001; Jansen, Van Den Bosch and Volberda, 2005). In this vein, and from a multi-level perspective, it should be highlighted that AC can also be studied at organisational, group or individual level (Mariano and Walter, 2015). Nonetheless, it has to be said that individual and group level AC are dependent on organisational routines, which enable transfer of learning at the organisational level (Cohen and Levinthal, 1990; Lane, Koka and Pathak, 2006).

Viewed as a knowledge-based dynamic capability (Zahra and George, 2002), research into AC has become a relevant area within the field of organisational learning and knowledge management (Lane, Koka and Pathak, 2006). Furthermore, AC has become a useful construct in innovation literature for understanding why some businesses develop more innovative products and are more successful at innovation activities than others (Easterby-Smith, Lyles and Tsang, 2008). Several studies have shown the positive effect of AC on innovation processes and outcomes (García-Pérez-de-Lema *et al.*, 2017) and on the development of radical innovation (Flor, Cooper and Oltra, 2018).

Regarding the nature of AC, as Cohen and Levinthal (1989, 1990) noted, this is dependent on businesses' past investment in R&D and results from an accumulation of knowledge within the firm. Thus, it can be stated that its development is path-dependent (Cohen and Levinthal, 1990) and that businesses enjoying

[12] As seen in Lane, Koka and Pathak (2006), even if they did not coin it by any term, Mowery (1983) indicated prior to Cohen and Levinthal (1989) that the capacity to acquire external knowledge is a product of a business' own R&D.

relevant prior knowledge are more likely to understand the new technologies and knowledge that can be transformed into new ideas or products (Tsai, 2001).

Through the emergence of new studies, new ways of understanding the construct begin to appear. In this way, Zahra and George (2002) differentiated between the "potential" and "realised" dimensions of AC. This re-conceptualisation offers an explanation for the possible inefficiency of some firms in utilising their "potential" AC. On the one hand, potential AC (PAC) refers to knowledge acquisition and assimilation. This dimension captures efforts expended in identifying and acquiring new external knowledge and in assimilating knowledge obtained from external sources. On the other hand, realised AC (RAC) includes knowledge transformation and exploitation, and encompasses new insights and consequences from the combination of existing and newly acquired knowledge, incorporating transformed knowledge into operations (Zahra and George, 2002). These different dimensions were empirically validated through a further study developed by Jansen, Van Den Bosch and Volberda (2005), who analysed the different organisational antecedents to each element of AC. Table 7 below taken from Miller *et al.* (2016), summarises each dimension and its influencing factors.

Dimensions/capabilities		**Description**	**Influencing factors**
PAC	Acquisition	The ability to search and develop connections to external knowledge sources	Prior internal knowledge, prior external knowledge, prior investments, human resources, communication
	Assimilation	Ability to understand, interpret, comprehend and learn from external knowledge	Level of education, diversity of backgrounds, organisational structure, internal communications, human resources
RAC	Transformation	Ability to internalise and convert external knowledge	Level of education, diversity of backgrounds, organisational culture, internal communication, human resources
	Exploitation	Ability to use and implement new knowledge	Organisational structure, bureaucracy, responsiveness

Table 7. Dimensions/capabilities, description and influencing factors of AC (Miller et al., 2016)

One of the most important elements for a deeper understanding of AC is its operationalisation which has caused controversy as authors have proposed different constructs for its analysis (Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Bishop, D'Este and Neely, 2011; Roberts *et al.*, 2012; Miller *et al.*, 2016). Even if in its origins it was measured in terms of R&D intensity (Cohen and Levinthal, 1989, 1990; Zahra and George, 2002), several authors (e.g. Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Escribano, Fosfuri and Tribó, 2009; Bruneel, D´Este and Salter, 2010; Bishop, D'Este and Neely, 2011; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Veugelers and Rey, 2014; Flor, Cooper and Oltra, 2018) argued that this operationalisation fails to offer a real view of a firm's AC. For instance, Bruneel, D´Este and Salter (2010) indicated that R&D intensity may underestimate the AC of service firms because these companies typically have small R&D budgets or do not conduct formal R&D, but they may have high levels of AC. Hervas-Oliver, Albors-Garrigos and Baixauli (2011) also supported this approach and showed the influence of AC on low-tech and SMEs' search strategies[13] to access knowledge from universities using non-R&D factors. In this regard, it is important to highlight that Cohen and Levinthal (1990) also pointed out, in their seminal work, that AC can be created in a variety of ways. In addition to R&D investment, these authors also acknowledged that manufacturing experience can provide the firm with the background necessary to both recognise and implement new methods, and went on to argue that AC can be developed through deliberate efforts to benefit from personnel exchange and training.

Criticism of the mainstream innovation research and policy, which is mainly based on high investment in R&D and advanced technologies as key drivers of growth and prosperity, led to research interest in low-medium technological (LMT) industries (e.g. Hirsch-Kreinsen, Jacobson and Robertson, 2006; Robertson, Smith and von Tunzelmann, 2009; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hirsch-Kreinsen, 2015a, 2015b) and granted great importance to the analysis of AC through non-R&D measures. This latter gave rise to the use of AC constructs based on businesses' routines and internal proceseses regarding external knowledge acquisition, assimilation, transformation and exploitation (e.g. Jansen, Van Den Bosch and Volberda, 2005; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Bishop, D'Este and Neely, 2011; Flor and Oltra, 2013; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018). Table 8 summarises some of the main AC measurements that have been used throughout the literature.

Authors	**AC operationalisation**
Cohen and Levinthal (1989, 1990)	- R&D intensity
Mowery and Oxley (1995)	- Investment in scientific and technical training - Number of scientists and engineers
Keller (1996)	- Investment in employee training
Veugelers (1997)	- Share of employees with a higher education degree - Number of doctorates within the R&D department
Tsai (2001)	- R&D intensity (defined as R&D expenditure divided by sales)
Cassiman and Veugelers (2002)	- Availability of a continuously staffed R&D department
Jansen, Van Den Bosch and Volberda (2005)	- Based on Zahra and George (2002), these authors developed a scale in order to measure both PAC and RAC distinguishing its dimensions: acquisition, assimilation, transformation and exploitation. The seven-point disagreement/agreement scale is made up of items relating to AC (Szulanski, 1996) and market orientation (Jaworski and Kohli, 1993)
Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio (2008)	- Organisational knowledge - Formalisation - Social integration mechanisms
Escribano, Fosfuri and Tribó (2009)	- R&D expenses - Permanent R&D - R&D personnel training - Ratio of scientists and researchers to total employees

Table 8. Summary of the main AC operationalisation used throughout the literature classified by authors

[13] A firm's search strategy is to use innovation inputs from external sources such to complement their in-house knowledge (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011).

Authors	AC operationalisation
Hervas-Oliver, Albors-Garrigos and Baixauli (2011)	- Human resources: − Incorporation of tertiary degree employees − Percentage of employees with tertiary degrees − Percentage of technicians over employees - Organisational aspects: − Design − Marketing effort - Technology with non-R&D activities: − The existence of a formal plan for innovation − The existence of a committee for technology planning and forecasting - R&D activities: − R&D expenditures − Percentage of R&D employees
Bishop, D'Este and Neely (2011)	- Authors operationalise the multiple aspects of AC in terms of a firm's explorative and exploitative learning capabilities (March, 1991): − Explorative learning encapsulates the capabilities developed by the firm to identify sources of information for new ideas, gaining access to sources of knowledge to improve (fundamental) understanding − Exploitative learning refers to the capabilities developed by the firm to apply knowledge for commercial ends
Hewitt-Dundas (2013)	- The existence of internal R&D activity in the business - Development of extramural R&D - Investment in training - Proportion of science and engineering graduates compared to the industry average
Flor and Oltra (2013)	- Consistent with the view that defines AC as a set of processes and routines, these authors attempted to represent it by reflecting separately the four dimensions suggested by Zahra and George (2002): − Acquisition construct: this included three items based on the theoretical contribution of Cohen and Levinthal (1990) − Assimilation construct: this comprised four items that measured the degree to which the firm is capable of analysing and understanding the new external knowledge with the existing knowledge structures based on Todorova and Durisin (2007) − Transformation: drawing on Zahra and George (2002) and Todorova and Durisin (2007). a four-item construct was defined − Knowledge exploitation: drawing on Zahra and George (2002), the authors defined a five-item construct
Flor, Cooper and Oltra (2018)	- Adapted the items used by Jansen, Van Den Bosch and Volberda (2005), which in turn were based on Zahra and George (2002) and Szulanski (1996)
Kobarg, Stumpf-Wollersheim and Welpe (2018)	- R&D intensity (share of R&D expenditure of total turnover) - Continuity of a firm's internal R&D activities - Degree of personnel training as the proportion of personnel expenditure invested in employee training and continued education - Share of employees holding a university diploma or other higher education degree
Biedenbach, Marell and Vanyushyn (2018)	- Multiple-item summated scale based on the conceptualisation by Lane et al. (2006), comprising components of exploratory learning, transformative learning and exploitative learning

Table 8. (cont.) Summary of the main AC operationalisation used throughout the literature classified by authors

As Galán-Muros and Plewa (2016) state, companies are more likely to engage in UBC whenever they see beneficial outcomes from such engagement, which in turn is likely to depend on the business' AC. The literature has highlighted that companies need a minimum amount of knowledge, i.e. AC, to be able to engage in partnerships (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). Cassiman and Veugelers (2002) found a positive relationship between the extent to which companies are able to benefit from external knowledge and the probability of undertaking a cooperative agreement. Therefore, businesses with higher AC levels will be more likely to cooperate with universities (Davey *et al.*, 2011, 2018; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017) since these have the ability to acquire, assimilate, transform and exploit university knowledge. This is supported by several other studies (e.g. Negassi, 2004; Singh, 2005; Vanhaverbeke, Van de Vrande and Chesbrough, 2008; Bishop, D'Este and Neely, 2011) that have shown that companies with higher AC levels are more prone to cooperation and open innovation.

In addition to the research body that has analysed the role of AC in UBC, other streams have studied the effect of UBC on businesses' AC. In the study carried out by Bishop, D'Este and Neely (2011), it was observed that companies benefit from interactions with universities, nurturing the multiple facets of a firm's AC. This study confirmed that benefits from interactions with universities are multifaceted, including enhancement of a firm's explorative and exploitative capabilities. Given this causality, UBC literature has shown interest in the analysis of the impact of UBC on AC and vice versa (Kodama, 2008; Bishop, D'Este and Neely, 2011; De Fuentes and Dutrénit, 2012; Bodas Freitas, Geuna and Rossi, 2013; Miller *et al.*, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018; Kesting, Gerstlberger and Baaken, 2018). Nonetheless, the impact of AC on UBC is inconclusive, especially in SMEs or low-tech industries (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). Table 9 below summarises the diverse and fuzzy results of the latest empirical studies into the effect of AC on UBC and the effect of AC on UBC's results.

Authors	**Objective of the study**	**AC operationalisation**	**UBC activity**	**Result**
Bruneel, D´Este and Salter (2010)	To analyse the factors that diminish the barriers to UBC	Percentage of staff with a higher education degree	Cooperative R&D	Results showed that AC (measured as the percentage of higher educated staff) is negatively associated with UBC orientation-related barriers (differences in the orientations of industry and universities). In addition, doctoral degrees are more inclined to perceive higher transaction-related barriers (barriers related to conflicts over IP, and dealing with university administration) to interactions with universities.
Hervas-Oliver, Albors-Garrigos and Baixauli (2011)	To explore the pattern of a firm's search strategy through its AC to acquire external flows of knowledge from universities and research transfer offices (RTOs)	Human resources: − Incorporation of tertiary degree employees − Percentage of employees with tertiary degrees − Percentage of technicians over employees Organisational aspects: − Design − Marketing effort Technology with non-R&D activities: − The existence of a formal plan for innovation − The existence of a committee for technology planning and forecast R&D activities: − R&D expenditures − Percentage of R&D employees	Not specified (technology cooperation)	A firm's AC, measured by non-R&D expenditure, moderates and influences the decision to engage in cooperation agreements with universities and RTOs.

Table 9. Studies analysing the effect of AC on UBC

Authors	Objective of the study	AC operationalisation	UBC activity	Result
Hewitt-Dundas (2013)	Analysis of the relationship between a firm's AC level and the extent of cooperation with the university	− R&D: the existence of internal R&D activity in the business − R&D: if they were undertaking extramural R&D − Non R&D: business investment in training − Non R&D: proportion of science and engineering graduates they employed and how this compared to the industry average were also included	Not specified (cooperation for innovation)	Having internal R&D capability is found to be strongly associated with university cooperation. The study suggests the complementarity of internal R&D and external networking and that internal capability is necessary in identifying external knowledge, assimilating this and exploiting it in the business. Furthermore, the study suggests that as AC levels (educational levels of the workforce) increase, businesses become more likely to form innovation links with universities.
García-Pérez-de-Lema *et al.* (2017)	To study how different UBC governance styles impact SMEs' innovation and performance	Multiple item scale: - Product and services' research and development capacity - Level of technological and scientific information - Personnel education - Skill to gather and use relevant information from markets	Research and innovation projects, advice and training activities	A firm's AC positively affects the development of UBC.
Biedenbach, Marell and Vanyushyn (2018)	Examine the role of firms' AC in UBC and, in particular, whether AC moderates the effects of university cooperation on firms' innovativeness	Multiple-item summated scale based on the conceptualisation by Lane et al. (2006), comprising components of exploratory learning, transformative learning and exploitative learning	Not specified	The results suggest that benefiting from university cooperation is conditional upon the firm's level of AC. At low levels of AC, engaging with universities does not translate into any noticeable increase in innovative output. In contrast, medium to high levels of AC are where a firm benefits most from cooperating with a university. They also show that these effects are more pronounced for firms operating in sectors characterised by lower levels of technology and knowledge intensity.
Kobarg, Stumpf-Wollersheim and Welpe (2018)	Investigate the potential influence of AC and innovation competencies on the relationship between UIC and product innovation performance	A set of multiple measures since previous research also used several measures to operationalise AC. - R&D intensity as the share of R&D expenditure of total turnover - Continuity of a firm's internal R&D activities - Degree of personnel training as the proportion of personnel expenditure invested in employee training and continued education - Share of employees holding a university diploma or other higher education degree	Not specified	Provides evidence for potential negative effects of AC in the context of cooperative R&D (substitution effect). - AC in terms of internal R&D negatively moderates the relationship between UBC and incremental innovation performance and has no effect on the relationship between UBC and radical innovation performance. - AC related to employee know-how has no moderating effect on the relationship between UBC and incremental innovation performance but positively moderates the relationship between UBC and radical innovation performance.

Table 9. (cont.) Studies analysing the effect of AC on UBC

2.4.2.5. Innovation

Innovation[14] is considered the success factor for companies' survival and growth (Raymond and St-Pierre, 2010). As is well known, companies do not innovate alone and cooperate with commercial or scientific agents in their innovation processes, employing both internal and external flows of knowledge with the aim of exploring or exploiting innovation (Guerrero, Urbano and Herrera, 2019).

The involvement of companies in networks allows them to acquire new knowledge and to be more competitive (García-Pérez-de-Lema *et al.*, 2017). As Rammer, Czarnitzki and Spielkamp (2009) showed, businesses (SMEs in particular) rely heavily on external knowledge as a crucial complement to in-house R&D and innovation. Under this paradigm, universities are required by society and governments to turn scientific developments into useful innovations for industry (Veugelers and Rey, 2014), thereby becoming a motor for industrial innovation (Perkmann, Tartari, McKelvey et al., 2013). Nevertheless, as seen in Vega-Jurado, Kask and Manjarrés-Henriquez (2017), tracing the effects of universities on industrial innovation has been a difficult task due to the wide spectrum of activities through which knowledge can be exchanged, as well as the complex set of factors that moderate the relationship between agents (Ahrweiler, Pyka and Gilbert, 2011).

Despite the complexity of the analysis, some studies have tried to analyse the impact of UBC on innovation performance and some of them (e.g. Aschhoff and Schmidt, 2008; Maietta, 2015; García-Pérez-de-Lema *et al.*, 2017) have shown a positive association. In addition, Amara and Landry (2005) discovered that the use of university knowledge increases the likelihood of radical innovation.

With regard to the effect of UBC on innovation, it is essential to bear in mind that without AC and innovation capacity (hereafter IC) in the business sector, companies may not take advantage of cooperation with universities (Veugelers and Rey, 2014). Besides, the way in which companies develop innovation can influence cooperation with universities (Phan and Siegel, 2006; Perkmann, Neely and Walsh, 2011; Muscio and Vallanti, 2014).

The following sub-sections summarise the innovation-related business characteristics that can have an impact on UBC engagement and activity development.

Innovation capacity

Hogan *et al.* (2011, p.1266) defined IC as *"*a firm's ability, relative to its competitors, to apply the collective knowledge, skills, and resources to innovation activities relating to new products, processes, services, or management, marketing or work organisation systems, in order to create added value for the firm or its stakeholders*"*. In addition to being a necessary condition for companies to respond better to market changes (Wang and Ahmed, 2007) and develop sustainable competitive advantage (Wolff and Pett, 2006; Nieto and

[14] Even though mainstream literature has equated high R&D intensity with high innovativeness, empirical studies have shown that innovation takes place in companies with low or no R&D (Santamaría, Nieto and Barge-Gil, 2009). On this basis, the present study looks at innovation from a broader perspective than the classic view of R&D intensity since R&D is merely one possible way in which innovativeness can be attained (Kirner, Kinkel and Jaeger, 2009).

Santamaría, 2010; Gu, Jiang and Wang, 2016), IC also contributes to further development of open innovation practices (Samson and Gloet, 2014; Carrasco-Carvajal and García-Pérez-De-Lema, 2020). As Carrasco-Carvajal and García-Pérez-De-Lema (2020) stated the degree of IC is positively related to SMEs' openness and it could be stated that companies with higher IC levels may be more likely to cooperate with universities.

Innovation degree

Perkmann, Neely and Walsh (2011) remarked that the extent to which companies innovate, and the degree of the innovations (hereafter ID) developed, reduce the existing differences between universities and businesses.

When it comes to innovation, it is essential to distinguish the degree of developed innovations. Whilst incremental innovations deal with minor changes and modifications, radical innovations are related to major departures from existing capabilities in the firm and establish the basis for absolutely new products and services (Ritala and Hurmelinna-Laukkanen, 2013). The development of radical innovations requires a large amount of new knowledge (Dewar and Dutton, 1986) that is distant from a firm's existing competences and practices (Green, Gavin and Aiman-Smith, 1995). This gap between a firm's existing knowledge and the knowledge required to innovate forces companies to bring external knowledge inside (Green, Gavin and Aiman-Smith, 1995). Also, radical innovations need high R&D investments (Laursen and Salter, 2006) and cooperation with heterogeneous partners (Hagedoorn, 1993). As Lin (2017) stated, companies requiring a heterogeneity of cooperative resources are more prone to engage in R&D with universities. In this regard, the study undertaken by Guerrero, Urbano and Herrera (2019) showed that companies developing radical innovations are more prone to cooperate with universities than companies undertaking incremental innovations.

Traditionally, due to the complementarity of a university's knowledge for businesses, cooperation with universities has been considered of an explorative-oriented nature (Vega-Jurado, Kask and Manjarrés-Henriquez, 2017). In addition, Kaufmann and Tödtling (2001) showed that universities are more likely to stimulate companies' advanced innovations than other external partners due to their non-economic interest in knowledge generation. Several scholars have argued for the key role of universities in a company's radical and exploratory[15] innovation practices (Belderbos *et al.*, 2004; Eom and Lee, 2010; Perkmann, Neely and Walsh, 2011; Janeiro, Proença and Gonçalves, 2013; Lin, 2017; Guerrero, Urbano and Herrera, 2019).

[15] Based on March's (1991) dichotomy of exploration and exploitation, the analysis of R&D alliances has differentiated between exploitative and explorative cooperations (Vega-Jurado, Kask and Manjarrés-Henriquez, 2017). Exploration practices involve developing new knowledge, a learning process or the acquisition of new external knowledge, whereas exploitation refers to refinement and extension of existing knowledge (Levinthal and March, 1993; Alcalde and Guerrero, 2016).

2.4.2.6. UBC willingness and support

The identification of the elements that determine UBC patterns requires highlighting the importance of companies' willingness and support for UBC. As Qiao and Li (2015) stated, willingness is a necessary condition for cooperation. Some studies on UBC (e.g. Fontana, Geuna and Matt, 2006; Lai, 2011; Galán-Muros *et al.*, 2017; Davey *et al.*, 2018) have shown that businesses' willingness and support for cooperation shape UBC engagement and activity development.

The reports developed by Davey *et al.* (2018) and Galán-Muros *et al.* (2017) within their comprehensive European level study on the state of UBC, affirmed that cooperating companies are more predisposed and supportive towards UBC than non-cooperating ones. To this end, as it can be seen in Galán-Muros *et al.* (2017) and Davey *et al.* (2018) these authors conceptualised and developed a scale for measuring the extent to which companies support UBC. This measurement tool is composed of the elements summarised in Table 10 below.

UBC willingness and support measurement scale[16]
– Availability of contacts and relationships within the university for cooperation
– Understanding of what universities expect to achieve through cooperation
– Availability of knowledge and skills to select and address UBC activities
– Managerial support for UBC
– Belief that universities play a key role in their efforts to innovate
– Belief in their responsibility to cooperate with universities in the fields of education and research
– Belief that they have much to offer universities in the areas of education and research
– Ability to absorb knowledge and technology from universities

Table 10. UBC willingness and support measurement scale (Galán-Muros et al., 2017; Davey et al., 2018)

2.5. Summary

This chapter aimed to generate a comprehensive view of UBC and a compilation of UBC's determining factors. First, the importance of external knowledge acquisition and cooperation with universities for companies in the knowledge-based society was described. Then, an explanation of the transformation of a university into an entrepreneurial university and the appearance of the "Triple Helix" theory led to a discussion on the emergence and relevance of UBC. Afterwards, a comprehensive review on UBC was presented. This sub-section included a review of UBC definitions and an approximation of UBC as a process. In turn, an overview of informal interactions and UBC activities was given, together with an explanation of the dynamic nature of UBC. Finally, the last section dealt with UBC's determining factors i.e. UBC's drivers and barriers; and the organisational context-related factors that may have an impact on UBC.

[16] Even though the original measurement scale developed by Galán-Muros *et al.* (2017) and Davey *et al.* (2018) denominates the construct as "UBC capabilities and beliefs", it has been considered more appropriate to call it "UBC willingness" in the framework of this study due to the nature of the items that make it up.

Chapter 3

Research framework

3. Research framework

3.1. Introduction

As has been seen in the literature review, the vast majority of existing studies have been focused on specific aspects of cooperation (e.g. the identification of UBC's drivers and barriers, the identification and importance of UBC activities, the analysis of cooperating businesses' characteristics, the analysis of the dynamic nature of cooperation and relationship stages, etc.). These are isolated studies that shed light on independent parts of the phenomenon without reaching a comprehensive and global understanding of cooperation (Carayol, 2003; D´Este and Patel, 2007; Perkmann *et al.*, 2013; Ankrah and Al-Tabbaa, 2015; Galán-Muros, 2015; Davey *et al.*, 2018; Galán-Muros and Davey, 2019; Skute *et al.*, 2019). Consequently, the complexity of UBC is not well understood (D´Este and Patel, 2007; Petruzzelli, 2011; Ankrah and Al-Tabbaa, 2015; Davey *et al.*, 2018; Skute *et al.*, 2019). According to the results obtained by Skute *et al.* (2019) in their bibliometric analysis, UBC's body of literature needs to be consolidated by building on new theoretical and empirical approaches that tie up loose ends. Similarly, Mascarenhas *et al.* (2018) also indicate that the UBC literature clearly calls for a greater conceptualisation and development of research into the different areas associated with it.

With the aim of contributing to UBC's literature body, the following sub-sections provide a critical analysis of the literature review, with a view to highlighting the limitations and shortcomings in the literature, and thereby defining research gaps.

3.2. Critical analysis of the literature

3.2.1. The importance of UBC

During the literature review, it was observed that the vast majority of UBC studies (e.g. Hall, Link and Scott, 2001; Barnes, Pashby and Gibbons, 2002; Carayol, 2003; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Fontana, Geuna and Matt, 2006; Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Santos *et al.*, 2020) are focused on industry. As Parmentola, Ferretti and Panetti (2020) indicate, in recent years, an intensification of cooperation between universities and industrial companies has been given, based on the belief that cooperative research may be a powerful source of innovation (Mansfield, 1998; Ambos *et al.*, 2008). As Hicks *et al.* (2001) stress industrial companies are more prone to cooperate with universities than others, due to their closeness with R&D. Industrial manufacturing firms are the major source of technological progress in the economy and these undertake more R&D activity than other firms (Stöllinger *et al.*, 2013).

Industry is the backbone of the European economy and has a profound impact on regions, in terms of socio-economic development, innovation and job creation[17] (BusinessEurope, 2017; European Commission,

[17] 35 million direct jobs in Europe in 2020 (European Commission, 2021b)

2021b). Given its importance, cooperative agreements between industrial companies and knowledge partners, including universities, are considered essential in order to address current and future socio-economic challenges (BusinessEurope, 2017; Ghobakhloo, 2018). Therefore, UBC literature shows the need to conduct studies that consolidate and tie up loose ends regarding UBC on this kind of companies (Skute *et al.*, 2017; Mascarenhas *et al.*, 2018).

3.2.2. UBC's determining factors

One of the main strands of UBC literature is the analysis of UBC's determining factors, identifying a wide spectrum of drivers, barriers and organisational context-related elements that might shape cooperation (e.g. Agrawal, 2001; Hall, Link and Scott, 2001; Bekkers and Bodas Freitas, 2010; Bruneel, D´Este and Salter, 2010; Gilsing *et al.*, 2011; Attia, 2015; O'Reilly and Cunningham, 2017; Vick and Robertson, 2018; Davey *et al.*, 2018; Rybnicek and Königsgruber, 2019; Skute *et al.*, 2019; Galan-Muros and Davey, 2019; Alexander *et al.*, 2020; Lopes and Lussuamo, 2020; Moraes Silva, Lucas and Vonortas, 2020; Tootell *et al.*, 2020; Alunurm, Rõigas and Varblane, 2020). However, due to the importance of UBC as an R&D input to innovation, the literature since 1970 has mainly been focused on R&D cooperation (Faulkner and Senker, 1994). As a result, most of the existing studies into UBC's determining elements have been analysed from this perspective, rather than taking into account the wide range of UBC activity types. Specifically, the vast majority of UBC's determining factors have been identified in studies regarding cooperative R&D projects (e.g. Hall, Link and Scott, 2001; Barnes, Pashby and Gibbons, 2002; Carayol, 2003; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Fontana, Geuna and Matt, 2006; Laursen and Salter, 2006; Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Rosendo-Ríos, Ghauri and Zhang, 2016; Santos *et al.*, 2020). This bias shows a major shortcoming in UBC knowledge as cooperation between businesses and universities can be developed through different activities[18] (e.g. Schartinger *et al.*, 2002; Perkmann and Walsh, 2007; D´Este and Patel, 2007; Bekkers and Bodas Freitas, 2008; Philpott *et al.*, 2011; Davey *et al.*, 2011, 2018; De Fuentes and Dutrénit, 2012; Ankrah and Al-Tabbaa, 2015; Galán-Muros and Plewa, 2016; Skute *et al.*, 2017; Benneworth *et al.*, 2017; García-Pérez-de-Lema *et al.*, 2017; Vick and Robertson, 2018; Alpaydın and Fitjar, 2020; Parmentola, Ferretti and Panetti, 2020; Sharma, 2020) on which determining factors (i.e. drivers, barriers and organisational-related elements) may generate different effects (e.g. Schartinger *et al.*, 2002; Bekkers and Bodas Freitas, 2008; Arza and López, 2011; De Fuentes and Dutrénit, 2012; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017; Vick and Robertson, 2018; Davey *et al.*, 2018; Alpaydın and Fitjar, 2020; Alunurm, Rõigas and Varblane, 2020; Parmentola, Ferretti and Panetti, 2020).

The development of studies taking a holistic view of UBC is essential to understand UBC patterns in both more developed activities (i.e. joint R&D, mobility of students and consultancy) and less developed

[18] It is important to note the lack of consensus regarding the technical terms used in the UBC literature, such as the interchangeable use of "interaction channels", "knowledge-transfer channels" or "activities" in relation to the different ways in which UBC can take place. As previously stated in Sub-section *2.3.2, Informal interactions and UBC activities*, drawing on Davey *et al*., (2018), we classify interactions between universities and companies as informal interactions and activities, depending on the existence of a contract or not (Bonaccorsi and Piccaluga, 1994).

activities (e.g. curriculum co-design and co-delivery, student entrepreneurship, governance or shared resources), the latter being the least analysed (Davey *et al.*, 2018). Nevertheless, as has been observed in the literature review, numerous studies have not taken into account this holistic approach of UBC activities and have targeted their analysis on the factors that determine cooperation in general terms. As an example, the study carried out by Laursen and Salter (2004) sought to identify what types of firms use universities as a source of innovation. In particular, these authors analysed the factors (i.e. search strategy "openness", R&D intensity, innovation radicalness, age, size and industry) that influence why companies cooperate with universities in their innovation activities. In this regard, the study[19] developed by Hanel and St-Pierre (2006) also tried to draw a portrait of a "typical" firm engaged in cooperation with universities. Years later, Rõigas, Mohnen and Varblane (2018) similarly tried to identify which companies use universities as cooperation partners. More recently, Moraes Silva, Lucas and Vonortas (2020) analysed the link between internal barriers to innovation (financial and knowledge obstacles) and the likelihood of technology-based SMEs to cooperate with universities and research institutes. This overall approach has resulted in the analysis of UBC as a *black box* (Lin and Yang, 2020) entailing a lack of knowledge about the impact of UBC determinants on the different UBC activity types. Several authors (e.g. Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Galán-Muros and Plewa, 2016; Mascarenhas *et al.*, 2018) consider this lack of knowledge to be one of the most important future lines for UBC research. Furthermore, Agrawal (2001, pp. 300-301) indicates that "basic research into the mechanics and characteristics of other channels, such as faculty consulting and the recruiting of graduate students, would make tremendous contributions to this area of inquiry". As Galán-Muros and Plewa (2016) state, studies analysing the influence of UBC's determining factors on the diverse UBC activities contribute to UBC literature by providing a big picture approach of UBC. This latter is key for both policy makers and university managers, since this approach provides them with the necessary knowledge to carry out specific and evidence-based programs and mechanisms for the promotion of UBC (Arza, 2010; Galán-Muros and Plewa, 2016). However, very few studies analysing UBC's determinants (e.g. Schartinger *et al.*, 2002; Bekkers and Bodas Freitas, 2008; Arza and López, 2011; Davey *et al.*, 2011, 2018; De Fuentes and Dutrénit, 2012; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017; Alpaydın and Fitjar, 2020; Alunurm, Rõigas and Varblane, 2020; Parmentola, Ferretti and Panetti, 2020) have taken into account this holistic approach of UBC. These studies have tried to put pieces together and create an integrated and comprehensive UBC framework. Nevertheless, the high complexity of the UBC phenomenon and the large number of elements that may determine it, has made it possible for researchers to carry out studies from manifold perspectives and there are still many unknowns regarding the impact of UBC's determinants on the different types of UBC activities (Skute *et al.*, 2019).

[19] The analysis was restricted to innovative companies: those that had participated over the previous three years in cooperative arrangements with any kind of information/knowledge partner to develop new or significantly improved products or manufacturing processes.

The following Table 11 synthesises the limitations found in extant studies regarding UBC's holistic view (For further information on each study see *Appendix I: Limitations found in extant studies*).

Authors	Limitation
Schartinger *et al.* (2002); Davey *et al.* (2011); Galán-Muros and Plewa (2016)	The analysis focuses only on the academic side.
Bekkers and Bodas Freitas (2008)	The analysis focuses only on R&D developing companies.
Bekkers and Bodas Freitas (2008); De Fuentes and Dutrénit (2012)	The analysis does not differentiate between informal interactions and formal activities.
Arza and López (2011)	The analysis focuses only on cooperation with PROs (Public Research Organisations) and does not provide specific knowledge regarding cooperation with universities.
De Fuentes and Dutrénit (2012)	The analysis focuses only on innovative companies and it focuses only on some types of UBC activities. Activities such as: staff mobility within the research-related domain; spin-off or start-up generation in valorisation-related domain; and activities regarding education (curriculum co-design, co-delivery, mobility of students and dual education programs) and management (shared resources and industry support) are not included in the analysis.
Davey *et al.* (2018)	The study includes all type[20] and all size companies (from 1 to more than 1,000 employees).
Alpaydın and Fitjar (2020)	The analysis focuses only on cooperating companies and only studies the impact of factors on the likelihood of cooperation.
Davey *et al.* (2018); Alunurm, Rõigas and Varblane (2020); Parmentola, Ferretti and Panetti (2020)	The study is only focused on differences between cooperating and non-cooperating companies with regard to barriers and drivers.

Table 11. Limitations found in the literature review regarding the impact of UBC's determinants on UBC activities

Based on the limitations found in the analysis of these studies (see Table 11):

- First, it can be stated that the analysis of UBC's determining factors must extend its boundaries to all kind of businesses, including those that do not innovate, do not carry out R&D activities and do not cooperate.
- Second, drawing on the classification developed by Davey *et al.* (2018), the analysis of the impact of UBC's determining factors must cover all kinds of UBC activities in the domains of education, R&D, valorisation and management. Additionally, research studies must differentiate informal interactions from formal activities since the former can be precursors of the latter (Faulkner and Senker, 1995; Plewa, Korff, Johnson, *et al.*, 2013; Azagra-Caro *et al.*, 2017; Vick and Robertson, 2018). The lack of empirical research into the relationship between informal interactions and formal activities requires future work to generate quantitative evidence to prove the existing relationship between them (Azagra-Caro *et al.*, 2017; Vick and Robertson, 2018). Besides, drawing on Laursen and Salter (2004) informal interactions can be analysed as a UBC's determining factor related to a company's openness.
- Third, while there are some studies that show differences between cooperating and non-cooperating companies in relation to drivers and barriers (e.g. Davey *et al.*, 2018; Parmentola,

[20] Intermediary connecting university and business, non-government organisations, sole-trades companies, association, not for profit organisation, family-owned companies, multinational organisation, public-owned company, privately-owned company.

Ferretti and Panetti, 2020), there are no studies that analyse differences in relation to organisational context-related factors. This lack of knowledge implies a research gap with regard to the identification of the most important organisational context-related factors for UBC likelihood and cooperation levels in UBC activities. This finding supports the statement of Agrawal (2001) and Skute *et al.* (2019) who highlighted a lack of knowledge of the organisational context-related factors of companies that seek to cooperate with academic partners. As Skute *et al.* (2019) indicated, much research attention needs to be devoted to the heterogeneity of UBC partners, as business characteristics may influence the antecedents and consequences of the different UBC activities. In this respect, Laursen and Salter (2014) and Lin and Yang (2020) noted that little research has explored the impact of companies' capabilities, willingness and openness. In turn, as can be seen in Sub-section *2.4.2 Organisational context-related factors*, the results of extant studies are still inconclusive as regards the impact of *(i) general business characteristics* (industry, location, legal form, headquarters, age, size, turnover, exports, technological level, employee's qualification, gender), *(ii) business openness* (external search breadth, cluster association, informal interactions), *(iii) R&D* (R&D intensity, R&D continuity, R&D program knowledge and participation), *(iv) LLL* (LLL commitment), *(v) AC*, *(vi) innovation* (innovation capacity, innovation degree) and *(vii) UBC willingness and support*.

- Fourth, as seen in these studies adopting a holistic view of UBC (e.g. Schartinger *et al.*, 2002; Bekkers and Bodas Freitas, 2008; Davey *et al.*, 2018) and UBC literature in overall (e.g. Cohen, Nelson and Walsh, 2002; Fontana, Geuna and Matt, 2006; Hanel and St-Pierre, 2006), studies have based their analyses on very heterogeneous samples in relation to companies' size. Besides, it is worth recalling that due to the predominant analysis of UBC from the R&D perspective, great number of studies have been conducted in large companies with big R&D departments (Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, 2010). As Branzei and Vertinsky (2006) pointed out, this limited approach has brought a need for more research on how SMEs cooperate with universities. In this vein, Lee *et al.* (2010) emphasised that the nature of UBC remains under-explored in the case of SMEs. Teece (2007) also indicated that it is necessary to define the "micro-foundation" of the business capacities that explain the ease or difficulty with which companies build their relational and transactional relationships, and to advance research into the factors that determine cooperation strategies employed by SMEs (Zahra and George, 2002). Hervas-Oliver, Albors-Garrigos and Baixauli (2011) and Vick and Robertson (2018) reinforced this shortage, emphasising the need to develop research into various industries, technology levels and sizes. SMEs are deeply rooted in the European business fabric and are essential to Europe's competitiveness and prosperity, as well as to the economic and social development. There are 25 million SMEs in Europe, which employ 2 out of 3 jobs, and represent the 50% of Europe's GDP (European Commission, 2020b). In the case of Spain, in November 2020, the 5.97% of the companies were SMEs and employed a 33.07% of the total employees (Dirección General de Industria y de la PYME, 2020). SMEs play a critical role for technological change and innovation systems (Muller, Robin, Schroder, *et al.*, 2019) and because of the multiple benefits that these can obtain from cooperation with universities (e.g. Bishop, D'Este and Neely, 2011; Davey *et al.*, 2011, 2018; European Union, 2011; Kitagawa and Lightowler, 2013; Vick and Robertson, 2018), research into the cooperation between SMEs and universities is essential.

Together with these limitations, as for the analysis of UBC's determining factors, it is important to state that extant studies have overlooked the importance of regional contexts in shaping UBC patterns (Parmentola, Ferretti and Panetti, 2020). Aforementioned in the literature review, the role of the region in UBC is a key piece (Breschi and Lissoni, 2001; Singh, 2005; D´Este and Patel, 2007; Eom and Lee, 2010; Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, 2010; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano, 2015; Galán-Muros and Davey, 2017; Davey *et al.*, 2018; Skute *et al.*, 2019; Alpaydın and Fitjar, 2020; Sharma, 2020). Such is the importance of the regional context, given the differences that may exist in relation to academic, industrial and political contexts, that authors such as Bekkers and Bodas Freitas (2008) and Bodas Freitas, Geuna and Rossi (2013) considered that their results should not be extrapolated to other countries[21]. Therefore, a holistic and comprehensive understanding of the UBC phenomenon and its determinants requires further studies covering a wide heterogeneity of regions (Mascarenhas *et al.*, 2018).

In the light of this critical review, it can be seen that the literature on UBC's determinants calls for further studies that:

(i) Analyse and identify the differences between cooperating and non-cooperating SMEs with regard to their organisational context-related factors,
(ii) Analyse the impact of organisational context-related factors on the likelihood of SMEs' to cooperate with universities in a multivariate analysis, and identify the most relevant ones,
(iii) Analyse the impact of organisational context-related factors on the cooperation levels in UBC activities of SMEs in a multivariate analysis, and identify the most relevant ones,
(i) Include companies at all technological levels in their sample, regardless of whether they are developers of R&D and innovation, or located in previously unexplored regions of interest to science.

3.2.3. The role of AC on UBC

AC is one of the most discussed business capabilities in UBC literature (e.g. Bruneel, D´Este and Salter, 2010; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018; Kobarg, Stumpf-Wollersheim and Welpe, 2018). Nevertheless, there are many unknowns about its influence on UBC, particularly in SMEs or low-tech industries (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011).

As previously seen, current empirical studies give opposing results with regard to the impact of AC on UBC. Despite the fact that the vast majority of studies show a positive influence (e.g. Cassiman and

[21] Bekkers and Bodas Freitas (2008) analysed a sample of 454 Dutch companies and Bodas Freitas, Geuna and Rossi (2013) a sample of 1,052 companies located in the North-Western Italian region of Piedmont.

Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018) other studies (e.g. Bruneel, D´Este and Salter, 2010; Kobarg, Stumpf-Wollersheim and Welpe, 2018) depict the opposite. In addition, its operationalisation has caused controversy among authors since multiple constructs have been employed for its analysis (Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Bishop, D'Este and Neely, 2011; Roberts *et al.*, 2012; Miller *et al.*, 2016). Although AC was originally operationalised as R&D intensity (e.g. Cohen and Levinthal, 1989, 1990; Tsai, 2001), several authors (e.g. Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Escribano, Fosfuri and Tribó, 2009; Bruneel, D´Este and Salter, 2010; Bishop, D'Este and Neely, 2011; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Veugelers and Rey, 2014; Flor, Cooper and Oltra, 2018) have argued that this operationalisation fails to offer a real view of a firm's AC. Under this approach, Hervas-Oliver, Albors-Garrigos and Baixauli (2011) argued that R&D intensity may not be a good measure of AC for SMEs, non-R&D performers and companies in low–medium-tech environments. Furthermore, criticism of the mainstream innovation research and policy, which is mainly based on high investment in R&D and advanced technologies as key drivers of growth and prosperity, led to the approach of AC through non-R&D measures (e.g. Hirsch-Kreinsen, Jacobson and Robertson, 2006; Robertson, Smith and von Tunzelmann, 2009; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hirsch-Kreinsen, 2015a, 2015b). Moreover, drawing on Zahra and George (2002) AC constructs based on businesses' routines and internal processes with regard to external knowledge appeared (e.g. Jansen, Van Den Bosch and Volberda, 2005; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Bishop, D'Este and Neely, 2011; Flor and Oltra, 2013; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018). On this basis, it can be stated that there are two main streams with regard to AC operationalisation. On the one hand, there is the use of factors related to a company's R&D capacity and training (i.e. R&D intensity, investment in training, number of employees with a higher education degree, etc.) (e.g. Cohen and Levinthal, 1989, 1990; Mowery and Oxley, 1995; Keller, 1996; Veugelers, 1997; Tsai, 2001; Cassiman and Veugelers, 2002; Escribano, Fosfuri and Tribó, 2009; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018). On the other hand, there is the use of constructs based on businesses' internal knowledge processes (e.g. Jansen, Van Den Bosch and Volberda, 2005; Bishop, D'Este and Neely, 2011; Flor and Oltra, 2013; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018). With regard to this latter, it is important to state that, unlike the operationalisation of AC as a proxy of R&D intensity or a firm's investment in training (e.g. Cohen and Levinthal, 1989, 1990; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018), the AC constructs based on company's routines and internal processes (e.g. Jansen, Van Den Bosch and Volberda, 2005; Flor and Oltra, 2013; Flor, Cooper and Oltra, 2018) allow more in-depth analyses since these differentiate both PAC and RAC dimensions. These different approaches towards AC operationalisation may have been the reason for opposing results. Nevertheless, to the best of our knowledge, no study has carried out a comparative analysis in relation to the differences that may happen depending on the operationalisation form used. Furthermore, the studies found in the light of the literature have analysed AC as a whole and have not analysed the impact of the different dimensions of AC. In turn, another important aspect to be highlighted in relation to AC is that existing studies have not been focused on any particular kind of activity, but on cooperation as a whole (Biedenbach, Marell and Vanyushyn, 2018; Kobarg, Stumpf-Wollersheim and Welpe, 2018). Some studies have analysed the impact of AC on cooperation for innovation (Hewitt-Dundas, 2013) or on technology cooperation (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). Very few studies have analysed the impact of AC on a specific type of activity. For example, Bruneel, D´Este and Salter (2010) analysed the impact of AC on cooperative R&D projects and García-Pérez-de-Lema *et al.* (2017) analysed the impact of AC on research and innovation projects, training and advice. To our knowledge, no studies have analysed the impact of AC on the different types of UBC activities.

Based on this critical review of the literature, it can be argued that it is necessary to develop a study that:

(i) Operationalises AC as both R&D intensity and as a construct based on businesses' internal routines and processes with regard to external knowledge acquisition, assimilation, transformation and exploitation,

(ii) and analyses the impact of AC on cooperation levels in UBC activities.

3.3. Research gaps

The critical review in the previous section shows that there are several unknowns about UBC that must be addressed. Consequently, the following research gaps were identified:

(i) Identify the differences between cooperating and non-cooperating manufacturing SMEs[22] with regard to their organisational context-related factors,

(ii) Analyse the impact of organisational context-related factors on the likelihood of manufacturing SMEs' cooperating with universities, and identify the most relevant ones,

(iii) Analyse the impact of organisational context-related factors on manufacturing SMEs' cooperation levels in UBC activities, and identify the most relevant ones,

(iv) Clarify the role of AC on manufacturing SMEs' cooperation levels in UBC activities, operationalising AC as (i) R&D intensity and (ii) as a construct based on businesses' internal processes; with the aim of clarifying the role of AC by comparing both approaches.

3.4. Summary

This chapter provided a critical analysis of the literature review, with a view to highlighting the limitations and shortcomings in the literature. As a result, four research gaps were defined.

[22] Also including R&D and innovation developers from all technological levels.

Chapter 4

Research objectives, research questions and hypotheses

4. Research objectives, research questions and hypotheses

4.1. Introduction

Having analysed and defined the theoretical part of the study, based on the theoretical framework and research gaps that had been identified, the following chapter deals with the definition of research objectives and research questions. In turn, the purpose of the study is defined, together with research hypotheses.

4.2. Main objective and research questions

As a result of the literature review, critical analysis and identification of research gaps, the main objective of the present study is to:

Explore and identify the main organisational context-related factors that determine both the likelihood of manufacturing SMEs to cooperate with universities and the cooperation levels in UBC activities

The accomplishment of this aim will help to clarify the following research questions:

- What are the organisational context-related factors that significantly differentiate cooperating from non-cooperating manufacturing SMEs?
- What are the organisational context-related factors that have an impact on the likelihood of manufacturing SMEs' cooperating with universities?
- What are the main organisational context-related factors that have a significant impact on manufacturing SMEs' cooperation levels in UBC activities?

To this end, four specific objectives were defined. The following sub-sections describe them in further detail.

4.3. Specific objective 1

As previously stated (see Sub-Section *3.2.2 UBC's determining factors*), one of the main strands of UBC literature is the analysis of UBC's determining factors, which has identified a wide spectrum of drivers, barriers and organisational context-related elements that might shape cooperation (e.g. Agrawal, 2001; Hall, Link and Scott, 2001; Bekkers and Bodas Freitas, 2010; Bruneel, D´Este and Salter, 2010; Gilsing *et al.*, 2011; Attia, 2015; O'Reilly and Cunningham, 2017; Vick and Robertson, 2018; Davey *et al.*, 2018; Rybnicek and Königsgruber, 2019; Skute *et al.*, 2019; Galan-Muros and Davey, 2019; Alexander *et al.*, 2020; Lopes and Lussuamo, 2020; Moraes Silva, Lucas and Vonortas, 2020; Tootell *et al.*, 2020; Alunurm, Rõigas and Varblane, 2020). However, as Agrawal (2001) and Skute *et al.* (2019) highlighted, there is a lack of knowledge of the organisational context-related factors of companies that seek to cooperate with academic partners. While there are studies showing differences between cooperating and non-cooperating companies in relation to UBC's drivers and barriers (e.g. Davey *et al.*, 2018; Parmentola, Ferretti and Panetti, 2020), to the best of our knowledge, no studies have analysed differences regarding organisational context-related elements. This shortage represents an important research gap since getting to know the differences between cooperating and non-cooperating companies is the first step towards identifying the factors that determine the likelihood of SMEs to cooperate with universities and the cooperation levels in UBC activities. This lack of knowledge leads us to the first specific objective:

Specific objective 1: *Identify the main differences between cooperating and non-cooperating manufacturing SMEs with regard to their organisational-context related factors.*

This first specific objective seeks to analyse and identify the main differences between cooperating and non-cooperating companies with regard to their organisational context-related elements, which can be classified into the following groups: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support.

4.4. Specific objective 2

Several academics have sought to identify the main organisational context-related factors that determine the likelihood of companies to cooperate with universities (e.g. Laursen and Salter, 2004; Hanel and St-Pierre, 2006; Rõigas, Mohnen and Varblane, 2018; Moraes Silva, Lucas and Vonortas, 2020). However, on account of the diverse and high number of elements that may have an impact on UBC, the influence of some organisational context-related factors such as businesses' capabilities, willingness and openness remains unclear (Laursen and Salter, 2014; Skute *et al.*, 2019; Lin and Yang, 2020). Besides, it was observed that existing studies have analysed organisational context-related factors in isolation (see Sub-section *2.4.2 Organisational context-related factors*), shedding light on a partial knowledge of the field. In turn, existing studies have based their analyses on very heterogeneous samples in relation to companies' size (e.g. Cohen, Nelson and Walsh, 2002; Schartinger *et al.*, 2002; Fontana, Geuna and Matt, 2006; Hanel and St-Pierre, 2006; Bekkers and Bodas Freitas, 2008) and there is no clear knowledge of the UBC phenomenon in SMEs (see Sub-section *3.2.2 UBC's determining factors*). Based on this state-of-the-art, a shortcoming has been identified with regard to studies analysing the impact of organisational context-related factors on SMEs' likelihood to cooperate with universities from a holistic approach. Existing studies have not provided systemic knowledge of the most important organisational context-related factors that may have an impact on SMEs' likelihood to cooperate with universities. Nevertheless, the literature's partial contributions have made it possible for this study to identify a battery of factors (see Sub-section *2.4.2 Organisational context-related factors*) that lay down the foundations for the development of a systemic analysis of the impact of organisational context-related factors on SMEs' likelihood to cooperate with universities. With the aim of addressing the aforementioned research gap, the following specific objective is defined:

Specific objective 2: *Identify the most determining organisational context-related factors on the likelihood of manufacturing SMEs' cooperating with universities*

This objective seeks, on the one hand, to explore the impact of the identified organisational context-related factors on the likelihood of manufacturing SMEs' cooperating with universities, and, on the other hand, to identify the most determining factors from a holistic perspective. To this end, a two-stage process is proposed:

1. The analysis and the identification of the most determining organisational context-related factors on manufacturing SMEs' likelihood to cooperate with universities in the different groups of factors identified in the literature, through multivariate analyses,
2. The analysis and the identification of the most determining organisational context-related factors on manufacturing SMEs' likelihood to cooperate with universities among all the different groups of factors identified in the literature, through multivariate analyses.

This specific objective leads to the identification of the most determining organisational context-related factors in the decision of manufacturing SME's whether to cooperate or not.

4.5. Specific objective 3

As previously stated, the vast majority of UBC's determining factors have been identified in studies regarding cooperative R&D projects (e.g. Hall, Link and Scott, 2001; Barnes, Pashby and Gibbons, 2002; Carayol, 2003; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Fontana, Geuna and Matt, 2006; Laursen and Salter, 2006; Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Rosendo-Ríos, Ghauri and Zhang, 2016; Santos *et al.*, 2020). This predominance has led to the generation of biased knowledge since UBC can be developed through different activities (e.g. Schartinger *et al.*, 2002; Perkmann and Walsh, 2007; D´Este and Patel, 2007; Bekkers and Bodas Freitas, 2008; Philpott *et al.*, 2011; Davey *et al.*, 2011, 2018; De Fuentes and Dutrénit, 2012; Ankrah and Al-Tabbaa, 2015; Galán-Muros and Plewa, 2016; Skute *et al.*, 2017; Benneworth *et al.*, 2017; García-Pérez-de-Lema *et al.*, 2017; Vick and Robertson, 2018; Alpaydın and Fitjar, 2020; Parmentola, Ferretti and Panetti, 2020; Sharma, 2020) on which determining factors (i.e. drivers, barriers and organisational-related elements) may generate different effects (e.g. Schartinger *et al.*, 2002; Bekkers and Bodas Freitas, 2008; Arza and López, 2011; De Fuentes and Dutrénit, 2012; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018; Vick and Robertson, 2018; Alpaydın and Fitjar, 2020; Alunurm, Rõigas and Varblane, 2020; Parmentola, Ferretti and Panetti, 2020). This lack of a systemic perspective on UBC calls for the development of studies that analyse in a holistic way the impact of organisational context-related factors on SMEs' cooperation levels in the various UBC activities in the domains of education, research, valorisation and management. The development of studies taking a holistic view of UBC activity types is essential to understand UBC patterns in both more developed activities (i.e. joint R&D, mobility of students and consultancy) and less developed activities (e.g. curriculum co-design and co-delivery, student entrepreneurship, governance or shared resources), which, in turn, have been the least analysed (Davey *et al.*, 2018) . This research gap leads to the definition of the following third specific objective:

Specific objective 3: *Identify the most determining organisational context-related factors on manufacturing SMEs' cooperation levels in UBC activities*

This objective seeks, on the one hand, to explore the impact of organisational context-related factors on manufacturing SMEs' cooperation levels in diverse UBC activities within the domains of (i) education, (ii) research, (iii) valorisation and (iv) management and, on the other hand, identify the most relevant ones.

This specific objective leads to the identification of the most determining factors on manufacturing SMEs' cooperation levels in various UBC activities.

4.6. Specific objective 4

As previously stated (see Sub-section *3.2.3 The role of AC on UBC*), AC is one of the most discussed business capabilities in UBC literature (e.g. Bruneel, D´Este and Salter, 2010; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018; Kobarg, Stumpf-Wollersheim and Welpe, 2018). Nonetheless, as seen in the critical review of the literature, the role of AC both on a business' likelihood to cooperate and on cooperation levels in diverse UBC activities remains unclear. As Hervas-Oliver, Albors-Garrigos and Baixauli (2011) stated, this lack of clarity is emphasised when it comes to SMEs or low-tech industries.

Whilst several studies have shown a positive influence of AC on UBC (e.g. Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018), some authors manifest opposing results (e.g. Bruneel, D´Este and Salter, 2010; Kobarg, Stumpf-Wollersheim and Welpe, 2018), while analysis of AC has also shown controversy in relation to its operationalisation. Although AC was originally operationalised as R&D intensity (e.g. Cohen and Levinthal, 1989, 1990; Tsai, 2001), scholars such as Hervas-Oliver, Albors-Garrigos and Baixauli (2011) argued that R&D intensity may not be a good measure of AC for SMEs, non-R&D performers and companies in low–medium-tech environments. Furthermore, criticism of the mainstream innovation research and policy, which is mainly based on high investment in R&D and advanced technologies as key drivers of growth and prosperity, led to the operationalisation of innovation and AC through non-R&D measures (e.g. Hirsch-Kreinsen, Jacobson and Robertson, 2006; Robertson, Smith and von Tunzelmann, 2009; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hirsch-Kreinsen, 2015a, 2015b). In turn, drawing on Zahra and George (2002), AC constructs appeared, based on businesses' routines and internal processes with regard to external knowledge (e.g. Jansen, Van Den Bosch and Volberda, 2005; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Bishop, D'Este and Neely, 2011; Flor and Oltra, 2013; Biedenbach, Marell and Vanyushyn, 2018; Flor, Cooper and Oltra, 2018). In short, it must be stressed that there are two main AC's operationalisation strands in the literature: (i) the use of factors related to a company's R&D capacity and training i.e. R&D intensity, investment in training, number of employees with a higher education degree, etc. (e.g. Cohen and Levinthal, 1989, 1990; Mowery and Oxley, 1995; Keller, 1996; Veugelers, 1997; Tsai, 2001; Cassiman and Veugelers, 2002; Escribano, Fosfuri and Tribó, 2009; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018) and, (ii) the use of constructs based on businesses' routines and internal processes (Jansen, Van Den Bosch and Volberda, 2005; Flor and Oltra, 2013; Flor, Cooper and Oltra, 2018). With regard to the latter, it is important to state that, unlike the operationalisation of AC as a proxy of R&D intensity or a firm's investment in training (e.g. Cohen and Levinthal, 1989, 1990; Tsai, 2001; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018), the AC constructs based on company's routines and internal processes (e.g. Jansen, Van Den Bosch and Volberda, 2005; Flor and Oltra, 2013; Flor, Cooper and Oltra, 2018) allow more in-depth analyses since these can differentiate both PAC and RAC dimensions. As Flor, Cooper and Oltra (2018) state, this distinction between PAC and RAC helps to identify which abilities matter most in the formation of external connections.

These diverse forms of operationalising AC may have been one of the reasons for the discrepancies as regards the various results on the impact of AC on UBC. Nevertheless, to the best of our knowledge, no study has carried out a comparative analysis of the differences that may appear depending on the operationalisation form used. Furthermore, the studies found in the light of the literature have analysed AC as a whole and have not analysed the impact of the different dimensions of AC.

On the other hand, the vast majority of existing studies analysing the impact of AC on UBC have focused their research on companies' likelihood to cooperate with universities without specifying any type of UBC activity (e.g. Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Biedenbach, Marell and Vanyushyn, 2018; Kobarg, Stumpf-Wollersheim and Welpe, 2018). Very few studies have analysed the impact of AC on a specific type of activity, with the exception of Bruneel, D´Este and Salter, (2010), who analysed R&D projects and García-Pérez-de-Lema *et al.* (2017), who analysed research and innovation projects, training and advice. As seen in the critical literature review, previous studies have failed to consider the impact of AC on the different types of UBC activities within the domains of education, research, valorisation and management.

Due to the importance of AC in the literature on UBC, it has been considered necessary to define a specific objective with the aim of clarifying the existing unknowns about the role of AC on UBC:

Specific objective 4: *Clarify the role of AC on manufacturing SMEs' cooperation levels in UBC activities.*

This objective seeks to analyse and compare the influence of AC, operationalised as (i) R&D intensity and as (ii) a construct based on businesses' routines and internal processes with regard to external knowledge, differentiating PAC and RAC, on manufacturing SMEs' cooperation levels in various UBC activities within the domains of (i) education, (ii) research, (iii) valorisation and (iv) management.

The results of this specific objective will shed light on existing unknowns about the role of AC on UBC.

4.7. Research purpose

When defining the research questions and objectives, the researcher inevitably thinks about the purpose of the study. It is important to highlight that a research study can have more than one purpose (Saunders, Lewis and Thornhill, 2009). The most common classification of research purposes used in the research method's literature highlights: *exploratory*, *descriptive* and *explanatory* purposes.

Exploratory studies are carried out when (i) there is not much knowledge on a particular phenomenon, (ii) the results of existing results are unclear or show serious limitations, (iii) the topic is highly complex or (iv) there is not enough theory available to guide the development of a theoretical framework (Sekaran and Bougie, 2016). Saunders, Lewis and Thornhill (2009) indicate that exploratory studies seek to clarify the understanding of a problem, such as if the researcher is unsure of its precise nature.

Descriptive studies are an extended piece of exploratory research or a piece of explanatory research. This kind of study seeks to collect data that describes characteristics of objects (such as persons, organisations, products, or brands), events, or situations (Sekaran and Bougie, 2016). They look for a "portrait", patterns, ideas or hypotheses, rather than testing or confirming them (Robson and McCartan, 2016). Exploratory studies should be thought as a means to an end rather than an end in itself.

Explanatory research is a continuation of descriptive research and its purpose goes beyond the mere description of characteristics; it seeks to analyse and explain why or how the phenomenon being studied is happening (Robson and McCartan, 2016). Explanatory studies establish causal relationships between variables and aim to analyse a situation or a problem in order to explain the relationship between them.

Table 12 below developed by Robson and McCartan (2016) summarises the main characteristics of each research purpose:

Research purpose	Characteristics
Exploratory research	- Finds out what is happening, e.g., in little understood situation - Seeks new insights - Asks questions - Assesses phenomena in new light - Generates ideas and hypotheses for future research - Is almost exclusively flexible in design
Descriptive research	- Portrays an accurate profile of person, event or situations - Requires extensive previous knowledge of the situation to be researched or described, to know appropriate aspects on which to gather information - May be either flexible or fixed in design
Explanatory research	- Seeks an explanation of the situation or problem, traditionally but not necessarily in the form of causal relationships - Explains patterns relating to the phenomenon being researched - Distinguishes between aspects of the phenomenon - May be either flexible or fixed in design

Table 12. Summary of the main characteristics of exploratory, descriptive and explanatory research purposes (Robson and McCartan, 2016)

Given the main and specific objectives of the present study and research questions, this research has a descriptive (Specific objective 1), exploratory (Specific objective 2 and Specific objective 3) and explanatory purpose (Specific objective 4).

4.8. Research hypotheses

4.8.1. Introduction

Having defined the main and specific objectives and the research questions to be addressed by the present study, this section deals with the definition and formulation of the hypotheses that led to Specific objective 4, whose purpose is explanatory.

4.8.2. Research hypotheses

As Robson and McCartan (2016) and Creswell (2013) note hypotheses are the predicted answers to a research question, and the predictions about the expected relationships among variables. As Creswell (2013) indicates in quantitative studies, researchers use quantitative research questions, hypotheses and objectives with the aim of shaping the focus of the purpose of the study. These are used frequently in social science research and especially in survey studies. With regard to the development of hypotheses in quantitative studies, it is important to highlight that not all quantitative studies formulate hypotheses, as this is dependent on the purposes of the study (Hernández Sampieri, Fernández and Baptista Lucio, 2014). As seen in Table 13, quantitative studies formulate hypotheses when they have correlational, explanatory or descriptive purposes, in an attempt to predict a figure or a fact.

Purpose of the study	Hypothesis formulation
Exploratory	No hypotheses are formulated
Descriptive	Hypotheses are only formulated when an event or data is predicted
Correlational	Correlational hypotheses are formulated
Explanatory	Causal hypotheses are formulated

Table 13. Formulation of hypotheses in quantitative studies with different purposes (Hernández Sampieri, Fernández and Baptista Lucio, 2014)

Given that quantitative studies can have several purposes (Saunders, Lewis and Thornhill, 2009), drawing on Hernández Sampieri, Fernández and Baptista Lucio (2014) the purposes of the specific objectives of the study were taken into account (see Sub-section *4.7 Research purpose*). On this basis, given the purposes of the first (descriptive), second (exploratory) and third (exploratory) specific objectives, hypotheses were only formulated for the achievement of the fourth objective, which was explanatory. These directional hypotheses, which were formulated in the light of the literature, are the guidelines for the achievement of the fourth specific objective and make predictions about the expected outcome (Creswell, 2013).

Specific objective 4: *Clarify the role of AC on manufacturing SMEs' cooperation levels in UBC activities*

Zahra and George (2002) defined AC as the ability of a company to acquire and assimilate (PAC), and transform and exploit (RAC) external knowledge, with the aim of generating opportunities for profit. As Cohen and Levinthal (1990) and Zahra and George (2002) stated, variations in businesses' AC levels can explain differences in knowledge transfer effectiveness among companies. The latter authors also indicated that AC is dependent on businesses' past investment in R&D, and is a result of an accumulation of knowledge within the firm. Therefore, it can be stated that businesses enjoying relevant prior knowledge are more likely to understand the new technologies and knowledge that can be transformed into new ideas or products (Tsai, 2001). In this regard, Galán-Muros and Plewa (2016) stated that companies are more likely to engage in UBC whenever they see beneficial outcomes from such an engagement, which in turn is likely to depend on business' AC.

Literature has highlighted that companies need a minimum level of AC to be able to engage in cooperation partnerships (Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). Companies with higher AC levels may be more likely to cooperate with universities (Davey *et al.*, 2011, 2018; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017) since these have the ability to acquire, assimilate, transform and exploit university knowledge. Several studies (e.g. Cassiman and Veugelers, 2002; Negassi, 2004; Singh, 2005; Vanhaverbeke, Van de Vrande and Chesbrough, 2008; Bishop, D'Este and Neely, 2011; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018) have shown that companies with higher AC levels are more prone to cooperation and open innovation. Drawing on the existing literature, AC is expected to have both a positive and significant influence on the cooperation levels in UBC activities.

As previously stated (see Sub-section *4.6 Specific objective 4*) there are two main AC operationalisation strands in the literature: (i) the use of factors related to a company's R&D capacity and training i.e. R&D intensity, investment in training, number of employees with a higher education degree, etc. (e.g. Cohen and Levinthal, 1989, 1990; Mowery and Oxley, 1995; Keller, 1996; Veugelers, 1997; Tsai, 2001; Cassiman and

Veugelers, 2002; Escribano, Fosfuri and Tribó, 2009; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018); and (ii) the use of constructs based on businesses' routines and internal processes with regard to the acquisition, assimilation, transformation and exploitation of external knowledge (Jansen, Van Den Bosch and Volberda, 2005; Flor and Oltra, 2013; Flor, Cooper and Oltra, 2018). Unlike the operationalisation of AC as a proxy of R&D intensity or a firm's investment in training (e.g. Cohen and Levinthal, 1989, 1990; Tsai, 2001; Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018), AC constructs based on a company's routines and internal processes (e.g. Jansen, Van Den Bosch and Volberda, 2005; Flor and Oltra, 2013; Flor, Cooper and Oltra, 2018) allow more in-depth analyses since these can differentiate both PAC and RAC dimensions. Based on the theoretical underpinnings, both operationalisations are expected to have a positive and significant influence on cooperation levels in UBC activities.

With the aim of clarifying and explaining the role of AC on manufacturing SMEs' cooperation levels in UBC activities, the following three hypotheses were defined:

- ***Hypothesis 1:*** *PAC has a positive and significant influence on cooperation levels in UBC activities.*
- ***Hypothesis 2:*** *RAC has a positive and significant influence on cooperation levels in UBC activities.*
- ***Hypothesis 3:*** *R&D intensity has a positive and significant influence on cooperation levels in UBC activities.*

Drawing on the classification of UBC activities developed by Davey *et al.* (2018), each of the three hypotheses were tested for the 14 UBC activities identified and categorised in the domains of education, research, valorisation and management. Accordingly, a total of 42 hypotheses were analysed, three for each of the activities. Table 14 below summarises, both, the UBC activities and the hypotheses to be analysed.

Domain	**UBC activity**	**H1: PAC has a positive and significant influence on cooperation levels in UBC activities**	**H2: RAC has a positive and significant influence on cooperation levels in UBC activities**	**H3: R&D intensity has a positive and significant influence on cooperation levels in UBC activities**
Education	Mobility of students	H1a	H2a	H3a
	Curriculum co-design	H1b	H2b	H3b
	Curriculum co-delivery	H1c	H2c	H3c
	Dual education programmes	H1d	H2d	H3d
	Lifelong learning	H1e	H2e	H3e
Research	Joint R&D	H1f	H2f	H3f
	Consultancy	H1g	H2g	H3g
	Mobility of staff	H1h	H2h	H3h
Valorisation	Commercialisation of R&D	H1i	H2i	H3i
	Academic entrepreneurship	H1j	H2j	H3j
	Student entrepreneurship	H1k	H2k	H3k
Management	Governance	H1l	H2l	H3l
	Shared resources	H1m	H2m	H3m
	Support	H1n	H2n	H3n

Table 14. Specific objective 4: summary of hypotheses: H1, H2 and H3

4.9. Summary

This chapter detailed the research objectives, research questions and hypotheses addressed in the present study. A critical analysis of the literature review and the identification of research gaps resulted in the definition of a main objective, three research questions and four specific objectives. Given the diverse nature of the objectives, the research had a descriptive purpose (Specific objective 1), exploratory purpose (Specific objective 2 and Specific objective 3) and explanatory purpose (Specific objective 4). Given the explanatory purpose of Specific objective 4, three hypotheses (H1, H2 and H3) were defined to achieve this. These directional hypotheses were formulated in the light of the literature; they made predictions about the expected outcomes and were the guidelines for addressing the fourth specific objective. Since the specific objective sought to clarify the role of AC on cooperation levels in UBC activities, each hypothesis was tested in the 14 UBC activities identified in the classification developed by Davey *et al.* (2018). Therefore, as can be seen in Table 14 a total of 42 hypotheses were defined.

Chapter 5

Research methodology

5. Research methodology

5.1. Introduction

Having defined the research objectives, research questions and hypotheses, the following sub-sections describe and justify the research methodology, research design and methods applied for the achievement of the present study.

Research methodology[23] refers to the theory of how research should be undertaken and it discusses the way or path to systematically solve a research problem or answer a research question (Kothari, 2004; Kumar, 2011). Research methodology has many dimensions and research methods [24] (Kothari, 2004) and is based on philosophical assumptions (Saunders, Lewis and Thornhill, 2009). Drawing on Saunders, Lewis and Thornhill's (2009) research "onion" (see Figure 2), every aspect related to the research methodology, design and methods of this study were defined.

(i) Research philosophy
(ii) Research approach
(iii) Research strategy
(iv) Research choices — ***Research design***
(v) Time horizons
(vi) Data collection techniques and procedures

Figure 2. Layers that make up the research "onion" (Saunders, Lewis and Thornhill, 2009)

The following sub-sections describe in detail and define in depth the different layers that make up the research "onion".

5.2. Research philosophy

Throughout the history of science, various currents of thought and interpretative frameworks have emerged, opening up different routes in the search for knowledge (Hernández Sampieri, Fernández and Baptista Lucio, 2014). As Hallebone and Priest (2008, p.26) indicate "A philosophy of science refers to a set of explicit fundamental assumptions and frames of reference that underpin a way to conceive of, and know about, a particular reality being studied in a research frame of reference". Philosophical assumptions help to orientate the research problem, its significance, and how to approach it so as to answer defined research

[23] Several academics (e.g. Kothari, 2004; Saunders, Lewis and Thornhill, 2009; Clough and Nutbrown, 2012) point out the need to distinguish research methodology and research methods. This distinction can be appreciated by seeing *methods* as some of the ingredients of research, while *methodology* provides the reasons for using a particular research "recipe" (Clough and Nutbrown, 2012).

[24] Research methods refer to the techniques and procedures used to obtain and analyse data (Saunders, Lewis and Thornhill, 2009).

questions, understand the problems under investigation and contribute to their solution (Saunders, Lewis and Thornhill, 2009; Kivunja and Kuyini, 2017). As Saunders, Lewis and Thornhill (2009) observe, there are three main ways of thinking about research philosophy: *epistemology*, *ontology* and *axiology*, which influence the way in which the researcher thinks about the research process (Hallebone and Priest, 2008; Saunders, Lewis and Thornhill, 2009):

- Epistemology is used to describe how researchers come to know something; how the truth or reality is known (Kivunja and Kuyini, 2017),
- Ontology is a branch of philosophy concerned with the assumptions researchers make in order to believe that something makes sense or is real, or the very nature or essence of the phenomenon under research (Scotland, 2012). There are two aspects of ontology to be highlighted: objectivism and subjectivism: objectivism argues that social entities exist in reality external to social actors concerned with their existence. Subjectivism indicates that the social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence (Saunders, Lewis and Thornhill, 2009).
- Axiology is a branch of philosophy that studies judgements about values (Saunders, Lewis and Thornhill, 2009).

As Saunders, Lewis and Thornhill (2009) indicate, management research can follow four main philosophies: (i) *positivism*, (ii) *realism*, (iii) *interpretivism* and (iv) *pragmatism*.

i. Positivism adopts the philosophical stance of a natural scientist. It works with an observable social reality and the end product of such research can be a law-like generalisation similar to those produced by physical and natural scientists.

ii. Realism also relates to scientific enquiry and argues that there is a reality quite independent of the mind. Realism is similar to positivism in that it assumes a scientific approach to the development of knowledge. In contrast to positivism, founded on deductive logic with empirical and predominantly quantitative methods, realism only assumes the existence of a social world external to the researcher that can be accessed through sense and research (Payne and Payne, 2004).

iii. Interpretivism is critical of positivism and argues that rich insights into this complex world are lost if such complexity is reduced entirely to a set of law-like generalisation. Interpretivism emphasises the difference between analysing people and objects, and advocates that it is necessary for the researcher to understand differences between humans in our role as social actors.

iv. Pragmatism holds that the main determinant of the epistemology, ontology and axiology that a researcher adopts is the research question, where one may be more appropriate than the other for answering particular questions. If the research question does not suggest a clear philosophy, this confirms the view of pragmatisms, that it is possible to work with variations in epistemology, ontology and axiology.

As Saunders, Lewis and Thornhill (2009) pointed out, the best philosophical choice[25] depends on the research question the researcher is seeking to answer. Table 15 below, developed by Saunders, Lewis and Thornhill (2009), compares the four main philosophies from the ontology, epistemology, axiology and data collection procedure perspective.

	Positivism	Realism	Interpretivism	Pragmatism
Ontology: the researcher's view of the nature of reality of being	External, objective and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research question
Epistemology: the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data
Axiology: the researcher's view of the role of values in research	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance	Research is value laden; the researcher is biased by world views, cultural experiences and upbringing. These will impact on the research	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

Table 15. Comparison of four research philosophies in management research (Saunders, Lewis and Thornhill, 2009)

In relation to this study, it should be pointed out that this adopts a *positivist* philosophy since:

- Ontology: the study adopts an external, objective and independent view of the nature of reality.
- Epistemology: the study seeks to generate knowledge through data, focuses on causality among variables and seeks to generalise the phenomenon by reducing it to its simplest elements.
- Axiology: the research is value-free, the researcher is independent of the data and maintains an objective stance.
- Data collection: although defined in later sections, data collection will be highly structured, based on a large sample and quantitative.

[25] As Saunders, Lewis and Thornhill (2009) indicate, the practical reality is that a particular question rarely falls into only one philosophical domain.

5.3. Research approach

Based on the different research philosophies described in the previous sub-section, research approaches provide a more practical guide for the overall configuration of the research (Saunders, Lewis and Thornhill, 2009). Deduction and induction are the main research approaches in the literature and these are related to the use of theory in research. Whilst, the deductive approach begins with the development of a theoretical perspective, leading to the definition of hypotheses and their subsequent testing through a research strategy, the inductive approach gathers data and develops theory as a result of the data analysis (Saunders, Lewis and Thornhill, 2009). Table 16 below details the main differences between the deductive and inductive approaches.

Deduction emphasises	Induction emphasises
- Scientific principles - Moving from theory to data - The need to explain causal relationships between variables - The collection of quantitative data - The application of controls to ensure validity of data - The operationalisation of concepts to ensure clarity of definition - A highly structured approach - Researcher independence of what is being researched - The necessity to select samples of sufficient size in order to generalise conclusions	- Gaining an understanding of the meanings humans attach to events - A close understanding of the research context - The collection of qualitative data - A more flexible structure to permit changes of research emphasis as the research progresses - A realisation that the researcher is part of the research process - Less concern with the need to generalise

Table 16. Major differences between deductive and inductive approaches to research (Saunders, Lewis and Thornhill, 2009)

By adopting a *positivistic* view, this study manifests a theory-testing approach, within which theory was first adopted as a framework for the subsequent analysis in a specific context through a research strategy. Consequently, the present study adopts a *deductive* approach. Deduction is based on what is considered to be scientific research, involving the development of a theory and a rigorous analysis that gives rise to the foundations for the explanation of the phenomenon. The deductive approach allows phenomena to be anticipated, predicted and controlled (Collis and Hussey, 2013).

5.4. Research design

The term *research design* refers to the plan or strategy conceived to obtain the desired information in order to answer the research question and objectives (Saunders, Lewis and Thornhill, 2009; Hernández Sampieri, Fernández and Baptista Lucio, 2014; Robson and McCartan, 2016; Sekaran and Bougie, 2016). In other words, “the research design seeks to turn research questions and objectives into a research project” (Robson and McCartan, 2016 p.71). Research designs can be (i) fixed, (ii) flexible or (iii) multi-strategy (Robson and McCartan, 2016). A fixed design is pre-specified before the main data collection stage and data is almost always in the form of numbers. This type of design is commonly referred to as a quantitative strategy. A flexible design evolves during data collection and data is typically non-numerical. This type of design is often referred to as a qualitative strategy. A multi-strategy design combines the main elements of both fixed and flexible designs. Commonly, the flexible phase is followed by a fixed phase.

Before going into the research design in depth, it is important to emphasise the difference between research design and tactics. Whilst research design refers to the general broad orientation taken in addressing research questions, tactics is about the finer detail of data collection and analysis (specific methods of investigation) (Robson and McCartan, 2016). Decision about tactics involves being clear about the differences between quantitative and qualitative data collection techniques and analysis procedures (Saunders, Lewis and Thornhill, 2009; Robson and McCartan, 2016).

As academics indicate, the research design must reflect that the researcher has carefully thought about it and it must be based on research questions and objectives (Saunders, Lewis and Thornhill, 2009; Robson and McCartan, 2016). Besides, it must be consistent with the research philosophy and research approach adopted. Robson and McCartan (2016) underlined that research design is concerned with the various issues which should be borne in mind when carrying out a research project (i.e. purpose, conceptual framework, research question, methods, sampling procedures). Following Saunders, Lewis and Thornhill's (2009) research "onion", *research strategies*, *research choices* and *time horizons* form the research design.

5.4.1. Research strategy

The present sub-section deals with a summary of the different research strategies that researchers can apply in their studies. Authors specialised in research methodology (e.g. Hakim, 2000; Yin, 2003; Hernández Sampieri, Fernández and Baptista Lucio, 2014; Robson and McCartan, 2016; Sekaran and Bougie, 2016) indicate that diverse research strategies can be used for exploratory, descriptive and explanatory research purposes (for more information see *Sub-section 4.7 Research purpose*). As Yin (2003) states, some of these strategies clearly belong to the deductive approach, whilst others to the inductive one. Nonetheless, allocating strategies to one approach or another is often too simplistic (Saunders, Lewis and Thornhill, 2009).

Saunders, Lewis and Thornhill (2009) indicate that the choice of the research strategy is guided by (i) the research questions and objectives, (ii) the extent of existing knowledge, (iii) the amount of time and other resources available, and (iv) the philosophical underpinnings. Although each strategy has its distinctive characteristics, there are large overlaps among them (Yin, 2003) and the use of a type of strategies does not exclude the use of another (Yin, 2003; Saunders, Lewis and Thornhill, 2009). As an example, it is possible to use the survey strategy as part of a case study. The main research strategies highlighted by Saunders, Lewis and Thornhill (2009) are summarised as follows:

- Experiment is a form of research that owes much to the natural sciences. The objective of this kind of research strategy is to study causal links. The simplest experiments seek to analyse whether there is a link between two variables, whether a change in one independent variable produces a change in another dependent variable (Hakim, 2000). More complex experiments also consider the size of the change and the relative importance of two or more independent variables (Saunders, Lewis and Thornhill, 2009).
- A survey is usually associated with the deductive approach. This is one of the most popular and common strategies in business and management research, and, it is frequently used to answer who, what, where, how much and how many questions. This strategy is very popular as it allows a large

amount of data to be collected from a sizeable population in quite an economical[26] way by administering a questionnaire to a sample. A survey makes it possible to generate findings that are representative of the whole population at a lower cost and complexity than collecting data for the whole population. This strategy requires time to (i) ensure that the sample is representative of the population, (ii) design and pilot the data collection tool and (iii) ensure a good response rate. Surveys allow quantitative data to be obtained and analysed by using descriptive and inferential statistics. In turn, data collected from a survey can be exploited to suggest possible reasoning for a particular relationship between variables, which leads to the design of models reflecting the relationship between variables (Saunders, Lewis and Thornhill, 2009). As Cohen, Manion and Morrison (2007) indicate surveys can be exploratory, descriptive and explanatory. Exploratory surveys do not assume or postulate any model, and seek to explore relationships and patterns (e.g. through correlation, regression, etc.). Descriptive surveys just describe data on variables of interest and explanatory surveys seek to test a model, causal relationship or hypothesis.

- Robson and McCartan (2016 p.50) define case study as a “strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence”. Yin (2003) also points out the importance of context in case studies, highlighting that within a case study, the boundaries between the phenomenon being studied and the context within which it is being studied are not always evident. This situation is opposite to that of the experimental strategy where the research undertaken is totally controlled. Case studies also differ from the survey strategy as the latter limits the ability to explore and understand the context by the variables included in the study (Saunders, Lewis and Thornhill, 2009).
- As Coghlan and Brannick (2005) indicate action research is an approach to research which aims at both taking action and creating knowledge or theory about that action. Unlike traditional research approaches which aim to only create knowledge, the outcomes of action research are both an action and a research outcome. This strategy works through a cyclical process of: (a) planning; (b) taking action; (c) evaluating the action, leading to further planning and so on. One of the main characteristics of this strategy is that the researcher is part of the organisation within which the research and the change process are taking place.
- Grounded theory is one of the best examples of the inductive approach (Glaser and Strauss, 1967). However, as Saunders, Lewis and Thornhill (2009) indicate this view is very simplistic and it is better to think of it as “theory building” through a combination of induction and deduction. In grounded theory data gathering begins without the formation of an initial theoretical framework; theory is developed from data generated by a series of observations. This data gives rise to the generation of predictions which are then tested in further observations that may or may not confirm them (Saunders, Lewis and Thornhill, 2009).

[26] Gathering data from a representative sample of the population, rather than from the whole population, reduces the cost of the research (Saunders, Lewis and Thornhill, 2009).

- Ethnography is also rooted in the inductive approach and emanates from the field of anthropology (Saunders, Lewis and Thornhill, 2009). Ethnography deals with describing and explaining the social world which research subjects inhabit and the way in which they would describe and explain it. This is a time-consuming research strategy, as the researcher needs to immerse themself in the social world to be investigated as completely as possible over a long period of time.
- Archival research strategy makes use of administrative records and documents as the principal source of data (Saunders, Lewis and Thornhill, 2009). The data used by the researcher is part of the reality they are studying, rather than being data collected for research purposes. The archival research strategy provides researchers with answers to research questions that focus on the past, and changes over time, whether the questions be explorative, descriptive or explanatory.

With regard to the selection of the research strategy, on the one hand, Saunders, Lewis and Thornhill (2009) remark that this must be based on the type of research question posed, the extent of existing knowledge, the amount of time and other resources available, as well as philosophical underpinnings. On the other hand, Yin (2003) indicates that researchers need to bear in mind the following three conditions in order to choose a strategy: (i) the type of research question posed, (ii) the extent of control an investigator has over actual behavioural events and (iii) the degree of focus on contemporary as opposed to historical events.

Table 17 below, developed by Yin (2003), analyses some of the main research strategies in relation to these three conditions.

Strategy	Form of research question	Requires control of behavioural events	Focuses on contemporary events
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

Table 17. Relevant situations for different research strategies (Yin, 2003)

Following the guidelines of Saunders, Lewis and Thornhill (2009) and Yin (2003) - type of research question, extent of existing knowledge on the topic, amount of time and resources, philosophical underpinning, extent of control and degree of focus on contemporary events- , it is agreed that the study will be approached using the survey strategy.

5.4.2. Research choices

The research strategies previously described (see Sub-section *5.4.1 Research strategy*) referred to both qualitative and quantitative data collection techniques and analysis procedures. One way of distinguishing both is that the focus of quantitative analysis is numbers and the focus of qualitative analysis is words. The term “quantitative” is predominantly used as a synonym for data collection techniques and analysis procedures such as questionnaires, graphs and statistics. As Williams (2007) indicates, quantitative studies seek explanations and predictions that can be generalizable and contribute to theory. In contrast, the term “qualitative” is used as a synonym for interviews or categorisations, which generate or use non-numerical data (Saunders, Lewis and Thornhill, 2009). For many years, social researchers have had to choose between quantitative and qualitative research. Fortunately, there is a growing recognition of the value of combining elements of both quantitative and qualitative research styles (Saunders, Lewis and Thornhill, 2009; Robson and McCartan, 2016).

The way in which a researcher chooses to combine quantitative and qualitative techniques and procedures is the “research choice”. In choosing the research method, it is possible either to use a single data collection technique and a corresponding analysis procedure, the so-called mono method, or to use more than one data collection technique and analysis procedure, i.e. multiple methods.

If a researcher selects to use a mono method, they will combine either a single quantitative data collection technique, such as a questionnaire, with a quantitative data analysis procedure; or a single qualitative collection technique and a single analysis procedure. By contrast, if they choose to combine data collection techniques and procedures using some form of multiple methods design, there are two possibilities: (i) multi-methods and (ii) mixed-methods. On the one hand, the term multi-method refers to the combination of more than one data collection and analysis technique but is restricted to a quantitative or qualitative view of the world. Therefore, the researcher can develop multi-method quantitative or multi-method qualitative studies. On the other hand, the mixed methods approach is the general term used when both quantitative and qualitative data collection techniques and analysis procedures are used in a research design. There are two types of mixed methods:

i. The *mixed-method research* that uses quantitative and qualitative data collection techniques and analysis procedures either at the same time (parallel) or one after the other (sequential) but does not combine them,
ii. The *mixed-model research* that combines quantitative and qualitative data collection techniques and analysis procedures as well as combining quantitative and qualitative approaches during other phases of the research such as research question generation.

As Saunders, Lewis and Thornhill (2009) indicate, if both quantitative and qualitative are combined (mixed methods), the potential for unexpected results rises. This choice is increasingly advocated in business and management research (Curran and Blackburn, 2001), where studies use quantitative and qualitative techniques and procedures as well as primary and secondary data.

In order to address the objectives and research questions previously defined, the present work, based on the survey strategy, is a multi-method study based on the quantitative approach.

5.4.3. Time horizons

Research studies can be differentiated into two categories in relation to their time horizon (i) cross-sectional studies and (ii) longitudinal studies. Cross-sectional studies analyse a particular phenomenon at a particular time and often employ the survey strategy (Robson and McCartan, 2016). Nevertheless, they may also use qualitative methods (Saunders, Lewis and Thornhill, 2009). Longitudinal studies analyse the change of a phenomenon for a period of time. In this sort of study, data is collected at more than one point in time or brief period (Robson and McCartan, 2016). It is important to state that the time horizon of a research study is independent of the research strategy pursued or method used (Saunders, Lewis and Thornhill, 2009).

The time horizon of the present study is cross-sectional as the objective of the study is to analyse a particular phenomenon at a particular time.

5.5. Data collection

In accordance with Williams (2007), quantitative research implies gathering data so that the information can be quantified and subjected to statistical treatment to address research questions and objectives. The following sub-section deals with the specification of data collection and all the aspects that need to be determined (i.e. unit of analysis and sampling design, selection and size) prior to the definition of the data collection method. After defining the data gathering method, the design of the research instrument, the pre-testing of the instrument and the process of data collection are discussed in detail.

5.5.1. Unit of analysis

Defining a unit of analysis is one of the most important issues in any scientific endeavour since this reflects distinctively the theoretical premises of a study (Jornet and Damsa, 2019). Unit of analysis is the main entity that researchers study and defines what or whose data will be collected. The unit of analysis depends on and must be consistent with the research purpose, objective and research design. The definition of a unit of analysis is the step prior to the definition of a sample. Once the unit is defined, a population can be delimited (Hernández Sampieri, Fernández and Baptista Lucio, 2014). Babbie (2001) observes that, studies in social science, commonly use the following units of analysis: individuals, groups, organisations, social artefacts, and social interactions (see Table 18).

Unit of analysis	Description
Individuals	Researchers tend to describe and explain social groups and behaviours by analysing and aggregating the behaviours of individuals.
Groups	A researcher may be interested in characteristics that belong to one group, considered as a single entity.
Organisations	If a researcher is studying corporations, the unit of analysis is the organisation (corporation).
Social artefacts	A social artefact is any product of social beings or their behaviour, such as: books, newspapers, paintings, poems…
Social interactions	Social interactions that might be units of analysis in social science research include: court cases, traffic accidents, fistfights, friendship choices, divorces…

Table 18. Classification of units of analysis commonly used in social sciences (Babbie, 2001)

As for the most common units of analysis in UBC literature, it should first be noted that the analyses of UBC have focused on both the academic (e.g. Schartinger *et al.*, 2002; Link, Siegel and Bozeman, 2007; Bekkers and Bodas Freitas, 2008; D´Este and Perkmann, 2011; Davey *et al.*, 2011, 2018; De Fuentes and Dutrénit, 2012; Galán-Muros and Plewa, 2016; Orazbayeva and Plewa, 2020) and business perspective (e.g. Bekkers and Bodas Freitas, 2008; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; De Fuentes and Dutrénit, 2012; García-Pérez-de-Lema *et al.*, 2017; Davey *et al.*, 2018; Alpaydın and Fitjar, 2020; Alunurm, Rõigas and Varblane, 2020). Secondly, it must be underlined that, regardless of the focus of the analysis, existing studies have analysed the phenomenon both at the individual (e.g. Link, Siegel and Bozeman, 2007; Bekkers and Bodas Freitas, 2008; D´Este and Perkmann, 2011; Galán-Muros and Plewa, 2016; Orazbayeva and Plewa, 2020) and institutional or organisational level (e.g. Davey *et al.*, 2011, 2018; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; De Fuentes and Dutrénit, 2012; García-Pérez-de-Lema *et al.*, 2017; Alpaydın and Fitjar, 2020; Alunurm, Rõigas and Varblane, 2020). With regard to this latter, it should be observed that both units of analysis are intermingled since UBC is acknowledged as a multi-level phenomenon (i.e. UBC is determined by both individual characteristics as well as organisational and institutional context-related characteristics) (Perkmann *et al.*, 2013; Skute *et al.*, 2019).

On the basis of the research objectives and research questions of the study, the analysis of the present study is focused on the business perspective and cooperating and non-cooperating manufacturing SMEs (organisation) is the unit of analysis.

5.5.2. Research population

Once the unit of analysis had been defined, the population to be studied was delimited. The population is the set of all the cases that match a range of specificities. A general shortcoming found in some research studies is that they do not sufficiently describe the characteristics of the population. Populations must be clearly identified in terms of content, location and time (Hernández Sampieri, Fernández and Baptista Lucio, 2014).

As previously seen, the region in which companies and universities are located plays a key role in the phenomenon of UBC (Breschi and Lissoni, 2001; Singh, 2005; D´Este and Patel, 2007; Eom and Lee, 2010; Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, 2010; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano, 2015; Galán-Muros and Davey, 2017; Davey *et al.*, 2018; Skute *et al.*, 2019; Alpaydın and Fitjar, 2020; Sharma, 2020). Therefore, for this analysis it was essential to define the characteristics of the region containing the population to be analysed.

In the critical review of the literature (see Sub-section *3.2 Critical analysis of the literature*), it was observed that a holistic and comprehensive understanding of the UBC phenomenon requires:

- Further studies covering previously unexplored regions of interest to science (Mascarenhas *et al.*, 2018),
- Analysis and identification of the differences between cooperating and non-cooperating companies,
- Studies including companies at all technological levels in their sample, regardless of whether they are developers of R&D and innovation.

Drawing on these issues, the present study focuses on the Basque Country, a region that: (i) has a great heterogeneity of companies in terms of size, R&D, innovation, technological level and UBC level; (ii) has not previously been analysed, and (iii) allows access to the population, sampling frame and sample.

5.5.2.1. Basque manufacturing SMEs

The Basque Country is a NUT2[27] small region in the north of Spain, that stands out in the Spanish landscape thanks to its industrial strength and well-educated workforce (OECD, 2013a). The region is characterised by a long trajectory in manufacturing activities and has a solid industrial base. In 2017, most of the industrial sectors in the Basque Country (at least those that account for 42.5% of its Gross Value Added (GVA)) were included in sectors classified by the OECD as having a "medium-low" technological level; only 5.1% of

[27] NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU.

industrial activities were at the high technological level (Eustat, 2020c). In 2019, the Basque manufacturing industry accounted for 19.38% of total Gross Domestic Product (GDP) (INE, 2021). According to data consulted in Eustat, (2020a), in 2019 there were 2,411 manufacturing SMEs, with their headquarters in the Basque Country. Basque companies manufacture a wide variety of capital goods, durable goods and other intermediate products. Based on Regional Innovation Scoreboard (RIS) 2019, the region ranks first of 19 regions at the state level in terms of population with tertiary education, lifelong learning, SMEs innovating in-house, innovative SMEs cooperating with others and R&D expenditure in the business sector (European Commission, 2019). As regards to governmental mechanisms for promoting UBC, it must be stressed that, even though there is still a lot of work to be done, the Basque Country is a region committed to UBC (KPMG, 2016). The Basque Government promotes cooperation between universities and companies through various mechanisms such as *I 2022 Basque University-Business Strategy* (Basque Government, 2017), *Hazitek*[28], *Elkartek*[29] and *Basque Digital Innovation Hub*[30], among others (For further information on the characteristics of the Basque Country, its university system and business fabric see *Appendix II: About the Basque Country*). All these features, together with the importance that manufacturing SMEs have for the region, as well as the fact that the region had not been previously analysed with regard to UBC, made this region appropriate for the study.

5.5.3. Sample design, selection and size

Researchers are interested in finding results that can be generalised or extrapolated to a population of people or things. However, scientists rarely, if ever, have access to every member of the population, and they collect data from a subset of population, which is known as a sample (Hernández Sampieri, Fernández and Baptista Lucio, 2014; Field, 2018).

Sample design refers to the techniques or strategies used to select a given number of people (or things) from a population, and this influences the quality of data and the inferences that researcher can make from it. Sampling techniques offer a number of methods to reduce the amount of data to be collected by considering only data from a sub-group rather than from all possible cases or elements (Mertens, 2010). As Cooper and Schindler (2008) indicate, sampling must be drawn on two premises:

- The similarities among the elements in the population,
- Some elements in the sample underestimate the value attached to a population, whilst others overestimate such a value.

Sampling techniques (or strategies) can be divided into two types: (i) probability or representative sampling, and (ii) non-probability and judgemental sampling (Saunders, Lewis and Thornhill, 2009; Mertens, 2010; Hernández Sampieri, Fernández and Baptista Lucio, 2014). On the one hand, probability sampling (or

[28] https://www.spri.eus/es/ayudas/hazitek/

[29] https://www.spri.eus/es/ayudas/elkartek/

[30] https://basqueindustry.spri.eus/es/basque-digital-innovation-hub/

representative sampling) is often associated with survey-based research strategies, where it is necessary to make inferences from the sample about a population in order to answer the research questions or to meet the objectives (Saunders, Lewis and Thornhill, 2009). This sampling requires specifying the size of the sample (Hernández Sampieri, Fernández and Baptista Lucio, 2014). As seen in Mertens (2010, p.317) "Henry (1990) and Conley and Fink (1992) make a case for the use of probability-based sampling because mathematically it is possible to analyse the possible bias and likely error. Sampling error is defined as the difference between the sample and the population, and can be estimated for random[31] samples". Random selection can be done in a variety of ways, such as using a lottery procedure that draws well-mixed numbers, drawing a set of numbers from a list of random numbers, or developing a computer-generated list of random numbers (Mertens, 2010). Probability sampling methods require the use of sampling frames and statistical analysis that can be carried out to estimate the population parameters from sample statistics. They also allow for tests of significance to be performed on the results (Markuerkiaga, 2014). On the other hand, non-probabilistic sampling selects cases for one or more purposes, and does not claim that these cases are statistically representative of the population (Mertens, 2010).

When selecting a sampling strategy, it is essential to take into account accessibility to the required sample frame. A sampling frame is any material or device used to obtain observational access to the finite population of interest. With the aid of the frame, it is possible to (i) identify and select a sample in a way that respects a given probability sampling design and (ii) establish contact with selected elements (by telephone, visit at home, mailed questionnaire, etc.) (Särndal, Swensson and Wretman, 2003). However, for some populations, it is not possible to obtain a complete listing of the members of the population, which makes it difficult to use the probability-based sampling strategies (Mertens, 2010). This essential consideration must be borne in mind in the selection of the population. Drawing on this consideration, the research philosophy (positivism), research approach (deductive), research objectives and questions, and research design (based on a multi-method, cross-sectional survey strategy), the sampling strategy used in this analysis is probabilistic. The final objective of this study is generalisation, and therefore, this seeks to undertake research in a statistically representative sample.

Prior to moving on to the calculation of the required sample, it should be stressed that a good sample must contain both, precision and accuracy (Cooper and Schindler, 2008; Saunders, Lewis and Thornhill, 2009; Mertens, 2010; Robson and McCartan, 2016). Precision calls for a sampling error that is within admissible limits for the purposes of the study, while an accurate sample is obtained when there is little or no bias or systematic variance. Another noteworthy factor is design sensitivity, namely the likelihood that an effect, if present, will be detected. The ability to detect statistical differences is determined by the amount of variability in the dependent measure within the sample. Sample size has a direct relationship with variability; larger samples have less variability, and smaller samples have more variability. It is easier to obtain statistical significance in larger samples. However, larger samples are more costly than smaller ones.

[31] Random means that the selection of each unit is independent of the selection of any other unit (Mertens, 2010).

Therefore, it is necessary to identify the smallest sample size that takes into account the variability in the dependent measure and is still sensitive enough to detect a statistically significant difference (Mertens, 2010).

Even if there are some rules of thumb regarding sample size (Henry, 1990; Conley and Fink, 1992), currently, the preferred method for calculating sample size is to use any of the various existing statistical programs (Mertens, 2010) or online calculators, such as SurveyMonkey's calculator[32] (e.g. Pan, Woodside and Meng, 2014; Sayedalamin *et al.*, 2017; Woodtli *et al.*, 2018; Fernando and Prathapan, 2019; Pai and Alathur, 2019; Sivasankaran *et al.*, 2019; Khalid *et al.*, 2020; Pius *et al.*, 2020; Gaffney, Bereznicki and Bereznicki, 2021). These tools allow researchers to personalise the estimation process to the exact needs as well as to play with estimates of sample size to measure the differential effects on precision.

Based on the information obtained from Eustat (2020a), the research population (Basque manufacturing SMEs) was defined as 2,411 companies in 2019. Taking this information as a basis and using Survey Monkey's sample size calculator, sample required for the study was calculated with a margin of error of 5% and a confidence level of 95%. As a result, it was concluded that the study required a minimum sample of 332 SMEs to be representative of the population.

Together with the calculation of the sample needed to be able to make statistical inferences, the sample size requirements of the statistical techniques selected for the analysis were assessed. With regard to the statistical tests used in Specific objective 1, the general rule of minimum 30 cases was taken into account for the parametric *t*-test (Berlanga Silvente and Rubio Hurtado, 2012; Rubio Hurtado and Berlanga Silvente, 2012). As to Specific objective 2, drawing on Peduzzi *et al.* (1996) it was assessed whether the sample size was sufficient for the variables included in the logistic regression models. As Peduzzi *et al.* (1996) note, a useful rule of thumb suggests that the number of the less common of the two possible outcomes divided by the number of predictor variables should be at least 10 or higher. To ensure that the sample was adequate for the variables included in the models, this value was checked for each regressions model. The values obtained in all cases were greater than 10, with the minimum case being 10.67. Regarding Specific objective 3, drawing on Green (1991), the $104+k$[33] rule of thumb was applied in each linear regression model, in order to assess the overall fit of the models and the individual predictors. The values obtained for all regression models were adequate, being 119 cases the minimum value required. Finally, with regard to Specific objective 4, as Kline (2016) indicates, it is impossible to give a single answer to what is a "large enough" sample size in SEM, since the following factors may have an impact on the sample size required:

- Complexity of the model: more complex models or those with more parameters require bigger sample sizes,

[32] https://es.surveymonkey.com/mp/sample-size-calculator/

[33] k is the number of predictors.

- Measurement level and normal distribution of outcome variables: when outcome variables are continuous and follow a normal distribution, smaller samples are required,
- Reliability levels: less precise data requires larger samples in order to offset the potential distorting effects of measurement error,
- Amount of missing data: higher levels of missing data require larger samples to compensate for loss of information,
- Number of indicators: fewer cases may be needed when there are multiple indicators for constructs of interest.

Shah and Goldstein (2006) add that the degree of multivariate normality (West, Finch and Curran, 1995), and estimation method (Tanaka, 1987) may also have an impact on the required sample size. Nevertheless, the following two approaches were found in the literature to determine the sample required for SEM analysis. On the one hand, Jackson (2003) suggests that researcher think about the minimum sample size in terms of the ratio of number of the cases (N) to the number of model parameters that require statistical estimates (q), the N:q rule. This author recommends a sample-size-to-parameter-ratio of 20:1. In other words, if the model has a total of q=10 parameters, then the minimum sample would be 20q, or N=200. The author notes that an N:q ratio of 10q is also admissible. On the other hand, as seen in Kline (2016), based on reviews of studies in different research areas, it is widely accepted that SEM analyses can be carried out with a median sample size of 200 cases (MacCallum and Austin, 2000; Boomsma and Hoogland, 2001; Shah and Goldstein, 2006). Applying this rule of thumb, the minimum sample size calculated for this analysis, 332 cases, can be considered appropriate for SEM analysis.

5.5.4. Data collection methods

Once the research design and sample size had been defined according to the research problem, the next stage was to collect relevant data from sampling units. Collecting data involves developing a detailed plan of procedures leading to the collection of data for a specific purpose. As Hernández Sampieri, Fernández and Baptista Lucio (2014) stressed, a detailed plan for data collection includes: (i) the identification of the sources from which the data will be obtained, (ii) location of the sources, (iii) definition of the method of collection, and (iv) preparation of data.

With regard to the identification and localisation of data, it should be noted that data can be collected in the form of primary or secondary data (Hox and Boeije, 2005; Robson and McCartan, 2016). Whilst primary data is collected for the specific research problem, using procedures that fit the research problem best, secondary data is data that was previously created by other researchers, who made it available for reuse by the general research community. One of the most important advantages of primary data collection is that operationalisation of constructs, research design and data collection strategy can be tailored to research questions, thereby ensuring that the study is coherent and that the information gathered addresses research questions. Nevertheless, primary data collection is costly and time-consuming (Hox and Boeije, 2005). Saunders, Lewis and Thornhill (2009) emphasised that (i) observation, (ii) semi-structured, in-depth and group interviews, and (iii) questionnaires are the main methods for the collection of primary data. Table 19 below describes the main features of each method:

Primary data collection method	Description
Observation	If research questions and objectives are concerned with what people do, an obvious way in which to discover this is to observe them.
Interview	An interview is an intentional conversation between two or more people. The use of interviews helps to gather valid and reliable data that is relevant to research questions and objectives. Within the category of "interview”, a distinction is made between semi-structured, in-depth and group interviews (including focus groups).
Questionnaire	In the field of business and management research, the questionnaire is the most commonly used method in the survey strategy. Questionnaire is a general term to include all techniques of data collection in which each person is asked to respond to the same set of questions in a predetermined order (deVaus, 2002). This general term includes both structured interviews and telephone questionnaires as well as those in which questions are answered without an interviewer present. The method therefore provides an efficient way of gathering responses for a large sample prior to a quantitative analysis. This method enables researchers to examine and explain relationships between constructs, particularly cause-and-effect relationships.

Table 19. Main methods for primary data collection (Saunders, Lewis and Thornhill, 2009)

With regard to secondary data, in cases where data available is relevant to the study, its use is beneficial since this may provide the researcher with a large sample at a lower cost. Nonetheless, as secondary data was originally gathered for a different purpose, this may not be optimal or suit the research problem (Hox and Boeije, 2005). As seen in Markuerkiaga (2014), there are different forms of secondary data such as: major indexes, reference guides, census data, statistical data, market data, industry data, corporate directories, international sources, textbooks, magazines and newspaper articles, among others (Zikmund, 2003; Cooper and Schindler, 2008).

In the case of the present study, data was collected through primary data, given that there was no previous specific data on the variables required for the study, with the exception of company size, which was accessed on the SABI (Iberian Balance Sheet Analysis System) database, and company’s province and CNAE, which were provided by the Basque Government. Based on the research question, objectives and research design, data collection for the study was carried out using the questionnaire method.

Despite the belief that the design of a questionnaire is straightforward, it is worth noting that it is necessary to ensure that it gathers the precise data to answer the research question and achieve the objectives. As Saunders, Lewis and Thornhill (2009) observed, the design of the questionnaire affects the response rate, reliability and validity of the data collected. The authors stressed that response rates, validity and reliability can be maximised by:

- Carefully designing questions,
- Defining a clear and pleasing layout of the questionnaire,
- Providing a clear explanation of the questionnaire,
- Pilot testing,
- Carefully planning and executing its administration.

The design of a questionnaire differs according to how it is administered. Questionnaires can be filled in by the respondent alone (self-administered) or by meeting researchers (Saunders, Lewis and Thornhill, 2009). As can be seen in Table 20, each modality offers different types of questionnaire:

Form of administration	Types of questionnaire
Self-administered	− Internet-mediated questionnaires: electronically using the internet − Postal or mail questionnaires: posted to respondents who return them by post after completion − Delivery and collection questionnaires: delivered by hand to each respondent and collected later
Meeting researchers	− Telephone questionnaires: questionnaires administered using the telephone − Structured questionnaires (sometimes known as interview schedules): questionnaires where interviewers meet respondents in person and ask the questions face-to-face

Table 20. Types of questionnaires according to their form of administration (Saunders, Lewis and Thornhill, 2009)

With regard to the choice of the questionnaire type, as Saunders, Lewis and Thornhill (2009) indicated, this is influenced by a combination of factors related to the research questions and objectives such as:

- Characteristics of respondents,
- Importance of reaching a particular person as respondent,
- Importance of respondents' answers not being contaminated or distorted,
- Required sample size, taking into account the likely response rate,
- Types of questions,
- Number of questions.

These considerations resulted in the analysis of the best type of questionnaire and strategy to reach the required sample for the development of the study. Drawing on Kliewe (2015), the advantages and disadvantages of the internet-mediated questionnaire were analysed (see Table 21):

Authors	Advantages
Tse (1998); Cobanoglu, Warde and Moreo (2001) Fleming and Bowden (2009)	− Cost- and time-efficient − Suitable for large sample size studies
Ilieva, Baron and Healey (2002); Griffis and (Goldsby, 2003)	− Data digitally gathered − Immediate use − Avoids human error in data coding
Fleming and Bowden (2009)	− Data gathering is independent of time and geographical proximity − Flexibility to respondents − Attractive questionnaire designs
Authors	**Disadvantages**
Fleming and Bowden (2009)	− May exclude individuals not using the internet
Mcdonald and Adam (2003); Sax, Gilmartin and Bryant (2003); Heerwegh and Loosveldt (2008); Pan, Woodside and Meng (2014)	− Lower response rates compared to face-to-face questionnaires (this may lead to non-response bias (NRB), the fact that responses from those units of analysis that do not answer the questionnaire may be different from the data gathered)
Klassen and Jacobs (2001)	− The lack of direct communication between respondents and researcher may lead to misunderstandings in the questions (this disadvantage may decrease participation rate if respondents are not sure about how to answer a specific question)
Mcdonald and Adam (2003)	− Email address change and deletion (questionnaire invitations cannot be delivered)

Table 21. Advantages and disadvantages of internet-mediated questionnaire (Kliewe, 2015)

As can be seen in Table 21 despite the manifold advantages of internet-mediated questionnaire, this data collection method also exhibits some disadvantages to bear in mind. However, in the case of this study it must be stated that, (i) internet use is widely spread among manufacturing SMEs, therefore no company is expected to be excluded, and (ii) pre-testing the survey extensively can overcome possible misunderstandings in the questions due to a lack of direct communication between respondents and researchers (Kliewe, 2015). Therefore, it was defined that internet-mediated questionnaire was a valuable and effective method to collect data for this study. Nonetheless, being aware of the large number of questionnaires that SMEs receive, the combination of an internet-mediated questionnaire (self-administered) with a structured questionnaire (face-to-face) was determined, in order to increase response rate and avoid NRB. This attempt to increase the response rate should decrease the number of non-respondents, and reduce NRB at the same time (Armstrong and Overton, 1977).

5.5.5. Variables of the empirical study

With the development of the literature review the most determining organisational context-related factors and main UBC activity types were identified. At the same time, the scales and operationalisations[34] used for measuring these factors were identified. This sub-section deals with the description of the variables, which are summarised in Table 22, and their operationalisation.

Predictor variables		
Group	**Variable**	**Shortcut**
General business characteristics	Industry	Industry
	Location	Location
	Legal form	Legal_form
	Headquarters	Headquarters
	Business group	Business_group
	Age	Age
	Size (ordinal)	Emloyees
	Size	Size
	Turnover	Turnover
	Exports	Market_BC
	Technological level	Tech_scale
	Employees’ qualification	HD_emp
	Gender	Female
Business openness	Cooperation in R&D	RD_coop
	Total number of R&D partners	RD_coop_tot
	Cooperation in LLL	LLL_coop
	Total number of LLL partners	LLL_coop_tot
	Cluster association	Clus_yes_no
	Informal interactions	Inf_int_yes_no
	Total number of informal interactions	Inf_int_tot
Research and development (R&D)	R&D development	RD_yes_no
	R&D intensity	RD_int
	R&D continuity	RD_continuity
	R&D program knowledge	RD_prog_know
	R&D program participation	RD_prog_partic
Lifelong learning (LLL)	LLL development	LLL_yes_no
	LLL commitment	LLL_commit
Absorptive capacity (AC)	Absorptive capacity (AC)	AC
	Potential absorptive capacity (PAC)	PAC
	Realised absorptive capacity (RAC)	RAC
Innovation	Innovation capacity (IC)	IC
	Product IC	IC_prod
	Organisation IC	IC_org
	Marketing IC	IC_mark
	Innovation degree (ID)	ID
UBC willingness and support	UBC willingness and support	UBC_will
	UBC resources	UBC_resources
	Cognitive closeness	Cogni_closeness
	UBC beliefs	UBC_beliefs

Table 22. Summary of the empirical variables of the study

[34] Operationalisation is the translation of concepts into tangible indicators of their existence (Saunders, Lewis and Thornhill, 2009).

Outcome variables		
Variable		**Shortcut**
Cooperation (yes/no)		Coop_yes_no
Cooperation levels	Mobility of students	Stu_mob
	Curriculum co-design	Co_des
	Curriculum co-delivery	Co_del
	Dual education	Dual_ed
	Lifelong learning	Li_learn
	Joint R&D	Joint_RD
	Consultancy	Cons
	Mobility of staff	Staff_mob
	Commercialisation	Commer
	Academic entrepreneurship	Act_ent
	Student entrepreneurship	Stu_ent
	Governance	Gov
	Shared resources	Shared_res
	Support	Support

Table 22. (cont.) Summary of the empirical variables of the study

Drawing on Kliewe (2015), the operationalisation of the variables included in the study followed two steps:

(i) Identification of existing scales,

(ii) Analysis of existing scales; determining whether they were suitable for the study (with or without modifications), or whether new scales needed to be developed.

With the aim of offering a detailed description of the variables and their operationalisation, prior to moving on to their description, essential concepts such as (i) temporal order and measurement levels of variables, (ii) latent constructs and (iii) Likert-type scale are explained.

5.5.5.1. Temporal order and levels of measurement

Temporal order means that one variable precedes another in time. Therefore, it is said that one variable probably affects or causes another variable, distinguishing between predictor and outcome variables (Creswell, 2013). Whilst variables considered to be the cause of the phenomenon are known as predictor (independent) variables, variables considered to change as a function of change in predictor variables are known as outcome (dependent) variables (Field, 2018).

In relation to levels of measurement, it is first necessary to understand the difference between a concept and a variable. As Kumar (2011) indicates, measurability is the main difference between a concept and a variable. Concepts can be defined as images or perceptions and therefore, their meaning can vary from individual to individual. On the other hand, variables are measurable, with varying degrees of accuracy. A concept cannot be measured, hence, it is necessary to convert it into a variable (either directly or through a set of indicators). As Creswell (2013) states, a variable refers to a characteristic or an attribute of an individual or an organisation that can be measured or observed, and this varies among the people or organisation being studied (Creswell, 2007). Broadly speaking, variables can be categorical or continuous. Whilst categorical variables are made up of categories, continuous variables provide a score for each individual and can take on a value on the measurement scale (Field, 2018). Both categorical and continuous variables can have different levels of measurement (Creswell, 2013; Hernández Sampieri, Fernández and

Baptista Lucio, 2014; Robson and McCartan, 2016; O'Leary, 2017; Field, 2018). The relationship between what is being measured and the numbers that represent what is being measured is known as level of measurement (Field, 2018). Levels of measurement refer to the nature of the differences that researchers try to capture within a particular variable (Creswell, 2013). As the literature indicates, categorical and continuous variables can be split into the following measurement levels: (i) binary (dichotomous), (ii) nominal, (iii) ordinal, (iv) interval and (v) ratio (Hernández Sampieri, Fernández and Baptista Lucio, 2014; Robson and McCartan, 2016; O'Leary, 2017; Field, 2018). Table 23 below summarises the main characteristics of each type.

Type of variable	**Measurement level**	**Description**
Categorical	Nominal	Nominal scales are made up of various categories that are equivalent in some sense. These categories are represented by randomly assigned numbers. Therefore, there is not any meaningful order between included categories. This scale type is inappropriate for mathematical calculations (Creswell, 2013; Hernández Sampieri, Fernández and Baptista Lucio, 2014; Field, 2018).
	Binary	The simplest form of a nominal variable names just two distinct types of things and is known as binary variable. In all cases an entity can be placed into only one of the two categories (Field, 2018).
	Ordinal	Ordinal scales are made up of categories ordered in some meaningful way. Nevertheless, this kind of scale does not indicate the magnitude of difference between categories (Creswell, 2013; Davey *et al.*, 2018).
Continuous	Interval	An interval variable has a meaningful order and equidistant units measure difference between categories. This kind of scale has no absolute zero point within the scale (Creswell, 2013; Field, 2018).
	Ratio	Ratio scales are similar to interval scales. However, in addition to being ordered in some meaningful way and using equidistant units to measure difference, these include an absolute zero point (Creswell, 2013; Field, 2018).

Table 23. Types of variables and measurement levels

5.5.5.2. Latent constructs

With regard to the operationalisation of the variables, it must be pointed out that in social sciences, studies often try to analyse things that cannot directly be measured, the so-called latent constructs. As Byrne (2016) indicates latent constructs are theoretical, and for their measurement, researchers need to capture observable indicators that represent them. There are first-order and second-order latent variables. A second-order latent variable is a latent variable whose indicators are themselves latent variables (Kline, 2016). As Anderson and Gerbing (1988) note, it is essential to specify the nature of latent constructs -reflective or formative-, when selecting a measurement scale. Table 24 below briefly describes both types of construct according to their nature.

Type of construct	**Description**
Reflective	The measurement of a reflective construct reflects its measures (items). That is to say, the direction of the relationship between the construct and its items is from the construct to the items (Diamantopoulos, Riefler and Roth, 2008). All the items in a reflective construct correlate positively, and a change in the latent construct results in a variation in all of these (Bollen and Lennox, 1991; Diamantopoulos, Riefler and Roth, 2008). Since all the items reflect the same construct, they are exchangeable. A replacement or elimination of one item would not change the construct's nature (Diamantopoulos and Winklhofer, 2001).
Formative	In contrast to reflective constructs, the direction of the relationship between a formative construct and its measures is from the measures to the construct (Diamantopoulos, Riefler and Roth, 2008). Formative constructs do not reflect their measures, measures cause (or form) their latent constructs (Coltman *et al.*, 2008). Accordingly, the meaning of the latent construct is given by its indicators (Diamantopoulos, Riefler and Roth, 2008) and each measure represents a specific aspect or facet of the construct (Edwards, 2011). Therefore, measures are not exchangeable as in the case of reflective measurement models and are not allowed to correlate (Kliewe, 2015).

Table 24. Types of construct

Some of the variables employed in this study such as UBC willingness, support, PAC, RAC, IC and ID are latent variables, and all of them are measured through reflective constructs.

5.5.5.3. Likert-type scale

The Likert-type scale is commonly employed in all fields of research (Carifio and Perla, 2008; Norman, 2010). Rensis Likert developed it in 1932 and a typical Likert-type scale is a 5-7-10- point ordinal scale used by respondents to rate the degree to which they agree or disagree with a statement (Jamieson, 2004; Dawes, 2008; Sullivan and Artino, 2013). As previously indicated (see Sub-section *5.5.5.1 Temporal order and levels of measurement*), in an ordinal scale, responses can be rated or ranked, but the distance between responses is not measurable. However, as seen in Kliewe (2015), Likert-type scales are generally treated and accepted as (quasi) interval since it is expected that respondents perceive distances between statements as equal (Kinnear *et al.*, 1996; Lukas, 2004). Accordingly, Norman (2010) and Sullivan and Artino (2013) indicate that Likert-type scales can be analysed by means of parametric tests. As Sullivan and Artino (2013) state, parametric tests are robust enough to provide largely unbiased results that are close to ‘‘the truth’’ when analysing Likert-type scale responses. In this regard, Rhemtulla, Brosseau-Liard and Savalei (2012) stress that the use of parametric tests in the presence of ordinal data produces acceptable results when the number of categories is five or more. Regarding the number of measurement points to be included in the scale, Matell and Jacoby (1971) note that determination of the optimal number of rating categories is essential in the construction scales. Nevertheless, academics do not reach a consensus, proposing different measures, such as five, seven or ten points (Dawes, 2008). As Cummins and Gullone (2000) point out, ten-point Likert-type scales offer a form of rating (one to ten) which lies within common experience, increasing the sensitivity of the measurement instrument. Given this advantage, and seeing that this is one of the most employed scales in UBC literature (e.g. Davey *et al.*, 2011, 2018; Galán-Muros and Plewa, 2016), a ten-point scale was defined for the variables measured through a Likert-type scale in the study. The scale ranges from “1 totally disagree” to “10 totally agree”. As the scale includes more than five categories, it was considered to be an interval scale.

5.5.5.4. Predictor variables of the study

The following sub-sections further detail the operationalisation and measurement level of the predictor variables included in the study. Due to the large number of organisational context-related factors found in the literature review, the predictor variables were classified according to their nature into seven groups: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support. Some of these predictor variables, namely (i) industry, (ii) location, (iii) size (ordinal) and (iv) turnover, were also used to check that gathered data belonged to the population to be analysed. In the case of the “industry” variable, it must be stressed that due to the fact that all respondents belonged to the manufacturing industry, the variable was not included in the analysis and it was only used to control the sample.

In connection with the measurement level of these variables, it should be stressed that drawing on Rhemtulla, Brosseau-Liard and Savalei (2012) ordinal variables with five or more categories were considered as interval or ratio scale for the selection and use of statistical tests.

Business general characteristics

Industry: Companies' industry was classified according to the National Classification of Economic Activities CNAE-2009 (Spanish Government, 2009) through a nominal scale. For further information on the CNAE codes included in manufacturing industry see *Appendix V: Variables of the empirical study*.

Location: The location of companies was classified through a nominal variable, which included the three provinces of the Basque Country (Araba, Gipuzkoa, Bizkaia) as seen in European Commission (2018).

Legal form: Respondents were asked to indicate their NIF (Personal Tax Identification) in order to i) have an identification code for each case and ii) classify their legal form. Based on the classification developed by the Spanish Government (2021), once the NIF information had been gathered from primary data, a nominal variable was generated classifying companies according to their legal form: Public Limited Company, Limited Liability Company, Cooperative society.

Headquarters: By means of a binary scale, respondents were asked to indicate whether their company was a headquarters or not.

Business group: Respondents were asked to indicate whether they belonged to a business group or not by means of a binary variable.

Age: The ordinal scale proposed by Berger and Udell (1998) was used to measure the age of companies.

Size (ordinal): Based on European Commission's (2015) SME definition, the ordinal scale employed by Davey *et al.* (2018) was used to classify companies by size.

Size: Company size was accessed on the SABI (Iberian Balance Sheet Analysis System) database.

Turnover: By means of an ordinal scale, based on European Commission's (2015) SME definition, respondents were asked to indicate the turnover range of their company.

Exports: Respondents were asked to indicate their percentage of sales in the Basque Country by means of a ratio scale.

Technological level: Based on Eustat's (2020a) technology classification by CNAE, an ordinal scale was generated, classifying companies according to their technology level: Low/ Medium-Low technology or Medium-High/ High technology.

Employees' qualification: Drawing on Kobarg, Stumpf-Wollersheim and Welpe (2018), through an interval scale, respondents were asked to indicate the percentage of employees with a higher degree in their company.

Gender: Respondents were asked to indicate the percentage of female workforce in their company by means of a ratio scale.

Business openness

Cooperation in R&D: In order to operationalise external search breadth, drawing on Laursen and Salter (2004), a nominal variable was generated to classify companies according to whether they cooperated for the development of R&D or not.

Total number of R&D partners: In order to operationalise external search breadth, drawing on Laursen and Salter (2004), a variable was created adding all the partners with whom companies cooperated in the development of R&D activities. For the creation of this variable, companies were first asked by means of a binary variable to indicate whether they cooperated in R&D activities with any of the following partners: suppliers, customers, competitors, consultants, vocational training centres, public research organisations, associations. Once the partners with whom the company cooperated for the development of R&D activities were known, a ratio variable was generated through the sum of the partners with whom the company cooperated.

Cooperation in LLL: In order to operationalise external search breadth, drawing on Laursen and Salter (2004) a nominal variable was generated to classify companies according to whether they cooperated for the development of LLL activities or not.

Total number of LLL partners: In order to operationalise external search breadth, drawing on Laursen and Salter (2004), a variable was created adding all the partners with whom companies cooperated in the development of LLL activities. For the creation of this variable, first, companies were asked by means of a binary variable to indicate whether they cooperated in LLL activities with any of the following partners: suppliers, customers, competitors, consultants, vocational training centres, public research organisations, associations. Once the partners with whom the company cooperated for the development of LLL activities were known, a ratio variable was generated through the sum of the partners with whom the company cooperated.

Cluster association: Based on an official list of Basque Clusters provided by the Basque Government (see *Appendix IV: Questionnaire*), respondents were asked through a binary scale to indicate whether they belonged to any of them. Based on gathered data, a binary scale was generated classifying companies according to whether they belonged to a cluster or not.

Informal interactions: Drawing on Cohen, Nelson and Walsh (2002); D´Este and Patel (2007) Perkmann and Walsh (2007); Bekkers and Bodas Freitas (2008); Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros (2010); Plewa, Korff, Johnson, *et al.* (2013) and Azagra-Caro *et al.* (2017) respondents were asked through a binary scale to indicate whether they took part in any of the following types of informal interactions:

- Events, forums, and/or meetings
- Conferences and/or congresses
- Workshops and/or symposia

Based on gathered data, a binary scale was generated manually, classifying companies according to whether they developed informal interactions or not.

Total number of informal interactions: Once the informal interaction types developed by companies were known, a ratio variable was generated manually, adding all the types of informal interactions developed.

Research and development

R&D development: Respondents were asked by means of a binary scale to indicate whether they developed R&D activities or not.

R&D intensity: Based on Kobarg, Stumpf-Wollersheim and Welpe (2018), R&D intensity was measured as the share of R&D investment. By means of a ratio scale, respondents were asked to indicate the R&D investment range of their company.

R&D continuity: In order to measure the continuity of companies' internal R&D, drawing on Kobarg, Stumpf-Wollersheim and Welpe (2018), respondents were asked through a nominal scale to indicate how internal R&D activities were developed in their company.

R&D program knowledge: By means of a binary scale, respondents were asked to indicate whether their company were aware of R&D public programs or not.

R&D program participation: By means of a binary scale, respondents were asked to indicate whether their company participated in R&D public programs or not.

Lifelong learning

LLL development: Respondents were asked by means of a binary scale to indicate whether they developed LLL activities or not.

LLL commitment: In order to measure the level of companies' commitment to lifelong learning, based on Kobarg, Stumpf-Wollersheim and Welpe (2018), the proportion of personnel expenditure invested in employee training and continued education was measured. Through a ratio scale, respondents were asked about the range of their personnel expenditure invested in LLL.

Absoprtive capacity

AC: Companies' AC was measured through an adaptation of the second-order construct developed by Jansen, Van Den Bosch and Volberda (2005). This adapted scale (see *Appendix V: Variables of the empirical study*) measures AC on the basis of companies' routines and internal processes with regard to external knowledge, and differentiates AC's two dimensions, PAC and RAC. Since the original scale was used to measure PAC and RAC levels of a large European multi-unit financial service firm, in the case of manufacturing SMEs, the drafting of its items required some modifications. Besides, it was translated from the source language (English) to the target languages (Spanish and English). In turn, to standardise the questionnaire, its measurement was transformed from a seven-point Likert-type scale to a ten-point Likert-type scale "1=Strongly disagree; 10=Strongly agree".

Innovation

IC: In order to operationalise innovation capacity, the second-order construct developed by Calik, Calisir and Cetinguc (2017) was adapted (see *Appendix V: Variables of the empirical study*). Drawing on OECD/Eurostat's (2018) OSLO manual, the construct distinguishes the capacity of companies to innovate in (i) product, (ii) process, (iii) organisation and (iv) marketing. The scale was translated from the source language (English) to the target languages (Spanish and English). In turn, to standardise the questionnaire, its measurement was transformed from a five-point Likert-type scale to a ten-point Likert-type scale "1=Strongly disagree; 10=Strongly agree".

ID: For the measurement of innovation degree, the innovation radicalness scale proposed by Gatignon *et al.* (2002) and employed by Flor, Cooper and Oltra (2018) was adapted (see *Appendix V: Variables of the empirical study*). In order to avoid problems with reverse coded items, one of the items was modified. The scale was translated from the source language (English) to the target languages (Spanish and English). In turn, to standardise the questionnaire, its measurement was transformed from a seven-point Likert-type scale to a ten-point Likert-type scale "1=Strongly disagree; 10=Strongly agree".

UBC willingness and support

In order to operationalise UBC willingness and support, the reflective construct developed by Galán-Muros et al. (2017) and Davey et al. (2018) was adapted (see *Appendix V: Variables of the empirical study*). The scale was tanslated from the source language (English) to the target language (Spanish and English). It was measured through a ten-point Likert-type scale "1=Strongly disagree; 10=Strongly agree".

5.5.5.5. Outcome variables of the study

The following sub-sections further detail the operationalisation and measurement level of the outcome variables included in the study.

Cooperation with universities:

Respondents were asked by means of a binary scale to indicate whether they cooperated or had ever cooperated with the university or not.

Cooperation levels

Cooperation levels: Drawing on the UBC activity classification developed by Davey *et al.* (2018), respondents were asked by a ten-point Likert-type scale "1=Strongly disagree; 10=Strongly agree" to indicate their degree of agreement or disagreement with the following statement:

"Our company cooperates or cooperated with the university to a large extent in…"

with regard to the following UBC activities:

- Education:
  - Curriculum co-design (e.g. business employers involved in curricula design with universities)
  - Curriculum co-delivery (e.g. guest lectures)
  - Mobility of students (e.g. student internships/placements)
  - Dual education programmes (e.g. part academic, part practical)
  - Lifelong learning for people from business (e.g. executive education, industry training and professional courses)
- Research:
  - Joint R&D (incl. joint funded research)
  - Consultancy for business (e.g. contract research)

  - Mobility of staff (i.e. temporary mobility of academics to business and of business people to universities)
- Commercialisation:
  - Commercialisation of R&D results (e.g. licencing/patenting)
  - Academic entrepreneurship (e.g. spin-offs)
  - Student entrepreneurship (e.g. start-ups)
- Management:
  - Governance (e.g. participation of academics on business boards and business people participation in university board)
  - Shared resources (e.g. infrastructure, personnel, equipment)
  - Industry support (e.g. endowments, sponsorship and scholarships)

5.5.6. The research instrument

Based on the variables previously described in sub-section *5.5.5 Variables of the empirical study*, a survey instrument entitled "*University-Business Cooperation, a study of the cooperating and non-cooperating business perspective*" was developed. Following the recommendations of Cooper and Schindler (2008), Bryman (2012), Creswell (2013), Robson and McCartan (2016) and O'Leary (2017), an internet-mediated questionnaire was created with the SurveyMonkey survey platform. The questionnaire was developed in Basque and Spanish[35] (the presentation letter developed to introduce the study and questionnaire, together with a translated version[36] of the questionnaire's contents (English) are attached in *Appendix III: Presentation letter for the questionnaire* and *Appendix IV: Questionnaire*).

As Brace (2013, p.1) indicated, it is clear to anyone undertaking data collection through a survey that the questionnaire is an important element in its success. An appropriate measurement instrument is one that records observable data that truly represents the concepts or variables that the researcher has in mind (Hernández Sampieri, Fernández and Baptista Lucio, 2014). As questionnaire is a set of questions that must be congruent with the problem statement and hypothesis (Brace, 2013). One recommendation for constructing a questionnaire is to analyse, variable by variable, what type of question or questions tend to be most reliable and valid for measuring that variable, according to the situation of the study (problem statement, characteristics of the sample, type of analysis to be carried out, etc.). Besides, it is also advisable to ask only the questions necessary to obtain the desired information or measure the variable (Hernández Sampieri, Fernández and Baptista Lucio, 2014).

The content of the questions in a questionnaire is as varied as the aspects it measures. Basically, two types of questions are considered: close- and open-ended questions. In close-ended questions, the response categories are defined a priori by the researcher and are shown to the respondent, who must choose the option that best describes their response. These can be binary (two response possibilities) or multi-

[35] Basque and Spanish are Basque Country's oficial languages (BOE, 1982)

[36] Due to stylistic constraints, the questionnaire is adapted to the style of the document.

chotomous (several response options). There are also close-ended questions in which participants can select more than one option or response category (multi-response). In other questions, the respondent is placed on a scale, such as Likert-type. In contrast, open-ended questions do not delimit the response alternatives in advance, so the number of response categories is very large; in theory, it is infinite, and can vary from population to population. As Hernández Sampieri, Fernández and Baptista Lucio (2014) highlighted, the choice of the type of questions contained in the questionnaire depends on the degree to which possible answers can be anticipated, the time available for coding, and whether a more precise response or a more in-depth response is desired. Building on this, as seen in Sub-section *5.5.5 Variables of the empirical study* the questionnaire developed for this study included close-ended questions: binary and multi-chotomous (multiple choice, multi-answer and polytomous –Likert-type scale-).

According to Hernández Sampieri, Fernández and Baptista Lucio (2014), questions must:

- Be clear, precise and understandable,
- Be as short as possible,
- Be formulated with simple vocabulary,
- Not be awkward,
- Address a single logic relationship between concepts,
- Not induce answers,
- Not be based on socially supported ideas,
- Not deny the issue being questioned,
- Not be offensive,
- Have an appropriate reading order.

The questions included in the questionnaire were drafted drawing on these recommendations, taking into account the profile of the respondent: company managers or business profiles with a general and outstanding knowledge of UBC in the company. As regards the drafting of the questions, since the present study used both an internet-mediated questionnaire and a structured questionnaire, special attention was paid to avoiding social desirability bias (SDB). SDB arises when respondents want to manage the impression that they are giving of themselves in terms of social responsibility (Brace, 2013). Therefore, when drafting the questionnaire, any term related to success was avoided, as were questions that might give rise to the interpretation of right or wrong answers. Furthermore, anonymity and strict confidentiality was guaranteed. It is also relevant to stress that, in order to avoid missing data, the questions were all mandatory.

Following Hernández Sampieri, Fernández and Baptista Lucio (2014), in addition to the relevant questions and response categories, the design of the questionnaire for the present study also included a cover page, an introduction, information about data protection, instructions inserted throughout the questionnaire and final acknowledgement. In this regard, the importance of the layout of the questionnaire must be emphasised. A poor questionnaire layout may cause questions to be overlooked or may bias the replies given. Therefore, a questionnaire must be respondent-friendly, attractive and encourage people to read words in the same order as other respondents read them. A well-designed layout prevents items or answer categories from being missed (Dillman, 2007). In order to make the questionnaire as respondent-friendly as possible, drawing on Markuerkiaga (2014), the following aspects were considered in the design of the questionnaire:

- The use of guidelines for ordering questions,
- The placement of instructions exactly where they were needed,
- The use of increased font sizes for certain written elements to attract attention (e.g. question numbers),
- The maintenance of simplicity, regularity, and symmetry,
- The use of bold text for questions and light text for answer choices,
- The separation of occasionally needed instructions from the question statement by font variation; italic font, smaller size, and text between brackets were used for notes,
- The use of vertical alignment of question subcomponents.

In an attempt to encourage respondents to fill in the questionnaire, its design and layout took into account the easiest and shortest way for them to do this. Thanks to the possibilities offered by the SurveyMonkey survey platform, the questionnaire was structured and set up in such a way that, depending on the answer given, the questionnaire skipped unnecessary questions. So, for example, if companies did not cooperate with universities, did not carry out LLL or R&D activities, they answered a shorter questionnaire. In order to generate this automatic configuration, the layout of the questionnaire did not match the groups of variables identified (see *Sub-section 2.4.2 Organisational context-related factors*). Nevertheless, even though the structure does not match these groups exactly, it gathers all the necessary information. The final layout of the questionnaire consists of the following sections:

- Cover page (including instructions and data protection)
- First section of questions named *"General information about the company"*
- Second section of questions named *"Specific data on UBC"*
- Third section of questions named *"AC, LLL, R&D and Innovation"*
- Fourth section of questions named *"Profile of the respondent"*
- Final cover (including final instructions and acknowledgement)

As can be seen in *Appendix IV: Questionnaire* on the final cover of the questionnaire, in addition to being thanked for their participation, respondents were asked if they would like to receive information about the results of the study. 280 companies (84.34%) showed interest in receiving the results of the study.

To conclude, it should be emphasised that both the internet-mediated questionnaire and structured questionnaire were identical, the only difference being that the internet-mediated questionnaire was conducted online through the SurveyMonkey platform while the structured questionnaire was conducted on paper and questions were skipped manually.

5.5.7. Questionnaire translation and pre-testing

With the aim of checking its content and layout, an initial version of the questionnaire was first contrasted with four academic experts in the UBC field, and an Economic Development and Infrastructure specialist from the Basque Government. After receiving their feedback, some minor changes were developed and a second version of the questionnaire was drafted. When this second version was ready (in Spanish), it was then translated to Basque. The questionnaire was translated using the back translation process. Translation processes need to be extremely cautious since questions must have an identical meaning for all participants, regardless of the language (Saunders, Lewis and Thornhill, 2009; Brace, 2013). In order to ensure this, once the Basque version of the questionnaire was ready, the questionnaire was back-translated into the original language to check if the questions were the same as the original ones. Once both versions were ready, a pre-test was developed. Five companies took part in the pre-testing of the questionnaire, the respondent's profiles being: two general managers, an R&D manager, a HR and talent acquisition specialist and a quality manager. Companies were randomly selected and these were contacted by email and telephone. Contact was first established at the company level, and once the objective of the research and the questionnaire had been explained, the most suitable respondent was chosen. When participants had finished filling in the questionnaire, they were asked about their experience and feedback.

According to the feedback gathered from the participants, the drafting and understanding of the questions included in the questionnaire was adequate. Therefore, no further modifications were carried out. The pre-testing of the questionnaire also made it possible to check that the internet-mediated tool worked correctly and that the questionnaire could be completed in the expected time.

5.5.8. Data collection techniques and procedures

As previously stated, data was gathered by means of an internet-mediated questionnaire and a structured questionnaire. The internet-mediated questionnaire (self-administered) was sent by email in representation of Mondragon Unibertsitatea and the Basque Government to a random list of 664 Basque Manufacturing SMEs, previously facilitated by the Basque Government. The questionnaire was opened on the 17th of September 2019, and closed on the 20th of December 2019 (a total duration of three months). A mass email was sent to these companies, explaining and inviting them to participate in the project. Companies received a friendly reminder each three weeks, encouraging them to participate. Out of 664 companies, 214 (32.23%) completed the entire questionnaire. In order to ascertain whether gathered responses were valid, in addition to checking that they were fully completed, it was ensured that the participating companies met the requirements to be part of the sample. To this end, it was checked that responses came from companies located in the Basque Country, belonged to the manufacturing industry, had a size of between 10 and 249 employees and a turnover of less than 50 million euros. As a result of this verification, 2 responses were discarded, reducing the response rate of the internet-mediated questionnaire to 212 companies (31.93%). As for the profile of the respondent, the email and questionnaire was addressed to company managers. As Carrasco-Carvajal and García-Pérez-De-Lema (2020) indicate, the choice of general manager as respondent is a common and established practice. Managers are the most significant decision-makers within SMEs (Van Gils, 2005). However, depending on the company, the email was redirected internally to the person with the most knowledge of UBC. The vast majority of the respondents were general managers (42.9%), with far lower percentages for R&D managers (8%), industrial managers (6.6%), and HR managers (5.2%); the remaining 37.3% was for other profiles.

In parallel to data collection through the internet-mediated questionnaire, a series of random calls were made to companies on the list that had not previously filled in the questionnaire, with the aim of informing them about the project and offering them a structured-questionnaire if they preferred this to completing the internet-mediated questionnaire. A total number of 120 companies volunteered to answer the structured-questionnaire (16.87% of the total list). Companies had the option to do the structured questionnaire on-line via Skype or Google Meets using the Survey Monkey platform, or face-to-face in their facilities, filling in the questionnaire on paper. Whilst 32 companies (26.7%) did the structured-questionnaire online, 80 (73.3%) filled in the structured questionnaire face-to-face in their facilities. The data collected on paper was carefully digitised after completion of the structured questionnaire. With regard to the respondent's profile, as with the internet-mediated questionnaire, the structured-questionnaire was answered by company managers or diverse profiles with a deep knowledge of the company's UBC situation. Similar to the internet-based questionnaire, the vast majority of the respondents were general managers (47.5%), followed with much lower percentages by HR managers (6.7%), industrial managers (4.2%) and R&D managers (2.5%); the remaining 39.2% was for other profiles.

Due to the complexity of setting an appointment to conduct the structured questionnaire with SMEs, the data collection period using this method was extended to the 28th of January 2020. As previously indicated, special attention was paid to drafting the questionnaire in order to avoid SDB, while equal care was also taken during data collection. In this regard, the respondent's data was guaranteed confidentiality and anonymity (Harms, 2015), while being reminded that they should consider that there were no right or wrong answers (Yang *et al.*, 2015).

Thanks to the combination of both methods, a total number of 332 responses (13.77% of the total population) were gathered, an overall response rate of 50%, meeting the number of cases necessary to have a statistically significant sample with a margin of error of 5% and a confidence level of 95%.

5.5.9. Data analysis techniques and procedures

As previously indicated (see Sub-section *5.4.2 Research choices*), the present study followed a quantitative research methodology. Therefore, the collection of data was proceeded by the quantitative analysis and interpretation phase (Saunders, Lewis and Thornhill, 2009). Data was analysed through descriptive statistics and several statistical tests, making use of IBM's SPSS Version 23 [37](Statistical Package for Social Sciences) statistical analysis software and Mplus Version 7[38], a statistical modelling program. Chapter *7 Data analysis and results* gives further details of the data analysis and statistical tests employed.

[37] https://www.ibm.com/analytics/spss-statistics-software

[38] https://www.statmodel.com/

5.6. Summary

This chapter has detailed the research methodology and design of the study, the variables employed, as well as the data collection and data analysis methods. Table 25 below summarises the research "onion" (Saunders, Lewis and Thornhill, 2009) of the study, namely, the key aspects of the research methodology, research design, data collection and analysis techniques and procedures employed in the study.

Research methodology		
Research philosophy	Positivism	
Research approach	Deductive	
Research design	Research strategy	Survey strategy
	Research choices	Multi-method study based on the quantitative approach
	Time horizon	Cross-sectional
Data collection	Unit of analysis	Organisation
	Research population	Basque industrial manufacturing SMEs (2.411 in 2019)
	Required sample size	332 SMEs (margin of error of 5% and a confidence level of 95%)
	Data collection techniques and procedures	Primary data: − Internet-mediated questionnaire (self-administered) − Structured questionnaire (face-to-face)
		Secondary data: − SABI database − Basque Government's database
Variables of the empirical study	Predictor variables	General business characteristics: *Industry, location, legal form, headquarters, business group, age, size, turnover, exports, technological level, employees' qualification, gender.*
		Business openness: *cooperation in R&D, total number of R&D partners, cooperation in LLL, total number of LLL partners, cluster.*
		R&D: *R&D development, R&D intensity, R&D continuity, R&D program knowledge, R&D program participation.*
		LLL: *LLL development, LLL commitment.*
		AC: *PAC, RAC.*
		Innovation: *IC, ID*
		UBC willingness and support: *UBC willingness and support*
	Outcome variables	*Cooperation, Mobility of students, Curriculum co-design, Curriculum co-delivery, Dual education, Lifelong learning, Joint R&D, Consultancy, Mobility of staff, Commercialisation, Academic entrepreneurship, Student entrepreneurship, Governance, Shared resources, Support*
Data analysis	Data analysis techniques and procedures	Descriptive and statistical tests with IBM's SPSS Version 23 and Mplus Version 7

Table 25. Summary of the research methodology, research design, data collection and analysis methods employed in the study

Chapter 6

Data and measurement assessment

6. Data and measurement assessment

Before starting the data analysis, it was necessary to evaluate both the data collected and the scales employed. Firstly, the distribution of the sample and the existence of missing data were analysed with the aim of selecting the most appropriate statistical techniques and estimators for the study. Secondly, the scales used for the measurement of the latent constructs were assessed. The following sub-sections detail in depth both the steps followed and the results obtained.

6.1. Normality assessment and missing data

6.1.1. Univariate normality

First, the univariate normality of the variables was assessed. Univariate normality deals with the distribution of a variable in the sample (West, Finch and Curran, 1995). The lack of normality mean that the shape of the sampling distribution is unknown, and thus it is not possible to know the probability of a particular test occurring (Hernández Sampieri, Fernández and Baptista Lucio, 2014). Together with the variables being measured at least at an interval scale, normal distribution is one of the assumptions for the use of parametric tests (Field, 2018).

As Pérez (2013) states, the assessment of the distribution of variables can be carried out through an exploratory analysis, using visual techniques and formal (statistical) tests. Visual techniques, such as histograms, provide a general idea of the shape of data. Formal techniques are mathematical tests through which normality assumptions are assessed.

Drawing on Field (2018), prior to undertaking normality assessment, the presence of outliers was assessed. Outliers are scores that differ largely from the rest of data and bias parameter estimation. In order to assess the presence of outliers, boxplot diagrams were checked in continuous variables (see Appendix VI: Normality assessment). As summarised in Table 26 below, some of the predictor and outcome variables used in the analysis showed outliers and/or extreme cases.

Predictor variable	Outliers	Extreme cases	Outcome variable	Outliers	Extreme cases
Size	✓	✓	Curriculum co-design	✓	✓
Employee’s qualification	✓		Curriculum co-delivery	✓	✓
Gender	✓		Dual education programmes	✓	
Total number of LLL partners	✓		Lifelong learning	✓	✓
R&D intensity	✓	✓	Joint R&D	✓	
LLL commitment	✓	✓	Consultancy	✓	✓
AC1_A1	✓		Staff mobility	✓	✓
AC1_A3	✓		Commercialisation	✓	✓
AC1_A4	✓		Academic entrepreneurship		✓
AC1_E1	✓		Student entrepreneurship		✓
AC1_E4	✓		Governance		✓
AC1_E5	✓		Shared resources		✓
IC_Proc2	✓		Support		✓
IC_Proc3	✓				
IC_Proc4	✓				
IC_Org3	✓				
IC_Org4	✓				

Table 26. Variables in the study with outliers and/or extreme cases

Once the presence of outliers and extreme cases had been identified, a decision had to be made as to whether to keep or remove them from the sample. As Gao, Mokhtarian and Johnston (2008) state, the pursuit of normal distribution by the removal of observations should be consciously weighed against the loss of model power and generalisability in the interpretation of the results. In accordance, Hair *et al.* (1999) state that, outliers and extreme cases of the sample are also representative of the population, and they increase the generality or ecological validity of the results (Elorza, 2009). Based on this premise, and with the aim of achieving a maximum representation of the population, it was decided to keep the outliers and extreme cases in the sample.

After reviewing outliers and extreme cases, the general trends and distribution of continuous data were checked by way of a visual inspection. This was carried out by means of histograms (see *Appendix VI: Normality assessment).* Even if in an ideal world, data would be distributed symmetrically around the centre of all scores, as Gao, Mokhtarian and Johnston (2008) state, in general, data obtained in the real world does not have univariate normal distributions. As can be seen in *Appendix VI: Normality assessment*, the gathered data did not show a bell-shaped curve. Thus, after this preliminary visual analysis, a Kolmogorov-Smirnov test was undertaken, along with an analysis of skewness and kurtosis, in order to assess data distribution. The Kolmogorov-Smirnov test is used when a sample is bigger than 50 cases (Romero Saldaña, 2016), and it compares the scores in samples to a normally distributed set of scores with the same mean and standard deviation. If the test is not significant ($p > .05$), it states that the distribution of the sample is not significantly different from a normal distribution. If the test is significant ($p < .05$) then the distribution of the sample is non-normal (Field, 2018). As can be seen in Table 27 and Table 28, and after visual inspection of the histograms, the results of the Kolmogorov-Smirnov test showed that continuous variables in the sample did not follow a normal distribution. Nevertheless, in large samples (e.g. $n > 300$) these tests can be significant even when the scores are only slightly different from a normal distribution, and thus, skew and kurtosis values must be checked (Kim, 2013).

A distribution can deviate from normal in two ways: (i) lack of symmetry (skew) and (ii) peakedness (kurtosis). Skewed distributions are not symmetrically distributed, and instead, the most frequent scores are grouped at one end of the scale. Skewed distributions can be positive (frequent scores are clustered at the lower tail) or negative (the frequent scores are clustered at the higher end). Distribution also varies in its kurtosis, namely the degree to which scores cluster at the ends of the distribution (known as the tail). Kurtosis tends to show how peaked a distribution is. Positive kurtosis (leptokurtic distribution) has many scores in the tail, which is known as heavy-tailed distribution, and it is pointed. In contrast, negative kurtosis (platykurtik distribution) is relatively thin in the tails (it has light tails) and tends to be flatter than the normal (Field, 2018). In a normal distribution the values of skew and kurtosis are 0, if kurtosis and skewness values are above or below 0, this represents a deviation. When kurtosis and skewness z-score's [39] absolute values are greater than 1.96 they are significant at $p < .05$; when they are above 2.58, they are significant at $p > .01$; and when they are above 3.29, they are significant at $p < .001$. Table 27 and Table 28 below show the results of the analysis of skewness and kurtosis' z-score values. Drawing on the cut-off values previously

[39] Z-scores of kurtosis and skewness were calculated by dividing the statistics by their standard error.

indicated, as can be seen in Table 27 and Table 28, several variables are skewed and show a degree of peakedness/flatness (grey-shaded cells). Accordingly, data analysis was adapted to this lack of univariate normality.

Predictor variable	Kolmogorov-Smirnov[a]			Kurtosis		Skewness	
	Statistic	df	Sig.	Kurtosis	Z-score	Skewness	Z-score
Size	0.23	332	.00	8.23	30.83	2.70	20.16
Market_BC	0.16	332	.00	-1.59	-5.94	0.06	0.47
HD_Emp	0.23	332	.00	2.10	7.88	1.46	10.87
Female	0.21	332	.00	2.51	9.41	1.37	10.27
RD_coop_tot	0.36	332	.00	0.39	1.45	1.20	8.99
LLL_coop_tot	0.14	332	.00	-0.11	-0.40	0.24	1.83
RD_int	0.27	332	.00	6.51	24.38	1.75	13.10
LLL_commit	0.43	332	.00	5.94	22.25	1.95	14.55
AC1_A1	0.23	332	.00	1.62	6.08	-1.33	-9.96
AC1_A2	0.13	332	.00	-0.30	-1.11	-0.52	-3.92
AC1_A3.	0.18	332	.00	0.48	1.78	-0.83	-6.20
AC1_A4	0.16	332	.00	0.19	0.69	-0.78	-5.83
AC1_AS1	0.13	332	.00	0.10	0.39	-0.50	-3.71
AC1_AS2	0.15	332	.00	0.00	0.01	-0.42	-3.13
AC1_AS3	0.12	332	.00	-0.12	-0.45	-0.20	-1.46
AC1_T1	0.12	332	.00	0.10	0.36	-0.46	-3.47
AC1_T2	0.13	332	.00	-0.31	-1.18	-0.44	-3.27
AC1_T3	0.12	332	.00	0.04	0.14	-0.31	-2.31
AC1_T4	0.10	332	.00	-0.62	-2.31	-0.25	-1.87
AC1_E1	0.13	332	.00	-0.13	-0.50	-0.14	-1.08
AC1_E2	0.13	332	.00	-0.51	-1.91	-0.07	-0.55
AC1_E3	0.13	332	.00	-0.36	-1.33	-0.21	-1.58
AC1_E4	0.14	332	.00	-0.16	-0.60	-0.18	-1.35
AC1_E5	0.13	332	.00	0.12	0.45	-0.42	-3.16
IC_Prod_1	0.15	332	.00	-0.04	-0.16	-0.60	-4.46
IC_Prod_2	0.15	332	.00	-0.72	-2.70	-0.52	-3.87
IC_Prod_3	0.14	332	.00	-0.94	-3.51	-0.35	-2.63
IC_Prod_4	0.17	332	.00	-0.84	-3.15	-0.48	-3.60
IC_Prod_5	0.17	332	.00	-0.65	-2.45	-0.64	-4.77
IC_Proc_1	0.13	332	.00	-0.72	-2.70	-0.30	-2.27
IC_Proc_2	0.19	332	.00	0.56	2.09	-0.96	-7.17
IC_Proc_3	0.19	332	.00	1.21	4.54	-1.04	-7.79
IC_Proc_4	0.17	332	.00	0.41	1.54	-0.82	-6.13
IC_Org_1	0.11	332	.00	-0.45	-1.67	-0.27	-2.02
IC_Org_2	0.12	332	.00	-0.55	-2.06	-0.18	-1.35
IC_Org_3	0.14	332	.00	-0.14	-0.51	-0.04	-0.31
IC_Org_4	0.15	332	.00	-0.36	-1.35	-0.31	-2.32
IC_Mark_1	0.12	332	.00	-0.94	-3.52	-0.10	-0.75
IC_Mark_2	0.11	332	.00	-0.94	-3.52	0.07	0.54
IC_Mark_3	0.11	332	.00	-1.00	-3.75	0.16	1.19
IC_Mark_4	0.13	332	.00	0.07	0.28	-0.54	-4.00
IC_Mark_5	0.16	332	.00	0.12	0.45	-0.67	-5.00
ID_1	0.16	332	.00	-0.24	-0.89	-0.69	-5.18
ID_2	0.11	332	.00	-0.90	-3.39	-0.03	-0.22
ID_3	0.13	332	.00	-0.89	-3.34	-0.23	-1.68
ID_4	0.14	332	.00	-0.71	-2.66	-0.39	-2.88
W1	0.14	332	.00	-1.10	-4.12	0.30	2.28
W2	0.12	332	.00	-1.02	-3.82	-0.09	-0.70
W3	0.12	332	.00	-1.01	-3.78	0.05	0.40
W4	0.15	332	.00	-1.03	-3.85	-0.32	-2.37
W5	0.18	332	.00	-0.43	-1.63	-0.54	-4.05
W6	0.12	332	.00	-0.56	-2.11	-0.37	-2.74
W7	0.13	332	.00	-0.52	-1.97	-0.45	-3.34
W8	0.11	332	.00	-0.85	-3.19	-0.19	-1.42
W9	0.12	332	.00	-1.11	-4.15	0.01	0.04
W10	0.16	332	.00	-0.67	-2.50	-0.40	-2.96

a. Lilliefors Significance Correction

Table 27. Kolmogorov-Smirnov test, kurtosis and skewness (predictor variables)

Outcome variable	Kolmogorov-Smirnov[a]			Kurtosis		Skewness	
	Statistic	df	Sig.	Kurtosis	Z-score	Skewness	Z-score
Joint_R	0.39	332	.00	0.59	2.19	1.43	10.69
Cons	0.4	332	.00	2.22	8.34	1.83	13.69
Staff_mob	0.44	332	.00	3.86	14.48	2.16	16.12
Co_des	0.45	332	.00	6.68	25.01	2.67	19.98
Co_del	0.45	332	.00	8.27	30.98	2.88	21.54
Stu_mob	0.35	332	.00	-1.21	-4.52	0.70	5.22
Dual_ed	0.40	332	.00	0.32	1.19	1.40	10.45
Li_lear	0.40	332	.00	1.66	6.21	1.69	12.65
Commer	0.45	332	.00	7.71	28.89	2.78	20.75
Ac_ent	0.47	332	.00	9.82	36.81	3.10	23.18
Stu_ent	0.49	332	.00	6.69	25.07	2.66	19.90
Gov	0.48	332	.00	18.38	68.86	4.04	30.20
Shared_res	0.45	332	.00	4.70	17.62	2.35	17.57
Support	0.46	332	.00	7.77	29.13	2.85	21.33

a. Lilliefors Significance Correction

Table 28. Kolmogorov-Smirnov test, kurtosis and skewness (outcome variables)

6.1.2. Multivariate normality

Whilst univariate normality describes the distribution of a single variable in a sample, multivariate normality describes the joint distribution of the variables. As Micceri (1989) and Chou, Bentler and Satorra (1991) stress, multivariate normality is even more difficult to obtain than univariate normality.

Screening for univariate normality can inform researchers whether multivariate normality may be an issue (Weston and Gore, 2006), since univariate normal distribution is a necessary (but insufficient) condition to address multivariate normality (West, Finch and Curran, 1995). When conducting an SEM, exploratory factor analysis (EFA) or confirmatory factor analysis (CFA), testing for multivariate normality is recommended. This is important since multivariate normality affects the estimator used in the analysis (Brown, 2006; Gao, Mokhtarian and Johnston, 2008; Maydeu-Olivares, 2017). Based on the normal distribution, the Maximum Likelihood (ML) method has been widely used in SEM, EFA and CFA (Brown, 2006). Nevertheless, when multivariate normality is not satisfied, it is dangerous to apply this method (Yuan, Bentler and Zhang, 2005). As Muthen and Kaplan (1985) indicate, a lack of multivariate normality leads to an overestimation of the Chi-Square statistic [40], which may result in a false rejection of the model, and an underestimation or overestimation of the standard errors of the parameter estimates. This situation gives rise to inflated or deflated statistics, and accordingly to possible erroneous attributions of significance of specific relationships in the model (Gao, Mokhtarian and Johnston, 2008).

As previously indicated, the continuous variables included in the study, both predictor and outcome did not follow a univariate distribution. Since this first condition was not met, robust estimators (adapted to the lack of normality) and methods were used in the study.

6.1.3. Missing data

As Schlomer, Bauman and Card (2010) indicate, every quantitative study should report the extent and nature of missing data, as well as the rationale and procedures used to handle them. As far as this study is

[40] Chi–squared statistic is an indicator of the degree of discrepancy between the model-implied and the sample-derived covariance matrices.

concerned, it should be noted that as all the questions in the survey were mandatory, no missing data was found.

6.2. Validation of latent constructs

The present sub-section deals with the validation of the latent constructs included in the study: AC, IC, ID and UBC willingness and support. As previously pointed out (see Sub-section *5.5.5 Variables of the empirical study*), the adaptations of the scales identified in the literature required revalidation to ensure the quality of the data (Cardoso Ribeiro, Gómez-Conesa and Hidalgo Montesinos, 2010; Paniagua Suárez, 2015). Drawing on various authors (Mulaik and Millsap, 2000; Brown, 2006; Weston and Gore, 2006; Byrne, 2016; Kline, 2016; Aldás Manzano and Uriel Jiménez, 2017; Field, 2018), the validation process followed these steps:

(i) *Dimensionality assessment:* an Exploratory Factor Analysis (EFA) was conducted to assess the dimensionality of the indicators

(ii) *Reliability assessment:* with the aim of analysing if the results of the scales were consistent, the reliability of constructs was checked by calculating:

   a. Cronbach's alpha (α)
   b. Composite Reliability (CR)

(iii) *Validity assessment:* in order to assess to what extent the scale measured what was intended, the validity of the measurements was checked by:

   a. Confirmatory Factor Analysis (CFA)
   b. Test for Convergent Validity
   c. Test for Discriminant validity

6.2.1. Dimensionality

Brown (2006, p.20) indicates that the objective of an EFA is "to evaluate the dimensionality of a set of multiple indicators (e.g. items for a scale) by uncovering the smallest number of interpretable factors needed to explain the correlations among them". EFA seeks to achieve parsimony by explaining the maximum amount of common variance in a correlation matrix using the smallest number of factors (latent variables). These factors represent clusters of variables that correlate highly with each other and that could be measuring aspects of the same underlying dimension (Lloret-Segura *et al.*, 2014; Field, 2018). EFA assumes that the measures are reflective of the underlying construct (Edwards, 2011), and each observed item analysed is carefully selected to reflect some characteristic of the factor it is intended to measure (Lloret-Segura *et al.*, 2014). However, EFA does not allow the researcher to determine which items measure which factors, nor the relationships that are assumed between the factors themselves; beyond whether or not they are related to each other. That is why it is called exploratory, it is only possible to determine the number of factors that can be expected (Lloret-Segura *et al.*, 2014). Therefore, results should only be used to guide future hypotheses, or to inform researchers about patterns within data sets (Field, 2018). Below, there follows a description of the EFA analysis performed with SPSS to assess the dimensionality of the latent constructs.

As mentioned above, Maximum Likelihood (ML) is one of the most employed extraction methods in EFA analysis (Lawley and Maxwell, 1971). Nonetheless, as a result of the noncompliance of normal distribution, its use is not recommended for this analysis (Briggs and MacCallum, 2003). Accordingly, the Unweighted Least Squares (ULS) method, a more robust method than ML, was employed. ULS has received favourable reviews for not being so limited by distributional assumptions and sample size (Wollins, 1995; Krijnen, 1996; Zygmont and Smith, 2014). With regard to factor rotation, the PROMAX oblique rotation with Kaiser Normalisation method was used. This kind of rotation allows factors to correlate among themselves, which is more appropriate for social science data (Field, 2018). This EFA configuration was consistent with recommendations given by Lloret-Segura *et al.* (2014).

As Brown (2006) indicates, in applied research, factor loadings greater than or equal to 0.40 are often interpreted as salient. Thus, items with factor loadings lower than 0.40 were supressed in all cases except for AC. Given the large number of items which make up the AC construct, drawing on Hair *et al.* (1999), only "high" values above 0.6 were included. Besides, in the analysis of all constructs, items loading on two factors were eliminated. In turn, theoretical aspects were also considered. Therefore, if an item loaded on a factor that was not theoretically related, it was not included.

Drawing on Field (2018), the Kaiser-Meyer-Olkin (KMO) measure (Kaiser, 1970) was used to verify the sampling adequacy for the analysis. Barlett's test of sphericity χ^2 was checked to assess whether the correlations among items were sufficiently large for EFA; and the variance explained by identified factors was also checked. The results obtained for each of the latent constructs are shown in the following sub-sections.

6.2.1.1. Absorptive capacity

Confirming the theory of Jansen, Van Den Bosch and Volberda (2005) and Zahra and George (2002), an extraction based on eigenvalues greater than 1 showed a 2-factor clear structure (see Table 29), differentiating potential (PAC) and realised absorptive capacity (RAC) dimensions.

AC Pattern Matrix[a]		
Item	**Factor**	
	1 (PAC)	**2 (RAC)**
AC1_E1	.98	
AC1_E2	.88	
AC1_E4	.88	
AC1_T3	.77	
AC1_T2	.75	
AC1_E3	.74	
AC1_T4	.67	
AC1_E5	.63	
AC1_AS3		
AC1_A3		.76
AC1_A1		.76
AC1_A2		.74
AC1_A4		.70
AC1_AS1		
AC1_AS2		
AC1_T1		

a. Rotation converged in 3 iterations.
KMO= .94
Barlett's test of sphericity, χ^2 (120)= 4.24, 0.37, p < .001
Factors obtained accounted for 61.43% of the variance

Table 29. EFA analysis of AC

6.2.1.2. IC

Following the structure proposed by Calik, Calisir and Cetinguc (2017), a 4-factor extraction was run. This aimed to check whether the scale differentiated the *product*, *process*, *organisation* and *marketing* dimensions. As can be seen in Table 30, the structure of the EFA exhibited a clear 3-factor structure since items on *Process* dimension did not show a clear pattern.

IC Pattern Matrix[a]				
Item	**Factor**			
	1 (Product)	**2 (Organisation)**	**3 (Marketing)**	**4 (Process)**
IC_Prod_1	.46			
IC_Prod_2	.94			
IC_Prod_3	.89			
IC_Prod_4	.90			
IC_Prod_5	.75			
IC_Proc_1				
IC_Proc_2				.77
IC_Proc_3		.69		.42
IC_Proc_4		.83		
IC_Org_1		.92		
IC_Org_2_		.72		
IC_Org_3		.54		
IC_Org_4	.58			
IC_Mark_1			.81	
IC_Mark_2			.88	
IC_Mark_3			.74	
IC_Mark_4			.44	
IC_Mark_5				
a. Rotation converged in 6 iterations.				
KMO= .91				
Barlett's test of sphericity, χ^2 (123)= 4,219.02 p < .001				
Factors obtained accounted for 60.65% of the variance				

Table 30. EFA analysis of IC

6.2.1.3. ID

In the case of ID, an extraction based on eigenvalues greater than 1 showed a clear 1-factor structure (see Table 31), supporting the scale developed by Gatignon *et al.* (2002).

ID Factor Matrix[a]	
Item	**Factor**
	1
ID_4	.88
ID_3	.85
ID_2	.83
ID_1	.80
KMO= .84	
Barlett's test of sphericity, χ^2 (6)= 859.8 p < .001	
Factor obtained accounted for 71.02% of the variance	

Table 31. EFA analysis of ID

6.2.1.4. UBC willingness and support

While the scale developed by Galán-Muros *et al.* (2017) and Davey *et al.* (2018) did not differentiate any dimension within the scale, an extraction based on eigenvalues greater than 1 showed a clear 3-factor structure. On the basis of the items grouped by each of the dimensions, these dimensions were called "*UBC resources*", "*Cognitive closeness*" and "*UBC beliefs*". The results of the analysis are shown in Table 32 below.

UBC Willingness and support Pattern Matrix[a]			
Item	Factor		
	1 (UBC resources)	2 (Cognitive closeness)	3 (UBC beliefs)
W2	.87		
W1	.85		
W3	.74		
W4	.40		
W9		.97	
W8		.81	
W10		.65	
W6			.94
W7			.83
W5			.50

a. Rotation converged in 5 iterations.
KMO= .85
Barlett's test of sphericity, χ^2 (45)= 1.919,23 p < .001
Factors obtained accounted for 64.94% of the variance

Table 32. EFA analysis of UBC willingness and support

6.2.2. Reliability

Reliability is the degree to which an instrument measures accurately without error. It measures the proportion of variation in measurement that is due to the diversity of values that the variable takes and is not due to error. A reliable instrument is accurate, i.e. it provides error-free measurements (García de Yébenes Prous, Rodríguez Salvanés and Carmona Ortells, 2009).

With the objective of analysing if the results of the measurement scales were accurate, the reliability or internal consistency of constructs was checked by calculating (i) Cronbach's alpha (α) and (ii) Composite Reliability (CR). Cronbach's α was calculated by conducting a reliability analysis using the software SPSS. CR was calculated based on the factor loadings of the CFA (see *6.2.3 Sub-section Validity*). As seen in Field (2018), Cronbach's alpha (α) values around 0.8 (or higher) are good. With regard to CR, values around 0.70 (or higher) are accepted (Hair *et al.*, 2017). Table 33 below summarises the values obtained in both analyses. As can be seen, all the Cronbach α values and CR values were above 0.8.

As for the IC construct, the CFA analysis (see Sub-section *6.2.3 Validity*) showed that the factor loading of·*IC_Prod_1* and *IC_Markt_4* were lower than 0.6 (the minimum factor loading for convergent validity). Consequently, the items were removed in two steps (checking factor loadings again when removing the item with the lowest load) and the model was assessed without these indicators.

Scale	Factor	Shortcut	Nº of items	Cronbach α	CR
AC	PAC	PAC	4	.81	.81
	RAC	RAC	8	.93	.93
IC	Product	Prod	4	.93	.90
	Organisation	Org	3	.83	.83
	Marketing	Mark	3	.84	.85
ID	ID	ID	4	.91	.89
UBC willingness and support	UBC resources	Ubc_res	4	.86	.90
	Cognitive closeness	Cog_clos	3	.86	.92
	UBC beliefs	Ubc_bel	3	.80	.83

Table 33. Cronbach α and Composite Reliability values: AC, IC, ID and UBC willingness and support

6.2.3. Validity

In order to assess the extent to which the scales measured what was intended, the validity of the measurements was checked by (i) Confirmatory Factor Analysis (CFA), (ii) test for Convergent Validity and (iii) test for Discriminant validity.

Once the underlying structure of the latent constructs had been explored through the EFA analysis, a CFA was performed to confirm the previously identified dimensions. Besides, the fit, interpretability and validity of the scale was ensured. The CFA analysis was performed with the Mplus software. Given the measurement level of the items and their lack of normal distribution, drawing on Maydeu-Olivares (2017), CFA analyses were carried out with the MLMV robust estimator. All ML estimators are based on ML but they simply differ in how they calculate standard errors and Chi-Square. MLMV is ML with robust errors to non-normality and Chi-Square adjusted by its mean and asymptotic variance described by Satorra and Bentler (1994). With regard to this estimator, it must be pointed out that this requires a minimum sample size of 200 cases (Maydeu-Olivares, 2017). This minimum sample size was met with the sample available (332 cases).

The acceptability of the CFA models was evaluated with goodness of fit indices. According to Brown (2006), fit indices can be classified into three categories (i) *absolute fit indices,* (ii) *parsimony fit indices and (iii) incremental or comparative fit indices.*

Absolute fit indices assess model fit at an absolute level (Brown, 2006). Chi Square ($\chi 2$) and standardised root mean square residual (SRMR) are indices classified within the category of absolute fit indices. Since Chi Square ($\chi 2$) is sensitive to large samples sizes, SRMR is traditionally used by researchers. SRMR can be viewed as the average discrepancy between the correlations observed in the input matrix and the correlations predicted by the model. A model with a SRMR value of 0 would indicate a perfect fit. Thus, the smaller the SRMR value, the better the fit. Hu and Bentler (1998) indicate that a value equal or below 0.08 is usually an optimal fitting value.

As Williams and Holahan (1994, p.162) state, "parsimony fit indices have a special purpose in that they attempt to account for the simplicity of a model at the same time that the overall goodness of fit is examined". Parsimony indices are based on the absolute fit indices and include a penalty function for poor parsimony (Brown, 2006). The root mean square error of approximation (RMSEA) is a widely employed parsimony fit index. As seen in Gómez (2014), RMSEA values between 0.05 and 0.08 indicate an acceptable fit.

Concerning comparative fit indices (also referred to as incremental fit indices), these evaluate the specified model solution in relation to a more restricted nested baseline model [41] (Brown, 2006). The comparative fit index (CFI) and the Tucker-Lewis index (TLI) are two of the most commonly applied comparative indices. According to Marsh and Hau (1996), CFI values above 0.9 indicate a satisfactory fit and, TLI values between 0.90 and 0.95 can be considered acceptable model fit values (Bentler, 1990).

Since each type of index provides important information, the following indices were assessed:

- Absolute fit indices: SRMR

[41] "A baseline model is a null or independence model in which the covariances among all input indicators are fixed to zero" (Brown, 2006, p. 84).

- Parsimony fit indices: RMSEA
- Comparative fit indices: CFI and TLI

Table 34 below summarises the results obtained in the CFA analyses. As can be seen, all fit indices were between the optimal values.

Fit indices	Optimal values	AC	IC	ID	UBC willingness and support
SRMR	<0.08	.04	.04	.01	.05
RMSEA	<0.05/<0.08	.06	.05	.03	.08
CFI	>0.95/>0.9	.94	.98	.99	.94
TLI	>0.9	.93	.97	.99	.92

Table 34. CFA: AC, IC, ID and UBC willingness and support

Traditionally, the way a construct is measured is said to be valid if included items actually measure what they are intended to measure (Cook and Campbell, 1979). Consequently, after developing the CFAs, convergent and discriminant validity were calculated. For a scale to be valid, on the one hand, items of the same dimension must correlate highly with one another (convergent validity). On the other hand, it must be ensured that the measurements are not related (discriminant validity) (Aldás, 2013). Compliance with these two conditions demonstrates that identified constructs are valid (Martínez-García and Martínez-Caro, 2009).

There are two tests that researchers can adopt to test for convergent validity; (i) verification of the factor loadings and their significance level, and (ii) the calculation of average extracted variance (AVE) (Aldás Manzano and Uriel Jiménez, 2017).

Table 35-Table 38 below show the verification of the loadings and their significance level. As Bagozzi and Yi (1988) stress, loadings should be above 0.6. As can be seen, all the factor loadings except *W5* in "UBC beliefs" were above 0.6 and their significance levels (p.value) were lower than 0.01. Drawing on Garmendia (2019), as removing *W5* produced similar values in the Cronbach alpha and composite reliability indices, and worsened the model fit, it was decided to maintain it as an exception. This decision was supported by the fact that its factor loading was above the minimum 0.4 (and quite close to 0.6) and the Cronbach alpha and composite reliability values were above 0.8.

AC		
Factor/Item	**Std. loading**	**Significance level**
PAC		
AC1_A1	.72	.00
AC1_A2	.74	.00
AC1_A3	.73	.00
AC1_A4	.69	.00
RAC		
AC1_E1	.84	.00
AC1_E2	.83	.00
AC1_E4	.86	.00
AC1_T3	.81	.00
AC1_T2	.75	.00
AC1_E3	.80	.00
AC1_T4	.77	.00
AC1_E5	.71	.00

Table 35. AC convergent validity test 1: loadings of the items on the factors

IC		
Factor/Item	**Std. loading**	**Significance level**
Product		
IC_Prod_2	0.89	.00
IC_Prod_3	0.87	.00
IC_Prod_4	0.9	.00
IC_Prod_5	0.83	.00
Organisation		
IC_Org_1	0.85	.00
IC_Org_2	0.82	.00
IC_Org_3	0.68	.00
Marketing		
IC_Mark_1_	0.81	.00
IC_Mark_2_	0.89	.00
IC_Mark_3_	0.71	.00

Table 36. IC convergent validity test 1: loadings of the items on the factors

ID		
Factor/Item	**Std. loading**	**Significance level**
ID_1	.80	.00
ID_2	.83	.00
ID_3	.86	.00
ID_4	.88	.00

Table 37. ID convergent validity test 1: loadings of the items on the factors

UBC willingness and resources		
Factor/Item	**Std. loading**	**Significance level**
UBC resources		
W1	.77	.00
W2	.74	.00
W3	.87	.00
W4	.74	.00
Cognitive closeness		
W8	.87	.00
W9	.85	.00
W10	.74	.00
UBC beliefs		
W5	.55	.00
W6	.85	.00
W7	.92	.00

Table 38. UBC willingness and resources convergent validity test 1: loadings of the items on the factors

In addition to analysing factor loadings, the AVE was calculated. AVE measures the amount of variance that is captured by a construct in relation to the amount of variance due to measurement error. AVE values above 0.5 are recommended (Fornell and Larcker, 1981). Table 39 below shows AVE values. As can be seen, the values obtained were above 0.5.

Scale	Factor	AVE
AC	PAC	0.52
	RAC	0.64
IC	Product	0.76
	Organisation	0.62
	Marketing	0.65
ID	ID	0.71
UBC willingness and support	UBC resources	0.61
	Cognitive closeness	0.68
	UBC beliefs	0.63

Table 39. Convergent validity test 2: AVE of the factors at the individual level

Based on the analysis of the factor loadings and their significance, together with the results of the AVE, the convergent validity of the constructs was demonstrated.

To conclude with the validation of the constructs, discriminant validity was assessed, that is, it was assessed whether identified dimensions were not overly correlated. It must be pointed out that, in the case of ID (first-order construct), it was not necessary to analyse its discriminant validity.

As Cohen *et al.* (2003) indicate, when correlations among factors exceed 0.85, the discriminant validity is considered to be poor. Therefore, it was expected that correlations among factors would be lower. Table 40-Table 42 below show the correlations among the factors. As can be seen, the highest correlation coefficient was 0.71, thereby fulfilling the discriminant validity.

Factor	**PAC**	**RAC**
PAC	1	
RAC	.71*	1
* $p < .001$		

Table 40. Correlations among AC's factors

Factor	**Product**	**Organisation**	**Marketing**
Product	1		
Organisation	.71*	1	
Marketing	.6*	.58*	1
* $p < .001$			

Table 41. Correlations among IC's factors

Factor	**UBC resources**	**Cognitive closeness**	**UBC beliefs**
UBC resources	1		
Cognitive closeness	.68*	1	
UBC beliefs	.65*	.59*	1
* $p < .001$			

Table 42. Correlations among UBC willingness and support's factors

6.3. Summary

This chapter dealt with the process followed to assess both the data collected and the measurement scales employed. Firstly, the univariate and multivariate normal distribution of the sample, together with the existence of missing data were assessed. This assessment allowed the most appropriate statistical techniques and estimators for each Specific objective to be selected. Secondly, the scales used for the measurement of the latent constructs (i.e. AC, IC, ID and UBC willingness and support) were assessed through three main stages (i) dimensionality, (ii) reliability, and (iii) validity assessment.

Chapter 7

Data analysis and results

7. Data analysis and results

7.1. Introduction

This chapter deals with the statistical analyses carried out to address the research questions and objectives determined for the study. As Cohen, Manion and Morrison (2007, p.86) indicate, “the prepared researcher will need to consider how the data will be analysed”. Therefore, guided by the research questions and research objectives, the data analysis and associated statistical tests to be used were defined according to (i) the measurement scale of the variables and (ii) the distribution of the data (Field, 2018).

Given the diverse purposes (descriptive, exploratory and explanatory) of the four specific objectives of the study, several data analysis techniques were employed. Specifically, for the development of the first objective, Pearson’s Chi-Square, Mann-Whitney and Independent samples *t*-test were used. With the aim of addressing the second objective, multiple logistic regression models were analysed through a two-stage process. As for the third objective, several linear regression models were run. Finally, an Structural Equation Modelling (SEM) approach was followed to test the research hypotheses of Specific objective 4. The analyses regarding the first, second and third specific objectives were developed with the aid of IBM’s SPSS Version 23 (Statistical Package for Social Sciences) statistical analysis software, while the fourth objective was address by means of the statistical modelling program Mplus Version 7.

Before describing the statistical analyses carried out to address Specific objectives 1, 2, 3, and 4, together with their respective results, the first sub-section of this chapter details the descriptive analysis of the sample.

7.2. Descriptive analysis of the sample

The following sub-sections deal with the descriptive analysis of the predictor and outcome variables employed in the analysis. On the one hand, these sub-sections describe the characteristics of the sample in relation to organisational context-related factors: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support. On the other hand, a description of the state of UBC, cooperation and cooperation levels, in the sample is given.

7.2.1. Predictor variables

7.2.1.1. General business characteristics

Despite all the respondents’ belonging to the manufacturing industry, as can be seen in Table 43 below, these were engaged in a variety of industrial activities according to their CNAE. The majority of respondents, 36.7%, belonged to “Manufacture of fabricated metal products, except machinery and equipment”, followed by companies in “Manufacture of machinery and equipment n.e.c” which accounted for 16.6% of the sample. The remaining activities within the manufacturing industry were represented in much smaller percentages.

Industry (CNAE)	Frequency	Percentage
(10) Manufacture of food products	17	5.1
(11) Manufacture of beverages	7	2.1
(14) Manufacture of wearing apparel	2	0.6
(16) Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	6	1.8
(17) Manufacture of paper and paper products	4	1.2
(18) Printing and reproduction of recorded media	7	2.1
(20) Manufacture of chemicals and chemical products	18	5.4
(21) Manufacture of basic pharmaceutical products and pharmaceutical preparations	1	0.3
(22) Manufacture of rubber and plastic products	16	4.8
(23) Manufacture of other non-metallic mineral products	7	2.1
(24) Manufacture of basic metals	6	1.8
(25) Manufacture of fabricated metal products, except machinery and equipment	122	36.7
(26) Manufacture of computer, electronic and optical products	5	1.5
(27) Manufacture of electrical equipment	22	6.6
(28) Manufacture of machinery and equipment n.e.c.	55	16.6
(29) Manufacture of motor vehicles, trailers and semi-trailers	4	1.2
(30) Manufacture of other transport equipment	4	1.2
(31) Manufacture of furniture	9	2.7
(32) Other manufacturing	8	2.4
(33) Repair and installation of machinery and equipment	12	3.6
Total	332	100

Table 43. Profile of the respondents, manufacturing activity

As to their location within the Basque Country, 17.8% of respondents were from the province of Araba, 33.7% from Bizkaia and the vast majority, 48.5%, from Gipuzkoa (see Table 44). 57.8% of the companies in the sample were a Limited Liability Company, 36.4% a Public Limited Company and 5.7% were a Cooperative Society (see Table 45).

Location	Frequency	Percentage
Araba	59	17.8
Gipuzkoa	161	48.5
Bizkaia	112	33.7
Total	332	100

Table 44. Profile of the respondents, location

Legal form	Frequency	Percentage
Public Limited Company	121	36.4
Limited Liability Company	192	57.8
Cooperative Society	19	5.7
Total	332	100

Table 45. Profile of the respondents, legal form

The vast majority of respondents, 94.3%, were head offices (see Table 46), while 72.6% did not belong to a business group (see Table 47). As for the age of their business, 73.5% of respondents were over 25 years old, 25% of them ranged from 5 to 24 years; 1.2% were 3-4; and 0.3% were 0-2 (see Table 48). With regard to their business size (see Table 49), the average sample size was 41.3 employees (SD=39.55).

Headquarters	Frequency	Percentage
No	19	5.7
Yes	313	94.3
Total	332	100

Table 46. Profile of the respondents, headquarters

Business group	Frequency	Percentage
No	241	72.6
Yes	91	27.4
Total	332	100

Table 47. Profile of the respondents, business group

Age	Frequency	Percentage
0-2	1	0.3
3-4	4	1.2
5-24	83	25.0
>=25	244	73.5
Total	332	100

Table 48. Profile of the respondents, age

Size		
N	Valid	332
	Missing	0
Mean		41.30
Median		28.00
Std. Deviation		39.55
Minimum		10.0
Maximum		249.0

Table 49. Profile of the respondents, size

As can be seen in Table 50 below, most of the respondents, 50.3%, had a turnover lower than 10M€. 26.2% of the respondents had a turnover lower than 2M€ and 23.5% a turnover lower than 50M€. As to the export orientation of respondents, what was measured by their percentage of local sales (see Table 51) there was no obvious pattern, with 19% of the respondents answering “1-9%” while 15.4% replied “90-100%”.

Turnover	Frequency	Percentage
<=2M€	87	26.2
<=10M€	167	50.3
<=50M€	78	23.5
Total	332	100

Table 50. Profile of the respondents, turnover

Exports (local sales)	Frequency	Percentage
0%	23	6.9
1-9%	63	19.0
10-19%	34	10.2
20-29%	22	6.6
30-39%	19	5.7
40-49%	16	4.8
50-59%	19	5.7
60-69%	13	3.9
70-79%	30	9.0
80-89%	42	12.7
90-100%	51	15.4
Total	332	100

Table 51. Profile of the respondents, exports

Concerning their technology level (see Table 52), the majority of SMEs, 66.6%, were classified as low and medium-low technological level, whilst the remaining respondents, 33.4%, were classified as medium-high and high technological levels.

Technological level	Frequency	Percentage
Low and medium-low	221	66.6
Medium-high and high	111	33.4
Total	332	100

Table 52. Profile of the respondents, technological level

Table 53 shows the state of the companies in relation to their percentage of employees' with a higher degree. As can be seen in Table 53, the percentage with the highest number of respondents was 0-9% employees, 30.4% of the respondents giving this reply. In second place, 29.2% of the respondents reported having 10-19% employees with a higher degree.

Employees' qualification	Frequency	Percentage
0-9%	101	30.4
10-19%	97	29.2
20-29%	55	16.6
30-39%	42	12.7
40-49%	10	3.0
50-59%	13	3.9
60-69%	5	1.5
70-79%	6	1.8
80-89%	3	0.9
Total	332	100

Table 53. Profile of the respondents, employees' qualification

To conclude with the general characteristics of the companies, the percentage of women in the workforce is described. In this connection, a large proportion of companies showed low levels of female workforce. 28.3% of respondents indicated a range of 1-9% , while 26.2% of companies reported 10-19% (see Table 54).

Gender (female)	Frequency	Percentage
0%	9	2.7
1-9%	94	28.3
10-19%	87	26.2
20-29%	54	16.3
30-39%	41	12.3
40-49%	25	7.5
50-59%	11	3.3
60-69%	4	1.2
70-79%	1	0.3
80-89%	3	0.9
90-100%	3	0.9
Total	332	100

Table 54. Profile of the respondents, gender

7.2.1.2. Business openness

As regards the variables included in "Business openness" (see Table 55), a large number of respondents, 42.2%, cooperated with external partners in R&D activity development; 18.1% of companies did not cooperate with external partners and the remaining 39.8% of companies did not develop R&D activities. Consequently, 57.9% of respondents did not cooperate with any R&D partner. The average number of external partners for R&D cooperation was 0.92 (SD=1.31) (see Table 56).

Cooperation in R&D	Frequency	Percentage
Company does not undertake R&D activities	132	39.8
R&D activities are internally developed	60	18.1
R&D activities are developed in cooperation with external partners	140	42.2
Total	332	100

Table 55. Profile of the respondents, cooperation in R&D

Total number of R&D partners		
N	Valid	332
	Missing	0
Mean		0.92
Median		0.00
Std. Deviation		1.31
Minimum		0.00
Maximum		5.00

Table 56. Profile of the respondents, total number of R&D partners

As to cooperation for the development of LLL activities (see Table 57), most respondents, 70.8%, developed them both internally and in cooperation with external partners. 16.3% of companies carried out LLL activities exclusively with external partners, while 4.2% of respondents only developed LLL activities internally. The remaining 8.7% of companies did not carry out LLL activities. The average number of external partners for LLL activity development in the sample was 2.25 (SD=1.45) (see Table 58).

LLL cooperation	Frequency	Percentage
Company does not undertake LLL activities	29	8.7
Company develops LLL activities internally	14	4.2
Company develops LLL activities with external partners	54	16.3
Company develops LLL activities, both, internally and with external partners	235	70.8
Total	332	100

Table 57. Profile of the respondents, cooperation in LLL

Total number of LLL partners		
N	Valid	332
	Missing	0
Mean		2.25
Median		2.00
Std. Deviation		1.45
Minimum		0.00
Maximum		7.00

Table 58. Profile of the respondents, total number of LLL partners

As for belonging or not to a cluster association (see Table 59), it was appreciated that the great majority of respondents, 72.3%, did not belong to any clusters.

Cluster association	Frequency	Percentage
No	240	72.3
Yes	92	27.7
Total	332	100

Table 59. Profile of the respondents, cluster association

Finally, the majority of companies in the sample, 55.7%, did not carry out informal interactions and the average number of the total informal interactions carried out by the respondents was 0.78 (SD=1.02) (see Table 60).

Informal interactions		
N	Valid	332
	Missing	0
Mean		0.78
Median		0.00
Std. Deviation		1.02
Minimum		0
Maximum		3

Table 60. Profile of the respondents, informal interactions

7.2.1.3. Research and development

As far as R&D development is concerned, the majority of respondents, 60.2%, carried out R&D activities (see Table 61). With regard to respondents’ R&D intensity, measured as the share of R&D investment, most respondents, 48.8%, indicated that their investment was 0-9%. As can be seen in Table 62, very few companies indicated higher R&D investments.

R&D development	Frequency	Percentage
No	132	39.8
Yes	200	60.2
Total	332	100

Table 61. Profile of the respondents, R&D development

R&D intensity	Frequency	Percentage
No R&D investment	132	39.8
0-9%	162	48.8
10-19%	28	8.4
20-29%	6	1.8
30-39%	3	0.9
≥50%	1	0.3
Total	332	100

Table 62. Profile of the respondents, R&D intensity of the respondents

Regarding respondents' awareness of R&D public programs and their participation (Table 63 and Table 64), the vast majority of the respondents, 71.4%, claimed to be aware of existing programmes. Nevertheless, a lower percentage, 40.1%, reported taking part in them.

R&D program knowledge	Frequency	Percentage
No	95	28.6
Yes	237	71.4
Total	332	100

Table 63. Profile of the respondents, R&D program knowledge

R&D program participation	Frequency	Percentage
No	199	59.9
Yes	133	40.1
Total	332	100

Table 64. Profile of the respondents, R&D program participation

7.2.1.4. LLL

Almost all respondents, 91.3% of the sample, carried out LLL activities (see Table 65). In relation to their LLL commitment, measured as the proportion of personnel expenditure invested in employee training and continued education, 75.9% of companies gave this figure as 0-9%. The remaining companies indicated a much higher expenditure or did not perform LLL activities (see Table 66).

LLL development	Frequency	Percentage
No	29	8.7
Yes	303	91.3
Total	332	100

Table 65. Profile of the respondents, LLL development

LLL commitment	Frequency	Percentage
No LLL investment	29	8.7
0-9%	252	75.9
10-19%	30	9.0
20-29%	15	4.5
30-39%	5	1.5
40-49%	1	0.3
Total	332	100

Table 66. Profile of the respondents, LLL commitment

7.2.1.5. AC

As regards AC (see Table 67), respondents showed a higher average value with regard to AC's PAC dimension, 7.08 (SD=1.69), than its RAC dimension, 6.02 (SD=1.68). By averaging both dimensions, respondents showed an AC average value of 6.68 (SD=1.52).

		AC	PAC	RAC
N	Valid	332	332	332
	Missing	0	0	0
Mean		6.55	7.08	6.02
Median		6.68	7.25	6.12
Std. Deviation		1.52	1.69	1.68
Minimum		1	1	1
Maximum		10	10	10

Table 67. Profile of the respondents, AC

7.2.1.6. IC

Regarding respondents' IC levels (see Table 68), respondents showed an average value of 5.74 (SD=1.82). As to IC's different dimensions, product IC showed the highest average value 6.28 (SD=2.43), followed by organisation IC, 5.89 (SD=1.84) and marketing IC 5.05 (SD=2.25).

		Product	Organisation	Marketing	IC
N	Valid	332	332	332	332
	Missing	0	0	0	0
Mean		6.28	5.89	5.05	5.74
Median		6.50	5.83	5.00	5.76
Std. Deviation		2.43	1.84	2.25	1.82
Minimum		1	1	1	1
Maximum		10	10	10	10

Table 68. Profile of the respondents, IC

7.2.1.7. ID

With regard to ID, respondents showed an average value of 5.86 (SD=2.15) (see Table 69).

ID		
N	Valid	332
	Missing	0
Mean		5.86
Median		6.25
Std. Deviation		2.15
Minimum		1
Maximum		10

Table 69. Profile of the respondents, ID

7.2.1.8. UBC willingness and support

As far as UBC willingness and support is concerned (see Table 70), respondents showed an average value of 5.42 (SD=1.75). As to the different dimensions of the construct, UBC beliefs showed the highest mean value 5.98 (SD=1.99), followed by cognitive closeness, 5.23 (SD=2.07) and UBC resources 5.04 (SD=2.19).

		UBC resources	Cognitive closeness	UBC beliefs	UBC Willingness and support
N	Valid	332	332	332	332
	Missing	0	0	0	0
Mean		5.04	5.23	5.98	5.42
Median		5.00	5.33	6.33	5.45
Std. Deviation		2.19	2.07	1.99	1.75
Range		9	9	9	1
Minimum		1	1	1	1
Maximum		10	10	10	5.42

Table 70. Profile of the respondents, UBC willingness and support

7.2.2. Outcome variables

7.2.2.1. UBC cooperation

As can be seen in Table 71, the percentage of companies that cooperated or had cooperated previously with universities, 51.8%, was quite similar to, albeit slightly higher than, the percentage of companies that had never cooperated with the universities, 48.2%.

UBC	Frequency	Percentage
No	160	48.2
Yes	172	51.8
Total	332	100

Table 71. Profile of the respondents, UBC

In relation to this finding, it should be noted that the percentage of cooperating companies in the sample is similar to that obtained by Alunurm, Rõigas and Varblane (2020), who showed that 55% of the companies in their sample cooperated with universities. As the authors state, these results differ from other studies whose authors stated that 5-10% of the companies in their samples cooperated with universities (Tether, 2002; Chun and Mun, 2012). According to Alunurm, Rõigas and Varblane (2020), this difference may be caused by the inclusion of a wide range of UBC activities rather than joint R&D only.

7.2.2.2. UBC activity cooperation levels

As regards UBC activities, analysing the sample as a whole (see Table 72), it was observed that cooperation levels in all the activies were very low. On the one hand, mobility of students showed the highest score 3.73 (SD=3.46). On the other hand, student entrepreneurship exhibited the lowest one 1.26 (SD=0.64).

		Education					**Research**			**Valorisation**			**Management**		
		Mobility of students	Curriculum co-design	Curriculum co-delivery	Dual education	Lifelong learning	Joint R&D	Consultancy	Mobility of staff	Commercialisation	Academic entrepreneurship	Student entrepreneurship	Governance	Shared resources	Support
N	Valid	332	332	332	332	332	332	332	332	332	332	332	332	332	332
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean		3.73	1.68	1.68	2.80	2.35	2.62	2.27	1.94	1.64	1.56	1.26	1.40	1.86	1.69
Median		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Std. Deviation		3.46	1.64	1.67	3.07	2.41	2.72	2.36	2.00	1.52	1.51	.64	1.27	1.94	1.76
Minimum		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		10	10	10	10	10	10	10	10	10	10	4	10	10	10

Table 72. Profile of the respondents, UBC activities' level cooperating and non-cooperating SMEs

Accordingly, when analysing only cooperating SMEs (those that cooperated or had cooperated with universities) (see Table 73), it was observed that student mobility was the most developed activity, 6.28 (SD=3.11), followed by dual education, 4.48 (SD=3.52), and joint R&D, 4.14 (SD=3.09). While the scores achieved were generally low, student entrepreneurship, 1.51 (SD=0.83) and governance, 1.77 (SD=1.69), were the activities with the lowest participation.

		Education					**Research**			**Valorisation**			**Management**		
		Mobility of students	Curriculum co-design	Curriculum co-delivery	Dual education	Lifelong learning	Joint R&D	Consultancy	Mobility of staff	Commercialisation	Academic entrepreneurship	Student entrepreneurship	Governance	Shared resources	Support
N	Valid	172	172	172	172	172	172	172	172	172	172	172	172	172	172
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean		6.28	2.33	2.32	4.48	3.61	4.14	3.46	2.83	2.24	2.09	1.51	1.77	2.67	2.34
Median		7	1	1	3	3	3.50	2	1	1	1	1	1	1	1
Std. Deviation		3.11	2.09	2.15	3.52	2.83	3.09	2.81	2.48	1.94	1.97	0.83	1.69	2.45	2.27
Minimum		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		10	10	10	10	10	10	10	10	10	10	4	10	10	10

Table 73. Profile of the respondents, UBC activities' level cooperating SMEs

These findings were in accordance with the findings of Davey *et al.* (2018), who found in their European-level study that cooperation levels seemed to be low in the majority of UBC activities, especially in the field of management. In turn, it was observed that European businesses carried out more activities in the research and education areas than in the valorisation or management ones, with joint R&D and student mobility being the most developed activities (Davey *et al.*, 2018).

7.3. Specific objective 1

The first specific objective of this study sought to analyse and identify the main differences between cooperating and non-cooperating manufacturing SMEs with regard to their organisational context-related factors (see Figure 3). These were classified into the following groups: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support. This objective sought to establish the basis for understanding what shapes UBC in manufacturing SMEs.

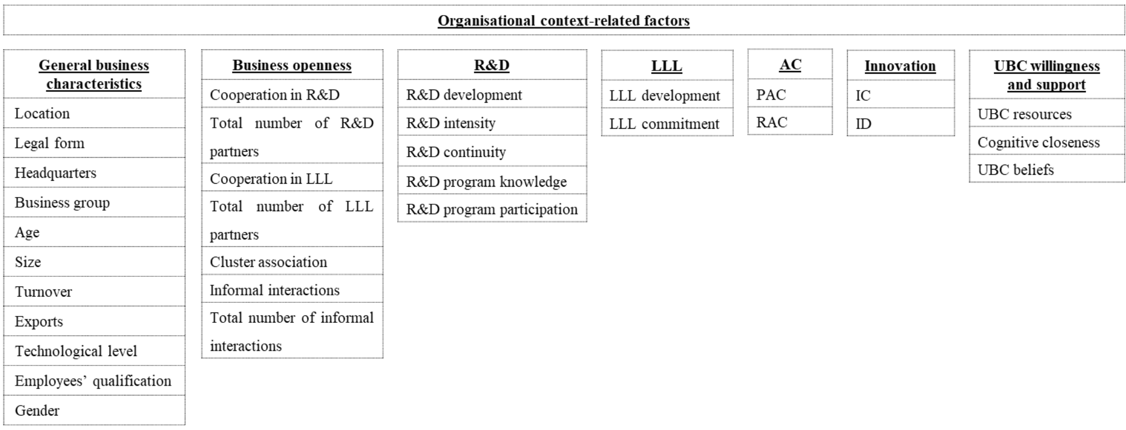

Figure 3. Specific objective 1: variables included in the analysis

Before describing the analysis carried out, the section below details in depth the statistical techniques employed.

7.3.1. Data analysis techniques

With the aim of identifying the main organisational context-related factors that distinguish cooperating and non-cooperating manufacturing SMEs, differences between groups were sought. For this purpose, a comparative descriptive analysis, together with a series of statistical analyses, was carried out. Since the measurement levels of the variables were different, diverse statistical tests were needed accordingly. Table 74 below summarises the statistical tests employed according to each measurement level:

Measurement level	Statistical test
Nominal data	Pearson's Chi-Square (non-parametric)
Ordinal data	Mann-Whitney (non-parametric)
Ratio-interval data	Independent samples t-test (parametric)

Table 74. Specific objective 1: statistical tests used

The most relevant information about the statistical tests employed is described below.

7.3.1.1. Pearson's Chi-Square

In the case of nominal variables, the non-parametric Pearson's Chi-Square test was used. This test allows assessment of the possible relationship between variables and groups. This compares observed frequencies in certain categories with frequencies that might be expected to get into these categories by chance (Field, 2018).

With regard to the Chi-Square test, it is important to remember that its sampling distribution is only approximate to a Chi-Square distribution, and that larger samples therefore provide better approximations than smaller ones. Small samples' significance tests are inaccurate if frequencies in each cell are less than five. When this situation arose in the analysis, Fisher's exact test[42] was used (Field, 2018).

Another important point to highlight about the Chi-Square test is that this does not provide any information on the magnitude of the association[43] between variables. Due to this shortcoming, post-hoc tests were carried out. In the case of *2x2* contingency tables, Phi coefficient φ or Cramér's V can be used. Nevertheless, since it is difficult to assess the value of the Phi coefficient, the use of Cramér's V is recommended and this was therefore employed in the analysis. Cramér's V measures how strongly two categorical fields are associated, and for this analysis, the cut-off values suggested by IBM (2020) were used (see Table 75).

Cut-off value	Magnitude of the association
$V \leq 0.2$	The result is weak. Although the result is statistically significant, the fields are only weakly associated.
$0.2 < V \leq 0.6$	The result is moderate. The fields are moderately associated.
$V > 0.6$	The result is strong. The fields are strongly associated.

Table 75. Cramér's V's cut-off values suggested by IBM (2020)

In addition to the magnitude of the effect, the assessment of *2x2* contingency tables was complemented with the information provided by the Odds ratios (OR). OR is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure (Szumilas, 2010).

For the analysis of larger *nxn* contingency tables, Cramér's V was also used, and this analysis was complemented with the assessment of standardised residuals. Standardised residuals allow assessment of the significance of each pair of relationships. If the value lies outside ±1.96 then it is significant at p <.05; if it lies outside ± 2.58, it is significant at p<.01; and if it lies outside ± 3.29 it is significant at p<.001 (Field, 2018).

7.3.1.2. Mann-Whitney

In order to identify differences between cooperating and non-cooperating companies with regard to ordinal categorical variables, Mann-Whitney's test was used. This test relies on scores being ranked from lowest to highest and allows testing of the hypothesis that two groups differ from each other in one variable (ordinal or continuous). Mann-Whitney's test works by looking at differences in the ranked positions of scores in different groups. However, SPSS does not provide information about the size of its effect, for which reason, the magnitude of discovered effects was calculated by means of the following formula:

$$r = \frac{z}{\sqrt{N}} \tag{1}$$

[42] Even though Fisher's test was initially intended for use 2x2 contingency tables, it can be used in larger ones (Field, 2018).

[43] Estimates of effect size are useful for determining the practical or theoretical importance of an effect, the relative contributions of factors, and the power of an analysis. (Fritz, Morris and Richler, 2012).

in which z is the z-score that SPSS produces and N is the size of the sample. These z-scores can be used to calculate an effect size, such as the *r* proposed by (Cohen, 1988). Following Cohen's guidelines for *r*, it was considered that a large effect is 0.5 (the effect accounts for 25% of the variance), a medium effect is 0.3 (the effect accounts for 9% of the variance), and a small effect is 0.1 (the effect explains 1% of the total variance) (Fritz, Morris and Richler, 2012). It should be borne in mind that *r* is not measured on a linear scale; thus, for example, an effect $r=0.6$ is not twice as big as $r=0.3$ (Field, 2018).

7.3.1.3. Independent t-test

For the analysis of interval or ratio scales, the independent *t*-test was used. This is a statistical test used to assess whether two independent groups differ significantly from each other with respect to their means on a variable. With regard to the independent *t*-test, it is important to highlight that this is a parametric test and, therefore, univariate normal distribution and homogeneity of variances are required in each group. Since univariate normality was not met, the Bootstrapping technique (Efron and Tibshirani, 1993 seen in Field, 2018) and the bootstrap confidence intervals were used. Bootstrapping manages the lack of normality by estimating the properties of the sampling distribution from the sample data. Specifically, the sample data is treated as a population from which smaller samples (bootstrap samples) are taken (putting the data back before a new sample is drawn). The statistic of interest is calculated in each sample and, by taking many samples, the sampling distribution can be estimated. The standard error of the statistic is estimated from the standard deviation of this sampling distribution created from the bootstrap samples. From this standard error, confidence intervals and significance tests can be computed (Field, 2018).

Homogeneity of variances (homoscedasticity) is the assumption that the spread of outcome scores is roughly equal at different points on the predictor variable. With the aim of assessing this assumption, Levene's test was performed while running the independent samples *t*-test. If Levene's test is significant (*p*. value < .05), then the variances differ significantly from one group to another. Since the result of this test depends on the size of the sample, and it is possible to adjust the degrees of freedom (df) of the *t*-test to compensate for the degree to which variances are unequal, there is a good argument for ignoring Levene's test. It is recommended that *t*-test should be read from "*Equal variances not assumed"* (Field, 2018).

As with previously described tests, when comparing groups, it is important to determine their effect size, which is a measure of the "strength" of the difference in means or other values considered (Creswell, 2013a; Alhija and Levy, 2009; Cortina, 2003). In order to assess an effect's magnitude, *t*-values were converted into an r_{PB}-value using the following equation:

$$r_{PB} = \sqrt{\frac{t^2}{t^2 + df}} \tag{2}$$

in which *t* is the statistic SPSS produces and *df* the degrees of freedom. The r_{PB} *"Point–biserial correlation*" is a standardised measure of the strength of relationship between two variables when one of the two variables is dichotomous (McGrath and Meyer, 2006; Fritz, Morris and Richler, 2012; Field, 2018). It conceptualies relationships in terms of the degree to which variability overlaps in the quantitative variable and the dichotomous variable. Even though the commonly cited benchmarks for *r* were intended for use with the r_{PB} (Cohen, 1988), as McGrath and Meyer (2006) and Fritz, Morris and Richler (2012) state, this should be assessed by the following cut-off values: 0.10 as a weak effect, 0.24 as a moderate effect, and 0.37 as a strong one. As regards r_{PB}, unlike Pearson's *r* or Crame´r's V, r_{PB} is not a valid description of the proportion of variability accounted for (Siegel & Castellan, 1988, p. 231, seen in (Fritz, Morris and Richler, 2012)).

7.3.2. Analysis and results

This sub-section deals with the analysis and results obtained in the first specific objective. As previously, stated, organisational context-related factors were sorted according to their nature into seven main groups: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support. These groups guided the course of this analysis.

Before starting with the description of the results, it must be highlighted that, in addition to their statistical significance, the results were also assessed by their effect size. The magnitude of an effect allows researchers to move away from a simple identification of statistical significance toward a more interpretable, quantitative description of the size of an effect (Fritz, Morris and Richler, 2012).

The following sub-sections show a descriptive and statistical comparison between cooperating and non-cooperating SMEs with regard to the variables included in each group. The statistical test used for each analysis is indicated, together with its result. If the result was significant, the magnitude of the effect is shown.

7.3.2.1. General business characteristics

With reference to employees' qualification, the descriptive analysis showed that cooperating SMEs, M=3.19 (SE=0.14), had a higher average value than non-cooperating SMEs, M=1.98 (SE=0.09). This dissimilarity was statistically proven and the difference, 1.21, BCa 95% CI [0.86, 1.55,], was significant at (t(288.07)= 6.91, p<.001) presenting a strong effect of r_{PB}=.38.

In relation to business size, the analysis indicated that on average, cooperating SMEs showed larger business sizes (M=51.47, SE= 3.57) than non-cooperating SMEs (M=30.36, SE=2.04). This difference, 21.11, BCa 95% CI [12.55, 29.07], was significant at t(270.06)= 5.13 p<.001 and presented a moderate effect of r_{PB}=.3.

The descriptive analysis showed that the distribution between cooperating and non-cooperating companies differed with regard to turnover levels. Non-cooperating companies presented lower turnover levels than cooperating businesses. While 39.4% of non-cooperating companies were classified within the "<=2M€ category", only 14% of cooperating companies fell into this category. In the same line, although not a big difference, 51.7% of cooperating companies were classified in the "<=10M€ category" while, 48.8% of non-cooperating companies fell within this range. Finally, a greater difference was observed in the "<=50M€ category", to which 34.3% of cooperating companies belonged, as compared to only 11.9% of non-cooperating companies. The statistical analysis confirmed that turnover levels in cooperating businesses (Mdn=<=10M€) statistically differed from non-cooperating businesses (Mdn=<=10M€:), U=18.71, z=6.18, p=<.001, *r*=.34, with a moderate effect.

Both the descriptive and statistical test showed that, on average, cooperating SMEs had lower local sale levels (M=4.88, SE=0.25) than non-cooperating businesses (M=7.37, SE=0.27). This difference, -2.49, BCa 95% CI [-3.22, -1.76,] was significant at *t*(326.38)=-6.70, p<.001, representing a moderate effect of r_{PB}=.34.

The descriptive analysis showed that the distribution of cooperating and non-cooperating SMEs differed with regard to technological levels. Non-cooperating SMEs showed more cases classified at low and medium-low technological levels (74.4%) than cooperating companies (59.3%). Accordingly, cooperating companies exhibited higher percentages with regard to medium-high and high technological levels (40.7%) than non-cooperating ones (25.6%). By means of statistical analysis, it was noted that technological levels in cooperating businesses (Mdn= Low/ Medium-Low technology) differed statistically from non-cooperating businesses (Mdn= Low/ Medium-Low technology), U=15.80, z=2.90, p=<.005, with a weak effect (*r*=.16).

With regard to being part of a business group, the descriptive analysis showed a big difference between cooperating and non-cooperating companies. While 64.5% of cooperating companies were part of a business group, only 18.8% of non-cooperating businesses showed this characteristic. By means of statistical analysis, it was confirmed that there was a significant difference with regard to being part of a business group between cooperating and non-cooperating companies (Pearson's Chi-Square: 11.64, df(1); Exact Sig. (2-sided): p<.01). Cooperation with universities in companies belonging to a business group was 2.38 times more likely than in companies that did not. However, although the result was statistically significant, the fields were only weakly associated (Cramér's V: .19. Exact Significance: p<.01).

As regards female percentage in companies, a significant difference was discovered. In accordance with the descriptive analysis, female percentage levels in cooperating businesses, M=3.92 (SE=0.14), differed statistically from non-cooperating businesses, M=3.34 (SE=0.14); 0.58, BCa 95% CI [0.19, 0.97] being significant at *t*(328.24)=2.95, p<.005. This difference had a weak magnitude (r_{PB}=.16).

Although significant differences were found in relation to the previously mentioned variables, in the case of the variables *Location*, *Legal_form*, *Headquarters* and *Age* no statistically significant differences were appreciated. The statistical values of these variables can be seen in *Appendix VII: Specific objective 1*.

Table 76 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables[44] regarding general business characteristics.

[44] Although previously indicated, at this point it is worth remembering that, drawing on Rhemtulla, Brosseau-Liard and Savalei (2012), ordinal scales with more than five categories were analysed as interval/ratio scales.

Variable	Cooperating SMEs	Non-cooperating SMEs	Statistical test	Statistically significant/ Effect size
Location	– Araba: 16.9% – Gipuzkoa: 52.3% – Bizkaia: 30.8%	– Araba: 18.8% – Gipuzkoa: 44.4% – Bizkaia: 36.9%	Chi-square:	No
Legal form	– Public limited company: 34.9% – Limited liability company: 57% – Cooperative societies: 8.1%	– Public limited company: 38.1% – Limited liability company: 58.8% – Cooperative societies: 3.1%	Chi-square	No
Headquarters	– No: 5.2% – Yes: 94.8%	– No: 6.3% – Yes: 93.8%	Chi-square	No
Business group	– No: 35.5% – Yes: 64.5%	– No: 81.3% – Yes: 18.8%	Chi-square	Yes/ Weak
Age	– 0-2 years: 0.6% – 3-4 years: 1.2% – 5-24 years: 20.9% – ≥25years: 77.4% – Mdn=4 (≥25years)	– 0-2 years: 0% – 3-4 years: 1.3% – 5-24 years: 29.4% – ≥25years: 69.4% – Mdn=4 (≥25years)	Mann-Whitney	No
Size	M=51.47, SE= 3.57	M=30.36, SE=2.04	*t*-test	Yes/ Moderate
Turnover	– <=2M€: 14% – <=10M€: 51.7% – <=50M€: 34.3% – Mdn=2 (<=10M€)	– <=2M€: 39.4% – <=10M€: 48.8% – <=50M€: 11.9% – Mdn=2 (<=10M€)	Mann-Whitney	Yes/ Moderate
Exports (local sales)	– 0%: 9.9% – 1-9%: 27.3% – 10-19%: 12.2% – 20-29%: 7.6% – 30-39%: 6.4% – 40-49%: 4.1% – 50-59%: 5.2% – 60-69%: 4.1% – 70-79%: 8.1% – 80-89%: 8.7% – 90-100%: 6.4% – M=4.88, SE=0.25	– 0%: 3.8% – 1-9%: 10% – 10-19%: 8.1% – 20-29%: 5.6% – 30-39%:5% – 40-49%: 5.6% – 50-59%: 6.3% – 60-69%: 3.8% – 70-79%: 10% – 80-89%: 16.9% – 90-100%: 25% – M=7.37, SE=0.27	*t*-test	Yes/ Moderate
Technological level	– Low/ Medium-Low technology: 59.3% – Medium-High/ High technology: 40.7% – Mdn=1 (Low/ Medium-Low technology)	– Low/ Medium-Low technology: 74.4% – Medium-High/ High technology: 25.6% – Mdn=1 (Low/ Medium-Low technology)	Mann-Whitney	Yes/ Weak
Employees' qualification	– 0 9%: 16.9% – 10-19%:27.9% – 20-29%:21.5% – 30-39%:15.7% – 40-49%:3.5% – 50-59%: 7% – 60-69%:2.3% – 70-79%: 3.5% – 80-89%: 1.7% – M=3.19, SE=0.14	– 0 9%: 45% – 10-19%:30.6% – 20-29%:11.3% – 30-39%:9.4% – 40-49%:2.5% – 50-59%: 0.6% – 60-69%:0.6% – M= 1.98, SE=0.09	*t*-test	Yes/ Strong
Gender	– 0%: 2.3% – 1-9%: 19.2% – 10-19%: 27.9% – 20-29%: 17.4% – 30-39%: 16.9% – 40-49%: 7.6% – 50-59%: 5.2% – 60-69%: 1.7% – 70-79%: .6% – 80-79%: 0% – 90-100%: 1.2% – M=3.92, SE= 0.14	– 0%:3.1% – 1-9%: 38.1% – 10-19%: 24.4% – 20-29%: 15% – 30-39%: 7.5% – 40-49%: 7.5% – 50-59%: 1.3% – 60-69%: .6% – 80-89%: 1.9% – 90-100%: 0.6% – M=3.34, SE=0.14	*t*-test	Yes/ Weak

Table 76. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to general business characteristics

7.3.2.2. Business openness

As to the total number of LLL partners, the descriptive analysis showed that cooperating SMEs, M=1.28 (SE= 0.11), had a higher average value than non-cooperating SMEs, M=0.38 (SE= 0.06). This dissimilarity was statistically proven and the difference, 0.78 BCa 95% CI [0.57, 0.99], was significant at t(313.34)= 7.65 p<.001, presenting a strong effect of (r_{PB}=.4).

As was seen in the descriptive analysis, cooperating SMEs (M=1.16 SE= 0.08) participated in more informal interactions with university participation than non-cooperating SMEs (M=0.38 SE= 0.06). This difference 0.78 BCa 95% CI [0.58, 0.99] was significant at *t*(313.34)= 7.65 p<.001, representing a strong effect of r=.4.

Whilst 57% of cooperating SMEs replied that R&D activities in their company were carried out in cooperation with external agents, only 22.1% admitted to performing these activities in-house. Within the framework of non-cooperating companies, it was observed that a smaller percentage of companies, 26.3%, carried out R&D activities with external agents and that only 13.8% of them performed these activities in-house. Cooperation with external agents in R&D activities turned out to be moderately associated with university cooperation (Pearson's Chi-Square: 53.58, df(2); Exact Sig. (2-sided): p<.001, Cramér's V: .40, Exact Significance: p<.001). As the analysis highlighted, the proportion of cooperating companies that undertook R&D activities cooperatively (Standardised residual=3.0) was higher than the proportion of non-cooperating companies (Standardised residual=-3.1).

With regard to the total number of R&D partners, the analysis indicated that, on average, cooperating SMEs cooperated with more partners in the development of R&D activities (M=1.28 SE= 0.11) than non-cooperating companies (M=0.53 SE= 0.08). This difference 0.75 BCa 95% CI [0.48, 1.02] was significant at t(310.74)= 5.51 p=<.001, representing a moderate effect of r_{PB} =.3

As was shown in the descriptive analysis, cooperating and non-cooperating companies differed in the way they developed lifelong learning activities. The statistical analysis indicated that there was a moderate significant relationship between the way in which companies carried out lifelong learning activities (in-house, externally or both) and cooperation with universities (Pearson's Chi-Square: 29.44, df(3); Exact Sig. (2-sided):p<.001, Cramér's V: .3, Exact Significance: p<.001). With regard to this association, on the one hand, it was noted that the proportion of non-cooperating companies exclusively undertaking external lifelong learning activities was higher (Standardised residual=2.7) than the proportion of cooperating companies (Standardised residual =-2.1). On the other hand, it was seen that the proportion of cooperating companies that carried out lifelong learning activities both internally and externally was higher (Standardised residual =2.0) than the proportion of non-cooperating companies (Standardised residual =-2.0).

The descriptive analysis showed that 64.5% of cooperating SMEs participated in some kind of informal interaction (informal meetings, conferences or workshops with university participation), whilst only 22.5% of non-cooperating SMEs. The statistical analysis exhibited a moderate (Cramér's V: .42, Exact Significance: p< .001) and significant relationship between cooperation with universities and participation in some kind of informal interaction (Pearson's Chi-Square: 59.36, df(1); Exact Sig. (2-sided): p<.001).

The analysis reflected that cooperation with universities was 6.27 times more likely in companies that carried out informal interactions with universities (95% Confidence Interval: 3.86-10.18) than in companies that did not undertake them.

Whilst 37.2% of cooperating SMEs belonged to a cluster association, only 17.5% of non-cooperating SMEs did. The statistical test confirmed the relationship between UBC and cluster association (Pearson's Chi-Square: 16.07, df(1); Exact Sig. (2-sided): p<.001). This relationship showed a moderate effect (Cramér's V: .22, Exact Significance: p<.001). It was discovered that cooperation with universities in companies belonging to a cluster association was 2.8 times more likely (95% Confidence Interval: 1.15-4.59) than in companies that did not belong to a business cluster.

Table 77 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables regarding business openness.

Variable	Cooperating SMEs	Non-cooperating SMEs	Statistical test	Statistically significant/ Effect size
R&D cooperation	– No R&D: 20.9% – Internally: 22.1% – External cooperation: 57%	– No R&D: 60% – Internally: 13.8% – External cooperation:26.3%	Chi-square	Yes/ Moderate
Total number of R&D partners	– 0:47.1% – 1:9.9% – 2:20.9% – 3:14% – 4:5.8% – 5:2.3% – M=1.28, SE= 0.11	– 0:74.4% – 1:8.1% – 2:10% – 3:5.6% – 4:1.3% – 5: 0.6% – M=0.53, SE= 0.08	*t*-test	Yes/ Moderate
LLL cooperation	– No LLL: 5.8% – Internally: 2.3% – External cooperation: 8.1% – Internally and external cooperation: 83.7%	– No LLL: 11.9% – Internally: 6.3% – External cooperation: 25% – Internally and external cooperation: 56.9%	Chi-square	Yes/ Moderate
Total number of LLL partners	– 0:8.7% – 1:7.6% – 2:26.2% – 3:30.8% – 4:19.2% – 5:5.8% – 6:1.2% – 7:0.6% – M= 1.16, SE= 0.06	– 0:21.9% – 1:21.3% – 2:27.5% – 3:21.3% – 4:4.4% – 5:2.5% – 6:0.6% – 7:0.6% – M=0.38, SE= 0.06	*t*-test	Yes/ Strong
Informal interactions	– No: 35.5% – Yes: 64.5%	– No: 77.5% – Yes: 22.5%	Chi-square	Yes/ Moderate
Total number of informal interactions	– 0:77.5% – 1:11.3% – 2:7.5% – 3:3.8% – M=1.16, SE= 0.08	– 0:35.5% – 1:27.9% – 2:22.1% – 3:14.5% – M=0.38, SE= 0.06	*t*-test	Yes/ Strong
Cluster	– No: 62.8% – Yes: 37.2%	– No: 82.5% – Yes: 17.5%	Chi-square	Yes/ Moderate

Table 77. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to business openness

7.3.2.3. R&D

The descriptive analysis showed that the vast majority of cooperating businesses, 79.1%, undertook R&D activities. However, in the framework of non-cooperating businesses, only 40% admitted to undertaking these types of activities. This noticeable difference was demonstrated by the statistical analysis, which showed a moderate (Cramér's V: .4 Exact Significance: $p<.001$) and significant association between R&D activity development and cooperation with universities (Pearson's Chi-Square: 52.83, df(1); Exact Sig. (2-sided): $p<.001$). It was observed in the analysis that cooperation with universities was 5.67 times more likely in companies that performed R&D activities (95% Confidence Interval: 3.49-9.20) than in companies that did not.

With regard to R&D intensity, the analysis revealed clear differences between cooperating and non-cooperating SMEs. Whilst the vast majority of cooperating SMEs invested 0-9%, 63.4%, the majority of non-cooperating SMEs, 60%, did not make any investment since these did not undertake any R&D activity. Analysing the variable as a ratio scale, it was observed that cooperating SMEs exhibited a higher average mean, M=1 (SE=0.06), than non-cooperating SMEs, M=0.51 (SE=0.06). This difference 0.48 BCa 95% CI [0.31, 0.65] was significant at $t(323.76)=5.71$ $p<.001$, and showed a moderate effect ($r_{PB}=.30$).

As to R&D continuity, noticeable differences were observed between cooperating and non-cooperating SMEs in the descriptive analysis. It was seen that a larger percentage of cooperating SMEs, 35.5%, engaged in permanent R&D activity whilst only 7.5% of non-cooperating SMEs did. In the same vein, there were more cooperating SMEs undertaking R&D activities discontinuously (43%) than non-cooperating SMEs (27.5%). Besides, it was observed that only 0.6% of cooperating companies did not carry out internal R&D activities as opposed to 4.4% of non-cooperating companies. These differences were supported by the statistical analysis, which showed that RD continuity levels in cooperating SMEs (Mdn=2, "Discontinuous R&D") differed statistically from non-cooperating businesses (Mdn=0, "No R&D activities"), Fisher's Exact test: 74.49, Exact Sig. (2-sided): $p<.001$. This difference presented a moderate effect (V: .46, Exact Significance: $p<.001$).

The results of the descriptive analysis showed that 62.4% of cooperating SMEs had knowledge of public R&D programs whilst only 25.3% of non-cooperating SMEs knew about them. Through the statistical analysis, it was observed that knowledge of R&D programs and UBC were significantly and moderately associated (Pearson's Chi-Square: 37.56, df(1); Exact Sig. (2-sided): $p<.001$, Cramér's V: .34, Exact Significance: $p<.001$). As was observed in the study, cooperation with universities was 4.92 times more likely in SMEs with knowledge of R&D programs (95% Confidence Interval: 2.9-8.38) than in SMEs without.

Whilst 58.1% of cooperating SMEs admitted to participating in public R&D programs, only 20.6% of non-cooperating SMEs did so. In this respect, the statistical analysis highlighted that participation in R&D programs was moderately associated with university cooperation (Pearson's Chi-Square: 48.58, df(1); Exact Sig. (2-sided): $p<.001$ Cramér's V: .38, Exact Significance: $p<.001$). As was observed, cooperation with universities was 5.34 times more likely in SMEs that participated in R&D programs (95% Confidence Interval: 3.28-8.71) than in SMEs that did not.

Table 78 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables regarding R&D characteristics.

Variable	Cooperating SMEs	Non-cooperating SMEs	Statistical test	Statistically significant/ Effect size
R&D development	− No: 20.9% − Yes: 79.1%	− No: 60 % − Yes: 40%	Chi-square	Yes/ Moderate
R&D intensity	− No R&D investment: 20.9% − 0-9%%: 63.4% − 10-19%: 12.2% − 20-29%: 1.7% − 30-39%1.7% − 40-49%: 0% − ≥50%: 0% − M=1, SE=0.06	− No R&D investment: 60% − 0-9%: 33.1% − 10-19%: 4.4% − 20-29%: 1.9% − 30-39%:0% − 40-49%:0% − ≥50%: 0.6% − M=0.51, SE=0.06	*t*-test	Yes/ Moderate
R&D continuity	− No R&D: 20.9% − No internal R&D: 0.6% − Discontinuous R&D: 43% − Permanent R&D department:35.5% − Mdn=2 (Discontinuous R&D)	− No R&D: 60% − No internal R&D: 4.4% − Discontinuous R&D: 28.1% − Permanent R&D department: 7.5% − Mdn=0 (No R&D)	Chi-square	Yes/ Moderate
R&D program knowledge	− No: 37.6% − Yes: 62.4%	− No: 74.7% − Yes: 25.3%	Chi-square	Yes/ Weak
R&D program participation	− No: 41.9% − Yes: 58.1%	− No: 79.4% − Yes: 20.6%	Chi-square	Yes/ Weak

Table 78. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to R&D

7.3.2.4. LLL

With regard to LLL (see Table 79) , the analysis showed that there was no difference between cooperating and non-cooperating SMEs in relation to LLL development and LLL commitment. The statistical values of these variables can be found in *Appendix VII: Specific objective 1*. Table 79 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables regarding LLL characteristics.

Variable	Cooperating SMEs	Non-cooperating SMEs	Statistical test	Statistically significant/ Effect size
LLL development	− No: 5.8% − Yes: 94.2%	− No: 11.9% − Yes: 88.1%	Chi-square	No
LLL commitment	− 0%: 5.8% − 0-9%:78.5% − 10-19%:9.3% − 20-29%: 5.2% − 30-39%:1.2% − M=1.17, SE=0.05	− 0%: 11.9% − 0-9%: 73.1% − 10-19%:8.8% − 20-29%:3.8% − 30-39%:1.9% − 40-49%:0.6% − M=1.13, SE=0.06	*t*-test	No

Table 79. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to LLL

7.3.2.5. AC

As was seen in the descriptive analysis, cooperating SMEs (M=7.55 SE= 0.12) showed higher PAC levels than non-cooperating SMEs (M=6.59 SE=0.14). This difference; 0.96 BCa 95% CI [0.61, 1.29] was significant at $t(319.73)= 5.34$ $p<.001$ and represented a moderate effect of r_{PB} =.29.

With regard to RAC, the descriptive analysis exhibited a difference between cooperating and non-cooperating SMEs. Cooperating SMEs showed higher RAC levels (M=6.32 SE=0.13) than non-cooperating SMEs (M=5.72 SE=0.13). This difference, 0.60 BCa 95% CI [0.25, 0.96], was significant at $t(326.9)=3.27$, $p<.001$ and represented a weak effect of r_{PB}= 0.18.

In relation to this group of variables, it should be noted that based on the literature review and objectives of the study, the analysis of AC was focused on its dimensions and therefore, AC calculated as a mean of PAC and RAC was not analysed. Table 80 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables regarding AC.

Variable	Cooperating SMEs	Non-cooperating SMEs	Statistical test	Statistically significant/ Effect size
PAC	– M=7.55, SE=0.12	– M=6.59, SE=0.14	*t*-test	Yes/ Moderate
RAC	– M=6.32, SE=0.13	– M=5.72, SE=0.13	*t*-test	Yes/ Weak

Table 80. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to AC

7.3.2.6. Innovation

As was seen in the descriptive analysis, cooperating SMEs (M=6.19 SE=0.13) showed higher IC levels than non-cooperating SMEs (M=5.27 SE=0.15). This difference, 0.91 BCa 95% CI [0.52, 1.30], was significant at $t(320.3)= 4.67$ $p<.01$ and represented a moderate effect of r_{PB} =.25.

With regard to ID, the descriptive analysis exhibited a difference between cooperating and non-cooperating SMEs. Cooperating SMEs showed higher ID levels (M=6.30 SE=0.14) than non-cooperating SMEs (M=5.39 SE=0.18). This difference: 0.91 BCa 95% CI [0.44, 1.35] was significant at $t(307.04)= 3.89$ $p<.001$ and represented a weak effect of r_{PB}= .22.

In connection with this group of variables, it should be explained that, based on the literature review and objectives of the study, the analysis of IC was focused as a whole without differentiating its dimensions. For this purpose, the IC variable was calculated as the mean of the three dimensions (IC product, IC organisation and IC marketing) validated previously in the study (see *6.2 Validation of latent constructs*). Accordingly, IC product, IC organisation and IC marketing dimensions were not analysed. Table 81 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables regarding innovation.

Variable	Cooperating SMEs	Non-cooperating SMEs	Statistical test	Statistically significant/ Effect size
IC	– M=6.19, SE=.13	– M=5.27, SE=.15	*t*-test	Yes/ Moderate
ID	– M=6.30, SE=.14	– M=5.39, SE=.18	*t*-test	Yes/ Weak

Table 81. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to IC

7.3.2.7. UBC willingness and support

With regard to UBC resources, the analysis revealed clear differences between cooperating and non-cooperating SMEs. It was observed that cooperating SMEs exhibited a higher average mean, M=6.2 (SE=0.13), than non-cooperating SMEs, M=3.8 (SE=0.15). This difference, 2.4 BCa 95% CI [0.2, 2.8], was significant at $t(316.1)=11.8$ $p<.005$, and showed a strong effect ($r_{PB}=.66$).

As was seen in the descriptive analysis, cooperating SMEs (M=6.21 SE=0.12) showed higher cognitive closeness levels than non-cooperating SMEs (M=4.18 SE=0.15). This difference, 2.02 BCa 95% CI [1.62, 2.41], was significant at $t(309.57)=10.14$ $p<.005$ and represented a moderate effect of $r_{PB}=.49$.

As to UBC beliefs, the descriptive analysis exhibited a difference between cooperating and non-cooperating SMEs. Cooperating SMEs showed higher UBC beliefs levels (M=6.54 SE=0.14) than non-cooperating SMEs (M=5.38 SE=0.16). This difference, 1.16 BCa 95% CI [0.75, 1.58] was significant at $t(322.35)=5.54$ $p<.005$ and represented a weak effect of $r_{PB}=.29$.

It should be stressed that, based on the objectives of the study and the results obtained from the validation of the UBC willingness and support construct, it was determined that the analysis of UBC willingness and support was more enriching though its dimensions than an average value of its dimensions. Accordingly, UBC willingness and support, calculated as a mean of its dimensions, was not analysed. Table 82 below summarises the descriptive statistics, statistical test employed and results obtained in the analysis of the variables regarding the three dimensions of UBC willingness and support.

Variable	**Cooperating**	**Non-cooperating**	**Statistical test**	**Statistically significant/ Effect size**
UBC resources	M=6.20, SE=0.13	M=3.8, SE=0.15	*t*-test	Yes/ Strong
Cognitive closeness	M=6.21, SE=0.12	M=4.18, SE=0.15	*t*-test	Yes/ Moderate
UBC beliefs	M=6.54, SE=0.14	M=5.38, SE=0.16	*t*-test	Yes/ Weak

Table 82. Specific objective 1: differences between cooperating and non-cooperating SMEs in relation to UBC willingness and support

7.3.3. Summary

The analysis described in this section aimed to address Specific objective 1 "*Identify the most determining organisational context-related factors on the likelihood of manufacturing SMEs' cooperating with universities".* To this end, through various statistical tests (i.e. Pearson's Chi-Square, Mann-Whitney and Independent samples *t*-test), differences between cooperating and non-cooperating SMEs were sought in relation to the different groups of variables previously identified in the literature review: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support.

After developing the empirical analysis, it was observed that the organisational context-related factors, highlighted in bold in Figure 4 below, differed significantly between cooperating and non-cooperating SMEs.

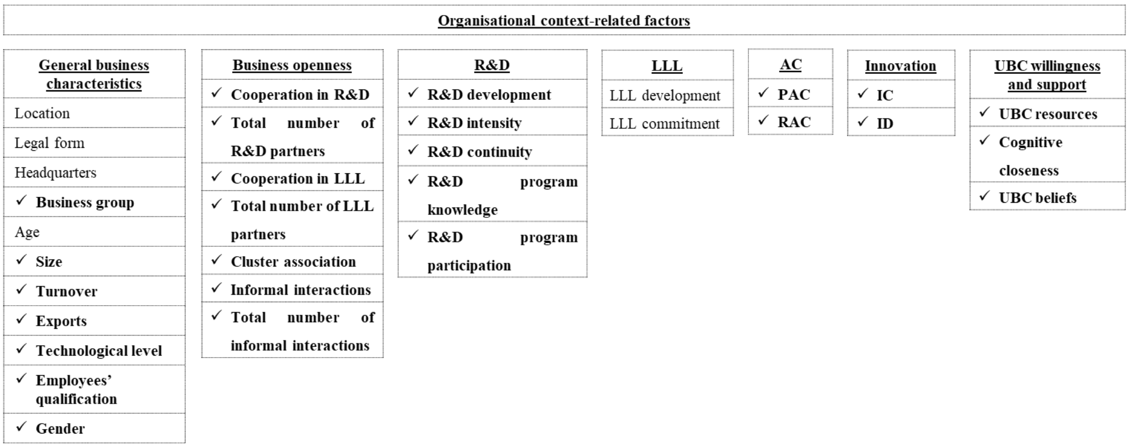

Figure 4. Specific objective 1: organisational context-related factors that significantly differentiated cooperating SMEs from non-cooperating SMEs

The variables identified in this analysis, lay the foundations for proceeding with the achievement of Specific objective 2, *" Identify the most determining organisational context-related factors on the likelihood of manufacturing SMEs to cooperate with universities",* and Specific objective 3, *"Identify the most determining organisational context-related factors on manufacturing SMEs' cooperation levels in UBC activities".*

7.4. Specific objective 2

Having identified the organisational context-related factors that significantly differentiated cooperating SMEs from non-cooperating SMEs (see *7.3 Specific objective 1*), the analysis concerning Specific objective 2 was conducted. This second objective sought on the one hand, to explore the impact of the identified organisational context-related factors in the different groups of variables on the predicted probability of SMEs to cooperate with universities, and, on the other hand, to identify the determining factors from a holistic perspective. To this end, a two-stage analysis was carried out:

1. identification of the most determining organisational context-related factors on manufacturing SMEs' likelihood to cooperate with universities in the different groups of factors identified in the literature, through multivariate logistic regression analyses,
2. identification of the most determining organisational context-related factors on manufacturing SMEs' likelihood to cooperate with universities among all the different groups of factors identified in the literature, through multivariate logistic regression analyses.

7.4.1. Data adequacy and correlation analysis

As Sperandei (2014) notes, one of the principal problems when building a regression model is to select the variables to include. Including too many variables makes models have less statistical power. Besides, multicollinearity problems may appear. Multicollinearity is a statistical phenomenon in which predictor variables are highly correlated and can cause unstable estimates and inaccurate variances which affect confidence intervals and hypothesis tests. As Midi, Sarkar and Rana, 2010 (p.253) note, "the existence of collinearity inflates the variances of the parameter estimates and give rise to incorrect inferences about relationships between explanatory and response variables". Multicollinearity is quite common when there are a large number of covariates in the model. Therefore, it was important not to include too many predictors and only include the predictors for which there was good theoretical grounding (Field, 2018).

Even though all the variables included in the analysis had a theoretical basis, in order to avoid multicollinearity problems, a correlation analysis was carried out between the variables in each group: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) innovation and (vi) UBC willingness and support, and among the groups (For further information see *Appendix VIII: Specific objective 2*). Furthermore, due to the multiple operationalisations of AC in the literature and the large number of variables analysed in this study, it was decided not to include PAC and RAC variables based on a company's external knowledge processes and routines, since both the variables *R&D intensity* (e.g. Cohen and Levinthal, 1989, 1990; Mowery and Oxley, 1995; Tsai, 2001; Escribano, Fosfuri and Tribó, 2009; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Kobarg, Stumpf-Wollersheim and Welpe, 2018), *R&D continuity* (e.g. Cassiman and Veugelers, 2002; Escribano, Fosfuri and Tribó, 2009; Hewitt-Dundas, 2013; Kobarg, Stumpf-Wollersheim and Welpe, 2018) and *employees' qualification* (e.g. Mowery and Oxley, 1995; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Kobarg, Stumpf-Wollersheim and Welpe, 2018) were also employed in the literature as an AC operationalisation.

Drawing on Field (2018), prior to developing the correlation analysis, data adequacy was assessed checking whether all the categorical variables contained the necessary quantity of data in each category. By means of contingency tables, incomplete information was checked. While checking these tables (see *Appendix VIII: Specific objective 2*), the expected frequencies were observed in each cell of the table in order to assess whether they were greater than 1 and no more than 20% were less than 5. The goodness of fit tests in logistic regression makes this assumption (Field, 2018). It was observed that in the case of the variable *RD_continuity*, there was not enough data. Thus, the use of this variable had to be discarded. Having assessed data adequacy, the correlation between variables was analysed.

By means of correlational research, it was possible to analyse the relationship between variables without making any statement about cause and effect (Cohen, Manion and Morrison, 2007; Field, 2018). Correlation coefficients are measurements of the strength of associations or relationships between two variables. Pearson's correlation coefficient (i.e. Pearson's product-moment correlation coefficient) is a standardised measurement of the strength of relationship between two variables. This value can range from -1 to +1. A coefficient of +1 indicates a perfect positive relationship; a coefficient of -1 indicates a perfect negative relationship; a coefficient of 0 indicates no linear relationship at all. Values of ±.1 represent a small effect (the effect explains 1% of the total variance); ±.3 is a medium effect (the effect accounts for 9% of the total variance); and ±.5 is a large effect (the effect accounts for 25% of the variance) (Field, 2018). Drawing on these thresholds, variables with a correlation higher than ±.5 were assessed. Since univariate normality was not met, the Bootstrapping method (Efron and Tibshirani, 1993 seen in Field, 2018) was used in the correlation analyses.

Table 83 below summarises both the pairs of variables that were found to be highly correlated in each group of variables (For further information see *Appendix VIII: Specific objective 2*), and the variables that were selected among them according to their weight in the literature.

Group	Highly correlated variables	Correlation value	Variable included
General business characteristics	− Size − Turnover	r(330) = .55, p<.01 (2-tailed)	− Size
Business openness	− Cooperation in R&D (*Company does not undertake R&D activities*) − Total number of R&D partners	r(330) = -.57, p<.01 (2-tailed)	− Total number of LLL partners
	− Cooperation in R&D (R&D activities are developed in cooperation with external partners) − Total number of R&D partners	r(330) = .82, p<.01 (2-tailed)	
	− Cooperation in LLL − Total number of LLL partners	r(330) = -.59, p<.001 (2-tailed)	
	− Informal interactions − Total number of informal interactions	r(330) = .86, p<.001 (2-tailed).	
R&D	There was a high correlation between all the variables in the group		− R&D intensity
Innovation	There was a high correlation between all the variables in the group		− IC − ID
UBC willingness and support	There was a high correlation between all the variables in the group		− UBC resources − Cognitive closeness − UBC beliefs

Table 83. Specific objective 2: highly correlated variables in each of the groups and selected variables

With regard to "General business characteristics", the selection of the variable *Size* over *Turnover* was based on a solid theoretical basis (e.g. Bayona Sáez, García Marco and Arribas Huerta, 2002; Abramovsky *et al.*, 2009; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Coad, Segarra and Teruel, 2016; González-Benito, Muñoz-Gallego and García-Zamora, 2016; Davey *et al.*, 2018), which argues the importance of including *Size* in the study due to its recognised significance in UBC.

As to "Business openness", the inclusion of the variables *Total number of R&D partners* and *Total number of LLL partners* was considered more enriching than including the other variables in the group, since these variables not only indicated whether companies cooperated with external partners, but they also indicated their external search breadth (Laursen and Salter, 2004). However, as *Total number of R&D partners* and *Total number of LLL partners* were an indicator of external search breadth, and had a moderate correlation between them, $r(330) = .43$, $p<.01$ (2-tailed), it was decided to include only *Total number of LLL partners.* The selection of this variable over the discarded one was based on the fact that the study included R&D-related variables and no significant variable had been previously found in relation to LLL. With regard to *Informal interactions* (a binary variable indicating whether companies developed informal interactions or not), this was discarded in favour of the variable *Total number of informal interactions* which provided greater information.

Concerning "R&D", only *R&D intensity* variable was included, as this was the most representative of the group. As regards "UBC willingness and support", it was decided to include the three variables since their high correlation was due to the fact that they formed a latent construct.

In the case of "Innovation", given that there were only two variables in the group, the regression was performed including both. Nevertheless, in addition to this correlation analysis, as is explained in the following sub-sections, the multicollinearity of each model was assessed again by means of the Variable

Inflation Factors (VIF) score and tolerance statistic. Thus, the possible effect of a high correlation was assessed.

Figure 5 below summarises the variables included (highlighted in bold) in the logistic regression analysis of each group (intra-group analysis) and in the inter-group logistic regression model.

Organisational context-related factors

General business characteristics	**Business openness**	**R&D**	**LLL**	**AC**	**Innovation**	**UBC willingness and support**
Location	Cooperation in R&D	R&D development	LLL development	PAC	✓ **IC**	✓ **UBC resources**
Legal form	Total number of R&D partners	✓ **R&D intensity**	LLL commitment	RAC	✓ **ID**	✓ **Cognitive closeness**
Headquarters	Cooperation in LLL	R&D continuity				✓ **UBC beliefs**
✓ **Business group**	✓ **Total number of LLL partners**	R&D program knowledge				
Age	✓ **Cluster association**	R&D program participation				
Size	Informal interactions					
Turnover	✓ **Total number of informal interactions**					
✓ **Exports**						
✓ **Technological level**						
✓ **Employees' qualification**						
✓ **Gender**						

Figure 5. Specific objective 2: variables included in the analysis

With regard to the number of variables included in the regression model, it is also important to ensure that the model does not include more variables than are justified for the given number of observations (Bagley, White and Golomb, 2001). As previously indicated (see *5.5.3 Sample design, selection and size*), drawing on Peduzzi *et al.* (1996), it was assessed whether the sample size was sufficient for the variables in the model. As Peduzzi *et al.* (1996) note, a useful rule of thumb suggests that the number of the less common of the two possible outcomes divided by the number of predictor variables should be at least 10 or higher. To ensure that the sample was adequate for the variables included in the models, this value was checked for each regression model. The values obtained in all cases were greater than 10, the minimum case being 10.67.

7.4.2. Logistic regression analysis

The following sub-sections deal with the logistic regression analyses which were run in order to identify the most determining organisational context-related factors on manufacturing SMEs' likelihood to cooperate with universities in the different groups of factors identified in the literature (intra-group analysis) and among all the factors and groups (inter-group analysis).

A regression model addresses two objectives: (i) it can predict the outcome variable for new values of the predictor variables, and (ii) it can help address questions about the field under study since the coefficient of each predictor variable specifically describes the relative contribution of that variable to the outcome variable, controlling simultaneously for the influences of the other predictor variables (Bagley, White and Golomb, 2001). Logistic regression is a commonly used type of regression analysis, where the dependent variable is dichotomous and the independent variables are continuous, categorical, or both. This regression does not assume that the relationship between the predictor variables and the outcome variable is linear (Midi, Sarkar and Rana, 2010; Camarero Rioja, Almazán Llorente and Mañas Ramírez, 2011). This regression type is particularly appropriate for models involving decision making (yes/no). In logistic regression researchers obtain the logarithm of the odds[45] of a positive outcome (where "positive" is defined by the encoding of the outcome variable, that is, Y=1); a straightforward algebraic manipulation transforms this into the outcome's probability (Bagley, White and Golomb, 2001, p.979).

The simplest logistic model has the following form:

$$logit(Y) = natural \log\ (odds) = \ln(\frac{\pi}{1-\pi}) = \alpha + \beta X \tag{3}$$

where π is the probability of the event, α is the Y intercept, β is the regression coefficient, and X is the predictor variable. The value of the regression coefficient (β) (also known as parameter estimates) determines the direction of the relationship between predictor variables (X) and the logit of outcome variable (Y). As Peng, Lee and Ingersoll (2002, p.4) indicate, "when β is greater than zero, larger (or smaller) X values are associated with larger (or smaller) logits of Y. Conversely, if β is less than zero, larger (or smaller) X values are associated with smaller (or larger) logits of Y".

Extending the logic of the simple logistic regression to multiple predictors, it is possible to generate a more complex logistic regression for the outcome variable as follows:

$$logit(Y) = \ln(\frac{\pi}{1-\pi}) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \tag{4}$$

α and βs are typically estimated by the ML method (Peng, Lee and Ingersoll, 2002).

With the aim of (i) exploring the impact of the previously identified organisational context-related factors on the likelihood of manufacturing SMEs' cooperating with universities, and, (ii) identifying the most determining factors from a holistic perspective, six logistic regression analyses were run, one for each of the groups of variables, and one for the inter-group analysis.

Drawing on Field (2018), the logistic analyses were performed using the default method of conducting the regression, "enter". In order to obtain more robust estimate parameters and standard errors, and avoid heteroscedasticity problems, the bootstrapping technique was employed (Adjei and Karim, 2016). Thus, for each of the models analysed, the regression results were checked against the bootstrapping results. Besides, to ensure the quality of the models, by examining residuals, possible influencing points were sought in each regression analysis. The main purpose of examining residuals was to (i) isolate points for which the model fitted poorly, and (ii) isolate points that exerted an undue influence on the model. In turn, multicollinearity and the soundness of each logistic regression model was assessed.

7.4.3. Assessment of residuals and model fit

To assess isolate points for which the models might fit poorly (outliers), standardised residuals were checked. The differences between the values of the outcome predicted by the model and the values of the

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[45] Odds are ratios of probabilities (π) of Y happening (Peng, Lee and Ingersoll, 2002).

outcome observed in the sample are known as residuals. These residuals show the error present in the model. If a model fits the sample data well, then all residuals will be small (if the model was a perfect fit of the sample data, then all residuals would be zero). Consequently, if a model is a poor fit of the sample data, then the residuals will be large; and if any cases stand out for having a large residual, they could be outliers (Field, 2018). According to Field (2018), only 5% of standardised residuals should lie outside ±1.96 value, and about 1% should lie outside ±2.58. Cases above 3 are cause for concern and cases close to 3 require inspection.

To assess isolate points that might exert an undue influence on the models, influence statistics, i.e. Cook's distance, leverage statistics and DFBeta (difference in beta value) were checked.

Cook's distance: Cook's distance is a measurement of the overall influence of a case on the model. Cook and Weisberg (1982) note that values greater than 1 may be cause for concern. As Field (2018) points out, if a significant outlier on Y is detected, but its Cook's distance is < 1, there is no real need to delete that point since it does not have a large effect on the regression analysis.

Leverage values: Leverage values (sometimes called hat values) are measurements of influence, which gauge the influence of the observed value of the outcome variable on the predicted values. Leverage values should be less than three times the average leverage value (the number of predictors (k) plus 1, divided by the sample size (n), (k + 1)/n (Pituch and Stevens, 2016). If no cases exert undue influence on the model, then it is expected that all of the leverage values are close to the average value. However, cases with large leverage values will not necessarily have a large influence on the regression coefficients as they are measured on the outcome variables rather than the predictors (Field, 2018).

DFBeta: The difference between a parameter estimated using all cases and estimated when one case is excluded is known as DFBeta in SPSS. DFBeta is calculated for every case and for each parameter in the model. By looking at the values of DFBeta, it is possible to identify cases that have a large influence on the parameters of the regression model. SPSS produces the standardised DFBeta values that are easier to interpret because cut-off values can be applied. Values above 1 indicate values that substantially influence the model parameters (Field, 2018).

Drawing on these cut-off values, all regression models showed adequate values regarding standardised residuals, Cook's distance and DFBeta. Nevertheless, in the logistic regression models for the groups "Business general characteristics", "Innovation", "UBC willingness and support" and the inter-group analysis, some cases showed higher leverage values than the established cut-off. Accordingly, these logistic regression models were run again without these cases to check whether their presence affected the parameter values or the goodness of fit of the models. As can be seen in *Appendix VIII: Specific objective 2*; the presence of these cases did not affect regression models and thus, these cases remained in the analysis and the regression model was considered valid.

In addition to analysing the residuals of the models, in order to assess multicollinearity, variance inflation factor (VIF) and tolerance statistic values were assessed in each regression model. VIF indicates whether a predictor has a strong linear relationship with the other predictors (Field, 2018). Drawing on Myers (1990), VIF values should be <10, values greater than 10 are cause for concern. Tolerance statistic is related to VIF, which is its reciprocal (1/VIF), and values below 0.1 indicate serious problems (Field, 2018). As can be seen in the corresponding sub-section for each model; the values achieved by all the models were adequate.

As to the soundness of each logistic regression model, drawing on Peng, Lee and Ingersoll (2002) (i) overall evaluation statistics, (ii) statistical significance of individual regression coefficients and (iii) goodness of fit statistcs were assessed. To assess the overall evaluation of the model, the Likelihood Ratio (LR) was checked. A logistic model is said to yield a better fit to the data if it exhibits a significant improvement over the intercept-only model (null model). The LR test showed whether this improvement was significant. To assess the statistical significance of individual regression coefficients (i.e., βs), the Wald chi-square statistic was verified. Finally, with regard to the goodness of fit of the model, the Cox and Snell (1989) and Nagelkerke (1991) descriptive statistics were assessed. These indices (pseudo R^2) are variations of R^2, which in linear regression is the proportion of the variation in the dependent variable that can be explained by predictors in the model (Field, 2018). Cox and Snell and Nagelkerke indices are attempts to yield an equivalent of this concept for the logistic model but, as Peng, Lee and Ingersoll (2002) indicate, none renders the meaning of variance explained, and none corresponds to predictive efficiency or can be tested in an inferential framework (Menard, 2000). Accordingly, researchers can treat these two pseudo R^2 indices as supplementary to one other.

The following sub-sections show the results and assessment of the logistic regression models.

7.4.4. Initial model

Before proceeding with the description of the logistic regression models, the initial model (block 0) is shown as this was the same for all of them (see Table 84 and Table 85).

Classification Table[a,b]					
Step 0	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	0	160	.0
		Yes	0	172	100.0
	Overall Percentage				51.8
a. Constant is included in the model.					
b. The cut value is .500					

Table 84. Specific objective 2: Initial model (block 0), classification table

		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Step 0	Constant	.072	.110	.434	1	.510	1.075

Table 85. Specific objective 2: Variables in the equation (block 0)

7.4.5. Business general characteristics

A six-predictor logistic regression was carried out to assess the effect of *Business group (Business_group), Size (Size), Exports (Market_BC), Technological level (Tech_scale), Employees' qualification (HD_emp) and Gender (Female)* on the likelihood that an SME cooperated with universities. The overall model was statistically significant when compared to the null model, (χ^2 (6): 75.10, $p < .001$), represented 27% of the variation of cooperation (Nagelkerke R^2) and correctly predicted 67.8% of the cases. As can be seen in Table 86, on the one hand, according to the model, the log of the odds of an SME cooperating with universities was positively related to SMEs' size ($p < .01$) and employees' qualification ($p < .001$). On the other hand, it was negatively related to local sales (a variable used to measure the impact of exports) (p <

.001). In other words, the larger the company size and the higher the percentage of employees with a higher degree, the more likely it was that an SME cooperated or had cooperated with universities. In contrast, the higher the percentage of local sales an SME had, the less likely it was that an SME cooperated or had cooperated with universities. *Business group* (p=. 62), *Technological level* (p= .92) and *Gender* (p=. 37) were not significant.

Predictor	**β**	***SE* β**	**Wald's χ^2**	***df***	***p***	**e^{β} (odds ratio)**	**95% C.I.for e^{β}**	
							Lower	**Upper**
Business_group	0.15	0.30	0.24	1.00	0.62	1.16	0.64	2.10
Size	**0.01**	0.00	7.38	1.00	**0.01**	**1.01**	1.00	1.02
Market_BC	**-0.11**	0.04	8.30	1.00	**0.00**	**0.90**	0.83	0.97
Tech_scale	0.03	0.28	0.01	1.00	0.92	1.03	0.59	1.79
HD_emp	**0.37**	0.10	13.89	1.00	**0.00**	**1.45**	1.19	1.76
Female	0.06	0.07	0.80	1.00	0.37	1.07	0.93	1.22
Constant	-0.90	0.48	3.49	1.00	0.06	0.41		
LR: χ^2 (6): 75.10, *p < .001*								
R2 = .20 (Cox & Snell), .27 (Nagelkerke).								

Table 86. Specific objective 2: Business general characteristics, full model

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	111	49	69.4
		Yes	58	114	66.3
	Overall Percentage				67.8
a. The cut value is .500					

Table 87. Specific objective 2: Business general characteristics, classification table

Model	**Variable**	**Collinearity Statistics**	
		Tolerance	**VIF**
1	Business_group	.850	1.176
	Size	.840	1.191
	Market_BC	.740	1.351
	Tech_scale	.867	1.154
	HD_emp	.723	1.384
	Female	.912	1.096

Table 88. Specific objective 2: Business general characteristics, multicollinearity analysis coefficients

7.4.6. Business openness

A three-predictor logistic regression was carried out to assess the effect of *Total number of informal interactions* (Inf_int_tot), *Cluster association* (Clus_yes_no) and *Total number of LLL partners* (LLL_coop_tot) on the likelihood that an SME cooperated or had cooperated with universities. The overall model was statistically significant when compared to the null model, (χ^2 (3): 68.64, $p < .001$), represented 25% of the variation of cooperation (Nagelkerke R^2) and correctly predicted 70.8% of the cases. As can be seen in Table 89, according to the model, the log of the odds of an SME cooperating with universities was positively related to *Total number of informal interactions* ($p < .001$) and *Total number of LLL partners* ($p < .001$). The higher the total number of informal interactions and the higher number of LLL partners, the more likely was that an SME cooperated or had cooperated with universities. *Cluster association* (p=. 08) was not significant.

Predictor	β	*SE* β	Wald's χ^2	*df*	*p*	e^β (odds ratio)	95% C.I.for e^β	
							Lower	Upper
Inf_int_tot	**.70**	.15	23.02	1	**.00**	2.01	1.51	2.68
Clus_yes_no	.51	.29	3.06	1	.08	1.66	.94	2.94
LLL_coop_tot	**.3**	.09	9.85	1	**.00**	1.35	1.12	1.62
Constant	-1.21	.24	26.23	1	.00	.3		
LR: χ^2 (3): 68.64, *p < .001*								
R^2=.19 (Cox & Snell), .25 (Nagelkerke)								

Table 89. Specific objective 2: Business openness, full model

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	121	39	75.6
		Yes	58	114	66.3
	Overall Percentage				70.8
a. The cut value is .500					

Table 90. Specific objective 2: Business openness, classification table

Model	Variable	Collinearity Statistics	
		Tolerance	**VIF**
1	Inf_int_tot	.805	1.243
	Clus_yes_no	.896	1.117
	LLL_coop_tot	.829	1.206

Table 91. Specific objective 2: Business openness, multicollinearity analysis coefficients

7.4.7. Research and development

An univariate logistic regression was carried out to assess the effect of *R&D intensity (RD_int)* on the likelihood that an SME cooperated or had cooperated with universities. The overall model was statistically significant when compared to the null model, (χ^2 (1): 34.37, *p < .001)*, represented 13% of the variation of cooperation (Nagelkerke R^2) and correctly predicted 69.9% of the cases. As can be seen in Table 92, the log of the odds of an SME cooperating with universities was positively related to *R&D intensity* (p < .001). The higher the R&D intensity of the company (measured as a company's R&D investment percentage), the more likely was that an SME cooperated or had cooperated with universities.

Predictor	β	*SE* β	Wald's χ^2	*df*	*p*	e^β (odds ratio)	95% C.I.for e^β	
							Lower	Upper
RD_int	.95	.18	27.42	1	.00	2.58	1.89	3.68
Constant	-.61	.17	13.18	1	.00	.54		
LR: χ^2 (1): 34.37, *p < .001*								
R^2=.10 (Cox & Snell), .13 (Nagelkerke)								

Table 92. Specific objective 2: R&D, full model

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	96	64	60.0
		Yes	36	136	79.1
	Overall Percentage				69.9
a. The cut value is .500					

Table 93. Specific objective 2: R&D, classification table

7.4.8. Innovation

A two-predictor logistic regression was carried out to assess the effect of *Innovation capacity (IC)* and *Innovation degree (ID)* on the likelihood that an SME cooperated or had cooperated with universities. The overall model was statistically significant when compared to the null model, (χ^2 (2): 23.67, *p < .001*), represented 9% of the variation of cooperation (Nagelkerke R^2) and correctly predicted 63.9% of the cases. As can be seen in Table 94, according to the model, the log of the odds of an SME cooperating with universities was positively related to *Innovation capacity* (p < .001). The higher the innovation capacity level of the SME, the more likely it was that an SME cooperated or had cooperated with universities. *Innovation degree* (p=. 13) was not significant.

Predictor	**β**	***SE* β**	**Wald's χ^2**	***df***	***p***	**e^{β} (odds ratio)**	**95% C.I.for e^{β}**	
							Lower	**Upper**
IC	**.22**	.08	8.39	1	**.00**	**1.25**	1.08	1.46
ID	.1	.06	2.31	1	.13	1.10	.97	1.25
Constant	-1.79	.42	18.4	1	.00	.17		
LR: χ^2 (2): 23.67, *p < .001*								
R^2=.07 (Cox & Snell), .09 (Nagelkerke).								

Table 94. Specific objective 2: Innovation, full model

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	96	64	60.0
		Yes	56	116	67.4
	Overall Percentage				63.9
a. The cut value is .500					

Table 95. Specific objective 2: Innovation, classification table

Model	**Variable**	**Collinearity Statistics**	
		Tolerance	**VIF**
1	IC_med	.662	1.511
	ID	.662	1.511

Table 96. Specific objective 2: Innovation, multicollinearity analysis coefficients

7.4.9. UBC willingness and support

A three-predictor logistic regression was carried out to assess the effect of the three dimensions of UBC willingness and support, *UBC resources (UBC_resources), Cognitive closeness (Cogni_closeness)* and *UBC beliefs (UBC_beliefs)* on the likelihood that an SME cooperated or had cooperated with universities. The overall model was statistically significant when compared to the null model, (χ^2 (3): 132.46, p < .001), represented 44% of the variation of cooperation (Nagelkerke R^2) and correctly predicted 74.1% of the cases. As can be seen in Table 97, according to the model, the log of the odds of an SME cooperating with universities was positively related to *UBC resources* (p < .001) and *Cognitive closeness* (p < .001). The higher the level of *UBC resources* and the higher level of *Cognitive closeness*, the more likely it was that an SME cooperated or had cooperated with universities. *UBC beliefs* (p=.16) was not significant.

Predictor	β	*SE* β	Wald's χ^2	*df*	*p*	e^{β} (odds ratio)	95% C.I.for e^{β}	
							Lower	Upper
UBC_resources	**.52**	.09	36.88	1	**.00**	**1.68**	1.42	1.99
Cogni_closeness	**.4**	.09	18.63	1	**.00**	**1.49**	1.24	1.78
UBC_beliefs	-.13	.09	1.97	1	.16	.88	.74	1.05
Constant	-3.89	.55	50.44	1	.00	.02		
LR: χ^2 (3): 132.46, *p < .001*								
R^2=.33 (Cox & Snell), .44 (Nagelkerke)								

Table 97. Specific objective 2: UBC willingness and support, full model

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	112	48	70.0
		Yes	38	134	77.9
	Overall Percentage				74.1
a. The cut value is .500					

Table 98. Specific objective 2: UBC willingness and support, classification table

Model	Variable	Collinearity Statistics	
		Tolerance	**VIF**
1	UBC_resources	.586	1.706
	Cogni_closeness	.550	1.817
	UBC_beliefs	.634	1.578

Table 99. Specific objective 2: UBC willingness and support, multicollinearity analysis coefficients

7.4.10. Inter-group analysis

Once the most determining factors in the different groups of variables had been identified, an inter-group analysis was performed in order to identify the most determining factors from a holistic perspective.

A fifteen-predictor logistic regression was carried out to assess the effect of *Business group (Business_group), Size (Size), Exports (Market_BC), Technological level (Tech_scale), Employees' qualification (HD_emp), Gender (Female), Total number of informal interactions* (Inf_int_tot), *Cluster association* (Clus_yes_no), *Total number of LLL partners* (LLL_coop_tot), *R&D intensity (RD_int), Innovation capacity (IC), Innovation degree (ID), UBC resources (UBC_resources), Cognitive closeness (Cogni_closeness)* and *UBC beliefs (UBC_beliefs)* on the likelihood that an SME cooperated or had cooperated with universities. The overall model was statistically significant when compared to the null model, (χ^2 (15): 189.97, p < .001), represented 58% of the variation of cooperation (Nagelkerke R^2) and correctly predicted 81.6% of the cases. As can be seen in Table 100, on the one hand, according to the model, the log of the odds of an SME cooperating with universities was positively related to *Size* (p <.05), *R&D intensity* (p< .05), *UBC resources* (p < .001) and *Cognitive closeness* (p < .01). On the other hand, the log of the odds of an SME cooperating with universities was negatively related to *Exports* (p< .05) and *Innovation capacity* (p < .05). Accordingly, the larger the company, the higher the intensity in R&D, the higher the UBC resources level and the higher the cognitive closeness level, the more likely it was that an SME cooperated or had cooperated with universities. In contrast, the higher the percentage of local sales an SME had and the higher the innovation capacity level of the SME, the less likely it was that an SME cooperated or had cooperated with universities. *Business group* (p=.73), *Technological level* (p=.99), *Employees' qualification* (p=.09), *Gender* (p=.21), *Total number of informal interactions* (p=.08), *Cluster association* (p=.58), *Total number of LLL partners* (p=.10), *Innovation degree* (p=.81), and *UBC beliefs* (p=.32) were not significant.

These results showed differences with regard to the findings obtained in the previous intra-group regression models. First, the variables *Employees' qualification, Total number of informal interactions* and *Total number of LLL partners* did not show a significant impact on the likelihood that an SME cooperated with universities. Second, the relationship between *Innovation capacity* and the log of the odds of an SME cooperating with universities, even if significant, became negative. Despite the differences found with respect to these variables, the final inter-group model was consistent with the previous models in relation to the variables *Size (Size), Exports (Market_BC), R&D intensity (RD_int), UBC resources (UBC_resources),* and *Cognitive closeness (Cogni_closeness)*.

Predictor	**β**	***SE* β**	**Wald's χ^2**	***df***	***p***	**e^{β} (odds ratio)**	**95% C.I.for e^{β}**	
							Lower	**Upper**
Business_group	-0.14	0.39	0.12	1.00	0.73	0.87	0.40	1.88
Size	**0.01**	0.01	4.13	1.00	**0.04**	**1.01**	1.00	1.02
Market_BC	**-0.12**	0.05	6.26	1.00	**0.01**	**0.88**	0.80	0.97
Tech_scale	0.00	0.35	0.00	1.00	0.99	1.00	0.51	1.99
HD_emp	0.21	0.12	2.89	1.00	0.09	1.23	0.97	1.57
Female	0.12	0.10	1.57	1.00	0.21	1.13	0.93	1.37
Inf_int_tot	0.32	0.18	3.17	1.00	0.08	1.38	0.97	1.96
Clus_yes_no	0.20	0.37	0.30	1.00	0.58	1.23	0.59	2.54
LLL_coop_tot	0.20	0.12	2.74	1.00	0.10	1.22	0.96	1.54
RD_int	**0.45**	0.22	4.36	1.00	**0.04**	**1.57**	1.03	2.41
IC	**-0.30**	0.12	6.20	1.00	**0.01**	**0.74**	0.59	0.94
ID	0.02	0.09	0.06	1.00	0.81	1.02	0.85	1.22
UBC_resources	**0.59**	0.10	33.87	1.00	**0.00**	**1.81**	1.48	2.20
Cogni_closeness	**0.31**	0.11	7.74	1.00	**0.01**	**1.37**	1.10	1.70
UBC_beliefs	-0.10	0.11	0.97	1.00	0.32	0.90	0.73	1.11
Constant	-4.02	1.03	15.28	1.00	0.00	0.02		
LR: χ^2 (15): 189.97, *p < .001*								
R^2=.44 (Cox & Snell), .58 (Nagelkerke)								

Table 100. Specific objective 2: Inter-group analysis, full model

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	131	29	81.9
		Yes	32	140	81.4
	Overall Percentage				81.6
a. The cut value is ,500					

Table 101. Specific objective 2: Inter-group analysis, classification table

Model	**Variable**	**Collinearity Statistics**	
		Tolerance	**VIF**
1	Business_group	.835	1.197
	Size	.775	1.290
	Market_BC	.689	1.451
	Tech_scale	.844	1.184
	HD_emp	.600	1.668
	Female	.856	1.168
	Inf_int_tot	.700	1.428
	Clus_yes_no	.826	1.211
	LLL_coop_tot	.747	1.339
	RD_int	.703	1.422
	IC_med	.538	1.857
	ID	.605	1.652
	UBC_resources	.552	1.811
	Cogni_closeness	.441	2.266
	UBC_beliefs	.603	1.659

Table 102. Specific objective 2: Inter-group analysis, multicollinearity analysis coefficients

7.4.11. Summary

As a result of the two-stage analysis carried out to address Specific objective 2, the following findings were obtained. First, through the analysis of the organisational context-related factors by groups (intra-group analysis) the variables of each group that related significantly to the log of the odds of an SME cooperating with universities were found. Figure 6 below highlights in bold [46] the variables found to be significant in each group of variables (intra-group analysis).

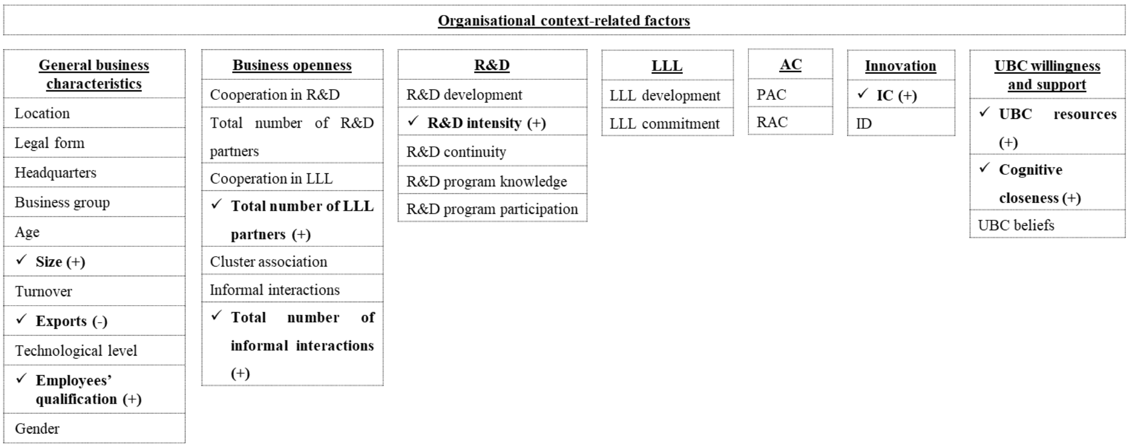

Figure 6. Specific objective 2: results of the intra-group analysis

Second, through the joint analysis of the variables included in the different groups of factors (inter-group analysis), the organisational context-related factors that significantly related to the log of the odds of an SME cooperating with universities were found. Figure 7 below highlights in bold the variables found to be significant in the holistic analysis (inter-group analysis).

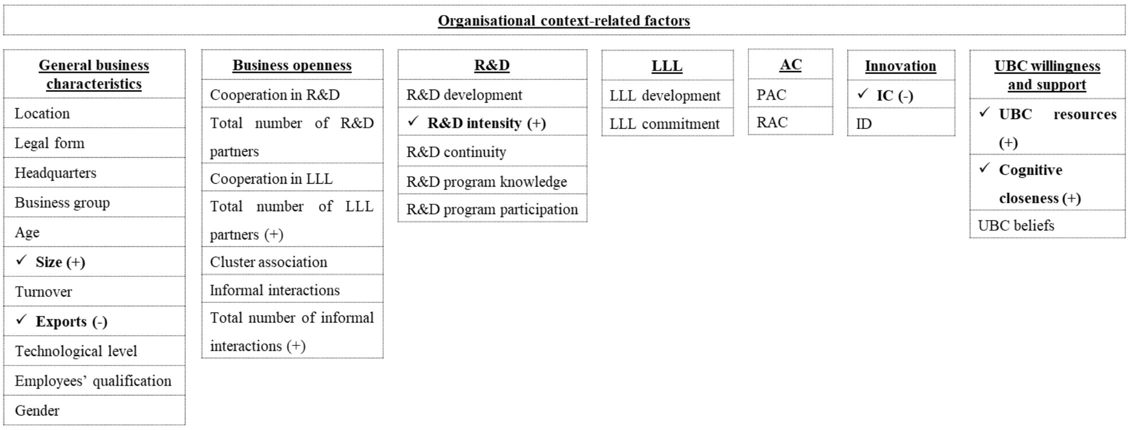

Figure 7. Specific objective 2: results of the inter-group analysis

This specific objective led to the identification of the organisational context-related factors determining *manufacturing* SMEs' predicted probability on UBC.

[46] The "+" sign indicates a positive causal relationship, while the "-" sign indicates a negative relationship.

7.5. Specific objective 3

The following section deals with the analysis performed to address Specific objective 3, namely to identify the organisational context-related factors that determine manufacturing SMEs' cooperation levels in UBC activities. This objective sought, on the one hand, to explore the impact of the organisational context-related factors, identified in the literature review, on manufacturing SMEs' cooperation levels in the diverse UBC activities within the domains of (i) education: mobility of students, curriculum co-design, curriculum co-delivery, dual education programmes and lifelong learning, (ii) research: joint R&D, consultancy and mobility of staff, (iii) valorisation: commercialisation, academic entrepreneurship and student entrepreneurship, and (iv) management: governance, shared resources and support. On the other hand, it sought to identify the determining factors of cooperation levels from a holistic perspective. To this end, 14 multiple linear regression models were run (one for each UBC activity).

In order to avoid multicollinearity problems and the inclusion of redundant variables (see Sub-section *7.4.1 Data adequacy and correlation analysis*), the analysis started with the variables previously verified and included in the analysis of Specific objective 2 (see Figure 8).

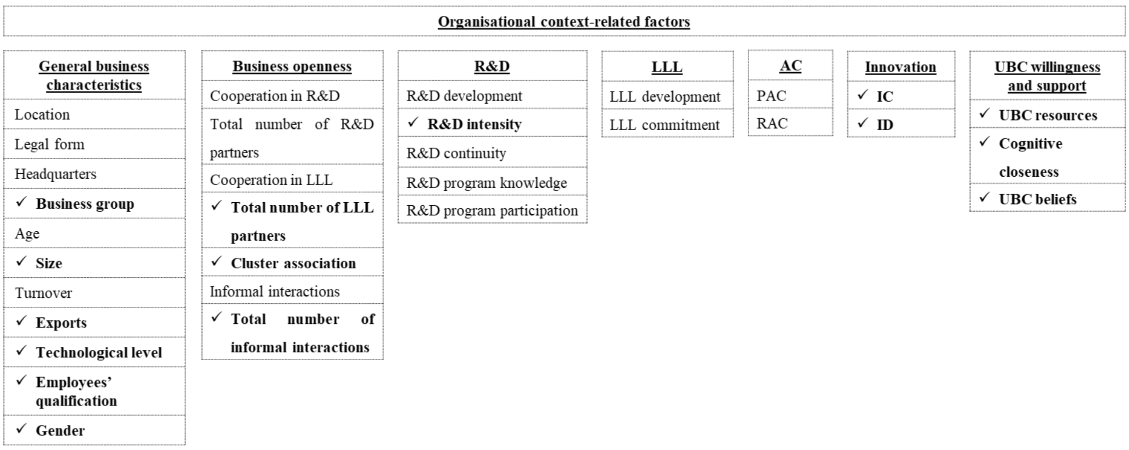

Figure 8. Specific objective 3: variables included in the analysis

7.5.1. Correlation analysis

As previously indicated, one of the principal problems when building a regression model is to select the variables to be included. In addition to the appearance of multicollinearity problems, including too many variables gives models less statistical power (Sperandei, 2014). Besides, the regression coefficient values depend on the variables introduced in the model (Field, 2018). Thus, prior to running the multiple linear regression models, correlation analyses were developed in order to identify the organisational context-related factors (predictor variables) that were associated significantly with manufacturing SMEs' cooperation levels in the diverse UBC activities (outcome variables). To this end, a Pearson's bivariate correlation test was performed for each model. Since variables on manufacturing SMEs' cooperation levels in the diverse UBC activities (outcome) did not follow a univariate normal distribution, Bootstrapping (Efron and Tibshirani, 1993 seen in Field, 2018) method and the bootstrap confidence intervals were assessed. Table 103 below shows the results of the correlation analysis.

UBC activity		Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	LLL_coop_tot	Clus_yes_no	Inf_int_tot	RD_int	IC	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Stu_mob	Pearson Correlation	.137*	.272**	-.361**	.119*	.286**	.119*	.292**	.209**	.337**	.289**	.225**	.198**	.479**	.409**	.264**
	Sig. (2-tailed)	.01	.00	.00	.03	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Std. Error	.05	.05	.05	.05	.05	.05	.05	.06	.05	.06	.05	.05	.04	.04	.05
	Bootstrap[c] 95% Confidence Interval Lower	.03	.18	-.46	.02	.18	.02	.19	.10	.24	.18	.12	.11	.39	.32	.16
	Bootstrap[c] 95% Confidence Interval Upper	.24	.36	-.27	.23	.39	.23	.39	.32	.44	.41	.33	.29	.56	.49	.36
Co_des	Pearson Correlation	.08	.280**	-.224**	.03	.135*	.01	.178**	.09	.200**	.218**	.154**	.04	.256**	.228**	.09
	Sig. (2-tailed)	.17	.00	.00	.55	.01	.89	.00	.09	.00	.00	.00	.46	.00	.00	.11
	Bootstrap[c] Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Std. Error	.06	.08	.05	.05	.05	.05	.05	.06	.05	.06	.06	.05	.04	.04	.05
	Bootstrap[c] 95% Confidence Interval Lower	-.04	.13	-.31	-.08	.03	-.08	.07	-.02	.10	.10	.04	-.06	.18	.14	-.02
	Bootstrap[c] 95% Confidence Interval Upper	.19	.45	-.13	.15	.24	.10	.27	.22	.30	.34	.27	.13	.34	.31	.19
Co_del	Pearson Correlation	.09	.232**	-.226**	.10	.273**	.07	.157**	.03	.301**	.254**	.168**	.09	.261**	.297**	.163**
	Sig. (2-tailed)	.11	.00	.00	.08	.00	.20	.00	.55	.00	.00	.00	.10	.00	.00	.00
	Bootstrap[c] Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Std. Error	.06	.07	.04	.06	.07	.05	.05	.05	.06	.07	.06	.06	.04	.04	.04
	Bootstrap[c] 95% Confidence Interval Lower	-.04	.10	-.31	-.02	.14	-.03	.05	-.07	.18	.12	.05	-.02	.18	.21	.09
	Bootstrap[c] 95% Confidence Interval Upper	.20	.38	-.13	.21	.41	.18	.26	.14	.41	.40	.29	.20	.35	.38	.23

Table 103. Specific objective 3: correlation analysis

UBC activity		Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	LLL_coop_tot	Clus_yes_no	Inf_int_tot	RD_int	IC	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Dual_ed	Pearson Correlation	.115*	.334**	-.223**	.10	.210**	.108*	.180**	.163**	.177**	.218**	.173**	.128*	.377**	.374**	.248**
	Sig. (2-tailed)	.04	.00	.00	.07	.00	.05	.00	.00	.00	.00	.00	.02	.00	.00	.00
	Bootstrap[c] Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Std. Error	.06	.06	.05	.06	.06	.06	.05	.06	.05	.05	.05	.05	.04	.04	.05
	Bootstrap[c] 95% Confidence Interval Lower	.00	.22	-.32	-.01	.10	.00	.08	.05	.09	.12	.07	.03	.29	.29	.15
	Bootstrap[c] 95% Confidence Interval Upper	.24	.45	-.13	.22	.33	.22	.28	.29	.28	.33	.27	.22	.46	.46	.34
Li_lear	Pearson Correlation	.154**	.263**	-.309**	.119*	.265**	.127*	.273**	.208**	.352**	.240**	.212**	.115*	.360**	.349**	.248**
	Sig. (2-tailed)	.01	.00	.00	.03	.00	.02	.00	.00	.00	.00	.00	.04	.00	.00	.00
	Bootstrap[c] Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Std. Error	.06	.06	.04	.05	.06	.05	.05	.06	.05	.06	.05	.05	.04	.04	.04
	Bootstrap[c] 95% Confidence Interval Lower	.05	.15	-.39	.01	.15	.04	.17	.08	.25	.13	.10	.02	.28	.27	.17
	Bootstrap[c] 95% Confidence Interval Upper	.26	.37	-.22	.23	.39	.23	.37	.33	.45	.35	.32	.22	.45	.43	.32
Joint_RD	Pearson Correlation	.196**	.214**	-.257**	.10	.231**	.08	.217**	.207**	.335**	.275**	.252**	.175**	.418**	.357**	.204**
	Sig. (2-tailed)	.00	.00	.00	.08	.00	.14	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Bias	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c] Std. Error	.06	.06	.05	.06	.05	.05	.05	.06	.06	.06	.05	.05	.05	.04	.05
	Bootstrap[c] 95% Confidence Interval Lower	.08	.11	-.35	-.01	.14	-.02	.12	.09	.22	.17	.15	.08	.32	.27	.10
	Bootstrap[c] 95% Confidence Interval Upper	.32	.33	-.17	.21	.34	.19	.32	.33	.45	.39	.35	.27	.51	.44	.31

Table 103.(cont.) Specific objective 3: correlation analysis

UBC activity				Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	LLL_coop_tot	Clus_yes_no	Inf_int_tot	RD_int	IC	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Cons	Pearson Correlation			.08	.249**	-.273**	.08	.220**	.152**	.194**	.131*	.313**	.212**	.257**	.168**	.395**	.354**	.285**
	Sig. (2-tailed)			.16	.00	.00	.16	.00	.01	.00	.02	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.06	.05	.06	.06	.07	.05	.06	.06	.06	.05	.05	.04	.04	.04
		95% Confidence Interval	Lower	-.04	.13	-.37	-.03	.09	.02	.09	.02	.20	.10	.16	.07	.32	.27	.20
			Upper	.19	.36	-.18	.19	.34	.29	.30	.24	.43	.34	.35	.26	.47	.44	.37
Staff_mob	Pearson Correlation			.151**	.236**	-.227**	.02	.254**	.07	.146**	.147**	.228**	.256**	.237**	.197**	.399**	.302**	.256**
	Sig. (2-tailed)			.01	.00	.00	.66	.00	.22	.01	.01	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.07	.05	.05	.06	.05	.06	.06	.06	.06	.04	.04	.04	.04	.05
		95% Confidence Interval	Lower	.03	.10	-.33	-.07	.15	-.03	.04	.04	.12	.15	.15	.11	.32	.23	.15
			Upper	.28	.38	-.12	.13	.38	.17	.26	.26	.34	.37	.31	.28	.48	.37	.35
Commer	Pearson Correlation			.136*	.224**	-.184**	.07	.217**	.134*	.161**	.10	.196**	.264**	.189**	.137*	.298**	.255**	.186**
	Sig. (2-tailed)			.01	.00	.00	.18	.00	.01	.00	.06	.00	.00	.00	.01	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.07	.05	.06	.07	.06	.06	.06	.06	.06	.04	.04	.04	.04	.04
		95% Confidence Interval	Lower	.02	.08	-.28	-.04	.09	.02	.04	-.01	.08	.14	.10	.06	.22	.17	.10
			Upper	.26	.37	-.09	.19	.35	.27	.27	.22	.32	.39	.28	.22	.38	.33	.26

Table 103.(cont.) Specific objective 3: correlation analysis

UBC activity			Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	LLL_coop_tot	Clus_yes_no	Inf_int_tot	RD_int	IC	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Ac_ent	Pearson Correlation		.09	.182**	-.170**	.05	.128*	.10	.166**	.07	.165**	.202**	.175**	.02	.229**	.241**	.183**
	Sig. (2-tailed)		.11	.00	.00	.35	.02	.06	.00	.20	.00	.00	.00	.74	.00	.00	.00
	Bootstrap[c]	Bias	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error	.06	.08	.05	.06	.07	.05	.05	.06	.05	.07	.06	.05	.04	.04	.04
		95% Confidence Interval Lower	-.02	.04	-.26	-.06	.00	.00	.06	-.04	.07	.07	.05	-.09	.15	.17	.10
		95% Confidence Interval Upper	.21	.34	-.07	.18	.27	.21	.27	.19	.27	.35	.30	.13	.31	.32	.25
Stu_ent	Pearson Correlation		.09	.219**	-.231**	.08	.122*	.08	.122*	.124*	.115*	.227**	.165**	.05	.233**	.264**	.192**
	Sig. (2-tailed)		.12	.00	.00	.15	.03	.12	.03	.02	.04	.00	.00	.36	.00	.00	.00
	Bootstrap[c]	Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error	.06	.07	.05	.06	.07	.06	.05	.06	.05	.07	.06	.06	.05	.04	.04
		95% Confidence Interval Lower	-.02	.08	-.32	-.03	.00	-.03	.02	.01	.01	.10	.04	-.07	.15	.18	.12
		95% Confidence Interval Upper	.21	.37	-.14	.20	.26	.19	.22	.24	.22	.37	.28	.16	.33	.35	.26
Gov	Pearson Correlation		.10	.309**	-.191**	.06	.10	.03	.169**	.02	.148**	.206**	.129*	.02	.234**	.196**	.111*
	Sig. (2-tailed)		.07	.00	.00	.25	.06	.63	.00	.69	.01	.00	.02	.68	.00	.00	.04
	Bootstrap[c]	Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error	.06	.10	.04	.06	.06	.04	.05	.05	.05	.08	.06	.05	.05	.03	.04
		95% Confidence Interval Lower	-.02	.11	-.27	-.05	.00	-.05	.07	-.07	.05	.06	.00	-.09	.15	.14	.03
		95% Confidence Interval Upper	.22	.50	-.11	.18	.22	.12	.26	.13	.25	.37	.26	.12	.32	.26	.20

Table 103.(cont.) Specific objective 3: correlation analysis

UBC activity				Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	LLL_coop_tot	Clus_yes_no	Inf_int_tot	RD_int	IC	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Shared_res	Pearson Correlation			.137*	.225**	-.196**	.04	.119*	.06	.191**	.11	.223**	.232**	.180**	.128*	.329**	.245**	.181**
	Sig. (2-tailed)			.01	.00	.00	.51	.03	.30	.00	.05	.00	.00	.00	.02	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.07	.05	.06	.05	.05	.06	.06	.05	.06	.06	.05	.04	.04	.05
		95% Confidence Interval	Lower	.02	.08	-.29	-.07	.02	-.04	.08	-.01	.11	.11	.07	.03	.24	.16	.08
			Upper	.25	.37	-.10	.15	.22	.16	.30	.22	.33	.36	.29	.23	.41	.33	.27
Support	Pearson Correlation			.10	.287**	-.237**	.09	.241**	.04	.157**	.09	.259**	.261**	.174**	.06	.277**	.298**	.183**
	Sig. (2-tailed)			.06	.00	.00	.12	.00	.48	.00	.10	.00	.00	.00	.24	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.08	.05	.06	.06	.05	.05	.06	.06	.06	.05	.05	.04	.04	.04
		95% Confidence Interval	Lower	-.01	.14	-.32	-.03	.13	-.04	.06	-.02	.14	.15	.07	-.04	.21	.23	.10
			Upper	.22	.44	-.14	.20	.35	.14	.26	.22	.36	.40	.27	.16	.35	.37	.27

Note: *p < .001, **p < .01, p <.05***

Table 103.(cont.) Specific objective 3: correlation analysis

The variables that showed a significant association were included in the regression models. Once the variables to be introduced in the regression models had been identified, as previously indicated (see *5.5.3 Sample design*, *selection and size*), the adequacy of the sample size for the analysis was assessed drawing on Green (1991). As the author states, with regard to multiple linear regression models there are two rules of thumb depending on the objective of the sample size assessment. If the aim is to test the overall fit of the model, Green (1991) recommends a minimum sample of 50+8k, where k is the number of predictors. When the objective is to test the individual predictors of the model, a sample of 104+k is required. Since there was an interest in assessing both, the overall fit of the model and the individual predictors, the most restrictive 104+k was assessed in each regression. The values obtained for all regression models were adequate, 119 cases being the minimum sample required.

7.5.2. Multiple linear regression analysis

Regression analysis is a way of predicting an outcome from a predictor variable (simple regression) or several predictor variables (multiple regression), and it is based on the following general equation:

$$Outcome_i = (model) + \ error_i \tag{5}$$

That is to say, it is possible to predict a value by means of a model plus some kind of error (Field, 2018).

Linear regression is a statistical model used to estimate the effect of one or more predictor variables on an outcome variable and is associated with Pearson's r coefficient. The higher the correlation between the variables (covariation), the more predictive the model is (Hernández Sampieri, Fernández and Baptista Lucio, 2014). Linear regression is based on the linear fit of the model. In other words, the data set is summarised by a straight line. As to regression models, it is important to fit the model that describes the data, since several lines could be used to summarise the general trend. To this end, “the method of least squares” mathematical technique is applied. This method examines all possible lines for the one with the least amount of difference between the observed data points and the line (i.e. residual analysis) (Field, 2018). Nonetheless, it is necessary to analyse the goodness of fit of the model.

The simple regression (one predictor variable) equation model is defined by the following equation:

$$Y_i = (b_0 + b_1 X_1) + \ \varepsilon_i \tag{6}$$

where Y_1 is the outcome variable, b_0 is the intercept, b_1 is the slope of the line, X_1 is the *i*th case’s score on the predictor variable and ε_i (residual term) represents the difference between the score predicted by the line for case *i* and the score that case *i* actually obtains. The equation is frequently conceptualised without the residual term. Nevertheless, it is important to remember that the regression model does not fit the data collected perfectly.

In the case of multiple regression (several predictor variables), the equation used is basically the same, except that for every extra predictor included, a coefficient is added. Each predictor variable has its own coefficient and the outcome variable is predicted from a combination of all the variables multiplied by their respective coefficients plus a residual term:

$$Y_i = (b_0 + b_1X_1 + \cdots + b_nX_n) + \varepsilon_i \tag{7}$$

where b_n is the coefficient of the *n*th predictor (X_n), and ε_i is the difference between the predicted and observed value of Y for the *i*th participant. Thus, a regression model in multiple regression is a model in the form of an equation (Field, 2018). Multiple regression can be used in the same way as a linear regression by giving a line that best fits data and providing predictions through the substitution of different values of X. However, its main use is to provide an estimate of the relative importance of the predictor variables in producing changes in outcome variables (Robson and McCartan, 2016). *b*-values indicate the strength of the relationship between a predictor and the outcome variable, if it is significant (Sig.<.05) (Field, 2018).

With the aim of exploring the impact of the previously identified organisational context-related factors on manufacturing SMEs' cooperation levels in the diverse UBC activities and identifying the determining ones, fourteen multiple linear regression models were run, that is to say, one for each UBC activity.

7.5.3. Entry method of the predictor variables

Together with the selection of the variables to be included in the model, the analytical strategy and the consequent method by which the predictor variables are entered in the multiple regression model is essential, since this also affects the values of the estimates (Field, 2018). Based on different analytic strategies, there are three main methods of entering predictor variables in the model: (i) hierarchical (blockwise entry), (ii) forced entry and (iii) stepwise (Tabachnick and Fidell, 2013; Field, 2018).

Drawing on the considerations of Field (2018), as the purpose of Specific objective 3 was exploratory , the multiple linear regression analyses were run through the stepwise method. This method determines an initial model containing only b_0 and the statistical software searches for the predictor variables that best predict the outcome variable. The program selects the predictor with the highest simple correlation with the outcome variable. Each time a predictor is added to the equation, a removal test is performed on the least useful predictor. In this method, the regression equation is constantly being reassessed to see whether any redundant predictor can be removed.

In order to obtain more robust estimate parameters and standard errors, and avoid heteroscedasticity problems, the bootstrapping technique was employed (Field, 2018). Thus, for each of the models analysed, the regression results were checked against the bootstrapping results.

7.5.4. Goodness of fit, assessment of residuals and verification of assumptions

7.5.4.1. Goodness of fit

In order to find and assess the models that best fitted data, a goodness of fit assessment was carried out. Drawing on Field (2018), R^2, multiple R and F-test values were checked to assess the goodness of fit of the models. These values ensure that final regression models are a significantly better predictor than the mean value, and allow the models that fit best to be selected.

R^2 represents the amount of variance in the outcome explained by the model relative to how much variation there was to explain in the baseline model. As a percentage, R^2 represents the percentage of the variation in the outcome that can be explained by the model. The multiple correlation coefficient (labelled multiple

R) is the correlation between the observed value of Y and the values of Y predicted by the multiple regression model. Large values of the multiple R represent a large correlation between the predicted and observed values of the outcome (R=1 represents a situation in which the model perfectly predicts the observed data). R is a gauge of how well the model predicts the observed data. Based on the sum of squares, the F-test provides information about the model compared with error in the model. F is based upon the ratio of the improvement due to the model and the difference between the model and the observed data. F- ratio is a measure of how much the model has improved the prediction of the outcome compared to the level of inaccuracy of the model. When a model is good, it is expected that the improvement in prediction due to the model will be large, and the difference between the model and the observed data will be small (Field, 2018). As to selecting the models that best fitted the data, the results of the confidence intervals of the estimated parameters of the best-fitted models (those with the highest significant R^2 and significant F Change) were compared against the results achieved by bootstrapping. In those cases where the significance of the estimated parameters was in accordance with the bootstrapping results, the analysis of the selected model continued. However, when the significance of the parameters did not match the bootstrapping results (i.e. the significance of the bootstrapped parameter estimates differed from the results previously achieved in the model), the subsequent model with the highest R^2 and significant F-change, that presented concordance with the bootstrapping results was selected. Table 104 below summarises the results obtained in the assessment, highlighting in bold the models selected.

UBC activity	**Model**	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
						R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**
Mobility of students	1	.479[a]	.230	.227	3.04221	.230	98.379	1	330	.000
	2	.550[b]	.302	.298	2.89990	.073	34.185	1	329	.000
	3	.571[c]	.326	.320	2.85415	.024	11.631	1	328	.001
	4	**.583[d]**	**.340**	**.331**	**2.82985**	**.013**	**6.659**	**1**	**327**	**.010**
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, Market_BC									
	3. Predictors: (Constant), UBC_resources, Market_BC, RD_int									
	4. Predictors: (Constant), UBC_resources, Market_BC, RD_int, Inf_int_tot									
Curriculum co-design	1	.222[a]	.049	.046	1.51466	.049	16.428	1	318	.000
	2	**.295[b]**	**.087**	**.082**	**1.48631**	**.038**	**13.250**	**1**	**317**	**.000**
	1. Predictors: (Constant), Size									
	2. Predictors: (Constant), Size, UBC_resources									
	c. Dependent Variable: Co_des									
Curriculum co-delivery	1	.326[a]	.106	.103	1.53007	.106	38.562	1	325	.000
	2	**.373[b]**	**.139**	**.134**	**1.50360**	**.033**	**12.543**	**1**	**324**	**.000**
	1. Predictors: (Constant), Inf_int_tot									
	2. Predictors: (Constant), Inf_int_tot, Cogni_closeness									
Dual education	1	.377[a]	.142	.139	2.84958	.142	54.587	1	330	.000
	2	.463[b]	.214	.209	2.73141	.072	30.172	1	329	.000
	3	**.484[c]**	**.234**	**.227**	**2.70041**	**.020**	**8.596**	**1**	**328**	**.004**
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, Size									
	3. Predictors: (Constant), UBC_resources, Size, Cogni_closeness									

Table 104. Specific objective 3: goodness of fit assessment

UBC activity	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df 1	df2	Sig. F Change
Lifelong learning	1	.360[a]	.129	.127	2.25877	.129	49.020	1	330	.000
	2	.434[b]	.188	.184	2.18404	.059	23.969	1	329	.000
	3	.475[c]	.226	.219	2.13612	.038	15.924	1	328	.000
	4	**.489[d]**	**.239**	**.230**	**2.12161**	**.013**	**5.504**	**1**	**327**	**.020**
	5	.498[e]	.248	.236	2.11225	.009	3.904	1	326	.049
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, Inf_int_tot									
	3. Predictors: (Constant), UBC_resources, Inf_int_tot, Market_BC									
	4. Predictors: (Constant), UBC_resources, Inf_int_tot, Market_BC, RD_int									
	5. Predictors: (Constant), UBC_resources, Inf_int_tot, Market_BC, RD_int, Size									
Joint R&D	1	.418[a]	.175	.172	2.47528	.175	69.818	1	330	.000
	2	.469[b]	.220	.215	2.40983	.045	19.167	1	329	.000
	3	**.501[c]**	**.251**	**.244**	**2.36511**	**.031**	**13.561**	**1**	**328**	**.000**
	4	.510[d]	.260	.251	2.35440	.009	3.991	1	327	.047
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, RD_int									
	3. Predictors: (Constant), UBC_resources, RD_int, Inf_int_tot									
	4. Predictors: (Constant), UBC_resources, RD_int, Inf_int_tot, Market_BC									
Consultancy	1	.395[a]	.156	.154	2.17387	.156	61.066	1	330	.000
	2	.441[b]	.195	.190	2.12683	.039	15.758	1	329	.000
	3	**.466[c]**	**.217**	**.210**	**2.10004**	**.023**	**9.448**	**1**	**328**	**.002**
	4	.478[d]	.228	.219	2.08827	.011	4.707	1	327	.031
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, Market_BC									
	3. Predictors: (Constant), UBC_resources, Market_BC, Inf_int_tot									
	4. Predictors: (Constant), UBC_resources, Market_BC, Inf_int_tot, Size									
Mobility of staff	1	.399[a]	.159	.157	1.84096	.159	62.467	1	330	.000
	2	.445[b]	.198	.193	1.80058	.039	15.970	1	329	.000
	3	**.464[c]**	**.215**	**.208**	**1.78425**	**.017**	**7.051**	**1**	**328**	**.008**
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, RD_int									
	3. Predictors: (Constant), UBC_resources, RD_int, Size									
Student entrepreneurship	1	.264[a]	.070	.067	.62418	.070	24.731	1	330	.000
	2	**.320[b]**	**.102**	**.097**	**.61410**	**.033**	**11.922**	**1**	**329**	**.001**
	3	.339[c]	.115	.107	.61074	.012	4.625	1	328	.032
	1. Predictors: (Constant), Cogni_closeness									
	2. Predictors: (Constant), Cogni_closeness, Market_BC									
	3. Predictors: (Constant), Cogni_closeness, Market_BC, Size									
Academic entrepreneurship	1	.241[a]	.058	.055	1.47240	.058	20.347	1	330	.000
	2	.274[b]	.075	.069	1.46145	.017	5.964	1	329	.015
	3	**.296[c]**	**.087**	**.079**	**1.45365**	**.013**	**4.543**	**1**	**328**	**.034**
	4	.284[d]	.081	.075	1.45670	-.007	2.384	1	328	.124
	5	.305[e]	.093	.085	1.44898	.012	4.514	1	328	.034
	1. Predictors: (Constant), Cogni_closeness									
	2. Predictors: (Constant), Cogni_closeness, RD_int									
	3. Predictors: (Constant), Cogni_closeness, RD_int, UBC_resources									
	4. Predictors: (Constant), RD_int, UBC_resources									
	5. Predictors: (Constant), RD_int, UBC_resources, Size									
Commercialisation	1	.298[a]	.089	.086	1.45846	.089	32.155	1	330	.000
	2	.371[b]	.137	.132	1.42117	.049	18.547	1	329	.000
	3	**.394[c]**	**.155**	**.147**	**1.40883**	**.017**	**6.787**	**1**	**328**	**.010**
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, RD_int									
	3. Predictors: (Constant), UBC_resources, RD_int, Size									

Table 104. (cont.) Specific objective 3: goodness of fit assessment

UBC activity	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df1	df2	Sig. F Change
Governance	1	.309[a]	.095	.093	1.21187	.095	34.775	1	330	.000
	2	**.357[b]**	**.128**	**.122**	**1.19187**	**.032**	**12.166**	**1**	**329**	**.001**
	3	.378[c]	.143	.135	1.18335	.015	5.757	1	328	.017
	1. Predictors: (Constant), Size									
	2. Predictors: (Constant), Size, UBC_resources									
	3. Predictors: (Constant), Size, UBC_resources, RD_int									
Support	1	.298[a]	.089	.086	1.68520	.089	32.079	1	330	.000
	2	.372[b]	.138	.133	1.64121	.050	18.930	1	329	.000
	3	.397[c]	.158	.150	1.62474	.020	7.702	1	328	.006
	4	**.416[d]**	**.173**	**.163**	**1.61226**	**.015**	**6.097**	**1**	**327**	**.014**
	5	.428[e]	.183	.171	1.60508	.010	3.934	1	326	.048
	6	.423[f]	.179	.169	1.60675	-.004	1.680	1	326	.196
	1. Predictors: (Constant), Cogni_closeness									
	2. Predictors: (Constant), Cogni_closeness, Size									
	3. Predictors: (Constant), Cogni_closeness, Size, RD_int									
	4. Predictors: (Constant), Cogni_closeness, Size, RD_int, Inf_int_tot									
	5. Predictors: (Constant), Cogni_closeness, Size, RD_int, Inf_int_tot, UBC_resources									
	6. Predictors: (Constant), Size, RD_int, Inf_int_tot, UBC_resources									
Shared resources	1	.329[a]	.109	.106	1.841	.109	40.183	1	330	.000
	2	.377[b]	.142	.137	1.809	.034	12.945	1	329	.000
	3	**.400[c]**	**.160**	**.153**	**1.792**	**.018**	**7.033**	**1**	**328**	**.008**
	1. Predictors: (Constant), UBC_resources									
	2. Predictors: (Constant), UBC_resources, RD_int									
	3. Predictors: (Constant), UBC_resources, RD_int, Size									

Table 104. (cont.) Specific objective 3: goodness of fit assessment

7.5.4.2. Assessment of residuals and multicollinearity

After assessing the goodness of fit of the models, the quality of the models was ensured by examining residuals. As in the analysis developed for the achievement of the previous *7.4 Specific objective 2,* isolated points for which the model fitted poorly (outliers), and isolated points that exerted an undue influence on the model (leverage points) were assessed. As to assessing isolated points for which the models might fit poorly (outliers), standardised residuals were checked. As for assessing isolated points that might exert an undue influence on the models, influence statistics, i.e. Cook's distance, leverage statistics and DFBeta were checked (For further information, see Sub-section *7.4.3. Assessment of residuals and model fit*). In order to assess the values obtained in each model's standardised residuals, Cook's distance, leverage values and DFBeta, the cut-off values previously applied in Specific objective 2 were used. Drawing on these cut-off values, it was noted that the fourteen models showed adequate values regarding standardised residuals, Cook's distance and DFBeta. Nonetheless, in relation to leverage values some models registered influential points. The process followed for the verification of these cases was as follows. After the identification of the possible leverage points, the possible influential cases were removed from the sample and the multiple linear regression models were re-run to verify whether the removed cases influenced the parameters and fit of the models. When the presence of leverage points exerted an undue influence on the model, it was checked whether these cases showed a pattern in relation to any variable and if there was a robust justification for maintaining them in the sample (i.e. cases with high values on a scale). As Hair *et al.* (1999) and Elorza (2009) indicate, outliers and extreme cases are also representative of the population, thus, maintaining them in the sample increases the generality or ecological validity of the results. However, in those models where neither a pattern nor a justification was found, influential leverage points were removed and the model was re-run. This was the case of the regression models run for curriculum co-design and curriculum co-delivery. Consequently, the sample employed decreased to 320 and 327 cases respectively, and therefore, they were no longer large enough for statistical inference.

In addition to the assessment of residuals, the multicollinearity of each model was assessed. In this way, it was verified whether the values of VIF and tolerance statistics were lower than 10 and 0.1 in each model (Field, 2018). As can be seen in Table 105 below, values achieved by all the models were adequate.

UBC activity	**Variables**	**Collinearity Statistics**	
		Tolerance	**VIF**
Mobility of students	UBC_resources	.863	1.158
	Market_BC	.867	1.153
	RD_int	.907	1.102
	Inf_int_tot	.836	1.196
Curriculum co-design	Size	.986	1.014
	UBC_resources	.986	1.014
Curriculum co-delivery	Inf_int_tot	.881	1.136
	Cogni_closeness	.881	1.136
Dual education	UBC_resources	.632	1.583
	Size	.940	1.064
	Cogni_closeness	.617	1.621
Lifelong learning	UBC_resources	.863	1.158
	Inf_int_tot	.836	1.196
	Market_BC	.867	1.153
	RD_int	.907	1.102
Joint R&D	UBC_resources	.873	1.146
	RD_int	.958	1.044
	Inf_int_tot	.865	1.156
Consultancy	UBC_resources	.868	1.152
	Market_BC	.916	1.092
	Inf_int_tot	.842	1.187
Mobility of staff	UBC_resources	.952	1.050
	RD_int	.941	1.063
	Size	.931	1.074
Student entrepreneurship	Cogni_closeness	.925	1.082
	Market_BC	.872	1.147
	Size	.859	1.165
Academic entrepreneurship	Cogni_closeness	.575	1.738
	RD_int	.887	1.128
	UBC_resources	.631	1.584
Commercialisation	UBC_resources	.952	1.050
	RD_int	.941	1.063
	Size	.931	1.074
Governance	Size	.966	1.035
	UBC_resources	.966	1.035
Support	Cogni_closeness	.794	1.260
	Size	.899	1.113
	RD_int	.869	1.151
	Inf_int_tot	.855	1.170
Shared resources	UBC_resources	.952	1.050
	RD_int	.941	1.063
	Size	.931	1.074

Table 105. Specific objective 3: *Multicollinearity analysis coefficients*

As a result of the verification of the goodness of fit and residuals and multicollinearity of the models, it was observed that the obtained multiple linear regression models were correct for the sample observed.

7.5.4.3. Assumptions of the multiple linear regression

When a multiple linear regression is performed, an equation that is correct for the sample observed is produced. However, for a regression model to be generalised, it is necessary to assess whether the assumptions are met (Field, 2018). For this reason, the following assumptions were assessed for each model.

No perfect multicollinearity: The compliance of this assumption was assessed with the previously described correlation analyses Table 83 and Table 103, and multicollinearity analyses (see Table 105). The assumption was met by all the models.

Homocedasticity: The variance of the residual terms should be constant at each level of the predictor variables. With the aim of verifying this assumption, the residual plot, *ZRESID (Y-axis) against *ZPRED (X-axis) [47] was assessed. As can be seen in Figure 9 - Figure 22, the homocedasticity assumption was not met. Nevertheless, as previously indicated, the bootstrapping technique was employed in the regression models as to achieve more robust estimate parameters and standard errors while avoiding heteroscedasticity problems .

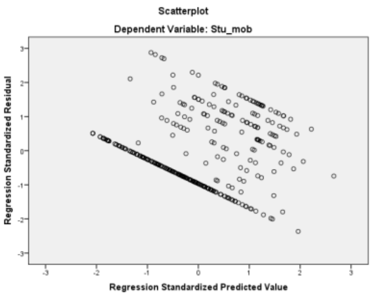

Figure 9. Specific objective 3: Mobility of students, homocedasticity assessment

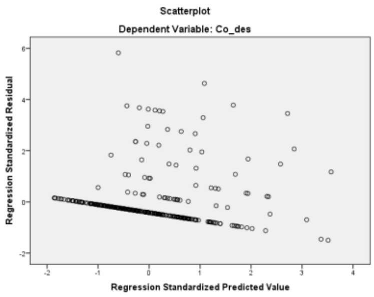

Figure 10. Specific objective 3: Curriculum co-design, homocedasticity assessment

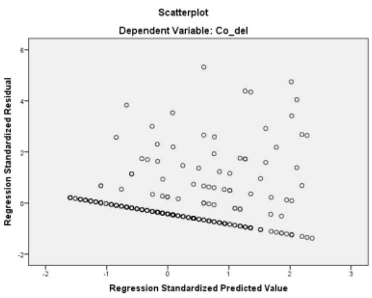

Figure 11. Specific objective 3: Curriculum co-delivery, homocedasticity assessment

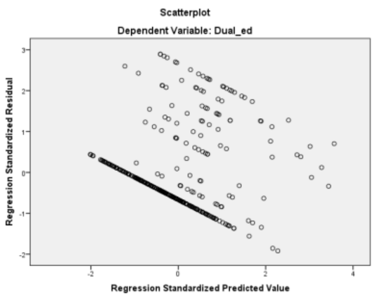

Figure 12. Specific objective 3: Dual education, homocedasticity assessment

[47] *ZRESID (standardised residuals, or errors): are the standardised differences between the observed data and the values that the model predicts). *ZPRED (the standardised predicted values of the dependent variable based on the model). These values are standardised forms of the values predicted by the model.

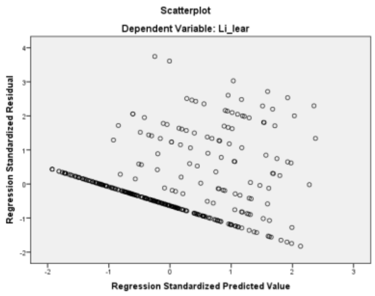

Figure 13. Specific objective 3: Lifelong learning, homocedasticity assessment

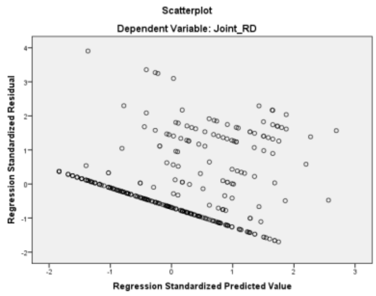

Figure 14. Specific objective 3: Joint R&D, homocedasticity assessment

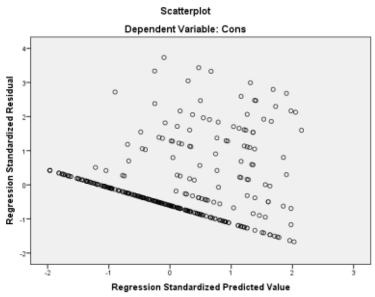

Figure 15. Specific objective 3: Consultancy, homocedasticity assessment

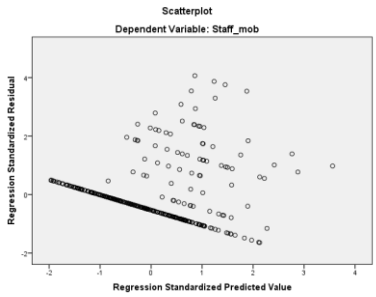

Figure 16. Specific objective 3: Mobility of staff, homocedasticity assessment

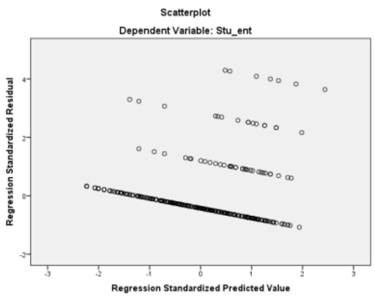

Figure 17. Specific objective 3: Student entrepreneurship, homocedasticity assessment

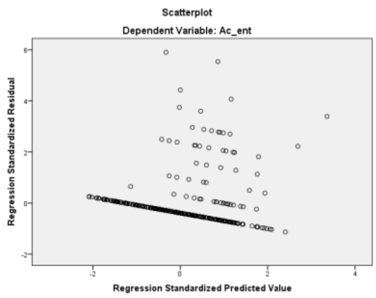

Figure 18. Specific objective 3: Academic entrepreneurship, homocedasticity assessment

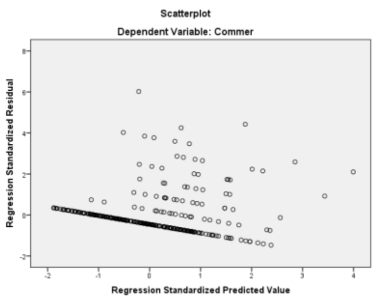

Figure 19. Specific objective 3: Commercialisation, homocedasticity assessment

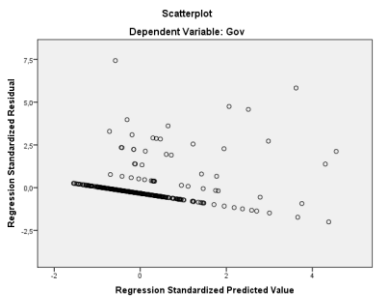

Figure 20. Specific objective 3: Governance, homocedasticity assessment

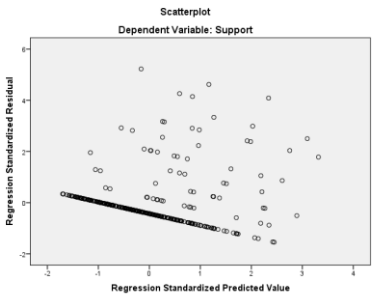

Figure 21. Specific objective 3: Support, homocedasticity assessment

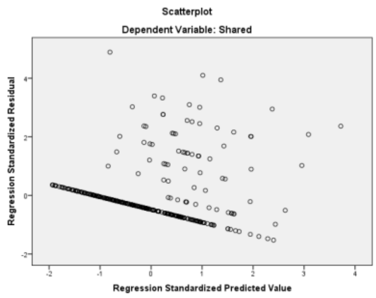

Figure 22. Specific objective 3: Shared resources, homocedasticity assessment

Independent errors: For any two observations the residuals should be uncorrelated (independent). In order to assess independence assumption, the value of the Durbin-Watson statistic was assessed for each model. It was assessed whether the values were close to 2 (and between 1 and 3) (Field, 2018). As can be seen in Table 106, the values achieved by all the models were adequate.

UBC activity	**Durbin-Watson**
Mobility of students	2.175
Curriculum co-design	2.142
Curriculum co-delivery	2.012
Dual education	1.970
Lifelong learning	2.01
Joint R&D	1.76
Consultancy	1.878
Mobility of staff	1.936
Student entrepreneurship	1.725
Academic entrepreneurship	2.039
Commercialisation	1.905
Governance	1.474
Support	2.063
Shared resources	1.896

Table 106. Specific objective 3: *Durbin-Watson*

Normally distributed errors: The residuals in the model should be random and normally distributed with a mean of 0. Histograms with normal plots of the residuals were assessed in order to test the normal distribution of errors. As can be seen in Figure 23-Figure 36, the distribution of the errors in the models did not follow a normal distribution.

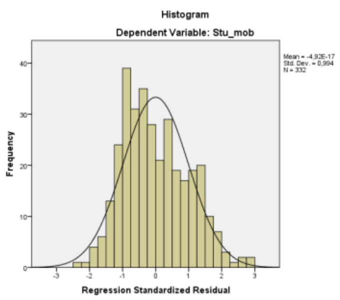

Figure 23. Specific objective 3: Mobility of students, assessment of the normal distribution of errors

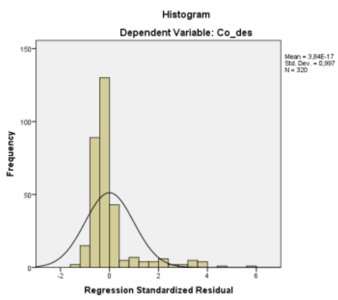

Figure 24. Specific objective 3: Curriculum co-design, assessment of the normal distribution of errors

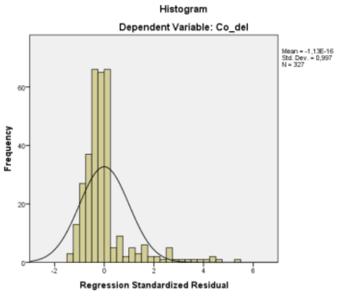

Figure 25. Specific objective 3: Curriculum co-delivery, assessment of the normal distribution of errors

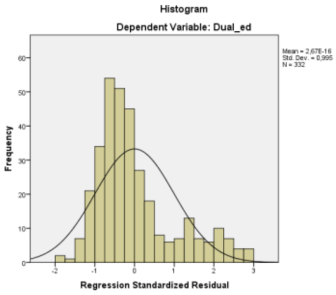

Figure 26. Specific objective 3: Dual education, assessment of the normal distribution of errors

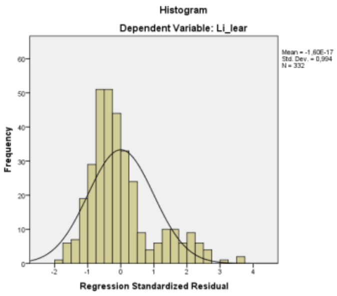

Figure 27. Specific objective 3: Lifelong learning, assessment of the normal distribution of errors

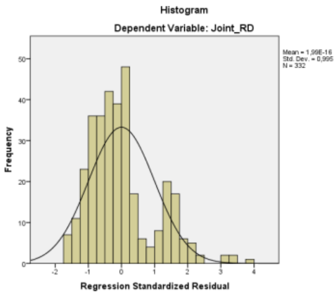

Figure 28. Specific objective 3: Joint R&D, assessment of the normal distribution of errors

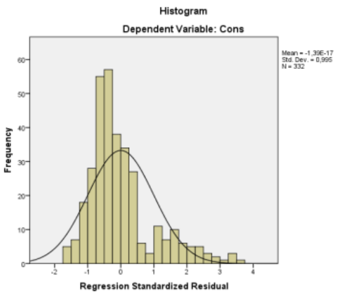

Figure 29. Specific objective 3: Consultancy, assessment of the normal distribution of errors

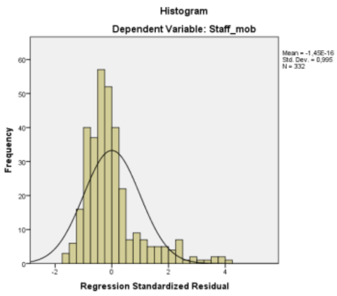

Figure 30. Specific objective 3: Mobility of staff, assessment of the normal distribution of errors

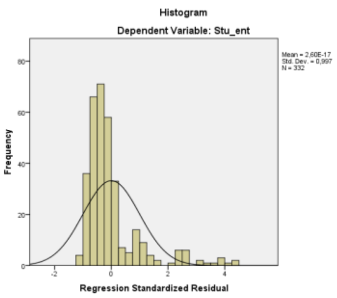

Figure 31. Specific objective 3: Student entrepreneurship, assessment of the normal distribution of errors

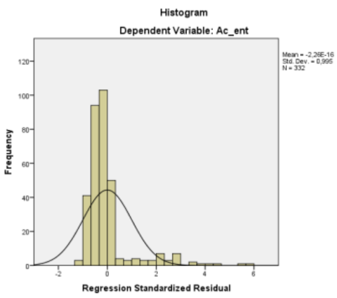

Figure 32. Specific objective 3: Academic entrepreneurship, assessment of the normal distribution of errors

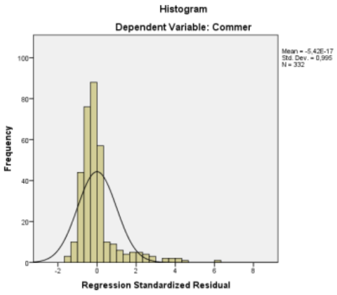

Figure 33. Specific objective 3: Commercialisation, assessment of the normal distribution of errors

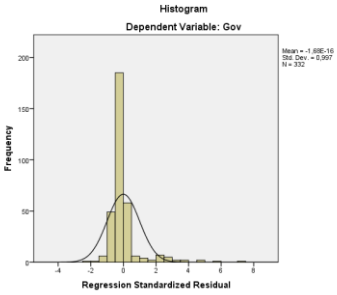

Figure 34. Specific objective 3: Governance, assessment of the normal distribution of errors

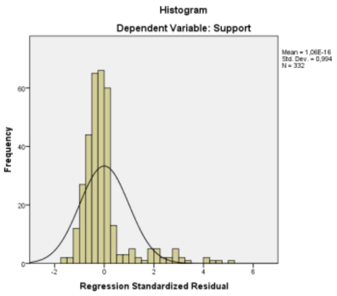

Figure 35. Specific objective 3: Support, assessment of the normal distribution of errors

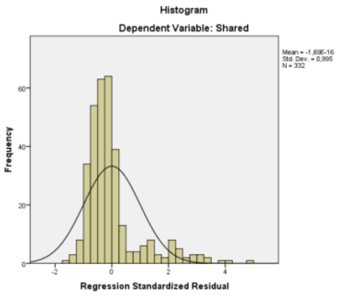

Figure 36. Specific objective 3: Shared resources, assessment of the normal distribution of errors

Linearity: The mean value of the outcome variable for each increment of the predictor should lie along a straight line. In order to test this assumption, the residual plot was checked. As can be seen in Figure 37-Figure 50, the linearity assumption was not met.

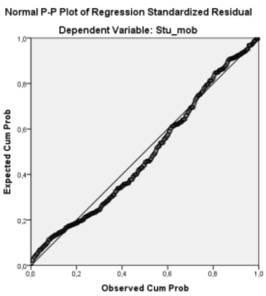

Figure 37. Specific objective 3: Mobility of students, linearity assessment

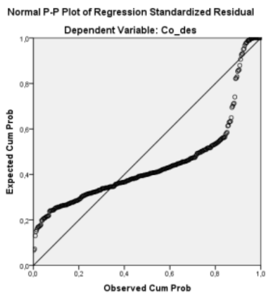

Figure 38. Specific objective 3: Curriculum co-design, linearity assessment

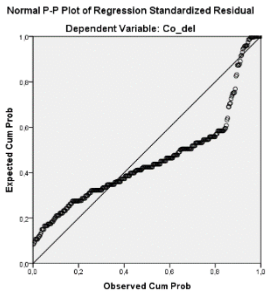

Figure 39. Specific objective 3: Curriculum co-delivery, linearity assessment

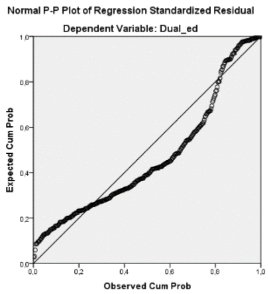

Figure 40. Specific objective 3: Dual education, linearity assessment

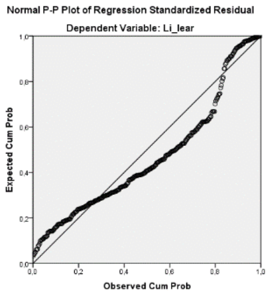

Figure 41. Specific objective 3: Lifelong learning, linearity assessment

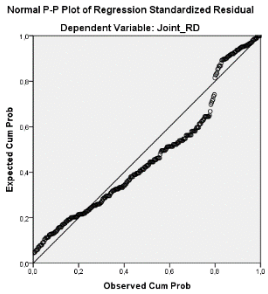

Figure 42. Specific objective 3: Joint R&D, linearity assessment

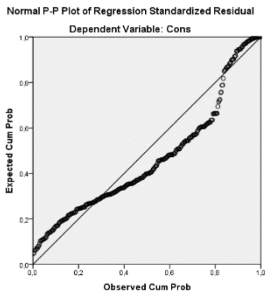

Figure 43. Specific objective 3: Consultancy, linearity assessment

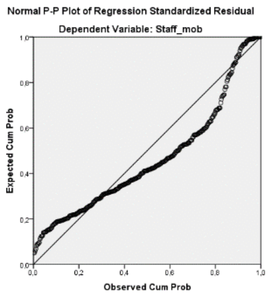

Figure 44. Specific objective 3: Mobility of staff, linearity assessment

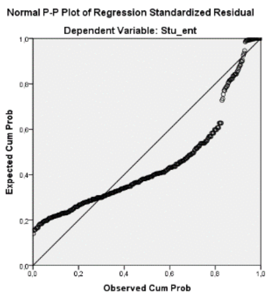

Figure 45. Specific objective 3: Student entrepreneurship, linearity assessment

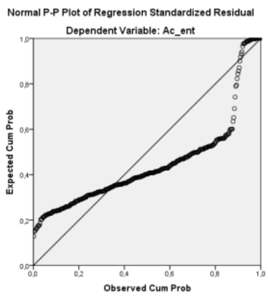

Figure 46. Specific objective 3: Academic entrepreneurship, linearity assessment

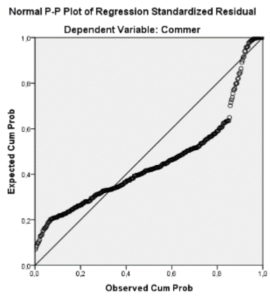

Figure 47. Specific objective 3: Commercialisation, linearity assessment

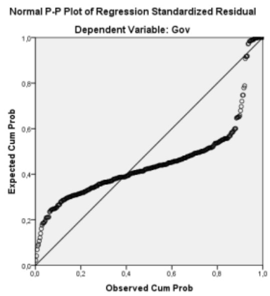

Figure 48. Specific objective 3: Governance, linearity assessment

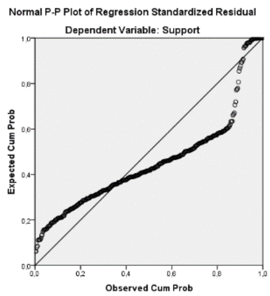

Figure 49. Specific objective 3: Support, linearity assessment

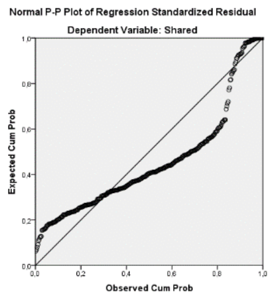

Figure 50. Specific objective 3: Shared resources, linearity assessment

Variable types: Variables must be quantitative or categorical (with two categories), and the outcome variable must be quantitative (measured at the interval level), continuous or unbounded (there should be no constraints on the variability of the outcome). The categorical variables included in the study were coded as a dummy except from the baseline category; accordingly, the assumption was met.

Non-zero variances: The predictor variables should have some variation in value (do not have variances of 0). It was verified that the predictor variables in all the models showed variation.

Predictor are uncorrelated with external variables: This is to say, predictors should not be highly correlated with variables that were not included in the model. Given the exhaustiveness of the literature review, the assumption was considered to be met.

Independence: All the values of the outcome variable should be independent. After data gathering and prior to the analysis, a check was run to ensure it that each value of the outcome variable came from a separate entity.

As a result of the assessment, it was noted that all the assumptions were not met (see Table 107), and consequently, it was not possible to draw statistical inferences.

Assessment of linear regression assumptions	
No perfect multicollinearity	Confirmed
Homocedasticity	Rejected
Independent errors	Confirmed
Normally distributed errors	Rejected
Linearity	Rejected
Variable types	Confirmed
Predictor variables are uncorrelated with external variables	Confirmed
Independence	Confirmed

Table 107. Specific objective 3: assessment of linear regression assumptions

7.5.5. Linear regression models

The following sub-sections describe the results of the 14 linear regression models run in order to (i) explore the impact and (ii) identify the organisational context-related factors that determine manufacturing SMEs' cooperation levels in the diverse UBC activities within the domains of (i) education: mobility of students, curriculum co-design, curriculum co-delivery, dual education programmes and lifelong learning, (ii) research: joint R&D, consultancy and mobility of staff, (iii) valorisation: commercialisation, academic entrepreneurship and student entrepreneurship, and (iv) management: governance, shared resources and support.

7.5.5.1. Mobility of students

As can be seen in Table 108, the final model (Nº4) showed that manufacturing SMEs' cooperation levels in mobility of students were positively related to *UBC_resources* ($p < .001$), *RD_int* ($p < .01$), *Inf_int_tot* ($p < .05$) and negatively related to *Market_BC* ($p < .001$).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.070	.418		-.167	.868	-.893	.753
	UBC_resources	.754	.076	.479	9.919	.000	.604	.904
2	(Constant)	1.983	.531		3.732	.000	.938	3.028
	UBC_resources	.666	.074	.423	8.998	.000	.520	.812
	Market_BC	-.265	.045	-.275	-5.847	.000	-.354	-.176
3	(Constant)	1.346	.555		2.424	.016	.254	2.439
	UBC_resources	.640	.073	.407	8.736	.000	.496	.784
	Market_BC	-.225	.046	-.234	-4.888	.000	-.316	-.134
	RD_int	.690	.202	.162	3.410	.001	.292	1.088
4	(Constant)	1.206	.553		2.180	.030	.118	2.294
	UBC_resources	.581	.076	**.369**	7.635	**.000**	.431	.731
	Market_BC	-.203	.046	**-.211**	-4.368	**.000**	-.294	-.112
	RD_int	.645	.201	**.151**	3.202	**.001**	.249	1.041
	Inf_int_tot	.431	.167	**.127**	2.580	**.010**	.103	.760

Table 108. Specific objective 3:Mobility of students, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
4	(Constant)	1.206	-.006	.497	.015	.292	2.139
	Market_BC	-.203	.001	.046	.001	-.289	-.114
	Inf_int_tot	.431	.004	.174	.016	.102	.781
	RD_int	.645	.017	.217	.002	.271	1.139
	UBC_resources	.581	-.004	.076	.001	.425	.727

a. Unless otherwise noted. bootstrap results are based on 1000 bootstrap samples

Table 109. Specific objective 3:Mobility of students, linear regression model, bootstrap

7.5.5.2. Curriculum co-design

With regard to curriculum co-design, the final model (Nº2) (see Table 110) showed that manufacturing SMEs' cooperation levels were positively related to *Size* (p < .001) and *UBC_resources* (p < .001).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.174	.139		8.425	.000	.900	1.448
	Size	.012	.003	.222	4.053	.000	.006	.018
2	(Constant)	.521	.225		2.311	.021	.077	.965
	Size	.011	.003	**.198**	3.670	**.000**	.005	.017
	UBC_resources	.140	.038	**.197**	3.640	**.000**	.064	.215

Table 110. Specific objective 3:Curriculum co-design, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
2	(Constant)	.521	.005	.180	.004	.154	.856
	Size	.011	.000	.004	.005	.004	.018
	UBC_resources	.140	-8.581E-5	.031	.001	.083	.205
a. Unless otherwise noted. bootstrap results are based on 1000 bootstrap samples							

Table 111. Specific objective 3:Curriculum co-design, linear regression model, bootstrapp

7.5.5.3. Curriculum co-delivery

As regards curriculum co-delivery (see Table 112), the final model (Nº2) showed that manufacturing SMEs' cooperation levels were positively related to *Inf_int_tot* (p < .001) and *Cogni_closeness* (p < .001).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.236	.107		11.555	.000	1.025	1.446
	Inf_int_tot	.515	.083	.326	6.210	.000	.352	.678
2	(Constant)	.527	.226		2.332	.020	.083	.972
	Inf_int_tot	.409	.087	**.258**	4.706	**.000**	.238	.580
	Cogni_closeness	.152	.043	**.195**	3.542	**.000**	.067	.236

Table 112. Specific objective 3:Curriculum co-delivery, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
2	(Constant)	.527	-.001	.184	.004	.121	.864
	Inf_int_tot	.409	-.003	.113	.001	.193	.627
	Cogni_closeness	.152	.000	.042	.001	.070	.243
a. Unless otherwise noted. bootstrap results are based on 1000 bootstrap samples							

Table 113. Specific objective 3:Curriculum co-delivery, linear regression model, bootstrapp

7.5.5.4. Dual education

As to dual education, the final model (Nº3) (see Table 114) showed that manufacturing SMEs' cooperation levels were positively related to *UBC_resources* ($p < .001$), *Size* ($p < .001$) and *Cogni_closeness* ($p < .01$).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.147	.392		.374	.709	-.624	.917
	UBC_resources	.526	.071	.377	7.388	.000	.386	.666
2	(Constant)	-.374	.387		-.964	.336	-1.136	.388
	UBC_resources	.456	.069	.326	6.559	.000	.319	.592
	Size	.021	.004	.273	5.493	.000	.014	.029
3	(Constant)	-.959	.432		-2.220	.027	-1.809	-.109
	UBC_resources	.309	.085	**.221**	3.642	**.000**	.142	.476
	Size	.019	.004	**.249**	5.005	**.000**	.012	.027
	Cogni_closeness	.267	.091	**.180**	2.932	**.004**	.088	.447

Table 114. Specific objective 3: Dual education, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
3	(Constant)	-.959	-.009	.326	.003	-1.617	-.295
	Size	.019	.000	.004	.001	.012	.028
	UBC_resources	.309	-.001	.086	.001	.140	.483
	Cogni_closeness	.267	.001	.093	.002	.083	.449
a. Unless otherwise noted. bootstrap results are based on 1000 bootstrap samples							

Table 115. Specific objective 3: Dual education, linear regression model, bootstrapp

7.5.5.5. Lifelong learning

As can be seen in Table 116, the final model (Nº4) showed that manufacturing SMEs' cooperation levels in mobility of students were positively related to *UBC_resources* ($p < .001$), *Inf_int_tot* ($p < .001$), *RD_int* ($p < .05$), and negatively related to *Market_BC* ($p < .01$).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.358	.311		1.154	.249	-.253	.969
	UBC_resources	.395	.056	.360	7.001	.000	.284	.506
2	(Constant)	.373	.300		1.242	.215	-.218	.964
	UBC_resources	.297	.058	.270	5.113	.000	.183	.412
	Inf_int_tot	.615	.126	.259	4.896	.000	.368	.862
3	(Constant)	1.426	.395		3.611	.000	.649	2.203
	UBC_resources	.269	.057	.245	4.691	.000	.156	.382
	Inf_int_tot	.509	.126	.214	4.049	.000	.262	.756
	Market_BC	-.136	.034	-.203	-3.991	.000	-.203	-.069
4	(Constant)	1.110	.415		2.676	.008	.294	1.926
	UBC_resources	.259	.057	**.236**	4.539	**.000**	.147	.371
	Inf_int_tot	.483	.125	**.204**	3.858	**.000**	.237	.730
	Market_BC	-.117	.035	**-.174**	-3.368	**.001**	-.186	-.049
	RD_int	.354	.151	**.119**	2.346	**.020**	.057	.651
5	(Constant)	.834	.436		1.912	.057	-.024	1.692
	UBC_resources	.251	.057	.228	4.402	.000	.139	.363
	Inf_int_tot	.453	.126	.191	3.602	.000	.205	.700
	Market_BC	-.100	.036	-.148	-2.781	.006	-.170	-.029
	RD_int	.321	.151	.108	2.121	.035	.023	.618
	Size	.006	.003	.103	1.976	.049	.000	.013

Table 116. Specific objective 3: Lifelong learning, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
4	(Constant)	1.110	.011	.350	.003	.414	1.779
	UBC_resources	.259	-.002	.053	.001	.155	.360
	Inf_int_tot	.483	.002	.147	.003	.215	.777
	Market_BC	-.117	-4.418E-5	.033	.003	-.185	-.051
	RD_int	.354	.005	.152	.024	.073	.683

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 117. Specific objective 3: Lifelong learning, linear regression model, bootstrapp

7.5.5.6. Joint R&D

With regard to Joint R&D, the final model (Nº3) (see Table 118) showed that manufacturing SMEs' cooperation levels in joint R&D were positively related to *UBC_resources* ($p < .001$), *Inf_int_tot* ($p < .001$) and *RD_int* ($p < .001$).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.019	.340		.055	.956	-.651	.688
	UBC_resources	.517	.062	.418	8.356	.000	.395	.639
2	(Constant)	-.327	.341		-.961	.337	-.998	.343
	UBC_resources	.476	.061	.385	7.805	.000	.356	.596
	RD_int	.724	.165	.216	4.378	.000	.399	1.049
3	(Constant)	-.276	.335		-.826	.409	-.935	.382
	UBC_resources	.400	.063	**.323**	6.319	**.000**	.275	.524
	RD_int	.642	.164	**.191**	3.921	**.000**	.320	.964
	Inf_int_tot	.506	.137	**.189**	3.682	**.000**	.235	.776
4	(Constant)	.358	.460		.778	.437	-.547	1.264
	UBC_resources	.387	.063	.313	6.106	.000	.262	.511
	RD_int	.565	.168	.168	3.371	.001	.235	.894
	Inf_int_tot	.454	.139	.170	3.266	.001	.181	.728
	Market_BC	-.077	.039	-.102	-1.998	.047	-.153	-.001

Table 118. Specific objective 3: Joint R&D, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
3	(Constant)	-.276	.009	.270	.307	-.796	.262
	UBC_resources	.400	-.004	.066	.001	.271	.532
	RD_int	.642	.014	.180	.002	.316	1.033
	Inf_int_tot	.506	-.002	.162	.002	.196	.837

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 119. Specific objective 3: Joint R&D, linear regression model, bootstrapp

7.5.5.7. Consultancy

As can be seen in Table 120, the final model (Nº3) showed that manufacturing SMEs' cooperation levels in consultancy were positively related to *UBC_resources* ($p < .001$) and *Inf_int_tot* ($p < .01$), and negatively to Market_BC ($p < .01$).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.132	.299		.442	.659	-.456	.720
	UBC_resources	.424	.054	.395	7.814	.000	.318	.531
2	(Constant)	1.154	.390		2.962	.003	.388	1.921
	UBC_resources	.381	.054	.354	7.012	.000	.274	.487
	Market_BC	-.132	.033	-.201	-3.970	.000	-.197	-.066
3	(Constant)	.994	.388		2.561	.011	.231	1.758
	UBC_resources	.327	.056	**.305**	5.812	**.000**	.217	.438
	Market_BC	-.110	.034	**-.167**	-3.280	**.001**	-.176	-.044
	Inf_int_tot	.380	.124	**.164**	3.074	**.002**	.137	.623
4	(Constant)	.664	.415		1.600	.111	-.152	1.481
	UBC_resources	.317	.056	.296	5.649	.000	.207	.428
	Market_BC	-.089	.035	-.135	-2.563	.011	-.157	-.021
	Inf_int_tot	.344	.124	.148	2.776	.006	.100	.588
	Size	.007	.003	.114	2.170	.031	.001	.013

Table 120. Specific objective 3:Consultancy, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	.994	-.029	.357	.006	.268	1.665
	UBC_resources	.327	.002	.058	.001	.224	.454
	Market_BC	-.110	.002	.034	.002	-.173	-.043
	Inf_int_tot	.380	-.002	.144	.011	.103	.677

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 121. Specific objective 3:Consultancy, linear regression model, bootstrapp

7.5.5.8. Mobility of staff

With regard to mobility of staff, the final model (Nº3) (see Table 122) showed that manufacturing SMEs' cooperation levels were positively related to *UBC_resources* ($p < .001$), *RD_int* ($p < .01$), and *Size* ($p < .01$).

Model		Unstandardised Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.114	.253		.451	.652	-.384	.612
	UBC_resources	.364	.046	.399	7.904	.000	.273	.454
2	(Constant)	-.122	.255		-.479	.633	-.623	.379
	UBC_resources	.336	.046	.368	7.368	.000	.246	.425
	RD_int	.494	.124	.200	3.996	.000	.251	.737
3	(Constant)	-.259	.257		-1.006	.315	-.766	.247
	UBC_resources	.316	.046	**.347**	6.924	**.000**	.227	.406
	RD_int	.431	.125	**.174**	3.456	**.001**	.186	.676
	Size	.007	.003	**.135**	2.655	**.008**	.002	.012

Table 122. Specific objective 3: Mobility of staff, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	-.259	.001	.190	.172	-.659	.126
	Size	.007	.000	.003	.036	.001	.013
	RD_int	.431	.004	.125	.001	.190	.688
	UBC_resources	.316	-.002	.049	.001	.222	.411
a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples							

Table 123. Specific objective 3: Mobility of staff, linear regression model, bootstrapp

7.5.5.9. Student entrepreneurship

As can be seen in Table 124 the final model (Nº2) showed that manufacturing SMEs' cooperation levels in student entrepreneurship were positively related to *Cogni_closeness* ($p < .001$), and negatively related to *Market_BC* ($p < .01$).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.831	.093		8.915	.000	.648	1.014
	Cogni_closeness	.082	.017	.264	4.973	.000	.050	.115
2	(Constant)	1.095	.119		9.173	.000	.860	1.329
	Cogni_closeness	.070	.017	**.226**	4.230	**.000**	.038	.103
	Market_BC	-.033	.010	**-.184**	-3.453	**.001**	-.052	-.014
3	(Constant)	1.009	.125		8.064	.000	.763	1.255
	Cogni_closeness	.064	.017	.204	3.783	.000	.031	.097
	Market_BC	-.027	.010	-.149	-2.671	.008	-.046	-.007
	Size	.002	.001	.121	2.151	.032	.000	.004

Table 124. Specific objective 3: Student entrepreneurship, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
2	(Constant)	1.095	.000	.080	.001	.939	1.266
	Market_BC	-.033	.000	.009	.001	-.051	-.015
	Cogni_closeness	.070	.000	.015	.001	.041	.099
a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples							

Table 125. Specific objective 3: Student entrepreneurship, linear regression model, bootstrapp

7.5.5.10.Academic entrepreneurship

With regard to academic entrepreneurship, the final model (Nº3) (see Table 126) showed that manufacturing SMEs' cooperation levels were positively related to *RD_int* ($p < .05$) and *UBC_resources* ($p < .05$).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.644	.220		2.929	.004	.211	1.076
	Cogni_closeness	.176	.039	.241	4.511	.000	.099	.253
2	(Constant)	.622	.218		2.847	.005	.192	1.052
	Cogni_closeness	.143	.041	.195	3.478	.001	.062	.224
	RD_int	.256	.105	.137	2.442	.015	.050	.463
3	(Constant)	.457	.231		1.981	.048	.003	.911
	Cogni_closeness	.078	.051	.107	1.544	.124	-.021	.178
	RD_int	.270	.105	**.145**	2.582	**.010**	.064	.476
	UBC_resources	.097	.046	**.142**	2.132	**.034**	.008	.187
4	(Constant)	.619	.206		3.004	.003	.213	1.024
	RD_int	.319	.100	.171	3.194	.002	.123	.516
	UBC_resources	.139	.037	.202	3.785	.000	.067	.212
5	(Constant)	.529	.209		2.532	.012	.118	.941
	RD_int	.278	.101	.149	2.749	.006	.079	.477
	UBC_resources	.127	.037	.184	3.422	.001	.054	.200
	Size	.004	.002	.116	2.125	.034	.000	.009

Table 126. Specific objective 3: Academic entrepreneurship, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
3	(Constant)	.457	.013	.146	.003	.171	.754
	Cogni_closeness	.078	-.003	.056	.172	-.030	.188
	RD_int	.270	.000	.136	.048	.022	.532
	UBC_resources	.097	.000	.047	.043	.004	.191

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 127. Specific objective 3: Academic entrepreneurship, linear regression model, bootstrapp

7.5.5.11.Commercialisation

As can be seen in Table 128, the final model (Nº3) showed that manufacturing SMEs' cooperation levels in commercialisation were positively related to *UBC_resources* (p < .001), *RD_int* (p < .001) and *Size* (p < .05).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.599	.201		2.985	.003	.204	.993
	UBC_resources	.207	.036	.298	5.671	.000	.135	.278
2	(Constant)	.398	.201		1.981	.048	.003	.793
	UBC_resources	.183	.036	.264	5.085	.000	.112	.253
	RD_int	.420	.097	.223	4.307	.000	.228	.612
3	(Constant)	.292	.203		1.435	.152	-.108	.692
	UBC_resources	.168	.036	**.242**	4.655	**.000**	.097	.239
	RD_int	.371	.098	**.197**	3.771	**.000**	.178	.565
	Size	.005	.002	**.137**	2.605	**.010**	.001	.009

Table 128. Specific objective 3: Commercialisation, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	.292	.005	.162	.079	-.009	.618
	UBC_resources	.168	.000	.030	.001	.111	.227
	RD_int	.371	.001	.115	.002	.164	.610
	Size	.005	-1.666E-5	.003	.048	.001	.011

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 129. Specific objective 3: Commercialisation, linear regression model, bootstrapp

7.5.5.12.Governance

As to governance, the final model (Nº2) (see Table 130) showed that manufacturing SMEs' cooperation levels were positively related to *Size* (p < .001) and *UBC_resources* (p < .01).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.990	.096		10.292	.000	.801	1.180
	Size	.010	.002	.309	5.897	.000	.007	.013
2	(Constant)	.502	.169		2.970	.003	.169	.834
	Size	.009	.002	**.275**	5.248	**.000**	.006	.012
	UBC_resources	.106	.030	**.183**	3.488	**.001**	.046	.165
3	(Constant)	.426	.171		2.495	.013	.090	.762
	Size	.008	.002	.251	4.734	.000	.005	.011
	UBC_resources	.097	.030	.168	3.201	.002	.037	.157
	RD_int	.198	.083	.126	2.399	.017	.036	.361

Table 130. Specific objective 3: Governance, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	.502	.004	.167	.006	.165	.839
	Size	.009	-5.512E-6	.003	.015	.003	.015
	UBC_resources	.106	-.001	.024	.001	.060	.152

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 131. Specific objective 3: Governance, linear regression model, bootstrapp

7.5.5.13.Support

As can be seen in Table 132, the final model (Nº4) showed that manufacturing SMEs' cooperation levels in support were positively related to *Cogni_closeness* (p < .01), *Size* (p < .001), *RD_int* (p < .01) and *Inf_int_tot* (p < .05).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.370	.252		1.471	.142	-.125	.865
	Cogni_closeness	.253	.045	.298	5.664	.000	.165	.341
2	(Constant)	.192	.248		.775	.439	-.296	.681
	Cogni_closeness	.206	.045	.243	4.606	.000	.118	.295
	Size	.010	.002	.229	4.351	.000	.006	.015
3	(Constant)	.181	.246		.736	.463	-.303	.665
	Cogni_closeness	.168	.046	.198	3.624	.000	.077	.260
	Size	.009	.002	.208	3.944	.000	.005	.014
	RD_int	.327	.118	.151	2.775	.006	.095	.560
4	(Constant)	.222	.245		.909	.364	-.259	.704
	Cogni_closeness	.135	.048	**.159**	2.819	**.005**	.041	.230
	Size	.008	.002	**.187**	3.523	**.000**	.004	.013
	RD_int	.313	.117	**.144**	2.670	**.008**	.082	.544
	Inf_Int_Tot	.233	.094	**.134**	2.469	**.014**	.047	.418
5	(Constant)	.048	.259		.187	.852	-.461	.558
	Cogni_closeness	.074	.057	.087	1.296	.196	-.038	.186
	Size	.008	.002	.183	3.472	.001	.004	.013
	RD_int	.332	.117	.153	2.833	.005	.101	.562
	Inf_int_tot	.198	.095	.115	2.081	.038	.011	.386
	UBC_resources	.102	.051	.127	1.983	.048	.001	.203
6	(Constant)	.197	.233		.846	.398	-.261	.654
	Size	.008	.002	.190	3.600	.000	.004	.013
	RD_int	.373	.113	.171	3.301	.001	.151	.595
	Inf_int_tot	.215	.095	.124	2.269	.024	.029	.401
	UBC_resources	.138	.043	.173	3.202	.001	.053	.223

Table 132. Specific objective 3: Support, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	.222	.002	.195	.256	-.176	.580
	Cogni_closeness	.135	.001	.046	.005	.055	.232
	Size	.008	.000	.003	.016	.001	.015
	RD_int	.313	.004	.136	.020	.075	.604
	Inf_int_tot	.233	.002	.110	.037	.027	.453
a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples							

Table 133. Specific objective 3: Support, linear regression model, bootstrapp)

7.5.5.14.Shared resources

As to shared resources, the final model (Nº3) (see Table 134) showed that manufacturing SMEs' cooperation levels were positively related to *UBC_resources* ($p < .001$), *RD_int* ($p < .01$) and *Size* ($p < .01$).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.393	.253		1.552	.122	-.105	.891
	UBC_resources	.292	.046	.329	6.339	.000	.201	.382
2	(Constant)	.179	.256		.702	.483	-.324	.682
	UBC_resources	.266	.046	.301	5.820	.000	.176	.356
	RD_int	.446	.124	.186	3.598	.000	.202	.691
3	(Constant)	.042	.259		.161	.872	-.467	.551
	UBC_resources	.247	.046	**.279**	5.382	**.000**	.157	.337
	RD_int	.383	.125	**.160**	3.061	**.002**	.137	.630
	Size	.007	.003	**.139**	2.652	**.008**	.002	.012

Table 134. Specific objective 3: Shared resources, linear regression model

Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	.042	.002	.212	.845	-.388	.479
	UBC_resources	.247	-.001	.045	.001	.164	.336
	RD_int	.383	.006	.134	.004	.130	.658
	Size	.007	7.648E-6	.003	.039	.001	.014
a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples							

Table 135. Specific objective 3: Shared resources, linear regression model, bootstrapp

7.5.5.15.Determinants of manufacturing SMEs' cooperation levels

Table 136 below summarises the variables identified as determinants of manufacturing SMEs' cooperation levels in the diverse UBC activities classified within the domains of education (mobility of students, curriculum co-design, curriculum co-delivery, dual education and lifelong learning), research (joint R&D, consultancy and staff mobility), valorisation (commercialisation, academic entrepreneurship and student entrepreneurship), and management (governance, shared resources and support).

As can be seen in Table 136, *Size*, *Exports*, *Inf_int_tot*, *RD_int*, *UBC_resources* and Cogni_closeness were the variables for which statistical significance was found.

	Education					Research			Valorisation			Management		
	Stu_mob	**Co_des**	**Co_del**	**Dual_ed**	**Li_learn**	**Joint_RD**	**Cons**	**Staff_mob**	**Commer**	**Stu_ent**	**Ac_ent**	**Gov**	**Shared_res**	**Support**
Business_group														
Size		.20*		.25*				.14**	.14***			.28*	.14**	.19*
Market_BC	-.21*				-.17**		-.17**			-.18**				
Tech_scale														
HD_emp														
Female														
Clus_yes_no														
Inf_int_tot	.13***		.26*		.20*	.19*	.17**							.13***
LLL_coop_tot														
RD_int	.15**				.12***	.19*		.17**	.20*		.15***		.16**	.14**
IC														
ID														
UBC_resources	.37*	.20*		.22*	.24*	.32*	.31*	.35*	.24*		.14***	.18**	.28*	
Cogni_closeness			.20*	.18**						.23*				.16**
UBC_beliefs						.								
Note: * *p* < .001, ***p* < .01, *p* <.05***														

Table 136. Variables identified as determinants of manufacturing SMEs' cooperation levels in diverse UBC activities within the domains of education, research, valorisation and management

7.5.6. Summary

With the aim of addressing Specific objective 3, i.e. identify the organisational context-related factors that determine manufacturing SMEs' cooperation levels in UBC activities, fourteen multiple linear regression models were run (one per each UBC activity). This specific objective sought, on the one hand, to explore the impact of the organisational context-related factors on manufacturing SMEs' cooperation levels in the diverse UBC activities within the domains of (i) education: mobility of students, curriculum co-design, curriculum co-delivery, dual education programmes and lifelong learning, (ii) research: joint R&D, consultancy and mobility of staff, (iii) valorisation: commercialisation, academic entrepreneurship and student entrepreneurship, and (iv) management: governance, shared resources and support. On the other hand, it aimed to identify the determining factors from a holistic perspective.

7.6. Specific objective 4

Last but not least, the analysis necessary for the achievement of Specific objective 4 was performed. Specific objective 4 sought to clarify the role of AC on manufacturing SMEs' cooperation levels in the 14 diverse UBC activities identified by Davey *et al.* (2018) in the domains of (i) education, (ii) research, (iii) valorisation, and (iv) management. Furthermore, this objective sought to analyse and compare the influence of AC, operationalised as (i) R&D intensity and as (ii) a construct based on businesses' routines and internal processes with regard to external knowledge, differentiating potential (PAC) and realised absorptive capacity (RAC). In order to attain Specific objective 4 and based on the literature review, the following three hypotheses were defined:

- **Hypothesis 1:** PAC has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities.
- **Hypothesis 2:** RAC has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities.
- **Hypothesis 3:** R&D intensity has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities.

These hypotheses were applied to the 14 UBC activities, and accordingly, a total of 42 hypotheses were defined (three for each of the activities). Table 137 below summarises the hypotheses defined.

Specific objective 4: Clarify the role of AC on manufacturing SMEs' cooperation levels in UBC activities				
Domain	**UBC activity**	**H1: PAC has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities.**	**H2: RAC has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities.**	**H3: R&D intensity has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities.**
Education	Mobility of students	H1a	H2a	H3a
	Curriculum co-design	H1b	H2b	H3b
	Curriculum co-delivery	H1c	H2c	H3c
	Dual education	H1d	H2d	H3d
	Lifelong learning	H1e	H2e	H3e
Research	Joint R&D	H1f	H2f	H3f
	Consultancy	H1g	H2g	H3g
	Mobility of staff	H1h	H2h	H3h
Valorisation	Commercialisation	H1i	H2i	H3i
	Academic entrepreneurship	H1j	H2j	H3j
	Student entrepreneurship	H1k	H2k	H3k
Management	Governance	H1l	H2l	H3l
	Shared resources	H1m	H2m	H3m
	Support	H1n	H2n	H3n

Table 137. Specific objective 4: summary of hypotheses: H1, H2 and H3

Given the explanatory purpose of Specific objective 4 and the fact that PAC and RAC, the variables of interest, were latent constructs, the hypotheses were tested by using an Structural Equation Modelling (SEM) approach, making use of MPlus statistical modelling program. For this purpose, 14 models were tested, one for each UBC activity. The composite models were identical, with only the UBC activity variable varying (see Figure 51).

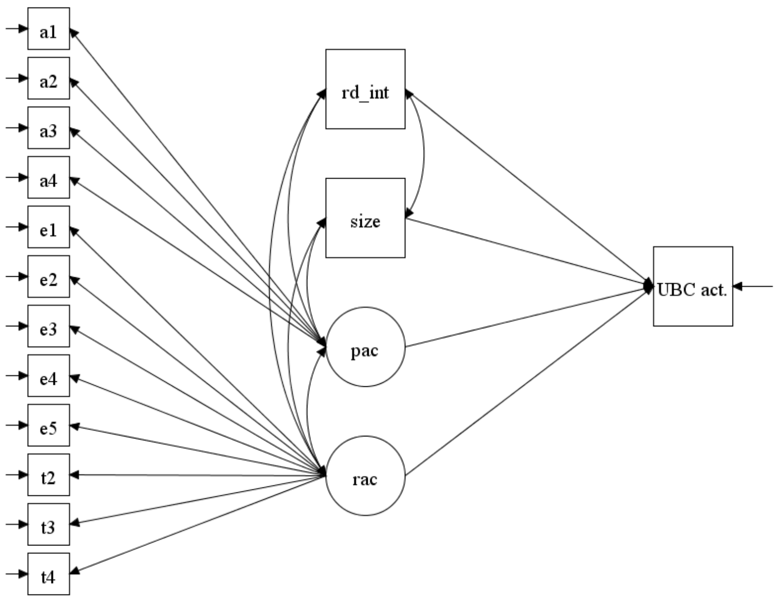

Figure 51. Specific objective 4: general composite model

With regard to the models, it should be noted that based on the results obtained in *7.5 Specific objective 3*, *Size* variable was included as a control variable. The results of Specific objective 3 showed that both *R&D intensity* and *Size* were determinants of manufacturing SMEs' cooperation levels in some UBC activities (For further information, see Sub-section *7.5.5 Linear regression models*).

7.6.1. Structural equation modelling (SEM)

SEM is a multivariate causal inference method (Pearl, 2012) that allows the study of the relationship between latent and observed variables (Manzano Patiño, 2017). Covariance is its basic statistic and has two main goals (i) to understand patterns of covariances among a set of observed variables and (ii) to explain as much of their variance as possible with tested models (Kline, 2016). As with other statistical techniques, the quality of the outputs in SEM depends on the validity of the theory and the appropriateness of latent constructs (Hayduk *et al.*, 2007).

Whilst other general linear models only represent latent constructs with a unique measure and without measurement error, SEM enables the use of multiple measures to represent constructs and addresses the issue of measure-specific error. The classical test-theory perspective indicates that variance of any observed measure consists of true scores and error. Reliable measures have less error and are considered a better measure of the underlying construct than are unreliable measures. This assumption is reflected in SEM when modelling error variance for dependent variables. The assumption is that dependent variables have some variance unexplained by the latent variable, thus error variance must also be modelled (Weston and Gore, 2006).

The term structural equation modelling (SEM) does not only refer to a single statistical technique but rather to a family of related procedures (Kline, 2016). SEM can be understood as a hybrid of factor analysis and path analysis. On the one hand, SEM's aim is similar to that of factor analysis, to obtain a parsimonious summary of the interrelationships among variables (Kahn, 2006). On the other hand, SEM's goal is also similar to that of path analysis, as researchers can test hypothesised relationships between constructs (Weston and Gore, 2006). Understanding SEM as a combination of factor analysis and path analysis prepares the researcher to think about the two main components of SEM, (i) the measurement model[48] and (ii) the structural model. First, the measurement model defines the relationship between observed variables (e.g. scales) and the constructs whose variables are hypothesised to measure. Second, the structural model defines the interrelationships among constructs. When both models are considered together, the model may be called the composite or full structural model (Weston and Gore, 2006).

7.6.2. Data assessment and estimator selection

Prior to model and hypothesis testing, it was necessary to address some issues related to data (i) missing data, (ii) multivariate normality and estimator selection, (iii) sample size and (iv) multicollinearity. With

[48] As Hoyle (1995) indicates, a model is a statistical statement, expressed with equations or diagrams, about the hypothesised relationships among variables.

regard to missing data, as was previously noted in Sub-section *6.1.3 Missing data*, since all the questions in the survey were mandatory, no missing data was found. Thus, it was not necessary to apply any procedure to handle this. Regarding multivariate normal distribution, a key issue in SEM, as previously indicated (see Sub-section *6.1.2 Multivariate normality*), the study did not meet the assumption. Accordingly, it was necessary to make use of a robust estimator which did not assume multivariate normality (Kline, 2016). Drawing on the recommendations of Maydeu-Olivares (2017) for continuous endogenous variables and non-normality, the maximum likelihood (ML) estimation with robust standard errors and a mean- and variance adjusted test statistic (MLMV) estimator was used. This estimator is based on ML, with robust errors to non-normality and chi-square adjusted by its mean and asymptotic variance described by Satorra and Bentler (1994) (Maydeu-Olivares, 2017). In relation to the sample size, as outlined in previous chapters (see *5.5.3 Sample design, selection and size*) a median sample size of 200 cases is required to perform SEM when data meets multivariate normal distribution (MacCallum and Austin, 2000; Boomsma and Hoogland, 2001; Shah and Goldstein, 2006; Weston and Gore, 2006; Kline, 2016). In the case of the present study, where the assumption of normality was not met, a minimum sample size of 200 cases remained being valid since this size was adequate for the MLMV estimator (Maydeu-Olivares, 2017). This minimum sample size was met with the sample available (332 cases). Finally, as in Specific objective 2 and Specific objective 3, multicollinearity was assessed (For further information, see *7.4.3 Assessment of residuals and model fit)*. In the case of SEM, since researchers use related measures as indicators of a construct, sometimes, these measures are too highly related for certain statistical operations to function properly, and may involve a multicollinearity problem (Weston and Gore, 2006). Drawing on Kline (2016), it was verified whether bivariate correlations among predictor variables were below r=*.85*. As can be seen in the results of the bivariate correlation analyses (see Table 138 and Table 139), bivariate correlations were below .85.

					AC1_A1	AC1_A2	AC1_A3	AC1_A4
AC1_A1	Pearson Correlation				1	.592**	.548**	.441**
	Sig. (2-tailed)					.000	.000	.000
	N				332	332	332	332
	Bootstrap[b]	Bias			0	-.001	.001	.000
		Std. Error			0	.049	.055	.055
		95% Confidence Interval	Lower		1	.482	.436	.329
			Upper		1	.687	.653	.546
AC1_A2	Pearson Correlation				.592**	1	.527**	.502**
	Sig. (2-tailed)				.000		.000	.000
	N				332	332	332	332
	Bootstrap[b]	Bias			-.001	0	.000	.000
		Std. Error			.049	0	.049	.052
		95% Confidence Interval	Lower		.482	1	.422	.390
			Upper		.687	1	.618	.603
AC1_A3	Pearson Correlation				.548**	.527**	1	.520**
	Sig. (2-tailed)				.000	.000		.000
	N				332	332	332	332
	Bootstrap[b]	Bias			.001	.000	0	-.001
		Std. Error			.055	.049	0	.052
		95% Confidence Interval	Lower		.436	.422	1	.410
			Upper		.653	.618	1	.614
AC1_A4	Pearson Correlation				.441**	.502**	.520**	1
	Sig. (2-tailed)				.000	.000	.000	
	N				332	332	332	332
	Bootstrap[b]	Bias			.000	.000	-.001	0
		Std. Error			.055	.052	.052	0
		95% Confidence Interval	Lower		.329	.390	.410	1
			Upper		.546	.603	.614	1

**. Correlation is significant at the 0.01 level (2-tailed).
b. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 138. Specific objective 4: bivariate correlation analysis among PAC indicators

				AC1_E1	AC1_E2	AC1_E3	AC1_E4	AC1_E5	AC1_T2	AC1_T3	AC1_T4_
AC1_E1	Pearson Correlation			1	.708**	.637**	.764**	.577**	.633**	.677**	.650**
	Sig. (2-tailed)				.000	.000	.000	.000	.000	.000	.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		0	.002	.003	.002	.002	.001	.001	.003
		Std. Error		0	.046	.058	.033	.051	.043	.043	.048
		95% Confidence Interval	Lower	1	.611	.515	.698	.476	.540	.586	.549
			Upper	1	.792	.744	.826	.680	.716	.756	.740
AC1_E2	Pearson Correlation			.708**	1	.729**	.706**	.544**	.606**	.664**	.663**
	Sig. (2-tailed)			.000		.000	.000	.000	.000	.000	.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.002	0	.000	.001	.002	.002	.000	.001
		Std. Error		.046	0	.042	.036	.051	.045	.036	.042
		95% Confidence Interval	Lower	.611	1	.637	.631	.447	.520	.587	.577
			Upper	.792	1	.801	.771	.640	.699	.730	.742
AC1_E3	Pearson Correlation			.637**	.729**	1	.708**	.546**	.497**	.602**	.679**
	Sig. (2-tailed)			.000	.000		.000	.000	.000	.000	.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.003	.000	0	.000	.002	.003	.002	-.001
		Std. Error		.058	.042	0	.041	.052	.059	.052	.042
		95% Confidence Interval	Lower	.515	.637	1	.623	.441	.381	.493	.592
			Upper	.744	.801	1	.782	.647	.610	.697	.755
AC1_E4	Pearson Correlation			.764**	.706**	.708**	1	.646**	.618**	.654**	.644**
	Sig. (2-tailed)			.000	.000	.000		.000	.000	.000	.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.002	.001	.000	0	.003	.001	.002	.000
		Std. Error		.033	.036	.041	0	.044	.043	.045	.039
		95% Confidence Interval	Lower	.698	.631	.623	1	.558	.529	.562	.554
			Upper	.826	.771	.782	1	.732	.695	.733	.711
AC1_E5	Pearson Correlation			.577**	.544**	.546**	.646**	1	.593**	.607**	.518**
	Sig. (2-tailed)			.000	.000	.000	.000		.000	.000	.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.002	.002	.002	.003	0	.001	.003	.002
		Std. Error		.051	.051	.052	.044	0	.051	.054	.052
		95% Confidence Interval	Lower	.476	.447	.441	.558	1	.489	.506	.409
			Upper	.680	.640	.647	.732	1	.686	.712	.620
AC1_T2	Pearson Correlation			.633**	.606**	.497**	.618**	.593**	1	.759**	.524**
	Sig. (2-tailed)			.000	.000	.000	.000	.000		.000	.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.001	.002	.003	.001	.001	0	.001	.003
		Std. Error		.043	.045	.059	.043	.051	0	.035	.057
		95% Confidence Interval	Lower	.540	.520	.381	.529	.489	1	.684	.404
			Upper	.716	.699	.610	.695	.686	1	.822	.633
AC1_T3	Pearson Correlation			.677**	.664**	.602**	.654**	.607**	.759**	1	.617**
	Sig. (2-tailed)			.000	.000	.000	.000	.000	.000		.000
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.001	.000	.002	.002	.003	.001	0	.003
		Std. Error		.043	.036	.052	.045	.054	.035	0	.049
		95% Confidence Interval	Lower	.586	.587	.493	.562	.506	.684	1	.514
			Upper	.756	.730	.697	.733	.712	.822	1	.705
AC1_T4	Pearson Correlation			.650**	.663**	.679**	.644**	.518**	.524**	.617**	1
	Sig. (2-tailed)			.000	.000	.000	.000	.000	.000	.000	
	N			332	332	332	332	332	332	332	332
	Bootstrap[b]	Bias		.003	.001	-.001	.000	.002	.003	.003	0
		Std. Error		.048	.042	.042	.039	.052	.057	.049	0
		95% Confidence Interval	Lower	.549	.577	.592	.554	.409	.404	.514	1
			Upper	.740	.742	.755	.711	.620	.633	.705	1

**. Correlation is significant at the 0.01 level (2-tailed).

b. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 139. Specific objective 4: bivariate correlation analysis among RAC indicators

7.6.3. Steps

As Weston and Gore (2006) state, SEM experts indicate that six steps are necessary in model and hypothesis testing (i) *data collection*, (ii) *specification*, (iii) *identification*, (iv) *estimation*, (v) *evaluation* and (vi) *modification*. Accordingly, after data collection, it was necessary to specify what relationships were assumed to exist, or not, between observed and latent variables (Weston and Gore, 2006). Later, it was analysed whether the model had been identified. The identification of the model is a basic requirement for SEM. The fact that a model is identified implies that a single solution can be obtained for every free parameter based on observed data (Kliewe, 2015). Three types of models can be differentiated, u*nderidentified, just identified* and *overidentified*. Underidentified models refer to models where there are more "unknowns" than the number of equations ("knowns"). Thus, an infinite number of solutions can be generated. Second, just identified models are those with the same number of "knowns" and "unknowns". This situation implies a unique solution and a perfect model fit. Third, overidentified models refer to those models where multiple solutions can be created for at least one parameter. An overidentified model has positive degrees of freedom (df > 0) and enable researchers to estimate the fit of the model (Kliewe, 2015). The models analysed in this research were overfitted (df=68)[49] and allowed model fit testing.

Once the models had been specified and identified, the estimation step proceeded. Estimation entails determining the value of the unknown parameter and the errors associated with the estimated values. As in regression models, estimation yields the unstandardised (analogous to a B weight) and standardised parameter values (analogous to β) (Weston and Gore, 2006). To carry out the estimation step, the four steps proposed by Mulaik and Millsap (2000) were followed. Consequently, prior to starting with the estimation, the measurement model was validated. This step was previously described in Sub-section *6.2 Validation of latent constructs*. As Mulaik and Millsap (2000) recommend, exploratory (EFA) and confirmatory (CFA) factor analyses were performed. By means of this assessment, the adequacy of the measurement model was verified. In other words, it was ensured that observed variables combined well to identify the underlying hypothesised constructs (Weston and Gore, 2006). Figure 52 shows the items that made up both dimensions of the construct, PAC and RAC, and their relationships (For further information, see Sub-section *6.2 Validation of latent constructs).*

[49] Drawing on Weston and Gore 2006) the number of degrees of freedom for the models were calculated by subtracting the number of parameters to be estimated from the number of known elements (correlations) in the correlation matrix.

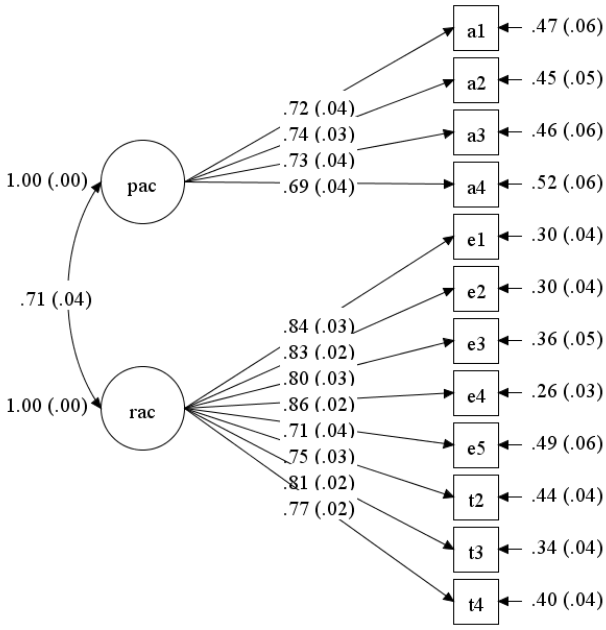

Figure 52. Specific objective 4: measurement model[50]

Once the measurement model had been assessed, the measurement and structural portions of the model were tested simultaneously. So as to assess the acceptability of the composite model (see *6.2 Validation of latent constructs*), goodness of fit indices were analysed. Specifically, SRMR (absolute fit index), RMSEA (parsimony fit index) and CFI and TLI (comparative fit indices) were examined (For further information about these indices see Sub-section *6.2.3 Validity*). As Weston and Gore (2006) note, sometimes, the proposed model is not the best-fitting model and, and as a result respecifications may be needed. In this case, the values obtained for each model were between the optimal values (see Table 140) and no respecification was introduced.

Outcome variable	**Fit indices** (Optimal values)			
	SRMR (<.08)	**RMSEA** (<.05/<.08)	**CFI** (>.95/>.9)	**TLI** (>.95/>.9)
Mobility of students	.04	.05 (.04-.07)	.93	.92
Curriculum co-design	.04	.05 (.04-.07)	.93	.91
Curriculum co-delivery	.04	.05 (.04-.06)	.93	.92
Dual education	.04	.05 (.04-.06)	.93	.91
Lifelong learning	.05	.05 (.04-.07)	.93	.91
Joint R&D	.04	.05 (.04-.06)	.93	.92
Consultancy	.04	.05 (.04-.06)	.93	.92
Mobility of staff	.04	.05 (.04-.06)	.93	.92
Commercialisation	.04	.05 (.04-.06)	.93	.92
Academic entrepreneurship	.04	.05 (.04-.07)	.93	.91
Student entrepreneurship	.04	.05 (.04-.06)	.93	.91
Governance	.04	.05 (.04-.06)	.93	.92
Support	.04	.05 (.04-.06)	.93	.92
Shared resources	.04	.05 (.04-.06)	.93	.92

Table 140. Specific objective 4: goodness of fit of the models

[50] In order to facilitate the legibility, the prefix "AC1_" of the observed variables was removed.

Finally, the estimation of parameters was assessed and the hypotheses defined in the literature were tested.

7.6.4. Results

Table 141 below summarises the standardised parameter values, significance and standard errors of the estimated parameters for each of the 14 models tested.

Domain	**UBC activity**	**Size**		**R&D intensity**		**PAC**		**RAC**	
		Standardised Coefficients		**Standardised Coefficients**		**Standardised Coefficients**		**Standardised Coefficients**	
		Beta	**Std. Error**	**Beta**	**Std. Error**	**Beta**	**Std. Error**	**Beta**	**Std. Error**
Education	Mobility of students	.19*	.05	.20*	.05	.30*	.08	-.03 (*p*=.70)	.08
	Curriculum co-design	.24**	.08	.15***	.06	.03 (*p*=.08)	.06	.04 (*p*=.05)	.07
	Curriculum co-delivery	.17**	.06	.19**	.06	.07 (*p*=.07)	.03	.04 (*p*=.61)	.07
	Dual education	.29*	.06	.15**	.05	.14 (*p*=.07)	.08	-.06 (*p*=.44)	.08
	Lifelong learning	.20*	.06	.18**	.05	.28*	.07	-.14 (*p*=.06)	.07
Research	Joint R&D	.14**	.05	.25*	.05	.18***	.08	-.05 (*p*=.51)	.08
	Consultancy	.19**	.06	.15**	.05	.25*	.08	-.09 (*p*=.31)	.08
	Mobility of staff	.18**	.003	.18*	.05	.02 (*p*=.07)	.08	.16***	.07
Valorisation	Commercialisation	.17**	.06	.22*	.06	.003 (*p*=.97)	.01	.013 (*p*=.09)	.09
	Academic entrepreneurship	.13mm (*p*=.06)	.07	.16***	.06	.07 (*p*=.38)	.08	.019 (*p*=.80)	.08
	Student entrepreneurship	.17***	.07	.19**	.07	.10 (*p*=.22)	.08	-.07 (*p*=.34)	.08
Management	Governance	.28***	.09	.13 (*p*=.07)	.07	-.004 (*p*=.54)	.07	.1 (*p*=.10)	.06
	Shared resources	.17**	.06	.18**	.06	.13 (*p*=.06)	.07	-.01 (*p*=.9)	.07
	Support	.24**	.08	.19**	.06	-.02 (*p*=.72)	.07	.10 (*p*=.14)	.07

Note: * *p* < .001, ***p* < .01, *p* <.05***

Table 141. Specific objective 4: results of the 14 models tested (SEM)

Once the parameters of the models were known, the previously defined hypotheses were tested. With regard to the first hypothesis, *H1: PAC has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities*, it was observed that *PAC* was positively related to mobility of students, lifelong learning, joint R&D and consultancy. Hence, hypotheses H1a, H1e, H1f and H1g were confirmed. As to the second hypothesis, *H2: RAC has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities, RAC* variable was found to be positively related to mobility of staff. Accordingly, hypothesis H2h was confirmed. Finally, as regards the third hypothesis, *H3: R&D intensity has a positive and significant influence on manufacturing SMEs' cooperation levels in UBC activities*, *RD_intensity* was significantly and positively related to all the UBC activities with the exception of governance. Thus, all the hypotheses regarding H3 were confirmed except H3l (governance). Table 142 below summarises the results achieved.

Specific objective 4: Clarify the role of AC on manufacturing SMEs' cooperation levels in UBC activities				
Domain	**UBC activity**	**H1: PAC has a positive and significant influence on cooperation levels in UBC activities.**	**H2: RAC has a positive and significant influence on cooperation levels in UBC activities.**	**H3: R&D intensity has a positive and significant influence on cooperation levels in UBC activities.**
Education	Mobility of students	H1a: Confirmed	H2a: Rejected	H3a: Confirmed
	Curriculum co-design	H1b: Rejected	H2b: Rejected	H3b: Confirmed
	Curriculum co-delivery	H1c: Rejected	H2c: Rejected	H3c: Confirmed
	Dual education	H1d: Rejected	H2d: Rejected	H3d: Confirmed
	Lifelong learning	H1e: Confirmed	H2e: Rejected	H3e: Confirmed
Research	Joint R&D	H1f: Confirmed	H2f: Rejected	H3f: Confirmed
	Consultancy	H1g: Confirmed	H2g: Rejected	H3g: Confirmed
	Mobility of staff	H1h: Rejected	H2h: Confirmed	H3h: Confirmed
Valorisation	Commercialisation	H1i: Rejected	H2i: Rejected	H3i: Confirmed
	Academic entrepreneurship	H1j: Rejected	H2j: Rejected	H3j: Confirmed
	Student entrepreneurship	H1k: Rejected	H2k: Rejected	H3k: Confirmed
Management	Governance	H1l: Rejected	H2l: Rejected	H3l: Rejected
	Shared resources	H1m: Rejected	H2m: Rejected	H3m: Confirmed
	Support	H1n: Rejected	H2n: Rejected	H3n: Confirmed

Table 142. Specific objective 4: results of hypothesis testing

7.6.5. Summary

The present sub-section deals with the analysis required to address Specific objective 4, i.e.to clarify the role of AC on manufacturing SMEs' cooperation levels in the 14 diverse UBC activities identified by Davey *et al.* (2018) in the domains of (i) education, (ii) research, (iii) valorisation, and (iv) management. In order to meet the objective, 14 models (one for each UBC activity) and 42 hypotheses (3 for each model) were tested by means of an SEM approach. The analysis allowed the influence of AC to be compared, operationalised as (i) R&D intensity and the influence of AC operationalised as (ii) a construct based on businesses' routines and internal processes with regard to external knowledge, differentiating potential (PAC) and realised absorptive capacity (RAC). Table 143 below highlights in bold the variables found to be significant in each UBC activity.

Domain	**UBC activity**	**R&D intensity**	**PAC**	**RAC**
Education	Mobility of students	✓	✓	
	Curriculum co-design	✓		
	Curriculum co-delivery	✓		
	Dual education	✓		
	Lifelong learning	✓	✓	
Research	Joint R&D	✓	✓	
	Consultancy	✓	✓	
	Mobility of staff	✓		✓
Valorisation	Commercialisation	✓		
	Academic entrepreneurship	✓		
	Student entrepreneurship	✓		
Management	Governance			
	Shared resources	✓		
	Support	✓		

Table 143. Specific objective 4: summary of the results obtained

7.7. Summary

The first section of the chapter provided a detailed descriptive analysis of the sample. This analysis described in depth both the predictor and outcome variables used in the study. Then, the following sections and sub-sections described the statistical analyses carried out to address the research questions, objectives and hypotheses determined for the study, together with the results obtained. Given the diverse purposes (descriptive, exploratory and explanatory) of the four specific objectives of the study, several data analysis techniques were employed.

Specific objective	**Statistical technique**	**Software**
1	Pearson's Chi-Square	SPSS
	Mann-Whitney	
	Independent samples *t*-test	
2	Multiple logistic regression	SPSS
3	Multiple linear regression	SPSS
4	SEM	Mplus

Table 144. Statistical techniques employed in the study

Chapter 8

Conclusions and recommendations

8. Conclusions and recommendations

This last chapter deals with the final conclusions and recommendations arising from the study. First, a discussion of the four specific objectives is provided, based on the empirical analysis developed before, which leads to the second sub-section on conclusions. The third sub-section of the chapter addresses the limitations of the study and proposed future lines of research. Finally, the fourth sub-section describes the contributions of the study.

8.1. Discussion

This first sub-section includes the discussion of the results obtained through the data analysis, contrasting them with the literature, thereby understanding to what extent they coincided with the results of previous studies. The discussion is organised according to the four specific objectives developed.

8.1.1. Specific objective 1

The following sub-section deals with the discussion of the results obtained for Specific objective 1. This specific objective sought to analyse and identify the differences between cooperating and non-cooperating manufacturing SMEs with regard to their organisational context-related factors. The factors analysed were classified into the following groups of variables: (i) general business characteristics, (ii) business openness, (iii) R&D, (iv) LLL, (v) AC, (vi) innovation and (vii) UBC willingness and support. The sub-section is structured by groups and discusses the results of each variable analysed.

8.1.1.1. Business general characteristics

With regard to the variables included in “General business characteristics”, the empirical analysis showed that cooperating SMEs differed from non-cooperating SMEs in relation to the vast majority of organisational context-related factors. Seven out of eleven variables exhibited significant differences.

Consistent with Ferrer-Lorenzo, Abella-Garcés and Maza-Rubio (2017), who indicated that companies belonging to a business group have better access to resources, technology, innovation and funding, the results of the analysis showed that cooperation with universities in SMEs belonging to a business group was more likely than in SMEs that did not belong to a business group. The results of the study also found that cooperating SMEs exhibited larger business sizes than non-cooperating SMEs. This finding supported the results of Bayona Sáez, García Marco and Arribas Huerta (2002) and Hervas-Oliver, Albors-Garrigos and Baixauli (2011), who proved that larger companies are more likely to cooperate with universities than smaller ones. According to the literature, small companies face more resource, funding and time limitations than larger companies (Bayona Sáez, García Marco and Arribas Huerta, 2002; Gray and Mabey, 2005; González-Benito, Muñoz-Gallego and García-Zamora, 2016). Moreover, it was observed that turnover levels in the cooperating group differed from the non-cooperating one. Non-cooperating SMEs presented lower turnover levels. This fact mirrored the findings of Hervas-Oliver, Albors-Garrigos and Baixauli (2011), who indicated that investment in R&D cooperative projects by SMEs can be limited due to problems of restricted cash flow or the inability to spend the minimum amount required to generate results.

Although the study did not include a direct measure of the export orientation of the company, the research found that, on average, cooperating SMEs differed from non-cooperating SMEs with regard to the percentage of local sales. Cooperating SMEs showed lower local sale percentages than non-cooperating SMEs. This result accords with the findings of Autio, Hameri and Nordberg (1996), who stated that SMEs with strategic goals to internationalise their business activities are potential candidates for cooperation.

As regards technological level, in agreement with Laursen and Salter (2004), who indicated that technological capacity of companies is related to the use of universities as a source of knowledge, the results of the empirical analysis corroborated that technological levels in the cooperating SMEs differed statistically from the non-cooperating ones. The analysis showed that there were more non-cooperating SMEs in low and medium-low technological levels than cooperating SMEs. This finding also supported the results obtained by Verbano, Crema and Venturini (2015), who pointed out variances in low-tech and high-tech SMEs' cooperation approaches.

According to the results of the study, there was a significant difference between both groups of SMEs with regard to employees' qualification. Cooperating SMEs exhibited a higher average level of employees' with a higher degree than non-cooperating SMEs. These results agreed with the findings of García-Pérez-de-Lema *et al.* (2017), who noted that SMEs' R&D cooperation strategies (including cooperation with universities) depend on two main factors connected with employees' qualification, i.e. AC and informal interactions. On the one hand, drawing on previous studies, companies' AC can be determined by employees' qualification level (Cohen and Levinthal, 1990; Keller, 1996; Veugelers, 1997; Cassiman and Veugelers, 2002; Kobarg, Stumpf-Wollersheim and Welpe, 2018). On the other hand, informal interactions, which are considered to be precursors of UBC activities (Plewa, Korff, Johnson, et al., 2013), go hand in hand with having a prior relationship with the university partner, a driver for UBC (Davey *et al.*, 2018).

Consistent with Gilligan (1993), Carli and Eagly (2016) and Liao, Zhang and Wang (2019) the results of the study stressed that cooperating SMEs differed statistically from non-cooperating SMEs in relation to the female percentage in companies. Cooperating SMEs showed a higher average value of women in workforce than non-cooperating SMEs. Liao, Zhang and Wang (2019) stressed that the feminist caring theory highlights that females in general have a stronger tendency toward altruism (Gilligan, 1993), are more concerned with the ethics of "relationships and responsibilities" and may be more concerned about the relationship between firms and stakeholders due to "empathy and care" (Carli and Eagly, 2016).

The characteristics, resources and support mechanism in regional contexts are essential in the development of UBC. The region in which the company is located can shape the likelihood of the company to cooperate. Factors such as geographical proximity between universities and businesses (Breschi and Lissoni, 2001; Singh, 2005; Davey *et al.*, 2011, 2018; Galán-Muros, 2016; Sharma, 2020), knowledge industrialisation (Eom and Lee, 2010) and industry concentration (D´Este and Patel, 2007; Sharma, 2020) are considered key determinants of UBC. The present study focused on Basque manufacturing SMEs; thus, a specific region (NUTS 2) was analysed. However, whether there were differences at the provincial level (NUTS 3) was analysed, and this study was unable to demonstrate this. The results indicated that there were no significant differences between cooperating and non-cooperating SMEs in relation to their province.

The study into the state of UBC developed by Davey *et al.* (2018) showed that the most likely business cooperators in Europe were publicly-owned businesses. Since it was not found clear evidence in the literature with regard to the role of legal form, the study analysed the existence of differences between cooperating and non-cooperating SMEs in relation to this variable. The results of the study showed that there was no difference between both groups. Furthermore, the results of the study showed that there were no differences between cooperating and non-cooperating SMEs in relation to being a headquarter or not. This finding might be contrary to the previous study of Lopes and Lussuamo (2020), who stated that companies whose headquarters were located outside the region under study can influence cooperation negatively. In turn, even though García-Pérez-de-Lema *et al.* (2017) and Merchán Hernández (2010) emphasised the existence of differences between young and mature companies with regard to UBC, the findings of the current study did not support the previous research. No differences were found between cooperating and non-cooperating SMEs in relation to age.

8.1.1.2. Business openness

The empirical results showed that cooperating SMEs differed from non-cooperating SMEs in relation to all the variables analysed in "Business openness".

Drawing on Laursen and Salter (2004), the study operationalised companies' external breadth by means of four variables (i) *Cooperation in R&D, (ii) Total number of R&D partners, (iii) Cooperation in LLL* and (iv) *Total number of LLL partners.* The results of the analysis found that cooperating SMEs differed from non-cooperating SMEs in relation to these four variables. With regard to *Cooperation in R&D*, the results indicated that a higher proportion of cooperating SMEs carried out R&D activities in cooperation with external partners. As to *Total number of R&D partners*, the analysis indicated that cooperating SMEs cooperated with more external partners for the development of R&D activities. Concerning *Cooperation in LLL*, the statistical analysis indicated that there was a relationship between the way in which companies carried out LLL activities and cooperation with universities. On the one hand, it was noted that the proportion of non-cooperating SMEs exclusively undertaking external LLL activities was higher. On the other hand, it was seen that the proportion of cooperating SMEs that carried out LLL activities both internally and externally was higher. In relation to *Total number of LLL partners* the results of the analysis revealed that cooperating SMEs cooperated with a higher number of external partners in LLL. This result was consistent with Lin (2017), who stated that companies requiring a heterogeneity of cooperative sources are more prone to engage with universities, and with several empirical studies that have contributed to support a possible positive triadic relationship between external search breadth, cooperation with external partners and AC (Cockburn and Henderson, 1998; Jones and Craven, 2001; George *et al.*, 2001; Cassiman and Veugelers, 2002; Zahra and George, 2002; Negassi, 2004; Jansen, Van Den Bosch and Volberda, 2005; Singh, 2005; Vanhaverbeke, Van de Vrande and Chesbrough, 2008; Murovec and Prodan, 2009; Bishop, D'Este and Neely, 2011; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Davey *et al.*, 2011, 2018; Ferreras-Méndez, Fernández-Mesa and Alegre, 2016; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017; Flor, Cooper and Oltra, 2018).

Consistent with D'Este, Guy and Iammarino (2013), who indicated that university-business relationships are frequently associated with specialised spatial concentrations of firms, the results of the study showed that cooperating SMEs differed from non-cooperating SMEs with regard to cluster association membership. The results indicated that cooperation with universities in companies belonging to a cluster association was more likely than in companies that did not belong to a business cluster.

Informal interactions between university and industry partners are essential for UBC since these connections can be a precursor of UBC activities (Plewa, Korff, Johnson, et al., 2013). The participation of companies in public meetings, conferences or workshops and symposiums with university participation can generate the necessary personal and professional links (Cohen, Nelson and Walsh, 2002; Perkmann and Walsh, 2007; Plewa, Korff, Johnson, et al., 2013; Azagra-Caro et al., 2017), which, together with trust (Rappert, Webster and Charles, 1999), lead to the development of UBC activities. In order to analyse the possible differences between cooperating and non-cooperating SMEs regarding informal interactions, two variables were assessed: *Informal interaction development* and *Total number of informal interactions.* The results of the analysis supported previous findings since it was observed that cooperating SMEs differed from non-cooperating SMEs in both variables. First, in relation to the development of informal interactions, it was observed that more cooperating SMEs participated in some kind of informal interaction (informal meetings, conferences or workshops with university participation). Second, regarding the total number of informal interactions, the results showed that cooperating SMEs participated in more informal interactions with universities.

8.1.1.3. Research and development

As to the variables included in "R&D", the empirical results showed that cooperating SMEs differed from non-cooperating SMEs in relation to all the variables included in this group.

Supporting the results of Bodas Freitas, Geuna and Rossi (2013), who noted that expenditures in R&D encouraged companies to look for knowledge from universities, the results showed that significant differences existed between cooperating and non-cooperating SMEs in relation to *R&D intensity*. On the one hand, it was observed that cooperation with universities was more likely in the SMEs that carried out R&D activities. On the other hand, it was observed that cooperating SMEs showed higher R&D intensity levels than non-cooperating SMEs.

According to the literature, the continuity with which companies carry out R&D activities may determine their search for external knowledge (Miotti and Sachwald, 2003; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). In this regard, Mohnen and Hoareau (2003) noted that only companies that perform in-house R&D are able to extract knowledge from universities. The results of the analysis might corroborate this since the median value of non-cooperating SMEs corresponded to companies that did not perform R&D activities.

Consistent with the literature, the results of the present study showed that there were significant differences between cooperating and non-cooperating SMEs concerning *R&D program knowledge* and *R&D program participation*. The results showed that cooperation with universities was more likely in SMEs with knowledge of R&D programs and in SMEs that participated in R&D programs. These results supported Mohnen and Hoareau (2003), who pointed out that cooperation with universities is a characteristic of companies that receive government support; as well as backing previous findings (Veugelers, 1997;

Cassiman and Veugelers, 2002; Mohnen and Hoareau, 2003; Negassi, 2004; Fontana, Geuna and Matt, 2006; Abramovsky *et al.*, 2009) that highlighted the positive effect of public funding and cooperation.

8.1.1.4. Lifelong learning

Regarding the variables related to lifelong learning (LLL), *LLL development* and *LLL commitment* (measured as a company's expenditure on LLL), no differences were found between cooperating and non-cooperating SMEs. These results are in accordance with Leiponen (2005), who pointed out that LLL is not limited to a specific kind of company. Besides, these mirrored the findings of Santamaría, Nieto and Barge-Gil (2009) and Hirsch-Kreinsen (2015a), who highlighted that training is crucial in the innovation process of any firm.

8.1.1.5. Absorptive capacity

Although several studies have shown a positive influence of AC on UBC (e.g. Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018), some authors have produced opposing results (e.g. Bruneel, D´Este and Salter, 2010; Kobarg, Stumpf-Wollersheim and Welpe, 2018). The results of the study reflected that there were differences between cooperating and non-cooperating SMEs in relation to companies' *PAC* and *RAC* levels. Cooperating SMEs showed higher *PAC* and *RAC* levels than non-cooperating ones. This evidence supported the idea that AC (measured as a construct based on businesses' routines and internal processes with regard to external knowledge) might have a positive influence on UBC, as pointed out by several (e.g. Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018).

8.1.1.6. Innovation

In connection with the variables included in "Innovation", the findings showed that cooperating SMEs differed from non-cooperating SMEs in relation to the two variables included.

In accordance with De Fuentes and Dutrénit (2012), who stressed that IC is an important driver for UBC, the results of the study indicated that there were significant differences between cooperating and non-cooperating SMEs with regard to IC. Cooperating SMEs showed higher IC levels than non-cooperating SMEs. This finding seemed to be also in agreement with those obtained by Samson and Gloet (2014) and Carrasco-Carvajal and García-Pérez-De-Lema (2020), who found that IC contributes to SMEs' openness and cooperation practices.

The study developed by Guerrero, Urbano and Herrera (2019) highlighted that companies developing radical innovations are more likley to cooperate with universities than companies undertaking incremental innovations. The results obtained in this study matched this finding since significant differences were found between cooperating and non-cooperating SMEs in relation to ID. Cooperating SMEs showed higher ID levels than non-cooperating SMEs. A possible explanation for this result is that radical innovations require a large amount of new knowledge (Dewar and Dutton, 1986) that is distant from a firm's existing competences and practices (Green, Gavin and Aiman-Smith, 1995), high R&D investments (Laursen and

Salter, 2006) and cooperation with heterogeneous partners (Hagedoorn, 1993). These characteristics of radical innovation may force companies to bring external knowledge inside (Green, Gavin and Aiman-Smith, 1995).

8.1.1.7. UBC willingness and support

Several authors (Fontana, Geuna and Matt, 2006; Lai, 2011; Galán-Muros *et al.*, 2017; Davey *et al.*, 2018) underline that companies' willingness and support for UBC has a key role in shaping UBC engagement. Accordingly, the results of the analysis showed significant differences between cooperating and non-cooperating SMEs in relation to the three dimensions of the construct, i.e. *UBC resources, Cognitive closeness*, and *UBC beliefs.* Specifically, cooperating SMEs exhibited higher levels in all three dimensions of the construct. These results supported previous studies, which underlined the importance of social factors such as initial awareness, contacts and prior relationships, management support and cognitive closeness in UBC (Dyer and Singh, 1998; Santoro and Chakrabarti, 2002; Boschma, 2005; Gulati, 2007; Davey *et al.*, 2012, 2018; Muscio and Pozzali, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013; Ankrah and Al-Tabbaa, 2015).

8.1.2. Specific objective 2

The sub-section below includes a discussion of the results obtained for Specific objective 2. This second specific objective sought to identify the most determining organisational context-related factors on the likelihood of manufacturing SMEs to cooperate with universities. To be more precise, this specific objective sought on the one hand, to explore the impact and identify the most determining organisational context-related factors of each group of variables on the likelihood of SMEs to cooperate with universities. On the other hand, it sought to identify the most determining factors from a holistic perspective, that is, among all the identified groups. This sub-section offers a discussion of the results obtained for each intra-group analysis and a discussion of the final inter-group-analysis.

8.1.2.1. Business general characteristics

A six-predictor logistic regression was carried out to assess the effect of *Business group (Business_group), Size (Size), Exports (Market_BC), Technological level (Tech_scale), Employees' qualification (HD_emp) and Gender (Female)* on the likelihood that an SME cooperated with universities. According to the results of the regression model, on the one hand, the variables *Size* and *Employees' qualification* showed a positive impact on the likelihood that an SME cooperated with universities. On the other hand, the variable *Exports* (measured as local sales percentage) exhibited a negative significant impact. Employees' qualification showed the greatest impact, followed by the negative impact of local sales and the positive effect of size.

As regards business size, the results supported the findings of Bayona Sáez, García Marco and Arribas Huerta (2002) and Hervas-Oliver, Albors-Garrigos and Baixauli (2011), who stressed that larger companies are more likely to cooperate with universities than smaller ones. Several studies have emphasised that smaller companies face more resource, funding and time limitations than larger ones (Bayona Sáez, García Marco and Arribas Huerta, 2002; Gray and Mabey, 2005; González-Benito, Muñoz-Gallego and García-Zamora, 2016).

In relation to the positive impact of employees' qualifications, this finding was broadly consistent with previous studies. First, employees' qualification level and training can determine the AC of companies, (Cohen and Levinthal, 1990; Keller, 1996; Veugelers, 1997; Cassiman and Veugelers, 2002), which several authors found to be positively related to UBC (e.g. Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018). As Galán-Muros and Plewa (2016) and Cassiman and Veugelers (2002) pointed out, companies are more likely to engage in UBC whenever they see beneficial outcomes from such engagement, which in turn is likely to depend on the business' AC. The literature has highlighted that companies need a minimum amount of knowledge to be able to engage in partnerships. Therefore, businesses with highly-skilled employees seem to be more capable of acquiring, assimilating, transforming and exploiting external knowledge and thus, cooperating with universities (Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018). Second, in accordance with the literature, cooperation engagement also depends on SMEs' ability to develop personal relationships within their environments (Singh, 2005; Bishop, D'Este and Neely, 2011). Informal interactions with external partners (Rappert, Webster and Charles, 1999) and prior relationships (Davey et al., 2018) are therefore essential. In this connection, employees' qualifications might be a key element in facilitating these necessary relational aspects, since employees' with a higher degree have a prior relationship with universities and might have a broader network of contacts.

Concerning the negative impact of *Exports*, it must be stressed again that, in the absence of a direct measurement of SMEs' export orientation, a measurement of the percentage of local sales was employed. Thus, for the interpretation of the results, it was inferred that the higher the local sales, the lower the export orientation of the company. Although this was a proxy variable and not a direct measurement, the results obtained corroborated previous theory. The results of the study indicated that the higher the percentage of local sales an SME had, the less likely it was that an SME cooperated or had cooperated with universities. This finding supported Autio, Hameri and Nordberg (1996), who indicated that SMEs with strategic goals to internationalise their business activities are potential candidates for cooperation. In accordance with the literature, exporting companies need to improve the quality of their products in order to expand (Grossman and Helpman, 1995), thereby making them more likely to cooperate with universities for R&D or innovation development.

With regard to the variables *Business group (Business_group)*, *Technological level (Tech_scale)* and *Gender (Female)*, the results of the logistic regression model showed that they were not significantly related to the log of the odds of an SME cooperating with universities.

Even though the results of Specific objective 1 emphasised that cooperation with universities in SMEs belonging to a business group was more likely than in SMEs that did not belong to a business group, the regression model did not show a significant relation between business group membership and cooperation with universities. Similarly, the analysis of Specific objective 1 exhibited significant differences in relation to the technological level of cooperating and non-cooperating manufacturing SMEs. The analysis showed that there were more non-cooperating SMEs in low and medium-low technological levels than cooperating SMEs. Nevertheless, the logistic regression model indicated that this variable did not significantly impact the likelihood of cooperation. As Vanhaverbeke and Cloodt (2014) noted, open innovation was initially associated with high-tech industries where technological breakthroughs are an important form of innovation. However, in accordance with the results of this study, the literature notes that there is no reason to believe that medium-low and low-tech companies are less likely to be able to face open innovation challenges than medium-high and high-tech firms are (Bender and Laestadius, 2005). As Santamaría, Nieto and Barge-Gil (2009) indicated, innovation in low-medium technology companies is not usually based on the latest scientific or technological knowledge but these firms depend on non-formal R&D activities and the use of external knowledge. As for the impact of the percentage of women in the workforce, the regression model did not exhibit a significant effect of this variable on SMEs' likelihood to cooperate. Although cooperating SMEs showed a higher average value of women in workforce than non-cooperating SMEs, this variable did not determine cooperation.

8.1.2.2. Business openness

A three-predictor logistic regression was carried out to assess the effect of *Total number of informal interactions* (Inf_int_tot), *Cluster association* (Clus_yes_no) and *Total number of LLL partners* (LLL_coop_tot) on the likelihood that an SME cooperated with universities. In accordance with the results of the regression model, the variables *Total number of informal interactions* and *Total number of LLL partners* exhibited a positive impact on the likelihood that a manufacturing SME cooperated with universities. Concerning the measure of the impact of these variables on manufacturing SMEs' likelihood to cooperate, the total number of informal interactions showed the greatest one, followed by the total number of LLL partners.

The development of informal interactions between university and industry partners is recognised as essential in UBC literature since these connections can be a precursor of UBC activities (Plewa, Korff, Johnson, et al., 2013). The participation of companies in public meetings, conferences or workshops and symposiums with university participation can generate the necessary personal and professional links (Cohen, Nelson and Walsh, 2002; Perkmann and Walsh, 2007; Plewa, Korff, Johnson, et al., 2013; Azagra-Caro et al., 2017), which, together with trust (Rappert, Webster and Charles, 1999), lead to the development of UBC activities. In accordance with the results of the regression model, the total number of informal interactions developed by manufacturing SMEs had a significant positive effect on cooperation likelihood.

Drawing on Laursen and Salter (2004), the measurement of companies' external breadth was operationalised by means of the variable *Total number of LLL partners*. The results of the logistic regression model indicated that the higher the total number of LLL partners, that is, the broader the external breadth of the SME, the more likely it was that an SME cooperated with universities. This finding was in accordance with Lin (2017) who showed a link between external search breadth and UBC, emphasising that there was a positive relationship between both variables. In turn, as described below, this result may be explained by a broader theoretical discussion. According to the literature, on the one hand, companies cooperating with external partners have a minimum AC level that allows them to benefit from cooperation (Zahra and George, 2002; Jansen, Van Den Bosch and Volberda, 2005; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011). On the other hand, several studies have stressed that cooperation with a broader variety of partners enhances companies' AC levels (Cockburn and Henderson, 1998; George *et al.*, 2001; Jones and Craven, 2001; Murovec and Prodan, 2009). The combination of these theoretical assumptions suggest that companies with broader external search breadth have higher AC levels. In accordance with the literature, AC is positively related to open innovation and UBC (e.g. Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018). Thus, the combination of these theoretical bases may explain how SMEs' external search breadth had a positive impact on the likelihood that an SME cooperated with universities.

With regard to cluster association membership, the results of the logistic regression model showed that the variable was not significantly related to the log of the odds of a manufacturing SME cooperating with universities. In spite of the fact that the results of the previous Specific objective 1 noted that cooperation with universities in the SMEs belonging to a cluster association was more likely than in the SMEs that did not belong to a cluster association, the regression model did not show a significant relationship between cluster association membership and cooperation with universities. It should be clarified that this dichotomous variable indicated whether the company belonged to a cluster association or not, not just to a geographical industrial agglomeration.

8.1.2.3. Research and development

With respect to R&D, a univariate logistic regression model was run to assess the effect of *R&D intensity* on the likelihood that an SME cooperated with universities. The results of the model showed that R&D intensity, measured as a company's R&D expenditure, had a significant positive effect on the probability that a manufacturing SME cooperated with universities. This finding was in accordance with Bodas Freitas, Geuna and Rossi (2013), who noted that companies with higher R&D expenditures looked for knowledge from universities. In turn, this positive relationship between R&D intensity and cooperation with universities, supported the findings of Laursen and Salter (2006) and Grimpe and Sofka (2009) who highlighted R&D investment as a key determinant of a company's external knowledge search strategy.

8.1.2.4. Innovation

A two-predictor logistic regression model was run to assess the effect of *Innovation capacity (IC)* and *Innovation degree (ID)* on the likelihood that an SME cooperated with universities. According to the model, IC turned out to be positively related to the log of the odds of an SME cooperating with universities. Based on this finding, the higher the IC level of the SME, the more likely it was that they cooperated with universities. Hogan et al. (2011) defined IC as "a firm's ability, relative to its competitors, to apply the collective knowledge, skills, and resources to innovation activities relating to new products, processes, services, or management, marketing or work organisation systems in order to create added value for the firm or its stakeholders". In accordance with this definition, empirical studies stressed that IC contributes to further development of open innovation practices (Samson and Gloet, 2014; Carrasco-Carvajal and García-Pérez-De-Lema, 2020). The result obtained in the regression model supported this theory.

As to the results obtained in relation to ID, the logistic regression model showed that there was not a significant relationship between the variable and the log of the odds of an SME cooperating with universities. Therefore, despite the fact that cooperating SMEs showed higher ID levels than non-cooperating SMEs, this variable did not have an impact on cooperation likelihood.

8.1.2.5. UBC willingness and support

A three-predictor logistic regression model was run to assess the effect of the three dimensions of UBC willingness and support, *UBC resources (UBC_resources), Cognitive closeness (Cogni_closeness)* and *UBC beliefs (UBC_beliefs)* on the likelihood that an SME cooperated with universities. As a result of the model it was found that the variables *UBC resources* and *Cognitive closeness* had a positive significant effect on the likelihood that an SME cooperated with universities, the impact of *UBC resources* being stronger than that of *Cognitive closeness.*

The variable *UBC resources* reflected an indirect measure of the contacts and relationships that SMEs had with universities, their management support for UBC and their understanding level about what cooperation with universities is and what it offers. The result obtained in the regression model supported previous studies which underlined the importance of social factors such as initial awareness, contacts and prior relationships, and management support (Dyer and Singh, 1998; Santoro and Chakrabarti, 2002; Gulati, 2007; Davey *et al.*, 2012, 2018; Muscio and Pozzali, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013; Ankrah and Al-Tabbaa, 2015). In accordance with UBC literature, being aware of the possibilities offered by engaging in UBC and having connections and suitable first contacts are essential to establish cooperation relationships (Davey *et al.*, 2012, 2018; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). UBC studies have recognised lack of awareness along with lack of contacts and relationships as one of the major barriers to UBC (Muscio and Pozzali, 2013; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018). By the same token, the literature has emphasised the importance of top management support and commitment, since managers that are not committed to UBC will not devote resources to UBC (Barnes, Pashby and Gibbons, 2002; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Ankrah and Al-Tabbaa, 2015; Attia, 2015; Rosendo-Ríos, Ghauri and Zhang, 2016; Davey et al., 2018).

The variable *Cognitive closeness* measured the cognitive closeness of SMEs with respect to universities. Specifically, this variable reflected the extent to which SMEs perceived they were able to absorb university knowledge and technology, together with the extent to which they were able to offer knowledge to universities both in education and R&D. In accordance with the result of the regression model, SMEs cognitive closeness had a positive significant impact on the likelihood that an SME cooperated with universities. This result was consistent with Boschma (2005), who indicated that the capacity of companies to absorb new knowledge requires cognitive proximity. That is to say, a company's cognitive base should be close enough to the new knowledge in order to communicate, understand and process it successfully (Boschma and Lambooy, 1999). Besides, this finding corroborated the RVB theory, which pointed out that companies only engage if there is a fit or complementarity between one organisation's resource need and another's resource provision (Das and Teng, 2000; Miotti and Sachwald, 2003).

With regard to *UBC beliefs*, it should be noted that despite the fact that cooperating SMEs showed higher levels than non-cooperating SMEs, the result of the regression model showed a non-significant effect of this variable on cooperation likelihood.

8.1.2.6. Inter-group analysis

Once the most determining factors in the different groups of variables had been identified, an inter-group analysis was performed in order to identify the most determining factors from a holistic perspective. A fifteen-predictor logistic regression was run to assess the effect of *Business group (Business_group), Size (Size), Exports (Market_BC), Technological level (Tech_scale), Employees' qualification (HD_emp), Gender (Female), Total number of informal interactions* (Inf_int_tot), *Cluster association* (Clus_yes_no), *Total number of LLL partners* (LLL_coop_tot), *R&D intensity (RD_int), Innovation capacity (IC), Innovation degree (ID), UBC resources (UBC_resources), Cognitive closeness (Cogni_closeness)* and *UBC beliefs (UBC_beliefs)* on the likelihood that an SME cooperated with universities. *UBC resources* showed the greatest impact, followed by *R&D intensity* and *Cognitive closeness.*

According to the model, on the one hand, the log of the odds of an SME cooperating with universities was positively related to *Size, R&D intensity, UBC resources* and *Cognitive closeness.* On the other hand, the log of the odds of an SME cooperating with universities was negatively related to *Exports* and *Innovation capacity*. On this basis, the larger the company, the higher the intensity in R&D, the higher the UBC resources level and the higher the cognitive closeness level, the more likely it was that an SME cooperated with universities. In contrast, the higher the percentage of local sales an SME had and the higher the IC level of the SME, the less likely it was that an SME cooperated. These results showed differences with regard to the findings obtained in the previous intra-group regression models. First, the variables *Employees' qualification*, *Total number of informal interactions* and *Total number of LLL partners* did not show a significant impact on the likelihood that an SME cooperated with universities. This fact suggested that in the presence of variables regarding other organisational context-related factor groups, these variables no longer had a significant impact. Hence, these variables were not determinant of the likelihood that an SME cooperated with universities. Second, the relationship between *Innovation capacity* and the log of the odds of an SME cooperating with universities, even if significant, became negative. This result reversed the finding obtained in the previous analysis and supported the results of the empirical study developed by Bayona Sáez, García Marco and Arribas Huerta (2002) who indicated that companies with higher innovation capacity, companies that try to improve their competitive position through innovation, are more likely to cooperate with customers or suppliers than universities, due to the long-term and more basic scientific orientation of universities. This finding was in accordance with the suggestion of Davey *et al.* (2011, 2018), who argued that scientific orientation is one of the main barriers to UBC. Whilst universities focus on generating and disseminating new basic knowledge, businesses usually seek directly applicable knowledge to provide short-term economic value (Dasgupta et al., 1994; Henderson, McAdam and Leonard, 2006; Bruneel, D´Este and Salter, 2010). Academic science tends to be oriented towards long-term, curiosity-driven research while businesses are interested in short- and medium-term outcomes (Perkmann, Neely and Walsh, 2011). These arguments agreed with Galán-Muros and Plewa (2016), who indicated that companies only engage in UBC if they see beneficial outcomes.

Despite the differences found with respect to these variables, the final inter-group model was consistent with the previous models in relation to the variables *Size (Size), Exports (Market_BC), R&D intensity (RD_int), UBC resources (UBC_resources),* and *Cognitive closeness (Cogni_closeness)*. These results were in accordance with the literature, as indicated in the discussion of the previous intra-group models.

As regards business size, the results supported the findings of Bayona Sáez, García Marco and Arribas Huerta (2002) and Hervas-Oliver, Albors-Garrigos and Baixauli (2011), who stressed that larger companies are more likely to cooperate with universities than smaller ones due to the fact that they have a greater amount of resources at their disposal (Bayona Sáez, García Marco and Arribas Huerta, 2002; Gray and Mabey, 2005; González-Benito, Muñoz-Gallego and García-Zamora, 2016).

Although the variable *Exports (Market_BC)* measured the percentage of local sales of the company, in order to analyse the possible impact of companies' export orientation, it was inferred that the higher the local sales, the lower the export orientation of the company was. Despite the fact that this was a proxy variable and not a direct measure, the findings of the model corroborated previous theory. The results of the study indicated that the higher the percentage of local sales an SME had, the less likely it was that they cooperated or had cooperated with universities. This finding supported Autio, Hameri and Nordberg (1996), who indicated that SMEs with strategic goals to internationalise their business activities are potential candidates for cooperation. In accordance with the literature, exporting companies need to improve the quality of their products in order to expand (Grossman and Helpman, 1995), making them more likely to cooperate with universities for R&D or innovation development. Internationalisation literature has shown the existing causality between R&D and innovation with exports (Soete, 1987; Sousa, Martínez-López and Coelho, 2008; Rodil, Vence and Sánchez, 2016). Exporting firms acquire overseas experience, know-how and technology in the global markets (Grossman and Helpman, 1995), leading to the development of their capacities (Rodil, Vence and Sánchez, 2016).

As regards R&D intensity, measured as a company's R&D expenditure, the variable showed a positive significant effect on the likelihood that an SME cooperated. This finding corroborated previous research since companies with higher R&D intensity levels are seen to have higher AC levels, which allows them to absorb the knowledge of universities (Cohen and Levinthal, 1989, 1990; Mowery and Oxley, 1995; Tsai, 2001; Escribano, Fosfuri and Tribó, 2009; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013). Besides, the result supported the findings of the empirical study developed by Bayona Sáez, García Marco and Arribas Huerta (2002) and the suggestions of Davey *et al.* (2018), who argued that scientific orientation is one of the main barriers to UBC. As previously stated, there is a gap between the knowledge demanded by companies and the nature of the knowledge generated by universities. Companies require applicable knowledge to provide short-term economic value while universities focus on generating and disseminating new basic knowledge (Dasgupta *et al.*, 1994; Henderson, McAdam and Leonard, 2006; Bruneel, D´Este and Salter, 2010; Perkmann, Neely and Walsh, 2011; Davey *et al.*, 2018). Drawing on Galán-Muros and Plewa (2016), companies only engage in UBC if they see beneficial outcomes; thus, companies with higher R&D intensity levels might be long-term knowledge-demanders, thereby making them more likely to cooperate. This suggestion is consistent with both Miotti and Sachwald (2003) and Hanel and St-Pierre (2006), who indicated that companies that invest heavily in R&D use close-to-science sources of knowledge in their innovative process, since it complements their resources at the technological frontier. Furthermore, this suggestion is in line with Bodas Freitas, Geuna and Rossi (2013), who noted that companies with higher R&D expenditures looked for knowledge from universities. This finding corroborated the RVB theory, which pointed out that companies only engage if there is a fit or complementarity between one organisation's resource need and another's resource provision (Das and Teng, 2000; Miotti and Sachwald, 2003). In turn, it supported previous studies which noted that the lack of funding is a main barrier to UBC (Carayol, 2003; Laukkanen, 2003; Bercovitz and Feldman, 2006; Perkmann, Neely and Walsh, 2011; van Der Sijde, 2012; Richard, Howells and Ramlogan, 2012; Plewa, Korff, Johnson, *et al.*, 2013; Ankrah and Al-Tabbaa, 2015; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017; Davey *et al.*, 2018).

In relation to *UBC resources,* a variable that indirectly measured the contacts and relationships that SMEs had with universities, their management support for UBC and their understanding level about what cooperation with universities was and what it offered, the findings obtained in the regression model supported previous literature. UBC literature has broadly underlined the importance of social factors such as initial awareness, contacts and prior relationships, and management support (Dyer and Singh, 1998; Santoro and Chakrabarti, 2002; Gulati, 2007; Davey *et al.*, 2012, 2018; Muscio and Pozzali, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013; Ankrah and Al-Tabbaa, 2015). Being aware of the possibilities offered by engaging in UBC and having connections and suitable first contacts are essential to establish cooperation relationships (Davey *et al.*, 2012, 2018; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013). Lack of awareness and lack of contacts and relationships is one of the most important barriers to UBC (Muscio and Pozzali, 2013; Galán-Muros and Plewa, 2016; Davey *et al.*, 2018). By the same token, top management support and commitment is necessary since managers that are not committed to UBC will not devote resources to UBC (Barnes, Pashby and Gibbons, 2002; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Ankrah and Al-Tabbaa, 2015; Attia, 2015; Rosendo-Ríos, Ghauri and Zhang, 2016; Davey et al., 2018).

Cognitive closeness measured the extent to which SMEs perceived they were able to absorb university knowledge and technology, together with the extent to which they were able to offer knowledge to universities both in education and R&D. The findings of the regression model emphasised that SMEs cognitive closeness had a positive significant impact on the likelihood that an SME cooperated with universities. This result was consistent with Boschma (2005), who indicated that the capacity of companies to absorb new knowledge requires cognitive proximity. In other words, a company's cognitive base should be close enough to the new knowledge in order to communicate, understand and process it successfully (Boschma, 2005).

8.1.3. Specific objective 3

The sub-section below discusses the results obtained for the Specific objective 3. Having identified the factors that determined the likelihood that an SME cooperated with universities, this third specific objective aimed to identify the organisational context-related factors that determined manufacturing SMEs' cooperation levels in UBC activities. This objective sought, on the one hand, to explore the impact of organisational context-related factors on manufacturing SMEs' cooperation levels in the diverse UBC activities within the domains of (i) education: mobility of students, curriculum co-design, curriculum co-delivery, dual education programmes and lifelong learning, (ii) research: joint R&D, consultancy and mobility of staff, (iii) valorisation: commercialisation, academic entrepreneurship and student entrepreneurship, and (iv) management: governance, shared resources and support. On the other hand, it aimed to identify the determining factors of SMEs' cooperation levels in UBC activities from a holistic perspective, i.e. taking into account the different organisational context-related factors that could have an impact on SMEs' cooperation levels. To this end, 14 correlation analyses and 14 multiple linear regression models were run (one for each UBC activity).

8.1.3.1. General discussion

Prior to running the regression models, a series of correlation analyses explored the organisational context-related factors that could be associated with SMEs' cooperation levels in the diverse UBC activities. Once the models had been run, it was observed that many of the variables that had previously shown a significant correlation turned out not to be associated with UBC levels. This was the case of the variables *Business group, Technological level, Employees' qualification, Gender, Cluster association, Total number of LLL partners, IC, ID* and *UBC beliefs.*

The results of the multiple linear regression models showed that, even if quite similar, the determinants of manufacturing SMEs' cooperation levels in the diverse UBC activities differed from the determinants of UBC likelihood. In this connection, two interesting differences were found. On the one hand, the variable *IC* was no longer significant. On the other hand, the variable *Total number of informal interactions* turned out to have a positive and significant impact on several UBC activities. This finding corroborated the importance acquired by the variable in the literature (Cohen, Nelson and Walsh, 2002; Perkmann and Walsh, 2007; Plewa, Korff, Johnson, et al., 2013; Azagra-Caro et al., 2017), suggesting that the development of informal interactions had a catalyst role in UBC. These findings might support the results of Plewa, Korff, Johnson, et al. (2013), who indicated that informal interactions can be precursors of UBC activities. Even if further analysis is still required, these findings make up for the lack of empirical research into the relationship between informal interactions and formal activities (Azagra-Caro *et al.*, 2017; Vick and Robertson, 2018), contributing to the literature with quantitative evidence that proved the existing relationship.

Several authors have suggested that businesses and universities can cooperate through different UBC activities (e.g. Schartinger *et al.*, 2002; Perkmann and Walsh, 2007; D´Este and Patel, 2007; Bekkers and Bodas Freitas, 2008; Philpott *et al.*, 2011; Davey *et al.*, 2011, 2018; De Fuentes and Dutrénit, 2012; Ankrah and Al-Tabbaa, 2015; Galán-Muros and Plewa, 2016; Skute *et al.*, 2017; Benneworth *et al.*, 2017; García-Pérez-de-Lema *et al.*, 2017; Vick and Robertson, 2018; Alpaydın and Fitjar, 2020; Parmentola, Ferretti and Panetti, 2020; Sharma, 2020) on which determining factors (i.e. drivers, barriers and organisational-related factors) may generate different effects (e.g. Schartinger *et al.*, 2002; Bekkers and Bodas Freitas, 2008; Arza and López, 2011; De Fuentes and Dutrénit, 2012; Galán-Muros and Plewa, 2016; García-Pérez-de-Lema *et al.*, 2017; Vick and Robertson, 2018; Davey *et al.*, 2018; Alpaydın and Fitjar, 2020; Alunurm, Rõigas and Varblane, 2020; Parmentola, Ferretti and Panetti, 2020). Supporting these studies, the results of the models showed that the impact of the organisational context-related factors varied according to the UBC activity. In turn, the impact varied both across and within the variables of the four UBC activity domains. Nevertheless, the results outlined that (i) mobility of students and lifelong learning were determined by the same variables (albeit not to the same extent), (ii) the variable *UBC resources* was positively related to all the activities in the research domain, and (iii) the variable *Size* was positively related to all the activities in the management domain.

Although no clear patterns were found among the variables and the diverse UBC activities, according to the results of the linear regression models, the variables *Size (Size), Exports (Market_BC), Total number of informal interactions (Inf_int_tot), R&D intensity (RD_int), UBC resources (UBC_resources)* and *Cognitive closeness (Cogni_closeness)* were significantly related to some of the UBC activities in the domains of education, research, valorisation and management. The results of the models clearly showed that *UBC resources* was the organisational context-related factor that exerted an impact on a greatest number of UBC activities and in turn, which had the highest impact in almost all the models. More specifically, the variable was found to be positively related to all the UBC activities except for curriculum co-delivery, student entrepreneurship and support. Hence, in agreement with UBC literature, availability of contacts and relationships between SMEs and universities, awareness of what UBC is and what it offers, and UBC support from management can be regarded as cooperation catalysts in most UBC activities (Dyer and Singh, 1998; Santoro and Chakrabarti, 2002; Gulati, 2007; Davey *et al.*, 2012, 2018; Muscio and Pozzali, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Plewa, Korff, Johnson, *et al.*, 2013; Ankrah and Al-Tabbaa, 2015). After *UBC resources*, the variables *R&D intensity*, *Size* and *Total number of informal interactions* were the factors that exerted an impact on a greater number of UBC activities. Finally, *Exports* and *Cognitive closeness* were the factors that had an impact on the least number of UBC activities. With regard to the magnitude of the relationships between the factors and the UBC activities, it can only be stated that it varied according to the UBC activity. It is worth noting that the variable *Exports* was the only variable with a negative impact. As previously stated, even if further research is required, this negative association may be due to a lack of alignment between companies' resources and resource needs, and the resources of universities (Dasgupta *et al.*, 1994; Henderson, McAdam and Leonard, 2006; Bruneel, D´Este and Salter, 2010; Perkmann, Neely and Walsh, 2011; Davey *et al.*, 2018).

With regard to the results obtained in the models, it must be borne in mind that not all the UBC activities were developed to the same extent. The SMEs in the sample undertook more activities in the research and education fields than in valorisation and management. Among the several reasons that could explain this situation, the differences in terms of the commitment required by each UBC activity must be highlighted (De Man, 2004; Davey *et al.*, 2011, 2018; Alunurm, Rõigas and Varblane, 2020). According to Alunurm, Rõigas and Varblane (2020), whilst UBC activities in the domain of education require medium commitment, the UBC activities in the domains of research, commercialisation and management require a greater one.

The sub-sections below offer a brief discussion on the organisational context-related factors identified as determinants of the diverse UBC activities in the different domains of UBC.

8.1.3.2. Education

In the domain of education, mobility of students, curriculum co-design, curriculum co-delivery, dual education and lifelong learning were analysed. Although these activities were grouped in the same domain, it should be noted that they are very different from each other.

Mobility of students and dual education correspond to the work integrated learning (WIL) area and are recognised as essential, since these activities provide graduates with the necessary business experience to innovate successfully and enable the transition from academic environment to work practice (Rampersad, 2015). On the one hand, mobility of students is probably the most common and best-known UBC activity (Galán-Muros and Davey, 2017; Davey *et al.*, 2018), and the results of the study corroborated this statement. This UBC activity turned out to be the one most developed by the manufacturing SMEs in the sample. Mobility of students includes placements or internships in companies (Lamichhane and Sharma, 2010). Thanks to this activity, students gain practical knowledge and possible employment opportunities (Drucker and Goldstein, 2007; Lamichhane and Sharma, 2010) while companies acquire new knowledge and have an opportunity to identify human talent (van Der Sijde, 2012). On the other hand, dual education programmes are an emerging form of higher education, allowing students to complete a degree programme at university whilst simultaneously receiving a certification of work experience in a company (Acatech, 2014, see in Davey *et al.*, 2018). The promotion and implementation of dual education programmes is one of the lines of action of the *I 2022 Basque University-Business Strategy* (Basque Government, 2017). Despite the fact that these activities are both based on WIL, they nonetheless differ significantly from one another. Cooperation in dual education programmes requires companies to have greater commitment and knowledge alignment with universities than mobility of students. On the one hand, dual education programmes require longer periods of time than mobility students, since the combination of lectures and practical learning in a company is carried out throughout the entire duration of the undergraduate, graduate or PhD programmes. On the other hand, cooperation in dual education programmes requires companies to become a practical learning space where students work on the curricular contents required to obtain their graduation. Thus, although it was the second most performed UBC activity, the companies in the sample indicated that they were less involved in dual education programmes than in mobility of students. In turn, with the exception of *UBC resources,* the results of the regression models showed huge differences regarding the determining factors of these two UBC activities. In this connection it is interesting to note the following two findings: First, unlike the results of mobility of students, *Size* and *Cognitive closeness* were positively associated with the development of dual education programmes. This finding supported dual education programmes' requiring higher levels of knowledge alignment (characterised by cognitive closeness) and commitment (characterised by size and resource availability). Second, it was surprising to see that mobility of students was determined by the same factors as lifelong learning. Lifelong learning is understood as the provision of adult education, permanent education and/or continuing education by universities to people employed in external organisations (Galán-Muros and Davey, 2017). Company employees can enrol in university courses, adapted to regional skill needs (Gunasekara, 2006b), or specific in-house training programmes (Caniëls and Van den Bosch, 2011). According to the results of the descriptive analysis, despite the low levels, lifelong learning proved to be one of the most developed cooperation activities in the sample after mobility of students, dual education and joint R&D. As in the case of student mobility, this activity was determined by *Exports (Market_BC), Total number of informal interactions (Inf_int_tot), R&D intensity (RD_int)* and *UBC resources (UBC_resources).* Drawing on this finding, it could be indicated that the manufacturing SMEs that cooperated in mobility of students to a greater extent, also did it in lifelong learning. With regard to the factors identified as the determinants of the cooperation levels of these activities, based on the literature previously discussed in Specific objective 2, it could be suggested that there might be an association between the determining factors of these activities. Student mobility and lifelong learning activities seemed to be developed to a greater extent by companies with higher R&D expenditures and higher AC levels, which in turn might have had higher *UBC resource levels* due to the alignment of resources between both partners and the benefit they considered to obtain from UBC. Moreover, these companies might have developed more informal interactions with universities because they had the AC required to participate in the events that universities participate. Accordingly, even if further research is required, the negative impact of *Exports* might be explained by the fact that companies with higher local sales could be (i) industrial subcontracting companies without their own product providing services to driving-force companies and other companies under the technical design from the contractor, (ii) non-technological manufacturing SMEs or (iii) low-value aggregated manufacturers. That is to say, these companies are the opposite of export-oriented companies, seemingly requiring neither university knowledge, which is characterised by being more basic and long-term oriented (Dasgupta *et al.*, 1994; Henderson, McAdam and Leonard, 2006; Bruneel, D´Este and Salter, 2010; Perkmann, Neely and Walsh, 2011; Davey *et al.*, 2018), nor highly-skilled employees.

Curriculum co-design and curriculum co-delivery are related to the joint delivery of programmes, courses, modules and planned experiences between academics and businesses within undergraduate, graduate or PhD programmes (Davey *et al.*, 2011; Galán-Muros and Davey, 2017). The descriptive analysis noted that both activities were one of the least developed UBC activities by the manufacturing SMEs in the sample. In accordance with the results of the models, these UBC activities were determined by different organisational context-related factors. On the one hand, curriculum co-design was positively related to size and UBC resources. These findings suggested that larger companies (possibly regional driving-force companies) with strong relationships with universities were the ones that cooperated to a greater extent in curriculum co-design. On the other hand, curriculum co-delivery was positively related to informal interactions and cognitive closeness. These findings indicated that companies (i) with closer cognitive proximity to university, which considered themselves more capable of absorbing the knowledge of the university and more able to offer knowledge to universities both in education and R&D, and (ii) that developed informal interactions to a greater extent (companies that were more open and proactive to participate in different kinds of events with university participation) were the ones that cooperated to a greater extent in curriculum co-delivery; that is to say, companies whose knowledge was aligned with university knowledge and were willing to interact with external agents to acquire and disseminate knowledge.

8.1.3.3. Research

As regards the domain of research, Joint R&D, Consultancy and Mobility of staff were analysed. Joint R&D can be defined as an arrangement in which partners cooperate to jointly achieve research objectives, independent of funding (Galán-Muros and Davey, 2017). With regard to consultancy activities in the field of R&D, these include contract research (Cohen, Nelson and Walsh, 2002; D´Este and Perkmann, 2011) and R&D consulting (Cohen, Nelson and Walsh, 2002). Finally, mobility of staff is the temporary movement of employees between universities and businesses for work-related purposes (Galán-Muros and Davey, 2017).

As previously indicated, the results of the models showed that *UBC resources* had a positive effect on all the activities included in the domain. In turn, this factor exhibited the strongest impact in the three models. Thus, it could be stated that contacts and relationships with universities, awareness of UBC and its benefits, and management support were key in the development of research-related activities. Surprisingly, it was observed that *R&D intensity* only related positively to joint R&D and staff mobility. Accordingly, it could be stated that consultancy did not require such intensive levels of R&D and AC. The results of the models also suggested that *Informal interactions* were positively associated with joint R&D and consultancy, whilst mobility of staff was positively related to size. These results suggested that joint R&D and consultancy were catalysed by social interactions and companies' openness, whilst mobility of staff was associated with larger company sizes and thus, with the availability of resources, such as having more R&D staff.

8.1.3.4. Valorisation

In relation to the UBC activities in the valorisation domain, commercialisation, student entrepreneurship and academic entrepreneurship were analysed. Commercialisation is the process of bringing scientific research and technologies to the market through the trading of intellectual property assets (Galán-Muros and Davey, 2017). Entrepreneurship in relation to UBC is described as actions involving universities in the creation of new ventures (Tornatzky *et al.*, 2002).

The results of the descriptive analysis showed that companies in the sample cooperated at very low levels with regard to the activities in the valorisation domain, specifically in student entrepreneurship (the least developed UBC activity among the 14 activities). In line with the results of the previous domains, it was observed that *UBC resources* exerted a positive impact in almost all the UBC activities included in the domain. Specifically, the variable was related to commercialisation and academic entrepreneurship. Nevertheless, the impact of *UBC resources* on commercialisation was stronger than the impact on academic entrepreneurship. According to the results of the regression models, commercialisation and academic entrepreneurship were also positively associated with *R&D intensity*. This finding suggested that these UBC activities were more closely linked to companies with higher research intensity than academic entrepreneurship. However, unlike academic entrepreneurship, commercialisation was positively associated with firm size, thereby suggesting that commercialisation activities were linked to SMEs' availability of resources. In contrast to the results of commercialisation and academic entrepreneurship, an interesting positive relationship was found between student entrepreneurship and *Cognitive closeness*. In this connection, it was suggested that the companies, which considered themselves more capable of receiving and offering knowledge to universities, were those that cooperated more in this activity. Although further research is needed, the negative association between student entrepreneurship and *Exports* might indicate that, unlike local-oriented companies, export-oriented companies are more prone to cooperate to a greater extent in student entrepreneurship.

8.1.3.5. Management

Concerning the domain of management, governance, shared resources and support were analysed. Governance refers to the participation of academics on business boards and business people participating in university boards. Activities regarding shared resources include sharing resources with universities such as infrastructure, personnel or equipment, while support-related activities cover endowments, sponsorship and scholarship from the business sphere to university (Davey *et al.*, 2018). In line with the results of the UBC activities related to valorisation, the results of the descriptive analysis showed that the manufacturing SMEs in the sample cooperated at very low levels in management-related activities. While participation in support-related activities may be a more sporadic activity, taking part in governance or engaging in resource-sharing implies a greater commitment for companies. This characteristic may be explained by the dynamic nature and evolution of the UBC relationship, and thus, further research is required. Based on the literature discussed in the results of Specific objective 2 and the results obtained, the following main conclusions were drawn. On the one hand, it was observed that all the activities in the domain were positively related to SMEs' size, and it could therefore be stated that management-related activities were associated with larger companies. On the other hand, it was observed that shared resources and support-related activities were related to *R&D intensity*. As regards the relationship between *R&D intensity* and shared resources, this was quite clear since the vast majority of resources shared by universities and companies, i.e. infrastructure, personnel or equipment, are related to R&D. In relation to support-related activities, it was observed that in addition to *Size* and *R&D intensity*, this activity was related to *Total number of informal interactions* and *Cognitive closeness*. This was an interesting finding since these positive relationships suggested that companies with higher AC levels and higher business openness, which took part to a greater extent in events with the participation of universities, were more prone to support universities with endowments, sponsorship or/and scholarships. Moreover, the positive relationship with *Cognitive closeness* showed that companies, which consider themselves more able to contribute to universities in education and research, were more cooperative in support-related activities.

8.1.4. Specific objective 4

The following sub-section deals with the discussion of the results obtained for Specific objective 4. This specific objective sought to clarify the role of AC on SMEs' cooperation levels in diverse UBC activities within the domains of (i) education: mobility of students, curriculum co-design, curriculum co-delivery, dual education programmes and lifelong learning, (ii) research: joint R&D, consultancy and mobility of staff, (iii) valorisation: commercialisation, academic entrepreneurship and student entrepreneurship, and (iv) management: governance, shared resources and support. Moreover, this objective aimed to analyse and compare the influence of AC, operationalised as (i) *R&D intensity* and as (ii) a latent construct based on businesses' routines and internal processes with regard to external knowledge, differentiating potential absorptive capacity (*PAC)* and realised absorptive capacity (*RAC).*

In order to address Specific objective 4, 42 hypotheses were tested through the analysis of 14 models by an SEM approach. According to the results obtained in these models, on the one hand, all the UBC activities were significantly and positively related to *R&D intensity* with the exception of governance. Thus, all the hypotheses regarding *H3: R&D intensity has a positive and significant influence on cooperation levels in*

UBC activities were confirmed with the exception of H3l (governance). This UBC activity was found to be solely significantly and positively related to *Size*, the control variable. On the other hand, the results of the models revealed that the variables *PAC* and *RAC* were related significantly and positively to a lower number of UBC activities.

The variable *PAC* captured the efforts expended by SMEs in identifying and acquiring new external knowledge, and in assimilating knowledge obtained from external sources (Zahra and George, 2002; Jansen, Van Den Bosch and Volberda, 2005; Flor and Oltra, 2013; Flor, Cooper and Oltra, 2018). Drawing on the literature, it was expected that SMEs with higher *PAC* levels would show higher cooperation levels with regard to those UBC activities that allow them to identify, acquire and assimilate new knowledge. This association was supported by the results, by the emergence of the positive relationship between *PAC* and mobility of students, lifelong learning, joint R&D and consultancy. Hence, as to *H1: PAC has a positive and significant influence on cooperation levels in UBC activities,* hypotheses H1a, H1e, H1f and H1g were confirmed. It must be highlighted that these UBC activities were the most developed by the SMEs in the sample. Even though this variable was related to a smaller number of UBC activities than *R&D intensity*, surprisingly, the magnitude of the relationship between *PAC* and the aforementioned UBC activities was higher than the magnitude of the relationship of these variables with *R&D intensity*.

The variable *RAC* considered SMEs' knowledge transformation and exploitation, and encompassed new insights and consequences from the combination of existing and newly acquired knowledge (Zahra and George, 2002). As to *RAC*, this variable was found to be exclusively related significantly and positively to mobility of staff. Hence, with regard to *H2: RAC has a positive and significant influence on cooperation levels in UBC activities,* hypothesis H2h was confirmed. Drawing on the results of the models, the variable *PAC* turned out to be significantly and positively related to more UBC activities than the variable *RAC*. In addition, it was observed that both AC's dimensions exhibited a significant and positive relationship with different UBC activities. This gave rise to an interesting finding: the differentiation of AC into its two dimensions, *PAC* and *RAC,* provided further details of the impact of AC on manufacturing SMEs' cooperation levels. This differentiation exhibited which UBC activities were developed at higher levels by the companies that developed to a greater extent processes and routines related to the acquisition and assimilation of external knowledge; and which were developed by the companies that developed to a greater extent processes and routines related to external knowledge transformation and exploitation. This was a striking finding since it suggested that those manufacturing SMEs that were able to transform and exploit external knowledge from the universities were the ones that cooperated in mobility of staff to a higher extent.

Given that the significant relationships found between the UBC activities and *R&D intensity*, *PAC* and *RAC* were in all cases positive, the results suggested that AC, independent of its operationalisation, had a positive impact on manufacturing SMEs' cooperation levels. These results mirrored those of the previous studies that found a positive relationship between AC and UBC (Cassiman and Veugelers, 2002; Hervas-Oliver, Albors-Garrigos and Baixauli, 2011; Hewitt-Dundas, 2013; Galán-Muros and Plewa, 2016; Lehmann and Menter, 2016; García-Pérez-de-Lema *et al.*, 2017; Biedenbach, Marell and Vanyushyn, 2018).

As regards AC's operationalisation, which has caused controversy in the literature due to the several constructs proposed for its analysis (Vega-Jurado, Gutiérrez-Gracia and Fernández-De-Lucio, 2008; Bishop, D'Este and Neely, 2011; Roberts *et al.*, 2012; Miller *et al.*, 2016), the following finding was revealed. In accordance with the results of the study, the impact of AC on manufacturing SMEs' cooperation levels in the diverse UBC activities varied according to the operationalisation used. The differences found in the models with regard to the impact of *R&D intensity* and *PAC* and *RAC,* gave rise to the suggestion that *R&D intensity* conditioned the development of more UBC activities than businesses' routines and internal processes with regard to external knowledge. Hence, supporting previous studies (Peer and Penker, 2014; Veugelers and Rey, 2014; Lehmann and Menter, 2016), the results of the study suggested that companies might have required a minimum AC level to be able to cooperate with universities in most of the UBC activities. Accordingly, although further research is needed, *R&D intensity* might be a better indicator of the capacity of a manufacturing SME to absorb universities' knowledge than PAC and RAC. Nevertheless, the significant relationships found between *PAC* and *RAC* and some UBC activities indicated that not only a minimum R&D intensity level was necessary to cooperate, but also higher PAC and RAC levels were required to cooperate in some UBC activities to a higher extent. This finding showed that cooperation levels in some UBC activities were not only dependent on the alignment of SMEs' and universities knowledge base, or the alignment of SMEs' and universities' resources, but also on SMEs' internal routines and processes with respect to external knowledge.

Finally, it is worth noting that, if the results achieved for Specific objective 4 are compared with the results obtained for Specific objective 3, the importance of *R&D intensity* and *Size* (control variable) decreases; in other words, with the introduction of more organisational context-related factors, these variables lose their importance.

8.2. Conclusions

The sub-sections below describe the final conclusions drawn from the study.

8.2.1. Profile of cooperating manufacturing SMEs

As an overall conclusion about the profile of cooperating manufacturing SMEs, it can be stated that cooperating SMEs have more resources and more advanced capabilities than non-cooperating SMEs. In addition to having more funding and human resources, cooperating manufacturing SMEs are more open to cooperating with external partners, have broader networks, make greater efforts regarding external cooperation and carry out informal interactions to a greater extent. These SMEs are more active in the development of R&D activities, have greater absorptive and innovation capacities, along with the development of more radical innovations. Accordingly, these companies have greater cognitive closeness to universities since they have, on the one hand, a greater capacity to absorb knowledge coming from universities, and on the other hand, a greater capacity to offer knowledge to universities both in education and R&D. Furthermore, cooperating SMEs display more willingness for UBC and greater support. Cooperating SMEs have more contacts and relationships with universities, greater management support regarding UBC and a higher understanding of what cooperation with universities involves and what it offers. In addition, cooperating SMEs believe to a greater extent that universities play a key role in their efforts to innovate and feel greater responsibility towards cooperation with universities in both, education and research.

With regard to the variables *LLL development*, *LLL commitment*, *Location*, *Legal form*, *Headquarters* and *Age*, it is concluded that despite the fact that they do not differ between cooperating and non-cooperating SMEs, deeper analyses might reveal the emergence of different UBC patterns. Finally, as to the variable *Location*, it is concluded that the province in which the companies are located does not turn out to be a differentiating factor. Nevertheless, this conclusion does not diminish the importance of the regional context, since all the companies are under a common regional umbrella (the Basque Autonomous Community).

8.2.2. Organisational context-related factors that determine manufacturing SMEs' likelihood to cooperate with universities

Based on the results of the final logistic regression model, it is concluded that companies' *Size*, *R&D intensity*, *UBC resources*, *Cognitive closeness*, *Exports* and *IC* determine the likelihood that an SME will cooperate with universities. According to this finding and the theoretical underpinnings previously discussed, the main conclusion is that the likelihood of an SME's cooperating with universities increases (i) as SMEs' capacity to absorb universities' knowledge increases, (ii) as SMEs' scientific orientation and knowledge base are closer to universities' knowledge, and (iii) as SMEs' availability of resources and funding increase. Hence, and in accordance with the RBV theory, it is concluded that, in general, the likelihood that manufacturing SMEs will cooperate with universities increases as the alignment between SMEs' resources and SMEs' resource needs become closer to universities' resources. That is to say, the manufacturing SMEs are more likely to cooperate with universities when they can obtain benefit from it.

The individual analysis of the factors identified as determinants also leads to the following conclusions. Firstly, given the positive effect of *Size*, UBC literature and UBC policies should bear in mind any variances that could appear among SMEs according to their size. Thus, it is not only necessary to analyse the differences that could exist among micro, SME and large companies, but it is also necessary to analyse the patterns that could exist within the SME category itself. Secondly, according to the results of the model, *UBC resources* show the highest positive impact among all the variables that have a significant effect on the likelihood that an SME will cooperate with universities. This finding shows that contacts and relationships that SMEs have with universities, their management support for UBC and their level of understanding of what cooperation with universities is and what it offers are equally as important as SMEs' capacity to absorb universities' knowledge, SMEs' scientific orientation and knowledge base, and SMEs' resources and funding. Thirdly, even though further analysis is required, the negative impact of *IC* leads to the conclusion that manufacturing SMEs in the sample do not, generally speaking, consider universities as a partner for innovation, unless they meet the previously described characteristic conducive to UBC. Similarly, the negative impact of *Exports*, an indicator of local sales, gives rise to the fourth conclusion, namely, that companies with higher local sales, such as industrial subcontracting companies, without an own product, which provide services to driving-force companies and other companies (Basque Government, 2007; European Commission, 2018, 2021a; Orkestra, 2018) are unlikely to engage in UBC, unless they meet the aforementioned conducive characteristics.

As a conclusion of the two-stage process carried out to explore and identify the determinant factors, it can be stated that the identification of the organisational context-related factors requires a holistic analysis, including the different groups of factors identified in the literature. With regard to the differences found between both stages, the positive impact of *UBC resources,* even though none of the variables in the group "Business openness" is significant in the final inter-group model, underlines the importance of relational aspects in cooperation likelihood. This leads to the conclusion that the likelihood of a manufacturing SME's cooperating with universities is determined by the specific contacts and relationships that the SME has with universities and not by how open it is to cooperation with external partners.

Given the large number of UBC activities through which companies can cooperate with universities, and the huge differences among them, it is concluded that the identification of the factors should be performed by type of UBC activity rather than cooperation in general. It is also concluded that the sample is too heterogeneous to obtain specific conclusions. Manufacturing SMEs include a wide variety of activities, sectors and sizes, and the conclusions reached are therefore very general.

8.2.3. Towards higher UBC levels

Based on the results of the study, not all the activities are developed to the same extent. According to the results, the most developed UBC activity is mobility of students, followed by dual education, joint R&D, lifelong learning and consultancy, activities belonging to the education and research domains. While cooperation levels in these activities are low, cooperation levels in the remaining activities – mobility of staff, shared resources, support, curriculum co-design, curriculum co-delivery, commercialisation, academic entrepreneurship, governance, and student entrepreneurship – are even lower. From these results, it is concluded that UBC activities in the valorisation domain, together with governance (management), are the activities least developed by the companies in the sample.

The results for cooperation levels in different UBC activities lead to the conclusion that the most developed activities are those that the manufacturing SMEs considered to be most beneficial. Nevertheless, the following two conclusions are also drawn. On the one hand, it is concluded that these activities can be those most familiar to the companies in the sample. Thus, it could be that these SMEs do not cooperate, or cooperate less, in the remaining activities due to a lack of knowledge. On the other hand, the low participation in the activities carried out to a lesser extent can be a consequence of the fact that they require greater commitment from companies, and could even be activities that take place at more advanced stages of the cooperation relationship. It is therefore concluded that the determinants of these less developed activities offer clues as to the type of SME that has a greater commitment and a more advanced stage of cooperation with universities.

As regards the conclusions about the factors determining the levels of cooperation, firstly, it is concluded that the organisational context-related factors determining the likelihood of cooperation differ from the factors determining the levels of cooperation in the diverse UBC activities. Two important conclusions are obtained with regard to these differences. On the one hand, *IC* is a factor that determines the likelihood of cooperation but not the levels of cooperation. On the other hand, and contrary to *IC*, *Total number of informal interactions* does not determine the likelihood of cooperation but does determine the levels of cooperation. This finding, gives rise to the conclusion that the development of informal interactions results in a catalyst of cooperation levels in some activities. Although further research is required, it can be concluded that informal interactions lead to the development of formal activities.

Secondly, the results obtained in the models lead to one of the most important conclusions of the study: the levels of cooperation in the diverse UBC activities are determined by different organisational context-related factors. These variances appear both among activities in different domains and within the same domain. Thus, it is concluded that cooperation activities are very different from each other and therefore need to be analysed independently, without losing sight of the overall UBC framework.

Thirdly, even though they have an impact on different UBC activities and at different levels, as a general conclusion, it can be indicated that the levels of cooperation in the various UBC activities are determined by *Size, Exports, Total number of informal interactions*, *R&D intensity*, *UBC resources* and *Cognitive closeness*. Furthermore, the broad impact of *UBC resources* suggests that, in addition to being key in determining the likelihood of cooperation, the availability of contacts and relationships between SMEs and universities, awareness of what UBC is and what it offers, and UBC support from management are catalysts for most UBC activities. In turn, it is also concluded that after *UBC Resources*, *R&D intensity*, *Size* and *Total number of informal interactions* are the factors that exert an impact on a greater number of UBC activities. This fact reinforces again the conclusion that the availability of resources, absorptive capacity, relationships, knowledge of what UBC is and what it offers, together with management support are key in UBC. In addition, the study concludes that the only factor that has a negative impact on cooperation levels is *Exports*, which is measured as a percentage of local sales.

The specific conclusions on the determinants of the different UBC activities are described below, starting with the field of education. In relation to the factors that determined student mobility, first, the positive impact of *R&D intensity* gives rise to the conclusion that R&D intensive companies seem to be more cooperative in student mobility due to the fact that these companies could have a greater need for university profiles. In contrast, the negative impact of *Exports* leads to the conclusion that companies with greater local sales cooperate less because they do not require further university profiles in their companies. These companies could be more prone to cooperate with vocational training centres. This reinforces the previous conclusion that companies with higher local sales are less likely to cooperate with universities due to a lack of resource alignment with universities. The positive impact of *Total number of informal interactions* produces the following conclusions. First, this finding results in the conclusion that companies that are more open to absorbing external knowledge and to being in contact with external partners find it more beneficial to host students on their premises. Second, it is concluded that the development of informal interactions provides companies with the necessary contacts and knowledge of UBC, and they therefore cooperate with universities to a greater extent. Third, this result gives rise to the conclusion that perhaps these companies not only cooperate to a greater extent because they are more open, and have more university contacts, but also because they have a higher AC, which enables them to take part in events with university participation.

According to the results, mobility of students and lifelong learning are determined by the same factors. This finding leads to the conclusion that those SMEs that most cooperate with universities in mobility of students also do so in lifelong learning. Thus, it is concluded that the type of manufacturing SME that benefits from mobility of students benefits equally from lifelong learning.

Even though mobility of students and dual education are involved in the area of WIL, one of the main findings of the study deals with the existing differences between both activities. In contrast to student mobility, cooperation in dual education is determined by *Size* and *Cognitive closeness*. Thus, it is concluded that larger companies with closer cognitive proximity undertake this activity to a greater extent. In other words, those companies that have the ability and resources to transform their companies into a learning space where students can work on curricular contents cooperate more in dual education. Hence, the lower cooperation levels in dual education could be caused by the fact that this activity seems to require more resources and closer cognitive proximity than mobility of students.

Concerning curriculum co-design and curriculum co-delivery, the following two conclusions are obtained. On the one hand, the determining factors of curriculum co-design, *Size* and *UBC resources*, lead to the conclusion that this activity could be mainly developed by regional driving-force companies, which, due to their weight in the region and awareness of the market, may have a stronger relationship with universities, together with sufficient influence to contribute to the definition of the curriculum that will affect the abilities and knowledge of future employees. On the other hand, the factors that determine curriculum co-delivery, *Total number of informal interactions* and *Cognitive closeness* give rise to the conclusion that (i) companies with closer cognitive proximity to university, which consider themselves to be more capable of absorbing the knowledge of the university and more able to offer knowledge to universities both in education and R&D, and (ii) companies that develop informal interactions to a greater extent (companies that are more proactive and open to taking part in different kinds of events with university participation and which may have greater university contacts) are the ones that cooperate to a greater extent in this activity. Therefore, companies whose knowledge is aligned with universities' knowledge and are willing to interact with external agents to acquire and disseminate knowledge cooperate in curriculum co-delivery to a greater extent.

As regards the research domain, it is concluded that *UBC resources* i.e. contacts and relationships with universities, awareness of UBC, and management support are key in the development of all the research-related activities. Another important conclusion is that, unlike Joint R&D and staff mobility, consultancy does not require that companies have a high R&D intensity to cooperate to a greater extent. This leads to the conclusion that SMEs engage in consultancy regardless of their R&D intensity. Nonetheless, the fact that this activity is negatively related to *Exports* and positively related to *Total number of informal interactions* results in the conclusion that SMEs with higher value-added products and services are the ones that cooperate to a greater extent in this activity. With regard to staff mobility, it is concluded that this activity is carried out to a greater extent by more R&D-intensive large companies, which have more resources, funding, personnel and laboratories at their disposal and stronger relationships with universities. Regional driving-force companies could be the SMEs that cooperate in mobility of staff to a greater extent. As for joint R&D, it is concluded that this activity is not size-dependent but determined by relational aspects and the capacity of SMEs to absorb university knowledge.

With regard to valorisation-related activities, the following conclusions are obtained. First, the low cooperation levels in these activities lead to the conclusion that these activities are carried out mainly by some specific types of SME, which could be in more advanced stages of a UBC relationship and have closer ties with universities. As to the factors determining each of the research-related activities, the following conclusions are produced. In relation to commercialisation, it is concluded that this activity is carried out to a greater extent by larger companies with higher R&D intensity. As regards academic entrepreneurship, it is concluded that this activity is developed to a greater extent by companies with a higher R&D intensity and a stronger relationship with universities. Thus, it is concluded that launching new joint business projects not only requires technical capacity, but also a strong relationship with and support from SMEs' management. As to student entrepreneurship, it is concluded that this activity not only requires that companies should be able to absorb knowledge from the university, but also that they feel able to offer knowledge to the university. In turn, the negative impact of local sales leads to the conclusion that export-oriented companies could be more prone to cooperate to a greater extent in this activity.

Concerning activities in the domain of management, it is observed that, generally speaking, all the activities in this domain are associated with larger companies. This leads to the conclusion that these activities could be developed to a greater extent by regional driving-force companies, which have a closer and more advanced relationship with universities due to their regional influence and greater cooperation in all the other UBC activities. This conclusion is clearly seen in the case of governance, which is determined by *Size* and *UBC resources.* As regards shared resources, the results of the study lead to the conclusion that R&D-intensive larger companies, which have more resources at their disposal, cooperate in this activity to a greater extent. Nevertheless, the high impact of *UBC resources* on shared resources results in the conclusion that the manufacturing SMEs that cooperate to a greater extent in this activity not only have a larger size and higher R&D intensity but also more contacts, relationships, UBC knowledge and management support for UBC. With regard to support, which can be considered as a more sporadic UBC activity requiring less commitment than taking part in governance or engaging in resource-sharing, the results show that this activity is developed to a greater extent by companies that consider themselves capable of both absorbing and providing knowledge to the university, and which are more open to external cooperation and knowledge.

To finish with the conclusions regarding the organisational context-related factors that determine the cooperation levels in the different UBC activities, the conclusions about the role of AC are now underlined. First, it should be noted that, regardless of the operationalisation used, AC has a positive impact on those UBC activities for which a significant association is found (all the UBC activities except from governance). Second, it is concluded that AC has a different impact on different UBC activities depending on the operationalisation used. The operationalisation of AC as SMEs' *R&D intensity* related to a greater number of UBC activities (all the UBC activities except governance) than the operationalisation of AC based on SMEs' processes and routines regarding external knowledge, i.e. *PAC* and *RAC*. This finding leads to the conclusion that *R&D intensity* is a better indicator of the capacity of manufacturing SMEs to cooperate and absorb university knowledge than the constructs based on internal processes and routines with respect to external knowledge, even concluding that SMEs require a minimum R&D orientation in order to cooperate with universities to a greater extent. Third, the fact that the variables *PAC* and *RAC* have an impact on UBC activities together with *R&D intensity*, the association of *PAC* being stronger than *R&D intensity*, leads to the conclusion that SMEs not only need a minimum of R&D orientation to cooperate with universities to a greater extent, but also it is necessary for companies to be proactive and make an effort in relation to external knowledge acquisition, assimilation, transformation and exploitation. Fourth, the fact that *PAC* and *RAC* are found to be related to the development of different UBC activities leads to the following conclusions. On the one hand, it is concluded that some UBC activities, such as mobility of students, lifelong learning, joint R&D and consultancy, are developed to a greater extent by the SMEs that make greater efforts in relation to the acquisition and assimilation of external knowledge. On the other hand, it is concluded that mobility of staff is developed to a greater extent by those SMEs that are more capable of transforming and exploiting external knowledge. Hence, it can be stated that certain UBC activities are developed to a greater extent when SMEs are able to transform and exploit knowledge at a higher level.

8.2.4. Recommendations for the promotion and support of UBC

Based on the results and conclusions of the study, the following lines contain a series of recommendations for policymakers and UBC stakeholders to be taken into account in the promotion and support of UBC.

First, it could be stated that cooperation between universities and manufacturing SMEs presents two major challenges. On the one hand, it is necessary to increase the number of SMEs that cooperate with universities. On the other hand, it is necessary to make efforts both to increase cooperation levels in diverse UBC activities and to advance UBC relationships. With regard to increasing the number of manufacturing SMEs cooperating with universities, specific mechanisms are required to foster cooperation among smaller and non-R&D SMEs, which seem to be less likely to cooperate with universities. In the case of these companies, it is considered that UBC could start with ad hoc training or consultancy activities, thereby helping them to improve their AC. These UBC activities would give rise to more advanced cooperation activities in the future. In this connection, the results of the study also seem to indicate that the actions needed to improve cooperation levels in the diverse UBC activities should also include the improvement of SMEs' AC. To this end, it is essential that, while continuing developing basic and long-term research, universities also adapt their activity to answer the needs of these kinds of companies. Such a transformation calls for public policies to encourage and promote academics in the involvement of these practices. In addition to the development of actions that improve SMEs' AC, both increasing the number of SMEs cooperating with universities and improving the levels of cooperation and advancing UBC relationships require specific actions for SMEs to:

- (i) acquire knowledge of the different types of existing UBC activities and the benefits that they can obtain from them
- (ii) acquire initial contacts with universities, leading to the establishment of informal interactions that could lead to formal cooperative relationships
- (iii) make company management aware of the benefits and importance of cooperation in order for them to increase their support for the UBC.

Second, it would be interesting to develop a specific UBC public body for the development and management of UBC strategies, policies and mechanisms that goes hand in hand with the Ministry of Education and the Ministry of Economic Development. Given the large number of UBC activities and the consequent multitude of stakeholders on both the university and the business side, it would be of great interest to set up a public body in charge of orchestrating all these actors. This public body should generate synergies, make efficient use of existing resources and promote UBC from a holistic perspective without neglecting any type of UBC activity. The existence of a specific public body that brings together all UBC stakeholders would play a key role in defining UBC policies adapted to the reality of both spheres since a proper definition of UBC policies and mechanisms requires awareness of both the needs of industry and the needs of the three missions of universities. In addition, the implementation of a UBC public body is essential to raise awareness among all public agents that can contribute to the promotion of UBC, such as development agencies, cluster associations, business associations or chambers of commerce, which often act as bridges between companies and universities.

8.3. Limitations

This study is not without its limitations. First, it is worth highlighting the limitations encountered in relation to the measurement levels and operationalisation of the variables included in the study. In order to facilitate completion of the questionnaire by the participating SMEs and, to obtain the greatest number of responses, the strategies followed led to the following series of constraints. On the one hand, the use of variables based on ranges and Likert-type scales made the results of the study less precise and more subjective than if purely interval or ratio variables had been used. On the other hand, the fact that the questionnaire was filled in by a unique respondent could have led to common method bias (CMB) (Podsakoff and Organ, 1986). Nonetheless, in order to lessen the effect that this limitation might have had, special attention was paid to avoiding social desirability bias (SDB), one of the major causes of CMB (Jordan and Troth, 2020), when drafting the questionnaire. As regards the outcome variables, it is essential to indicate that no time frame was indicated when asking the manufacturing SMEs (i) whether they cooperated or had ever cooperated with universities, or (ii) the extent to which they cooperated or had cooperated with universities. This omission made it impossible to know when cooperation had taken place or whether the organisational context-related factors were similar at this moment. Despite the implications that this could entail, given the slow pace of organisational change, it was considered that this limitation might not have had an impact on the results. In relation to the variable *Exports*, it must be stressed that the use of a measurement of the percentage of the local sales of the SMEs in the absence of a direct measurement of SMEs' export orientation led to an important limitation. Thus, the results concerning the impact of the export orientation of SMEs should be interpreted cautiously.

Second, the limitations with regard to the inference of the results should be acknowledge. On the one hand, the failure to meet the assumptions of the linear regression meant that the results of the models developed for the identification of the factors that determined SMEs' cooperation levels in the diverse UBC activities (Specific objective 3) could not be extrapolated to the population. On the other hand, the importance of the regional context in the analysis of UBC implied that the results achieved in this study could be useful for regions which share similar structural conditions to the Basque Country (European Commission, 2014) such as Aragón (Spain), Emilia-Romagna (Italy), West Midland (England - United Kingdom), Niederösterreich (Austria), Piemonte (Italy), Niedersachsen (Germany), Schleswig-Holstein (Germany), Wales (United Kingdom), Comunidad Foral de Navarra (Spain) and Nordrhein-Westfalen (Germany).

Third, the focus on manufacturing SMEs limits the knowledge generated to this specific industry. In turn, the study only analyses SMEs' perspective and it should be complemented with universities' point so as to have an overall picture of the phenomenon.

Fourth, as regards data collection techniques and procedures, despite all the efforts made to develop a high quality questionnaire, the fact that data was collected by means of both an internet-mediated questionnaire (self-administered) and a structured questionnaire (face-to-face) may have led to obtaining better quality data from the latter.

Fifth, the main exploratory character of the study constrains the achievement of more accurate results and conclusions.

Sixth, it is necessary to point out that the data analysed was prior to the Covid-19 crisis, so the results and conclusions obtained should be contrasted with post-pandemic data.

Finally, to conclude with the limitations of this study, it should be noted that, although these limitations set out the scope of the present study, they also guided future research to generate greater knowledge of UBC.

8.4. Future lines of research

This study led to the identification of a series of unknowns and research gaps that require undertaking in future research.

First, it would be interesting to carry out qualitative studies that enable more in-depth conclusions to be drawn about the quantitative results obtained. Furthermore, future studies should clarify the role of export orientation on UBC. In addition, future research should focus on the analysis of companies with higher local sales, thereby identifying those barriers that hinder their cooperation with universities. It would be also relevant to conduct studies into the identification of the organisational context-related factors that determine both cooperation likelihood and cooperation levels in diverse UBC activities in more specific samples regarding industrial activity, industry and size. Moreover, given the importance of size, it would be advisable to carry out studies that identify the possible patterns that could emerge with regard to companies' size and related characteristics.

Future studies should also examine the relationship between the development of informal interactions and cooperation levels in diverse UBC activities. These studies should analyse whether the development of UBC activities is a consequence of the development of informal interactions, or whether a positive association between this variable and UBC activities exists because companies undertaking informal interactions have greater AC. In this connection, on the one hand, future studies should analyse whether a minimum of AC is necessary to be able to cooperate with universities. On the other hand, future research should also analyse which operationalisation is best for measuring the AC needed to absorb knowledge from the university. In turn, the UBC literature should analyse whether SMEs with higher AC levels have closer cognitive proximity to universities.

In relation to the negative impact of IC on the likelihood that a manufacturing SME would cooperate with universities, future studies should go deeper into the causes that may explain this negative causality in detail. Concerning the importance of the variable *UBC resources,* both on cooperation likelihood and cooperation levels in the diverse UBC activities, a prominent line of research would focus on the identification of the types of companies that have the highest and lowest levels. In other words, it is important to identify what kind of companies have the most and the least university contacts, previous relationships, knowledge of what UBC is and what it offers, and management support. Additionally, identification of the factors that increase *UBC resources* in companies should be attempted.

As a future line, it would be also interesting to analyse the relationship between the activities that SMEs undertake simultaneously. Moreover, it would be interesting to identify which UBC activities trigger which depending on the characteristics of the company. In this connection, it is important to note that longitudinal studies should be carried out in order to analyse the evolution of the development of UBC activities and how the impact of UBC drivers and barriers varies during this evolution. What is more, on the one hand, it would also be of great interest to analyse the barriers that hinder cooperation in the less developed activities. On the other hand, it would be a major contribution to reveal whether the UBC activities developed to a lower extent are developed by companies in more advanced stages of UBC relationship. In addition, the characteristics of these companies should be analysed.

Given the importance of the regional context in shaping UBC, a comparison between the regions with similar structural conditions should be made in order to contrast the results obtained, and to make a benchmark of their UBC policies and mechanisms, with the aim of identifying the most appropriate ones. Finally, it is particularly important to develop studies with post-pandemic data to assess the changes that may have occurred in UBC as a result of the Covid-19 pandemic. Furthermore, it is vital to identify the role that universities have played in seeking solutions to the new social and economic challenges that have emerged as a result.

8.5. Contributions

This research contributes to the theoretical and practical development of UBC from a holistic perspective, testing relationships between organisational context-related factors and a wide variety of UBC activities that had never been tested before. These insights contribute to different research fields, such as entrepreneurial universities, knowledge and technology transfer and management, regional innovation systems, etc.

The sub-sections below describe both the theoretical contributions of the study to the literature, and the practical contributions for UBC stakeholders and UBC practitioners.

8.5.1. Contributions to the literature

Before describing the theoretical contributions of this study, it is worth highlighting the main features that make this study ground-breaking with respect to previous studies. On the one hand, unlike the vast majority of studies on the determinants of UBC, which exclusively focused their attention on UBC as the development of joint R&D projects (e.g. Hall, Link and Scott, 2001; Barnes, Pashby and Gibbons, 2002; Carayol, 2003; Mora-Valentín, Montoro-Sánchez and Guerras-Martín, 2004; Fontana, Geuna and Matt, 2006; Laursen and Salter, 2006; Bruneel, D´Este and Salter, 2010; Bodas Freitas, Geuna and Rossi, 2013; Plewa, Korff, Baaken, *et al.*, 2013; Rosendo-Ríos, Ghauri and Zhang, 2016; Santos *et al.*, 2020), this study contributes to the literature with empirical holistic knowledge on 14 different UBC activities. Specifically, the study provides insights into the diverse UBC activities included in the classification developed by Davey *et al.* (2018), who classified UBC activities into the domains of education, research, valorisation and management. On the other hand, the extensive literature review on the organisational context-related factors that could have had an impact on UBC provides hitherto non-existent holistic and in-depth knowledge.

The theoretical contributions arising from the four specific objectives addressed are listed below.

Firstly, the results for Specific objective 1 provide a detailed description of the differences between cooperating and non-cooperating manufacturing SMEs in relation to a wide range of organisational context-related factors classified into the following groups: general business characteristics, business openness, R&D, LLL, AC, innovation and UBC willingness and support. In turn, they provide the description of the general profile of the cooperating manufacturing SME.

Secondly, the results for Specific objective 2 contribute to identification of the organisational context-related factors that determine the likelihood of manufacturing SMEs to cooperate with universities in any type of interaction.

Thirdly, the results of Specific objective 3 provide holistic knowledge of the organisational context-related factors that determine the levels of cooperation in the following UBC activities:

- Education domain: mobility of students, curriculum co-design, curriculum co-delivery, dual education programmes and lifelong learning
- Research domain: joint R&D, consultancy and mobility of staff
- Valorisation domain: commercialisation, academic entrepreneurship and student entrepreneurship
- Management: governance, shared resources and support

Fourthly, the results for Specific objective 4 provide empirical knowledge of the role of AC in the cooperation levels of the aforementioned UBC activities. In turn, they provide empirical insights into the different operationalisations of AC.

Finally, this study contributes to the literature by identifying a number of future lines of research that should enable clarification of the remaining unknowns related to UBC.

8.5.2. Contributions to practice

In addition to theoretical contributions, the results of this research provide relevant empirical knowledge to the Basque UBC stakeholders, and cautiously, to the UBC stakeholders in the aforementioned regions with similar structural conditions. Although the results and conclusions obtained in the study could provide general insights into the cooperation patterns of manufacturing SMEs in other regions, given the importance of regional context in UBC, it is important to be sensitive to the generalisability of the results.

Identification of the organisational context-related factors that determine manufacturing SMEs' cooperation likelihood and cooperation levels in diverse UBC activities provides a "picture" of the types of SME that cooperate with universities in different types of UBC activities. This holistic and detailed knowledge of various UBC activities provides useful information for the development of evidence-based policies, strategies and mechanisms for UBC support and promotion. The availability of supporting evidence is essential to make efficient use of existing resources. Thus, the knowledge generated in this study is key (i) for different agents in the university sphere, such as higher education policymakers, rectors, deans, technology parks, university-business relations officers, TTOs, career offices, academics, and so on, and (ii) for different actors in the business sphere, such as economic development policymakers, business development agencies, county development agencies, business innovation centres, business associations, clusters, and so on. In turn, it is essential to highlight that the knowledge generated in this study is also of special interest to the manufacturing SMEs themselves, as it provides them with an overall insight into their situation regarding UBC. Moreover, it is a means for them to acquire knowledge of the different UBC activities that exist together with their benefits.

8.6. Summary

This last chapter described the final conclusions and recommendations arising from the study. In the first sub-section a discussion of the four specific objectives was provided, based on the contrast of the empirical results obtained with the literature. Then, the second sub-section dealt with the conclusions drawn from the results. Afterwards, the third sub-section of the chapter addressed the limitations of the study and described proposed future lines of research. Finally, the fourth sub-section aimed to summarise the contributions of the study.

Chapter 9

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9. References

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Chapter 10

Appendices

10. Appendices

10.1. Appendix I: Limitations found in extant studies

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations
Schartinger *et al.*, (2002)	The objective of this study is to analyse certain aspects of knowledge interactions between universities and industry.	− Collaborative research − Joint scientific publications − Contract research and consultancy − Mobility of researchers from universities to firms − Financing of university research assistants by firms − Joint supervision of Ph.D. and Masters theses − Training of firm members at universities − Lectures at universities given by firm members − Technology oriented new firm formation by university researchers	− Spatial distance − Knowledge proximity − Size structure of a field of science − Experience in external R&D collaboration of a field of science − Reputation of a field of science − Employment dynamics of a field of science − Intensity of marketing activities of fields of science − Size structure of the economic sector − R&D orientation of the economic sector − Export orientation of the economic sector − Employment dynamics of the economic sector	The analysis is focused on an academic perspective.

Table 145. Studies found through the literature review that have analysed the impact of UBC's determining factors from a holistic perspective

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations

Bekkers and Bodas Freitas (2008)	The objective of this study is to explore the factors affecting the relative importance[51] of a variety of knowledge transfer channels between university and industry.	Authors grouped 23 interaction channels into 6 clusters which bring together channels that often are given similar ratings from individual respondents.
		Interaction channels:
		− Scientific publications in (refereed) journals or books
		− Other publications, including professional publications and reports
		− Patent texts, as found in the patent office or in patent databases
		− Personal (informal) contacts
		− University graduates as employees (B.Sc. or M.Sc. level)
		− University graduates as employees (Ph.D. level)
		− Participation in conferences and workshops
		− Joint R&D projects (except those in the context of EU Framework Programmes)
		− Students working as trainees
		− Joint R&D projects in the context of EU Framework Programmes
		− Contract research (excl. Ph.D. projects)
		− Financing of Ph.D. projects
		− Sharing facilities (e.g. laboratories, equipment, housing) with universities
		− Staff holding positions in both a university and a business
		− Flow of university staff members to industry positions (exc. Ph.D. graduates)
		− Licenses of university-held patents and ‘know-how’ licenses
		− Temporary staff exchange (e.g. staff mobility programmes)
		− Personal contacts via membership of professional organisations
		− University spin-offs (as a source of knowledge)
		− Consultancy by university staff members
		− Specific knowledge transfer activities organised by the university’s Technology Transfer Office (TTO)
		− Contract-based in-business education and training delivered by universities
		− Personal contacts via alumni organisations.
		Identified clusters:
		− Scientific output, informal contacts and students;
		− Labour mobility;
		− Collaborative and contract research;
		− Contacts via alumni or professional organisations;
		− Specific organised activities;
		− Patents and licensing.
			− Sector:
			  − the pharmaceutical or biotechnology sector,
			  − chemical sector (excluding pharmaceuticals),
			  − machinery, basic and fabricated metal products, and mechanics,
			  − electrical and telecommunications equipment
			− Basic characteristics of the knowledge
			− Scientific disciplines
			− Organisational characteristics: size, type of research performed (basic, applied or experimental, as defined in OECD’s Frascati manual).
			− Individual characteristics: age, number of authored (or co-authored) papers and number of patents, as well as whether the respondent established any spin-off or start-up.
				On the one hand, the study analysed 454 R&D conducting small, medium and large-sized companies in The Netherlands, which does not provide information on companies that do not perform R&D activities. On the other hand, despite the great number of analysed interaction channels, the study does not differentiate between informal interactions and activities. Such a differentiation is essential since informal interactions can be precursors of formal activities and analysed as UBC’s determining factors.

Table 145. (cont.) Studies found through the literature review that have analysed the impact of UBC’s determining factors from a holistic perspective

[51] Bekkers and Bodas Freitas (2008) measured the importance of the interaction channel by a combination of quantity (frequency of use) and quality (how well knowledge is transferred).

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations
Arza and López (2011)	The study analyses firms' drivers for linking to public research organisations (PRO[52]) (first goal) and compares perceptions and behaviours of linked vs. unlinked firms (second goal).	Traditional: − Informal exchange: − Publications − Conferences − Hiring graduates Service: − Consultancies − Research contracts − Internships − Incubatorsl − University owned firms − Spin off Bi-directional: − Joint R&D − Networks − Scientific parks Commercial: − Licences − Patents	First goal: Firms' characteristics: − Size − Skills Firm's network behaviour: − Connection to suppliers and clients − Connections to other firms in the group − Connections to the headquarter − Firm's own evaluation of the importance of connections to other firms either to exchange information or to carry out research activities Sectoral specificities: − Intensity of investment in innovative activity − Productivity and likelihood to link to PRO Second goal: − Innovative behaviour − Success in achieving product or process innovation − Attitude towards patenting their innovative outcomes − Access to sources of finance for innovation − Conceptions about the importance of outcomes and roles pursued by PRO	The study analyses cooperation with PRO and does not provide specific knowledge regarding UBC. Furthermore, although the study analyses the importance of a wide range of activities, the analysis of the drivers focuses on how they affect the likelihood of cooperation (to cooperate or not to cooperate).

Table 145. (cont.) Studies found through the literature review that have analysed the impact of UBC's determining factors from a holistic perspective

[52] Organisations included as PRO are: Universities, Public Research Organisations (for industry and agriculture) and other government organisations for science and technology.

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations
De Fuentes and Dutrénit (2012)	The study discusses the impact of drivers of cooperation on channels of interaction, and the impact of these channels on the perceived benefits by researchers and firms.	On the basis of 10 interaction channels, the authors carried out a factorial analysis with the aim of identifying clusters based on the scores achieved by the channels. A. Information and training: − Publications − Conferences − Informal information − Training B. R&D projects & consultancy: − Contract R&D − Joint R&D − Consultancy C. Intellectual property rights: − Technology licenses − Patents D. Human resources: − Hiring	− Size − Sector − Ownership − R&D capabilities − Innovation strategy (openness strategy) − Linking strategy	On the one hand, authors limit their study to innovative companies, excluding those companies that had not performed product or process innovation at the firm, country or world level within a 3-year period prior to the survey. Hence, their final sample included 325 innovative manufacturing Mexican companies, limiting the knowledge generated to this type of company. On the other hand, they do not differentiate between informal interactions and activities. The differentiation of these two forms of cooperation is essential since informal interactions can be precursors of formal activities. Besides, despite the great number of analysed interaction channels following the UBC activity classification developed by Davey et al. (2018) some UBC activities are not included. For example: staff mobility within the research-related domain; spin-off or start up generation in valorisation-related domain and activities regarding education (curriculum co-design, co-delivery, mobility of students and dual education programmes) and management (shared resources and industry support).
Galán-Muros and Plewa (2016)	The study seeks to analyse the impact of UBC barriers and drivers on a series of UBC activities.	Education: − Curriculum design and delivery − Lifelong learning − Student mobility Research: − Professional mobility − R&D Valorisation: − Entrepreneurship Commercialization	Barriers: − Connections − Funding − Organisational culture − Internal characteristics Drivers: − Resource availability − Relationships	The analysis is focused on an academic perspective and does not include management-related activities.

Table 145. (cont.) Studies found through the literature review that have analysed the impact of UBC's determining factors from a holistic perspective

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations
García-Pérez-de-Lema *et al.* (2017)	The purpose of this research is to study how different university–firm governance styles impact on SMEs' innovation and performance. Within their study the authors analyse the following hypotheses: − H5. An SME's absorptive capacity affects its relationship with university. − H5a. An SME's absorptive capacity positively affects the development of a contractual relationship with university. − H5b. An SME's absorptive capacity positively affects the development of a relational relationship with university.	Relational University governance: − Firm fellowship for students − Business training − Business advice − Business forums − Technical training Contractual University governance: − Research conventions − Research and development project − Innovation projects	AC	The study is limited to the analysis of the impact of AC on 600 Spanish SMEs' UBC levels. As the authors note they have not considered certain variables which could affect university–firm partnerships.
Alpaydın and Fitjar (2020)	The study examines the extent to which companies perceive different dimensions of proximity to be important for the formation of their interactions with universities. It also investigates whether the importance of the different types of proximities varies depending on the type of interaction.	Knowledge exploration interactions: − Consultancy/ Contract research − Joint research projects Knowledge exploitation interactions: − Purchase of university patent, license or other IPRs − Use of universities' facilities, laboratories, equipment, etc. − Creation/funding of research centres, incubation centres, research, science and technology parks − Creation of new ventures/firms (spin-offs, start-ups) Competence enhancement interactions: − Joint PhD supervision/Industrial PhDs − Temporary staff exchanges for research purposes − Training of firm staff/employees − Student internships/apprenticeships − Student projects − Guest lecturing at universities − Recruitment of graduates based on a contract/referral − Co-development and co-delivery of curriculum Advice-seeking interactions: − Informal consultations Marketing interactions − Sponsorship, scholarships, fellowships provided to university − Joint organisation of events − Other interactions	− Cognitive Proximity: Sharing a common knowledge base and expertise with this university − Organisational Proximity: Being members of the same organisational network/structure (research center, research consortium, association, cluster, science park, etc.) − Institutional Proximity: Feeling that the university/faculty/unit has a business-friendly, entrepreneurial mindset. − Social Proximity: Having previous/ongoing interaction with this university. − Geographical Proximity: Being geographically close to our company.	The study carried out by the authors analyses a sample of 232 Norwegian companies that cooperate with universities, representing a great business heterogeneity both in terms of size and the sector in which they are located. As the authors state, Norwegian companies attach greater importance to innovation cooperation, and therefore interact to a higher extent with external partners than companies in other developed countries. As seen in the literature, both sector and size may determine UBC. Hence, the analysis of such a heterogeneous sample does not generate the necessary specific knowledge about each type of company. Besides, the study only covers companies that indicated cooperating with universities in the three years previous to the survey; and only analyse the impact of proximity dimensions on the decision to cooperate or not with the university in the different UBC types. They do not analyse the influence of these elements on cooperation levels.

Table 145. (cont.) Studies found through the literature review that have analysed the impact of UBC's determining factors from a holistic perspective

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations
Parmentola, Ferretti and Panetti (2020)	The research work attempts to explore patterns of UBC in four industry-specific clusters in the low-innovative region of Campania (Italy) with regard to three specific aspects (i.e., motivations, barriers and cooperation channels).	− Scientific publications in (refereed) journals or books − Co-participation in events − Affiliations with professional association − Students working as trainees in industry − Staffholding positions in both a university and a business − Temporary exchange ofacademic staf − Board interlocks − Joint R&D projects − Contract research − Financing ofscholarship by industry − Consultancy ofuniversity staffmembers in industry − Teaching activity externalization − Co-patenting − Licensing agreements − University spin-offs − Specific knowledge transfer activities organized by the university's TTO − Sharing facilities (e.g. laboratories, equipment, housing) with the industry	Sector: − Low-tech − High-tech Barriers: − Limited use of university/PRO knowledge in industry − Acquisition and use university/PRO knowledge − University/PRO knowledge is very theoretical − University/PRO knowledge is too general − Cultural differences − Cost of the application of university/PRO knowledge (time or money) − Risk of joint R&D projects − Difficulty in finding interesting R&D projects − Bureaucracy Motivators: − To solve specific technical or design problems − To develop new products and processes − To develop new research aimed at new patents − To improve product quality − To re-orient the R&D agenda − To gain access to new research through seminars − To scout for technology − To develop new basic research without scientific application − To hire graduate students	The study only focuses on the sectoral effect on UBC's barriers, drivers and cooperation channels.

Table 145. (cont.) Studies found through the literature review that have analysed the impact of UBC's determining factors from a holistic perspective

Author	Objective of the study	Analysed UBC activities	Analysed determining factors	Limitations
Alunurm, Rõigas and Varblane (2020)	The study looked at HIC[53] barriers in relation to firm characteristics and cooperation drivers. Q1: What kinds of barriers are significant for 'coop' firms and for 'non coop' firms? Q2: What barriers are significant for what kinds of firms? Q3: What drivers do firms find important for overcoming which barriers?	- Consultation: Informal advice, discussions, consultation projects (including agreement-based) - Training: Seminars, conferences, training sessions, short-term training programs - Education: Lifelong learning, firm managers and employees in long-term education programs - Internship: Student short-term projects at firms, internship - Curriculum development and delivery: Firm guest lectures, joint supervision of student research, joint development of curricula or modules - Joint R&D: Contract research, contract testing, expertise - Scientist mobility: Temporary or permanent employment of HEI scientists in firms - Management cooperation: Firm representatives in HEI management (board, councils, etc.) - Joint entrepreneurship: New joint ventures, spin-offs, start-ups	− Size − Turnover − Export orientation Performance (value added) − Barriers: ○ No financial resources ○ HEIs seem too large ○ Difficult to find partner in universities ○ HEI staff not motivated to cooperate ○ Stances, time options differ Drivers: ○ Financial support ○ Information on HIC, support for training interns	Even though the study takes into account a variety of cooperation channels, the authors do not analyse the impact of barriers and drivers on them. They only analyse the differences between the companies that cooperate with universities (in any of the interaction channels) and those that do not.

Table 145. (cont.) Studies found through the literature review that have analysed the impact of UBC's determining factors from a holistic perspective

[53] HIC: Higher education-industry cooperation

10.2. Appendix II: About the Basque Country

The Basque Country is a NUT2[54] small region in the north of Spain, consisting of three provinces: Araba, Gipuzkoa and Bizkaia, with a total population of 2,177,880 inhabitants, 4.6% of the state population, in 2019 (Orkestra, 2021). The region is one of the wealthiest regions in Spain (European Commission, 2020a), enjoys tax independence and stands out in the Spanish landscape thanks to its industrial strength and well-educated workforce (OECD, 2013a). Based on data gathered by Eustat (2020b), 7.10% of the Basque companies in 2019 were categorised as SME generating 39.01% of the jobs.The unemployment rate in 2019 was 9,2% (Spain: 14.1%; EU: 6.3%) (European Commission, 2021a). The Basque University System is made up of one public university (EHU/UPV) and two private universities (Mondragon Unibertsitatea and University of Deusto) (Basque Government, 2021b).

The region is characterised by a long trajectory in manufacturing activities and has a solid industrial base. In 2019 , the manufacturing industry accounted for 19.38% of total Gross Domestic Product (GDP) (INE, 2021). Businesses manufacture a wide variety of capital goods, durable goods and other intermediate products. The industrial production in the Basque Country is diverse and activities derived from metal, such as the production of steel and machine-tools, are extremely important. Industries such as the chemical and petrochemical and refineries, also account for a significant part of the region's GDP (European Commission, 2021a). In 2017, most of the industrial sectors in the Basque Country (at least those that account for 42.5% of its Gross Value Added (GVA)) were included in sectors classified by the OECD as having a "medium-low" technological level; only 5.1% of industrial activities were at the high technological level (Eustat, 2020c). The three essential enabling technologies of RIS3[55] Euskadi strategy are: biosciences, nanosciences and advanced manufacturing (Basque Government, 2021a).

As the Regional Innovation Scoreboard (RIS) 2019 indicates, the Basque Country ranks the 132nd out of 238 European regions and has increased its innovation performance in the last eight years. Even though it was classified as a high innovation region in the previous years, 2019 data classified it as a moderate innovation region (European Commission, 2019). Despite the fact that the Basque Country has slipped back in the ranking, it continues to maintain its position with respect to the rest of the regions of Spain (Innobasque, 2019). Based on RIS 2019 data (European Commission, 2019), the region ranks first of 19 regions at the state level in terms of population with tertiary education, lifelong learning, SMEs innovating in-house, innovative SMEs cooperating with others and R&D expenditure in the business sector. Nevertheless, with regard to SMEs' performance, the region ranks lower in relation to: sales of new-to-market and new-to-firm innovations in SMEs (2nd), SMEs introducing product or process innovations (3rd), SMEs introducing marketing or organisational innovations (5th) and Non R&D innovation expenditures in

[54] NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU.

[55] Smart Specialisation is a place-based approach characterised by the identification of strategic areas for intervention based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process (EDP) with wide stakeholder involvement (European Commission, 2021c).

SMEs (9th). In relation to the RIS 2019 data, it is worth noting that the region must also improve its situation with respect to: EPO patent applications (5th), trademark applications (9th) and design applications (9th).

As Innobasque (Basque Innovation Agency) indicated in 2019, increasing the number of innovative organisations, with a focus on SMEs, is one of the major challenges facing the Basque Country. This is in line with statements by the Basque Government (2019) which emphasised poor results in some innovation indicators in SMEs, as reflected in the official innovation surveys.

As regards to governmental mechanisms for promoting UBC, it must be stressed that, even though there is still a lot of work to be done, the Basque Country is a region committed to UBC (KPMG, 2016). The Basque Government promotes cooperation between universities and companies through various mechanisms such as:

- *I 2022 Basque University-Business Strategy*: this strategy recognises, influences and promotes the role of the Basque University System as a dynamic and transforming agent of the Basque Country. This strategy is one of the cornerstones of the Basque Government's commitment to strengthening the Basque University System, taking into account the scientific excellence of the universities, as well as the present and future needs of Basque companies. Its main objectives are to create and transfer knowledge, as well as to train human capital in a cooperative framework (Basque Government, 2017),
- *Hazitek*: subsidies to carry out Industrial Research or Experimental Development projects, either competitive or strategic in nature, in the business sector in the Basque Country, and in the areas of specialization of the Basque Science, Technology and Innovation Plan 2030[56]
- *Elkartek*: subsidies to support Collaborative Research, carried out by the Research, Development and Innovation Entities integrated in the Basque Science, Technology and Innovation Network of the Basque Country[57],
- *Basque Digital Innovation Hub*: Connected network of advanced manufacturing assets and services infrastructure for training, research, testing and validation available for SMEs and companies[58], among others.

[56] https://www.spri.eus/es/ayudas/hazitek/
[57] https://www.spri.eus/es/ayudas/elkartek/
[58] https://basqueindustry.spri.eus/es/basque-digital-innovation-hub/

10.3. Appendix III: Presentation letter for the questionnaire

10.3.1. English version

Dear Director,

The Basque Government aims to improve the competitiveness of our companies and therefore carries out periodic reviews of its R&D support initiatives and instruments in order to help companies like yours.

We are currently carrying out a "Study on University-Business Cooperation", on this occasion in cooperation with Mondragon Unibertsitatea, and which is a continuation of the one already carried out on "Non-technological innovation in SMEs", as well as the one currently being prepared on "Characterisation of Business R&D", in which you have participated. The aim of this new study is to find out the degree of cooperation between companies and the University with a view to promoting R&D activities.

As you know, your company meets the selection criteria and we would like to count again on your collaboration by answering a short questionnaire.

Click here to reply: https://es.surveymonkey.com/r/UELCUE?lang=es

If you have any questions, please do not hesitate to contact the Mondragon Goi Eskola Politeknikoa team by calling 664236852 or sending an e-mail to mvivar@mondragon.edu.

We hope that this new initiative will be of interest to you and we reiterate our thanks for your collaboration.

Yours sincerely,

Iosu Madariaga
Director de Tecnología y Estrategia

Nekane Errasti
Coordinadora Académica

EUSKO JAURLARITZA GOBIERNO VASCO

Mondragon Unibertsitatea
Goi Eskola Politeknikoa
Escuela Politécnica Superior

10.3.2. Spanish version

Estimado/a Director/a,

El Gobierno Vasco quiere favorecer la mejora de la competitividad de nuestras empresas y por tanto realiza revisiones periódicas de sus iniciativas e instrumentos de apoyo a la I+D para poder ayudar a empresas como la tuya.

Actualmente estamos realizando un "Estudio sobre la Cooperación Universidad-Empresa", en esta ocasión en colaboración con Mondragon Unibertsitatea, y que es continuación, tanto del que ya se realizó sobre "Innovación no tecnológica en las pymes", como del que está en elaboración "Caracterización de la I+D Empresarial" y en los que has participado. El objetivo de este nuevo estudio es conocer la situación de la colaboración entre las empresas y la Universidad de cara a dinamizar las actividades de I+D.

Como sabes, tu empresa responde a los criterios de selección por lo que nos gustaría contar de nuevo con tu colaboración respondiendo a un breve cuestionario.

Pincha aquí para contestar: https://es.surveymonkey.com/r/UELCUE?lang=es

Para cualquier aclaración, no dudes en contactar con el equipo de Mondragon Goi Eskola Politeknikoa a través del teléfono 664236852 o de la dirección de correo electrónico mvivar@mondragon.edu.

Esperamos que esta nueva iniciativa sea de tu interés y reiteramos nuestro agradecimiento por tu colaboración.

Recibe un cordial saludo,

Iosu Madariaga	***Nekane Errasti***
Director de Tecnología y Estrategia	Coordinadora Académica
EUSKO JAURLARITZA GOBIERNO VASCO	Mondragon Unibertsitatea Goi Eskola Politeknikoa Escuela Politécnica Superior

10.4. Appendix IV: Questionnaire

10.4.1. English version

University-Business Cooperation, a study of the cooperating and non-cooperating business perspective

The following are a set of simple instructions for the correct completion of the questionnaire.

Instructions:

Before starting, it is essential to notify you that, in case you wish to return, you should not use the buttons on your Internet browser. This action results in leaving the questionnaire without registering the answers on the previous page and will cause an error.

You can scroll through the questionnaire using the navigation buttons “Prev.” (Previous) and “Next” found at the bottom of the page.

By pressing “Next.”, the answers on the last page will be recorded and by pressing “Ant.”, the respondent may return to the previous page to review or edit their response.

In turn, on the top right, you will find an “EXIT”, which will allow you to exit the questionnaire (recording all the questions answered except for the last page) and return whenever you wish to complete it.

At the end of the questionnaire, you will find the “Done” button, which will submit the answers and save the questionnaire as complete. For any clarification regarding the questions, data protection, etc. do not hesitate to contact us through the following email: mvivar@mondragon.edu (María Vivar).

Thank you for your participation!

Data protection:

In accordance with Organic Act 3/2018, of 5 December, on Personal Data Protection and the guarantee of digital rights (LOPDGDD), and Regulation (EU) 2016/679, of the European Parliament and Council, of 27 April (“General Data Protection Regulation” or “GDPR”), MONDRAGON GOI ESKOLA POLITEKNIKOA JMA S.COOP., with CIF No. F20045241 Loramendi, 4, Section 23 – 20500 Arrasate-Mondragón, as responsible for the processing, is entitled to the processing of your personal data by providing consent to participate in this project, being processed only for the purpose of conducting the study established in the presentation email of the project. Your responses will be completely anonymous or will be anonymised as soon as reasonably possible, and finally destroyed once the final report has been prepared. In no case will your personal data be transferred to third parties unless we are legally bound to do so or if you have expressly authorised it. You can exercise the rights granted by the regulations, as well as contacting our Data Protection Representative at: dpo.mgep@mondragon.edu

I have read and accept the participation in the project.

Yes	No

1. General information about your company

Next, we will ask you a few questions to classify your company, depending on its characteristics.

Please answer the following questions:

1) *Enter your Tax Identification Number (NIF):*
2) *Is the centre from which you are responding the company's headquarter?*

Yes	No

3) *Enter the age of your company:*

0-2 years	3-4 years	5-24 years	≥50 years

4) *How many employees make up your company?*

1-9	10-49	50-249	250-999	≥1,000

5) *What percentage of the workforce is female?*

0%	1-9%	10-19%	20-29%	30-39%	40-49%
50-59%	60-69%	70-79%	80-89%	90-100%	

6) *Indicate the percentage of employees with a university degree:*

0-9%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%

7) *What is the range of your turnover?*

≤ €2M	≤ €10M	≤ €50M	> €50M

8) *Does your company belong to a business group?*

Yes	No

9) *Enter your percentage of sales with respect to the Basque market:*

0%	1-9%	10-19%	20-29%	30-39%	40-49%
50-59%	60-69%	70-79%	80-89%	90-100%	

10) Does your company belong to any of the following business clusters?

ACICAE	Automotive Components Industry Cluster
ACLIMA	Association of Environment Industries
AFM	Advanced Manufacturing Technologies. Spanish Machine Tool Manufacturers Association
AVIC	Basque Association of Engineering and Consulting Companies
BCLM	Logistics and Mobility Federation
BHC	Basque Health Cluster
CAE	Basque Country Food Cluster
CLUSPAP	Basque Country Paper Cluster
CLUSTERENER	Basque Energy Cluster
EIKEN	Basque Country Audiovisual and Digital Content Cluster
Eraikune	Basque Construction Cluster
ESKUIN	Hardware and Industrial Supplies Cluster
FMV	Basque Maritime Forum
FUNDICION	Casting Cluster
GAIA	Association of Electronic and Information Technology Industries of the Basque Country
HABIC	Equipment, Furniture and Design Cluster
HEGAN	Aeronautics and Space Association Cluster
MAFEX	Spanish Railway Association
SIDEREX	Spanish Association of Exporters of Steel Products and Facilities

2. Specific data on University-Business Cooperation

Next, we will ask you a few questions to know your perspective regarding University-Business Cooperation (hereinafter UBC)

11) Please select the most appropriate answer for your business reality:

Indicate your degree of agreement or disagreement with the folliowing statements:

“Our company…”

Scale to be used: 1 = Strongly disagree; 10 = Strongly agree.

- *Has enough contacts and relationships with universities, which it could contact to cooperate*

1	2	3	4	5	6	7	8	9	10

- *Understands well that the universities wish to obtain from a cooperation*

1	2	3	4	5	6	7	8	9	10

- *Has the skills and knowledge necessary to select and address UBC activities*

1	2	3	4	5	6	7	8	9	10

- *Has sufficient managerial support to cooperate with universities*

1	2	3	4	5	6	7	8	9	10

- *Believes that universities play a very important role in their efforts to innovate*

1	2	3	4	5	6	7	8	9	10

- *Believes that it is its responsibility to cooperate with universities in the field of education*

1	2	3	4	5	6	7	8	9	10

- *Believes that it is its responsibility to cooperate with universities in the field of research*

1	2	3	4	5	6	7	8	9	10

- *Has much to offer to universities in the field of education (developing and offering education and training)*

1	2	3	4	5	6	7	8	9	10

- *Has much to offer to universities in the field of research*

1	2	3	4	5	6	7	8	9	10

- *Has the ability to absorb knowledge and technology from universities*

1	2	3	4	5	6	7	8	9	10

- *Has the necessary time, financing, people, etc. to carry out UBC activities*

1	2	3	4	5	6	7	8	9	10

12) *The UBC must be understood as any type of interaction between any part of the University System and the business sphere. Under this definition: Has your company ever cooperated with the university?*

Yes	No

13) *Indicate your degree of agreement or disagreement with the following statement:*

"Our company cooperates or has cooperated with the university to a large extent"

Regarding the following activities:

Scale to be used: 1 = Strongly disagree; 10 = Strongly agree.

- *Curriculum co-design (e.g. business employers involved in curricula design with universities)*

1	2	3	4	5	6	7	8	9	10

- *Curriculum co-delivery (e.g. guest lectures)*

1	2	3	4	5	6	7	8	9	10

- *Mobility of students (e.g. student internships/placements)*

1	2	3	4	5	6	7	8	9	10

- *Dual education programmes (e.g. part academic, part practical)*

1	2	3	4	5	6	7	8	9	10

- *Lifelong learning for people from business (e.g. executive education, industry training and professional courses)*

1	2	3	4	5	6	7	8	9	10

- *Joint R&D (incl. joint funded research)*

1	2	3	4	5	6	7	8	9	10

- *Consultancy for business (e.g. contract research)*

1	2	3	4	5	6	7	8	9	10

- *Mobility of staff (i.e. temporary mobility of academics to business and of business people to universities)*

1	2	3	4	5	6	7	8	9	10

- *Commercialisation of R&D results (e.g. licencing/patenting)*

1	2	3	4	5	6	7	8	9	10

- *Academic entrepreneurship (e.g. spin-offs)*

1	2	3	4	5	6	7	8	9	10

- *Student entrepreneurship (e.g. start-ups)*

1	2	3	4	5	6	7	8	9	10

- *Governance (e.g. participation of academics on business boards and business people participation in university board)*

1	2	3	4	5	6	7	8	9	10

- *Shared resources (e.g. infrastructure, personnel, equipment)*

1	2	3	4	5	6	7	8	9	10

- *Industry support (e.g. endowments, sponsorship and scholarships)*

1	2	3	4	5	6	7	8	9	10

14) Which of the following actions does your company perform?

- *"Attendance at events with industry and university participation such as…:":*

Events, forums, and/or meetings.	Conferences and/or congresses.	Workshops and/or symposia.

3. Specific data on absorptive capacity, lifelong learning, R&D and innovation

Next, we would like to know the way in which your company acquires, assimilates, transforms and exploits external knowledge.

15) Please indicate your degree of agreement or disagreement regarding the following statements related to external knowledge.

- *We frequently hold meetings with clients.*

1	2	3	4	5	6	7	8	9	10

- *We regularly interact with external professionals, such as consultants or experts.*

1	2	3	4	5	6	7	8	9	10

- *We usually meet with suppliers to acquire new knowledge.*

1	2	3	4	5	6	7	8	9	10

- *We collect information on the state of the sector through informal means (e.g. meetings with other companies, conversations with other managers, networking).*

1	2	3	4	5	6	7	8	9	10

- *We quickly recognise the changes that occur in our environment.*

1	2	3	4	5	6	7	8	9	10

- *We quickly understand the new opportunities that arise to meet customer needs.*

1	2	3	4	5	6	7	8	9	10

- *We quickly analyse and interpret changing market demands.*

1	2	3	4	5	6	7	8	9	10

- *We consider the consequences of market changes in terms of new products/services.*

1	2	3	4	5	6	7	8	9	10

- *We register and keep the new knowledge acquired for future use.*

1	2	3	4	5	6	7	8	9	10

- *We quickly recognise the utility of new external knowledge to improve our knowledge.*

1	2	3	4	5	6	7	8	9	10

– *We regularly discuss the consequences of market trends and the development of new products.*

1	2	3	4	5	6	7	8	9	10

– *We are clear on how to carry out activities when new knowledge is incorporated.*

1	2	3	4	5	6	7	8	9	10

– *There is an assignment of roles and responsibilities to incorporate and implement new knowledge.*

1	2	3	4	5	6	7	8	9	10

– *We regularly consider how to best exploit knowledge from abroad.*

1	2	3	4	5	6	7	8	9	10

– *We know how to apply new knowledge to develop new products and services.*

1	2	3	4	5	6	7	8	9	10

– *There is good communication between employees to address issues related to the development of innovations.*

1	2	3	4	5	6	7	8	9	10

In this last section on the characteristics of your company, we will ask you a few questions to classify your company (anonymously) based on the lifelong learning, R&D and innovation activities carried out.

16) *Does your company offer lifelong learning activities to its employees?*

Yes	No

17) *Indicate the percentage of personnel expenditure invested in lifelong learning.*

No LLL (0%)	0-9%	10-19%	20-29%	30-39%	40-49%	≥50%

18) *Select the most appropriate option: How do you develop lifelong learning activities in your company?*

The company does not undertake LLL activities	Internally
In cooperation with external agents	Both, internally and with external partners

19) *With which of the following external agents do you cooperate to carry out lifelong learning activities?*

Suppliers of equipment, material, components or software	Customers	Competitors or other companies in the same branch of activity	Consultants, commercial laboratories or private R&D institutes
Universities	Vocational Training Centres	Public research organisations	Professional and sector associations

20) *Do you know the public sector programmes (Provincial Council, Basque Government, Europe, etc.) that exist to support business R&D?*

Yes	No

21) *Does your company carry out R&D activities?*

Yes	No

22) *Do you regularly participate in any public sector programme to support business R&D?*

Yes	No

23) *Select the most appropriate option: How are R&D activities developed in your company?*

The company does not undertake R&D activities	Internally	In cooperation with external agents

24) *With which of the following external agents do you cooperate to carry out R&D activities?*

Suppliers of equipment, material, components or software	Customers	Competitors or other companies in the same branch of activity	Consultants, commercial laboratories or private R&D institutes
Universities	Vocational Training Centres	Public research organisations	Professional and sector associations

25) *Indicate the intensity of your company's R&D, understood as the percentage of R&D expenditure with respect to the total turnover.*

No R&D (0%)	0-9%	10-19%	20-29%	30-39%	40-49%	≥50%

26) *Select the option that best represents the reality of your company with respect to internal R&D activities.*

The company does not perform R&D	The company does not perform internal R&D
The company discontinuously performs internal R&D	The company has an internal R&D department with permanent staff

27) *Indicate your degree of agreement or disagreement regarding the following statements.*

Scale to be used: 1 = Strongly disagree; 10 = Strongly agree.

- *We provide our customers with services that offer unique benefits that are superior to those of the competition.*

1	2	3	4	5	6	7	8	9	10

- *We actively work in the development of current products and in the creation of new products.*

1	2	3	4	5	6	7	8	9	10

- *We improve the range of our products and services with products and services that have not been previously launched.*

1	2	3	4	5	6	7	8	9	10

- *We seek to get new products with different technical specifications and features.*

1	2	3	4	5	6	7	8	9	10

- *We consider the creation of new products and services as crucial elements.*

1	2	3	4	5	6	7	8	9	10

– *We reduce the development time of new products and services.*

1	2	3	4	5	6	7	8	9	10

– *We are flexible to provide products and services according to customer demands.*

1	2	3	4	5	6	7	8	9	10

– *We develop internal solutions to improve our manufacturing processes.*

1	2	3	4	5	6	7	8	9	10

– *We actively work to constantly adapt our processes.*

1	2	3	4	5	6	7	8	9	10

– *We adopt innovative ways of working.*

1	2	3	4	5	6	7	8	9	10

– *We have good means for the use of technology, both in research and product development.*

1	2	3	4	5	6	7	8	9	10

– *We are better than our competitors in the way of developing tasks, processes, and management systems.*

1	2	3	4	5	6	7	8	9	10

– *We are successful in marketing and institutionalising new products.*

1	2	3	4	5	6	7	8	9	10

– *We consider it important to make changes in the appearance, packaging, shape, and volume of our products.*

1	2	3	4	5	6	7	8	9	10

– *We are constantly looking for new ways to deliver our products to our customers.*

1	2	3	4	5	6	7	8	9	10

– *We implement new marketing methods to promote our products.*

1	2	3	4	5	6	7	8	9	10

– *We make improvements in the way we interact with our customers to obtain their complete satisfaction.*

1	2	3	4	5	6	7	8	9	10

– *New ideas that arise from customers and suppliers are continuously evaluated and try to include them in product development activities.*

1	2	3	4	5	6	7	8	9	10

– *We present new ideas and methods to improve the processes that are important for the success of the company.*

1	2	3	4	5	6	7	8	9	10

- *We support employees to take initiatives in the creation of new ideas.*

1	2	3	4	5	6	7	8	9	10

- *Our employees skilfully transform information from internal and external sources into valuable knowledge for our company.*

1	2	3	4	5	6	7	8	9	10

- *We encourage collaboration and exchange of ideas between departments to produce new approaches.*

1	2	3	4	5	6	7	8	9	10

- *We test new ideas and methods to offer innovative solutions to customer problems.*

1	2	3	4	5	6	7	8	9	10

- *We constantly benefit from technology to improve the quality of our products and services.*

1	2	3	4	5	6	7	8	9	10

- *We have a strong capacity for innovation in design and manufacturing applications.*

1	2	3	4	5	6	7	8	9	10

- *We give importance to the training of R&D staff.*

1	2	3	4	5	6	7	8	9	10

- *We constantly increase the budget allocated to R&D staff.*

1	2	3	4	5	6	7	8	9	10

28) *Indicate your degree of agreement or disagreement regarding the following statements related to the characteristics of the innovations developed by your company in the last 3 years*.

Scale to be used: 1 = Strongly disagree; 10 = Strongly agree

- *They are a major improvement over previous technology.*

1	2	3	4	5	6	7	8	9	10

- *They constitute a great advance (radical innovation).*

1	2	3	4	5	6	7	8	9	10

- *They have originated products/services that are difficult to replace with others based on older technologies.*

1	2	3	4	5	6	7	8	9	10

- *They represent an important technological advance in a subsystem, part or component of the product.*

1	2	3	4	5	6	7	8	9	10

4. Profile of the respondent

Finally, we will classify the profile of the respondent. Please answer the following questions:

29) Indicate the position you occupy in your organisation:

CEO	Industrial Director	Other
R&D Director	People Management Director	

Thank you very much for your collaboration!

Your responses have been registered successfully.

In case you would like to know the results of the study or have more interest in the project, please indicate your contact information.

Once the project is finished, we will contact you to inform you about the results obtained.

If you have any questions, do not hesitate to contact us through the following email: mvivar@mondragon.edu (María Vivar)

Contact information:

30) Enter your full name:

31) Enter your email address:

32) Enter your contact telephone number:

10.6. Appendix V: Variables of the empirical study

10.6.1. CNAE codes included in manufacturing industry

Manufacturing industry	
Code	**Description**
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair and installation of machinery and equipment

Table 146. CNAE codes included in manufacturing industry (Spanish Government, 2009)

10.6.2. AC scale

AC scale Measurement: 10-point Likert-type scale: 1=Strongly disagree; 10=Strongly agree.	
PAC	**Items**
	1. We frequently hold meetings with clients
	2. We regularly interact with external professionals, such as consultants or experts
	3. We usually meet with suppliers to acquire new knowledge
	4. We collect information on the state of the sector through informal means
	5. We quickly recognise the changes that occur in our environment
	6. We quickly understand new opportunities that arise to meet customer needs
RAC	1. We consider the consequences of market changes in terms of new products/services
	2. We register and keep the new knowledge acquired for future use
	3. We quickly recognise the utility of new external knowledge to improve our knowledge
	4. We regularly discuss the consequences of market trends and the development of new products
	5. We are clear on how to carry out activities when new knowledge is incorporated
	6. There is an assignment of roles and responsibilities to incorporate and implement new knowledge
	7. We regularly consider how to best exploit knowledge from abroad
	8. We know how to apply new knowledge to develop new products and services
	9. There is good communication between employees to address issues related to the development of innovations

Table 147. AC scale adapted from Jansen, Van Den Bosch and Volberda (2005)

10.6.3. IC scale

IC scale Measurement: 10-point Likert-type scale: 1=Strongly disagree; 10=Strongly agree.	
Product	**Items**
	1. We provide our customers with services that offer unique benefits that are superior to those of the competition
	2. We actively work in the development of current products and in the creation of new products
	3. We improve the range of our products and services with products and services that have not been previously launched
	4. We seek to get new products with different technical specifications and features
	5. We consider the creation of new products and services as crucial elements
	6. We provide our customers with services that offer unique benefits that are superior to those of the competition
Process	1. We reduce the development time of new products and services
	2. We are flexible to provide products and services according to customer demands
	3. We develop internal solutions to improve our manufacturing processes
	4. We actively work to constantly adapt our processes
Organisation	1. We adopt innovative ways of working
	2. We have good means for the use of technology, both in research and product development
	3. We are better than our competitors in the way of developing tasks, processes, and management systems
	4. We are successful in marketing and institutionalising new products
Marketing	1. We consider it important to make changes in the appearance, packaging, shape, and volume of our products
	2. We are constantly looking for new ways to deliver our products to our customers
	3. We implement new marketing methods to promote our products
	4. We make improvements in the way we interact with our customers to obtain their complete satisfaction
	5. New ideas that arise from customers and suppliers are continuously evaluated and try to include them in product development activities

Table 148. IC scale adapted from Calik, Calisir and Cetinguc (2017)

10.6.4. ID scale

ID Measurement: 10-point Likert-type scale: 1=Strongly disagree; 10=Strongly agree.
Items
1. They are a major improvement over previous technology
2. They constitute a great advance (radical innovation)
3. They have originated products/services that are difficult to replace with others based on older technologies
4. They represent an important technological advance in a subsystem, part or component of the product

Table 149. ID scale adapted from Gatignon et al. (2002)

10.6.5. UBC willingness and support scale

UBC willingness and support Measurement: 10-point Likert-type scale: 1=Strongly disagree; 10=Strongly agree.
Items
1. Has enough contacts and relationships with universities, which it could contact to cooperate
2. Understands well that the universities wish to obtain from a cooperation
3. Has the skills and knowledge necessary to select and address UBC
4. Has sufficient managerial support to cooperate with universities
5. Believes that universities play a very important role in their efforts to innovate
6. Believes that it is its responsibility to cooperate with universities in the field of education
7. Believes that it is its responsibility to cooperate with universities in the field of research
8. Has much to offer to universities in the field of education (developing and offering education and training)
9. Has much to offer to universities in the field of research
10. Has the ability to absorb knowledge and technology from universities

Table 150. UBC willingness and support scale adapted from Galán-Muros et al. (2017) and Davey et al. (2018)

10.7. Appendix VI: Normality assessment

10.7.1. Normality assessment of predictor variables

10.7.1.1. Boxplot and histogram

Size

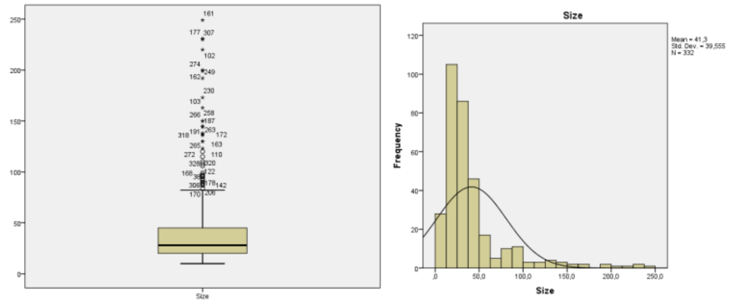

Figure 53. Size, boxplot and histogram

Exports

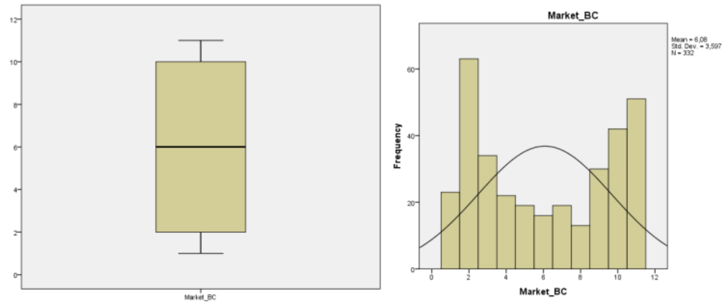

Figure 54. Exports, boxplot and histogram

Employee's qualification

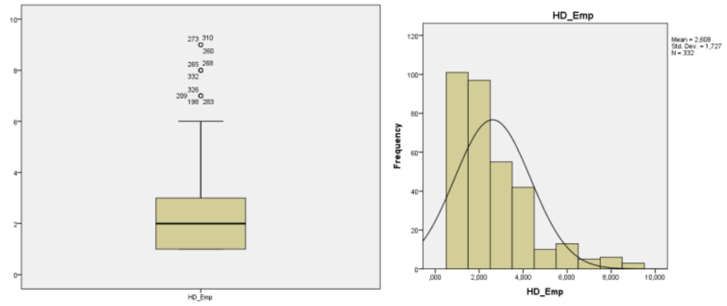

Figure 55. Employees' qualification, boxplot and histogram

Gender

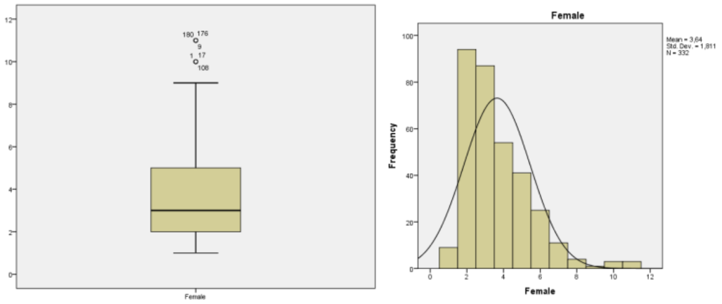

Figure 56. Gender, boxplot and histogram

Total number of R&D partners

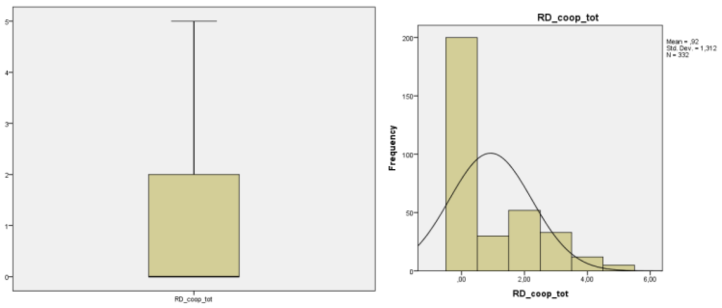

Figure 57. Total number of R&D partners, boxplot and histogram

Total number of LLL partners

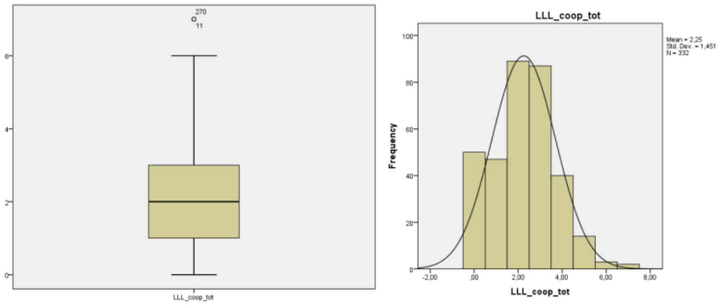

Figure 58. Total number of LLL partners, boxplot and histogram

R&D intensity

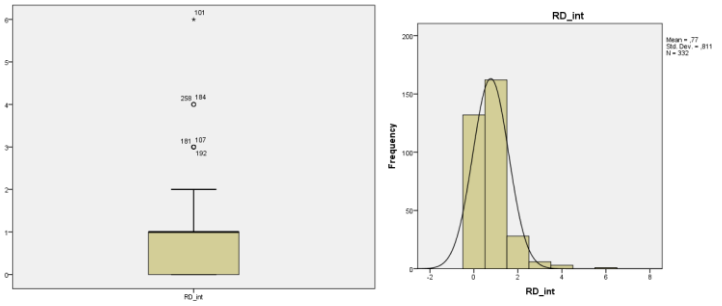

Figure 59. R&D intensity, boxplot and histogram

<u>*LLL commitment*</u>

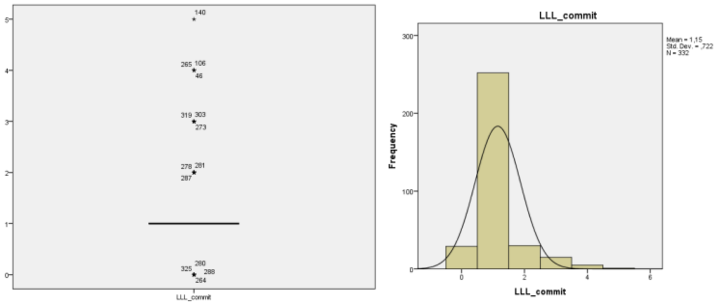

Figure 60. LLL commitment, boxplot and histogram

<u>*AC1_A1*</u>

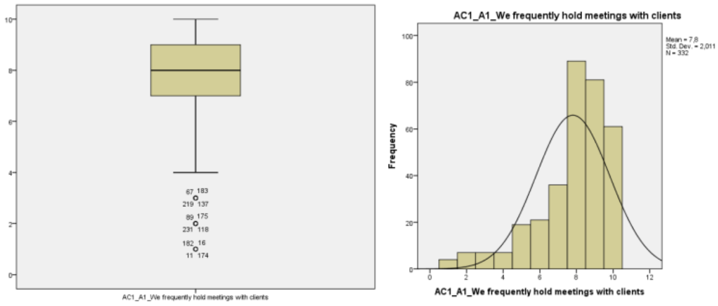

Figure 61. AC1_A1, boxplot and histogram

<u>*AC1_A2*</u>

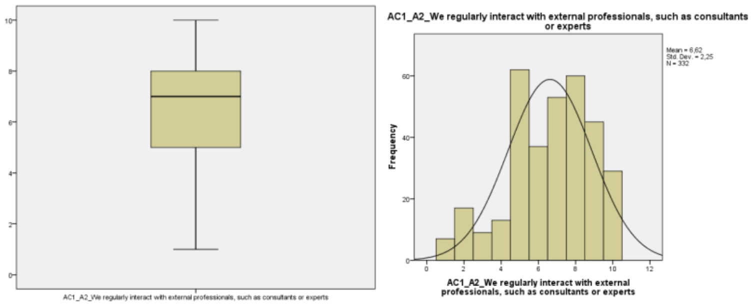

Figure 62. AC1_A2, boxplot and histogram

<u>*AC1_A3*</u>

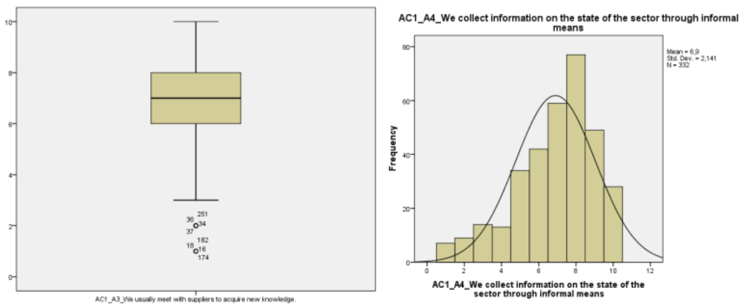

Figure 63. AC1_A3, boxplot and histogram

<u>AC1_A4</u>

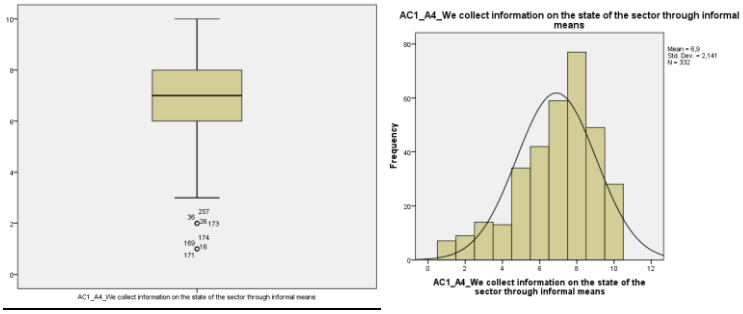

Figure 64. AC1_A4, boxplot and histogram

<u>AC1_AS1</u>

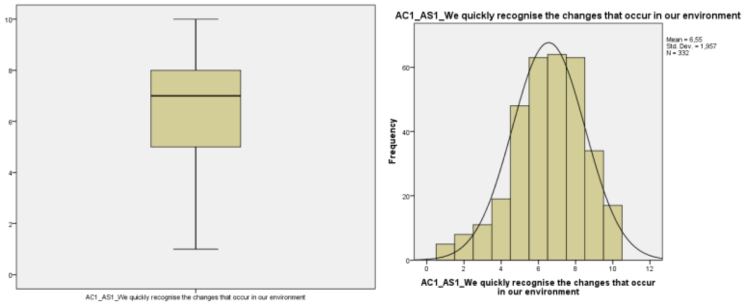

Figure 65. AC1_AS1, boxplot and histogram

<u>AC1_AS2</u>

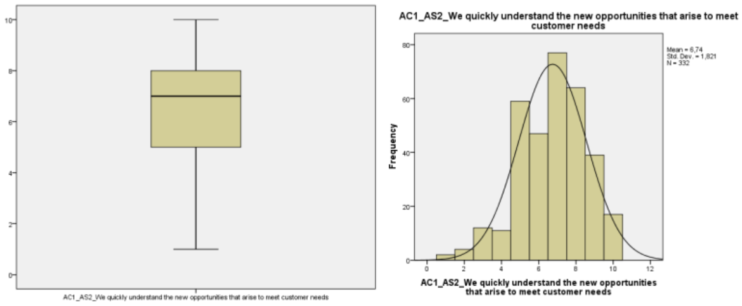

Figure 66. AC1_AS2, boxplot and histogram

<u>AC1_AS3</u>

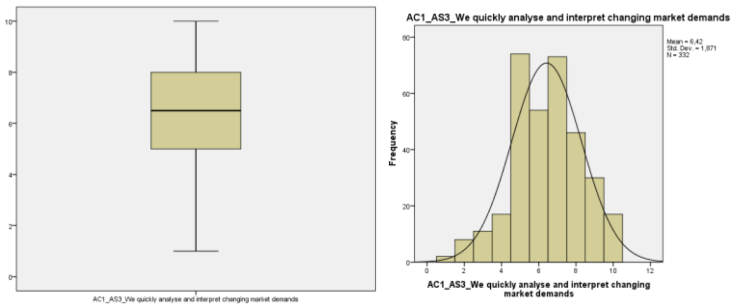

Figure 67. AC1_AS3, boxplot and histogram

<u>*AC1_T1*</u>

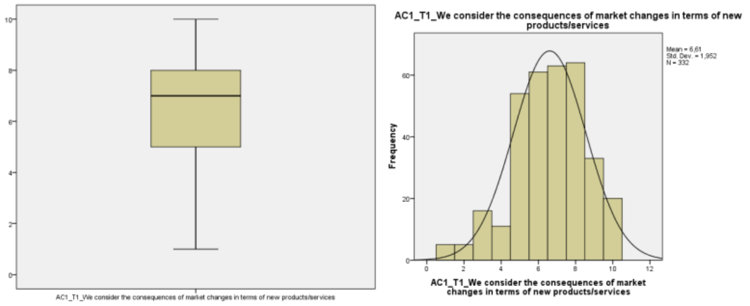

Figure 68. AC1_T1, boxplot and histogram

<u>*AC1_T2*</u>

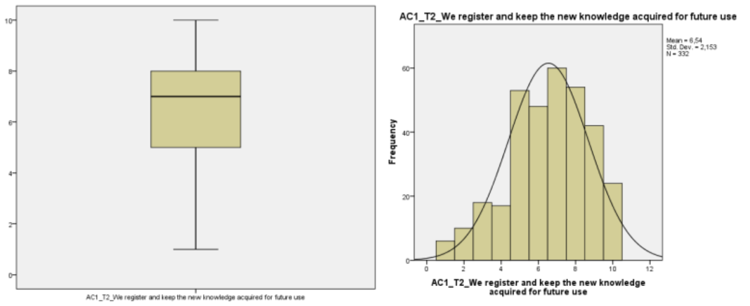

Figure 69. AC1_T2, boxplot and histogram

<u>*AC1_T3*</u>

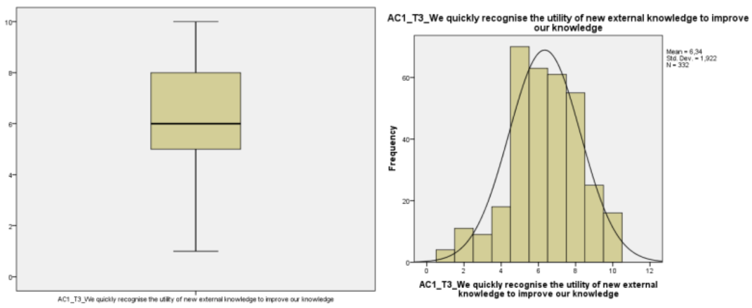

Figure 70. AC1_T3, boxplot and histogram

<u>*AC1_T4*</u>

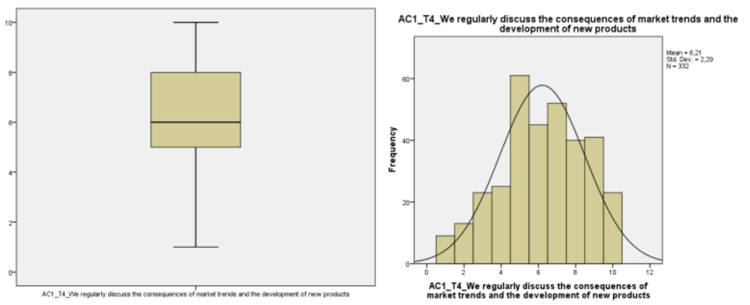

Figure 71. AC1_T4, boxplot and histogram

AC1_E1

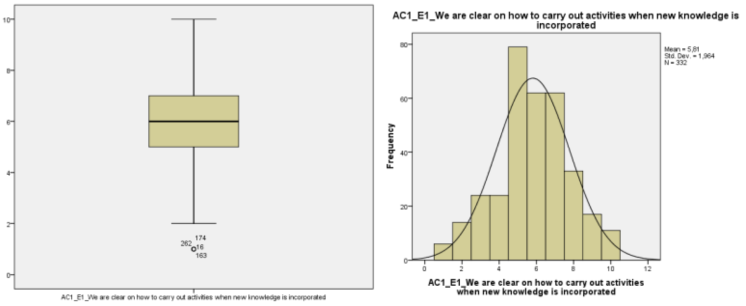

Figure 72. AC1_E1, boxplot and histogram

AC1_E2

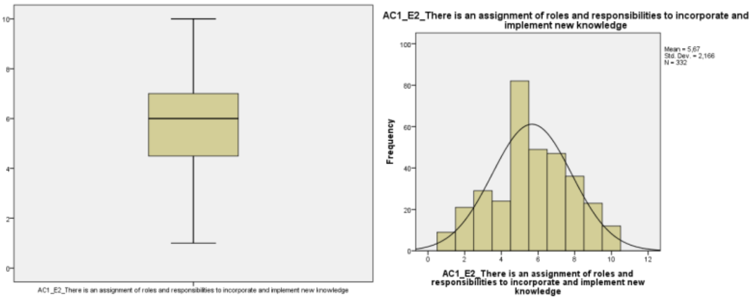

Figure 73. AC1_E2, boxplot and histogram

AC1_E3

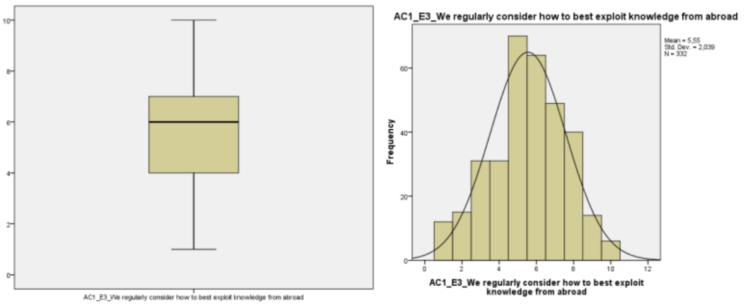

Figure 74. AC1_E3, boxplot and histogram

AC1_E4

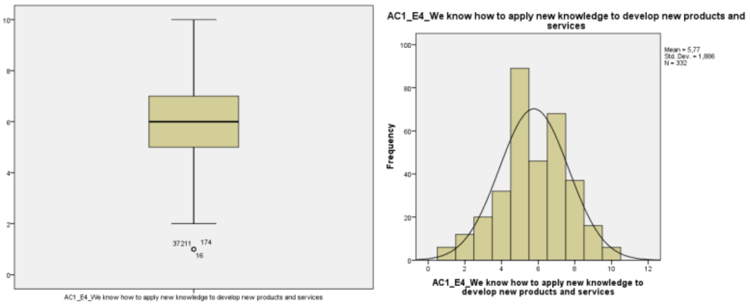

Figure 75. AC1_E4, boxplot and histogram

AC1_E5

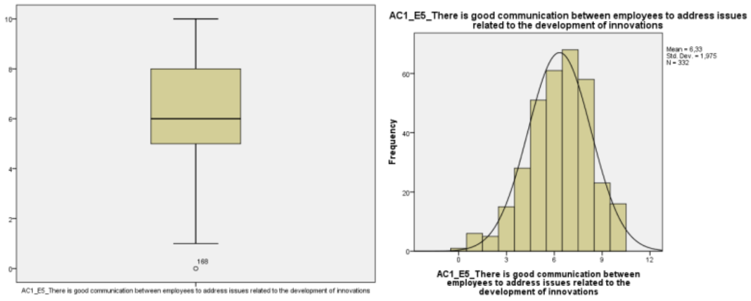

Figure 76. AC1_E5, boxplot and histogram

IC_Prod_1

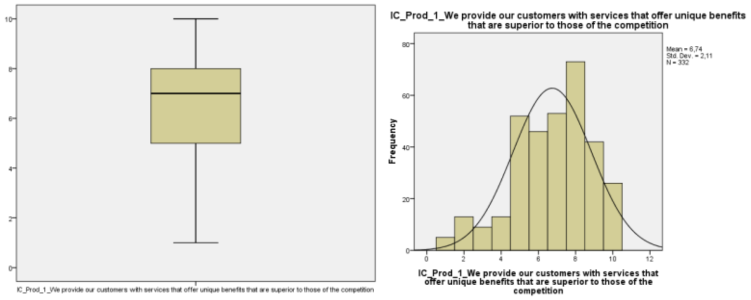

Figure 77. IC_Prod_1, boxplot and histogram

IC_Prod_2

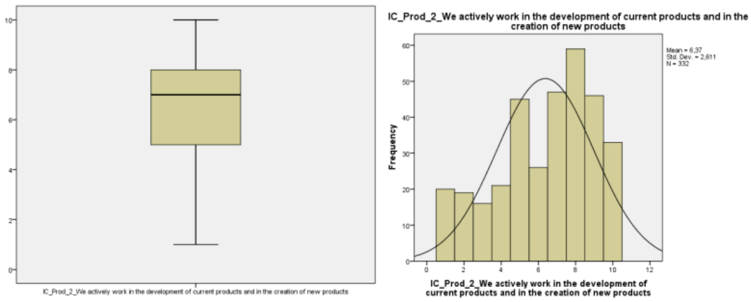

Figure 78. IC_Prod_2, boxplot and histogram

IC_Prod_3

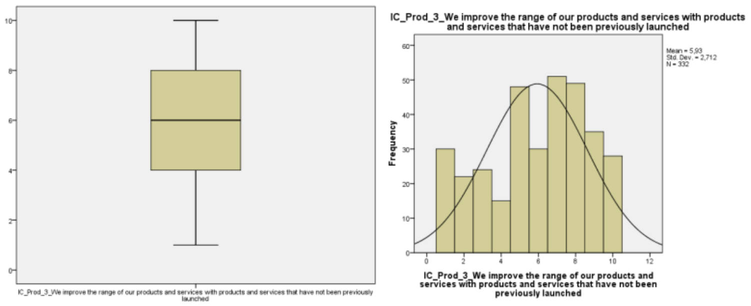

Figure 79. IC_Prod_3, boxplot and histogram

<u>*IC_Prod_4*</u>

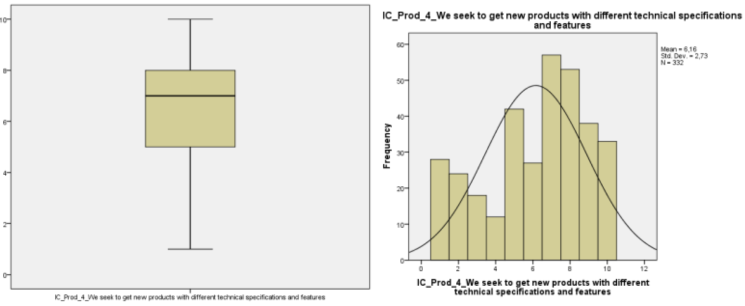

Figure 80. IC_Prod_4, boxplot and histogram

<u>*IC_Prod_5*</u>

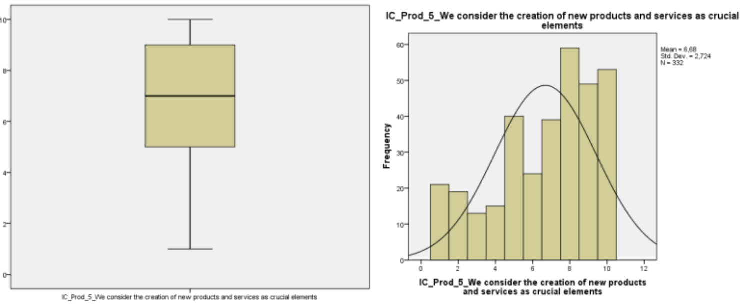

Figure 81. IC_Prod_5, boxplot and histogram

<u>*IC_Proc_1*</u>

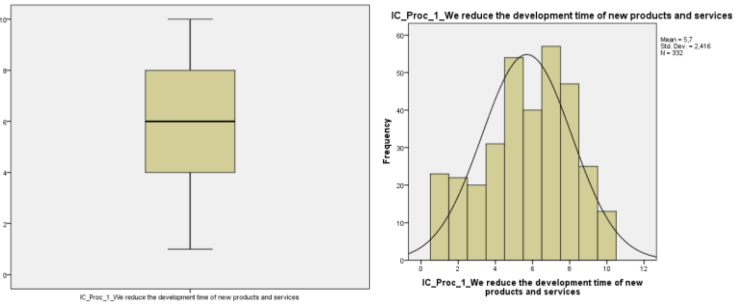

Figure 82. IC_Proc_1, boxplot and histogram

<u>*IC_Proc_2*</u>

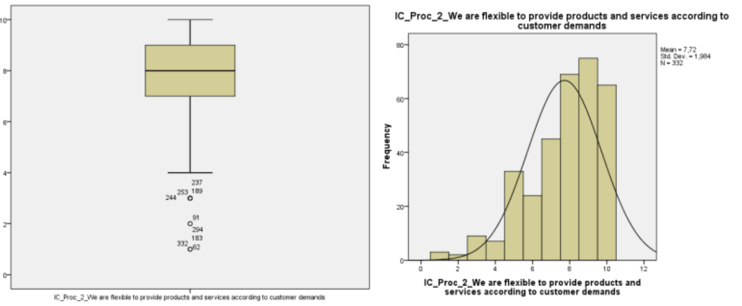

Figure 83. IC_Proc_2, boxplot and histogram

IC_Proc_3

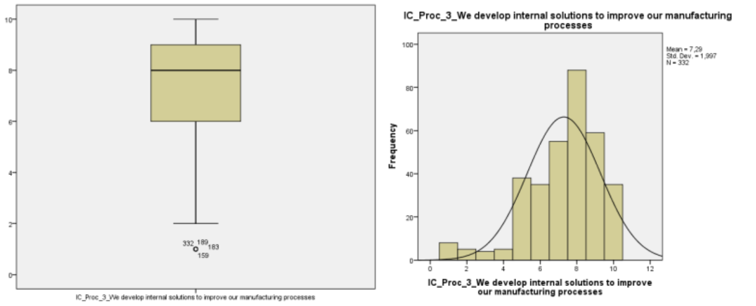

Figure 84. IC_Proc_3, boxplot and histogram

IC_Proc_4

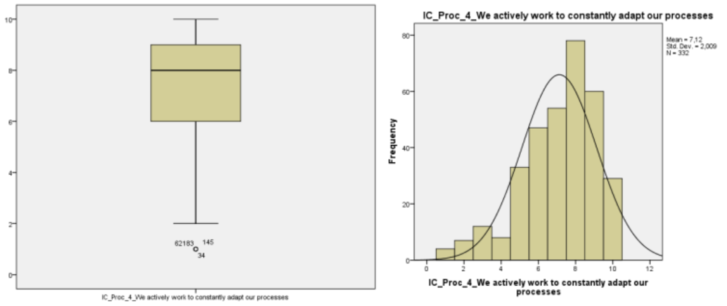

Figure 85. IC_Prod_4, boxplot and histogram

IC_Org_1

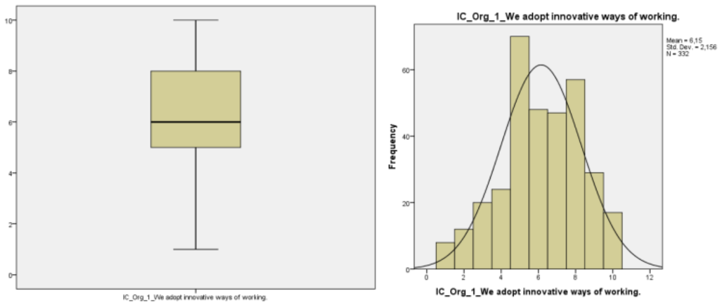

Figure 86. IC_Org_1, boxplot and histogram

IC_Org_2

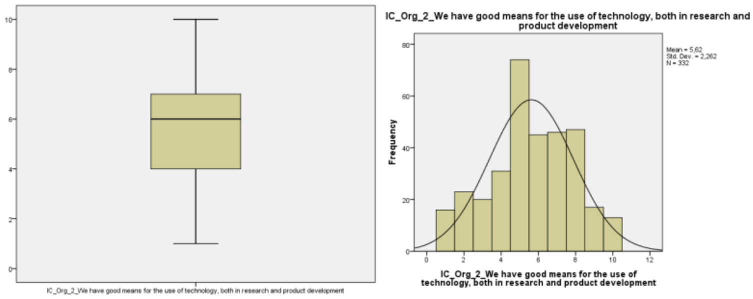

Figure 87. IC_Org_2, boxplot and histogram

IC_Org_3

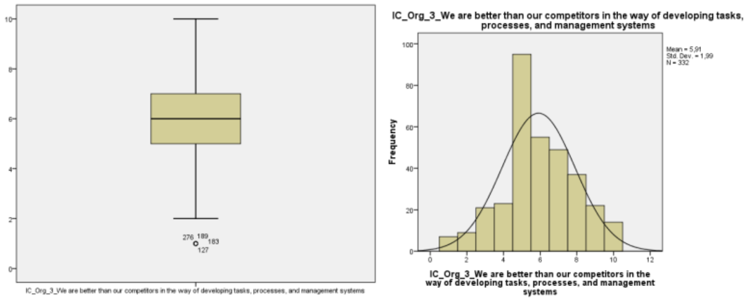

Figure 88. IC_Org _3, boxplot and histogram

IC_Org_4

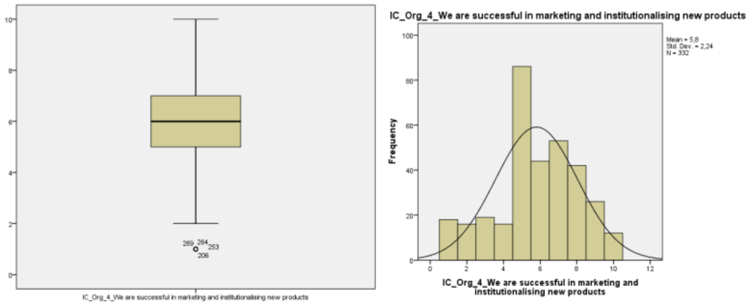

Figure 89. IC_Org_4, boxplot and histogram

IC_Mark_1

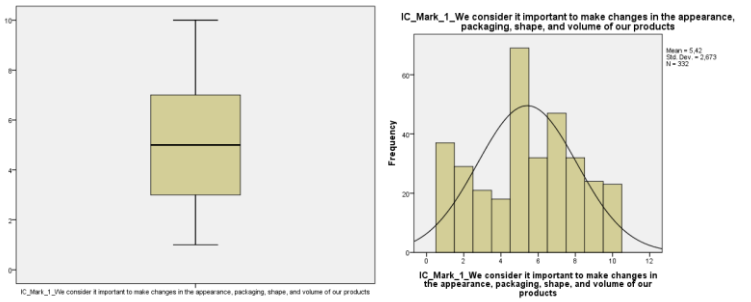

Figure 90. IC_Mark_1, boxplot and histogram

IC_Mark_2

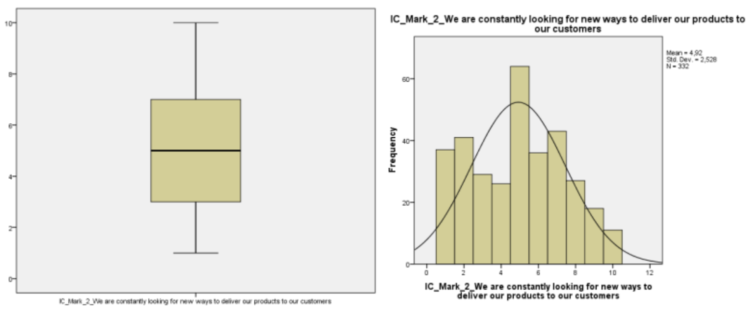

Figure 91. IC_Mark_2, boxplot and histogram

<u>*IC_Mark_3*</u>

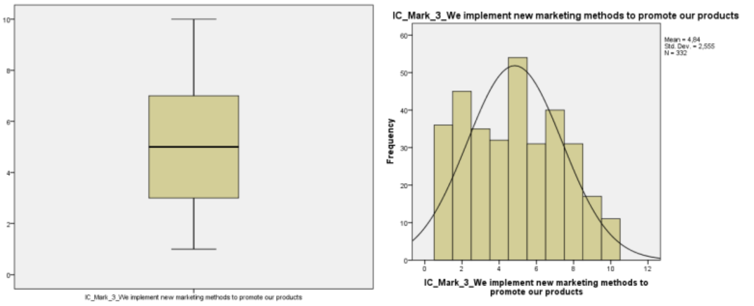

Figure 92. IC_Mark_3, boxplot and histogram

<u>*IC_Mark_4*</u>

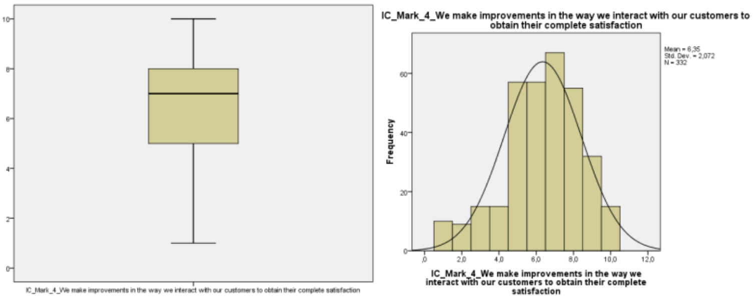

Figure 93. IC_Mark_4, boxplot and histogram

<u>*IC_Mark_5*</u>

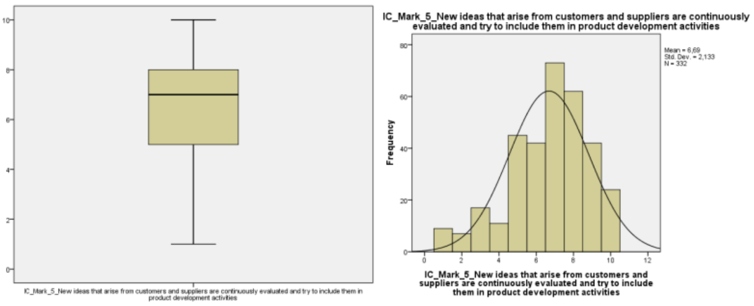

Figure 94. IC_Mark_5, boxplot and histogram

<u>*ID_1*</u>

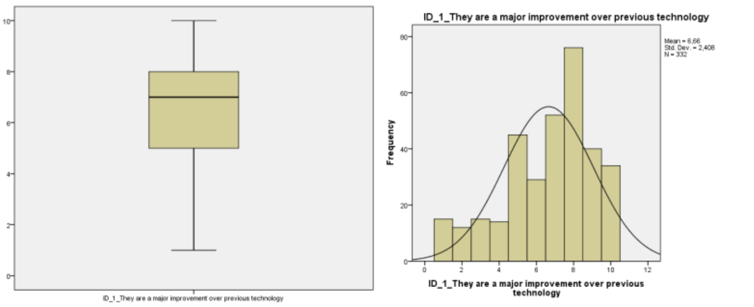

Figure 95. ID_1, boxplot and histogram

ID_2

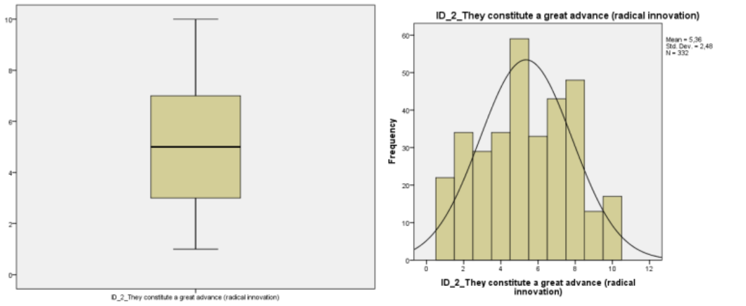

Figure 96. ID_2, boxplot and histogram

ID_3

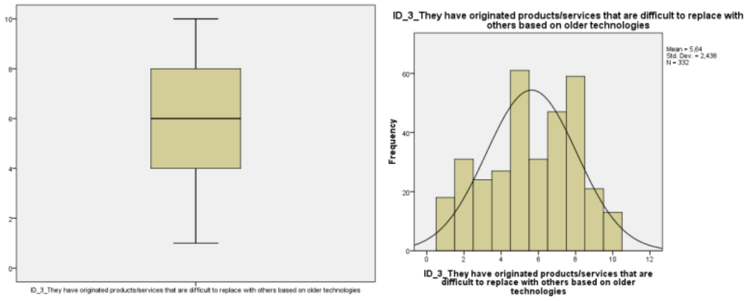

Figure 97. ID_3, boxplot and histogram

ID_4

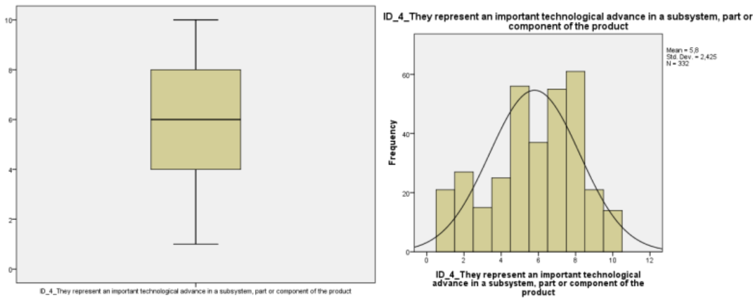

Figure 98. ID_4, boxplot and histogram

W1

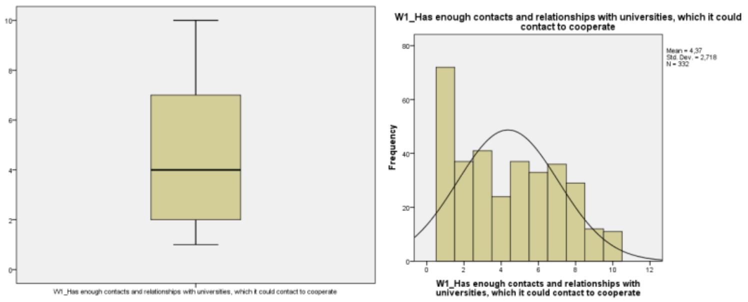

Figure 99. W1, boxplot and histogram

<u>*W2*</u>

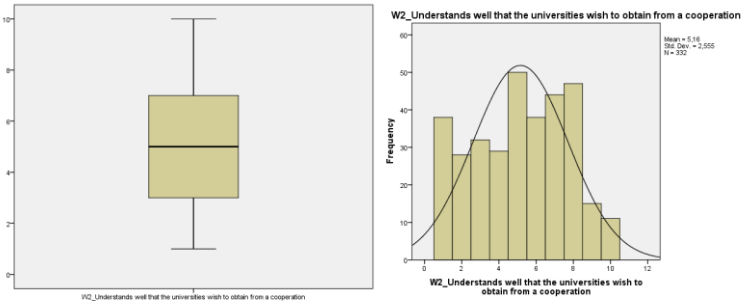

Figure 100. W2, boxplot and histogram

<u>*W3*</u>

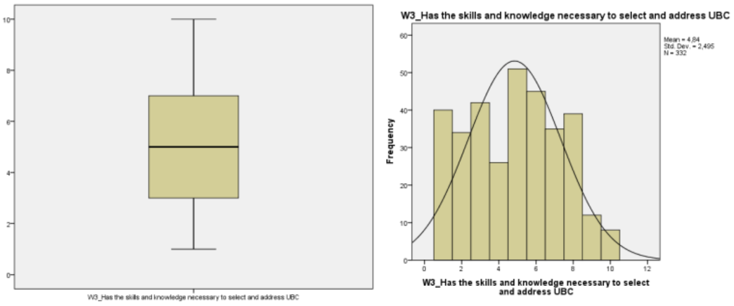

Figure 101. W3, boxplot and histogram

<u>*W4*</u>

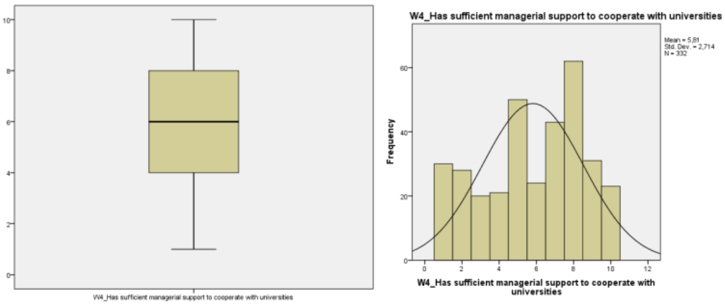

Figure 102. W4, boxplot and histogram

<u>*W5*</u>

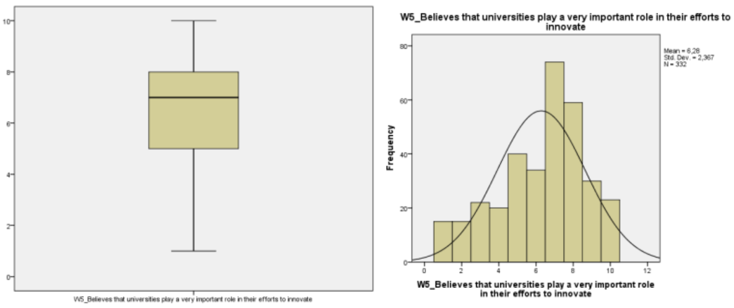

Figure 103. W5, boxplot and histogram

<u>*W6*</u>

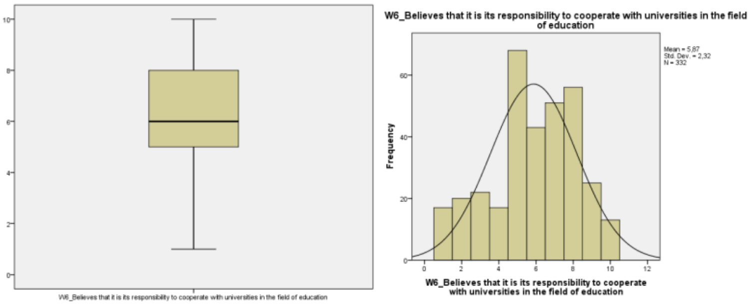

Figure 104. W6, boxplot and histogram

<u>*W7*</u>

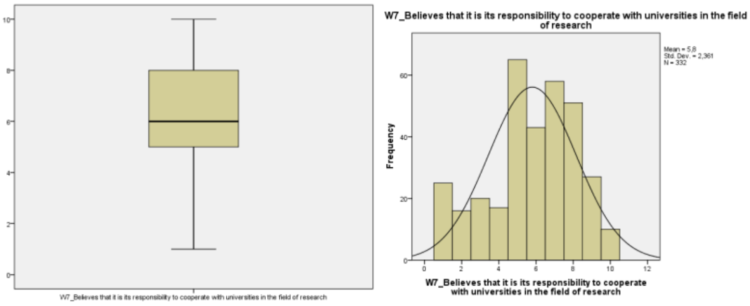

Figure 105. W7, boxplot and histogram

<u>*W8*</u>

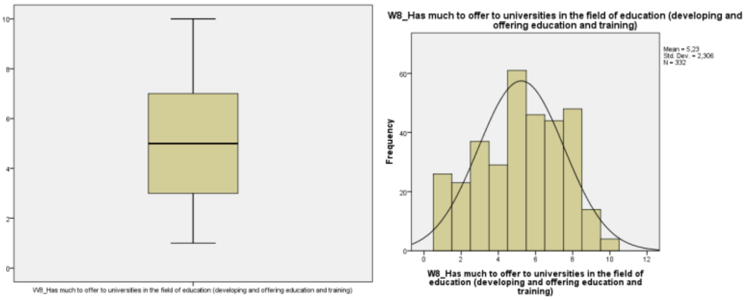

Figure 106. W8, boxplot and histogram

<u>*W9*</u>

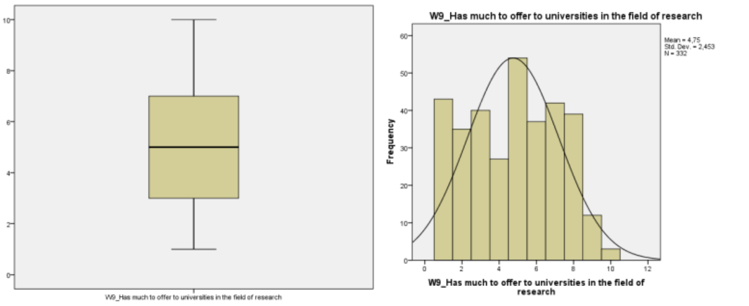

Figure 107. W9, boxplot and histogram

<u>W10</u>

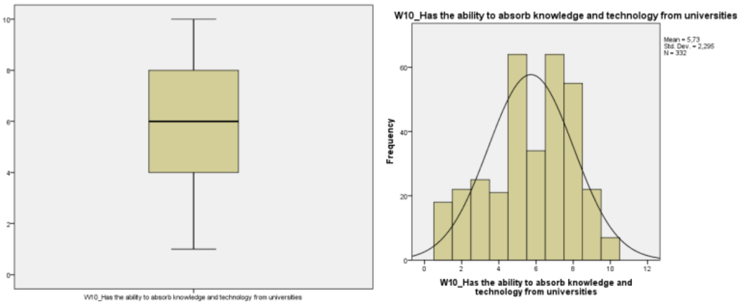

Figure 108. W10, boxplot and histogram

10.7.2. Normality assessment of outcome variables

10.7.2.1.Boxplot and histogram

<u>Stu_mob</u>

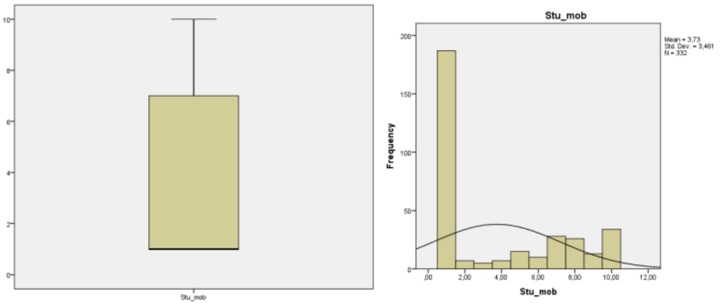

Figure 109. Stu_mob, boxplot and histogram

<u>Co_des</u>

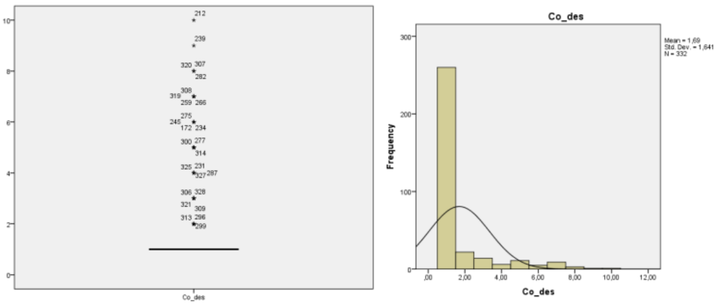

Figure 110. Co_des, boxplot and histogram

<u>Co_del</u>

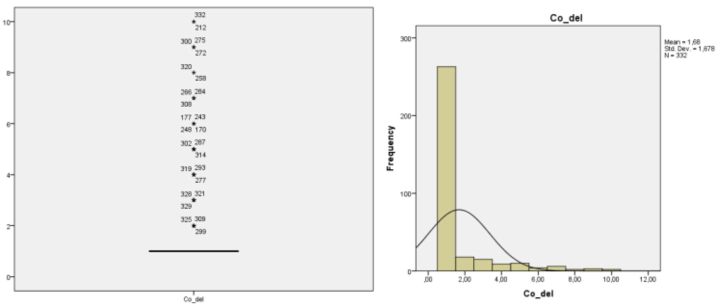

Figure 111. Co_del, boxplot and histogram

Dual_ed

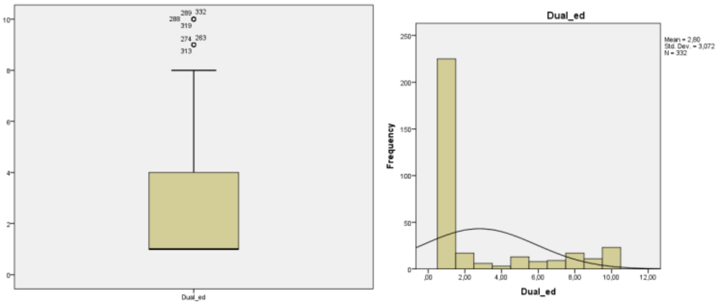

Figure 112. Dual_ed, boxplot and histogram

Li_lear

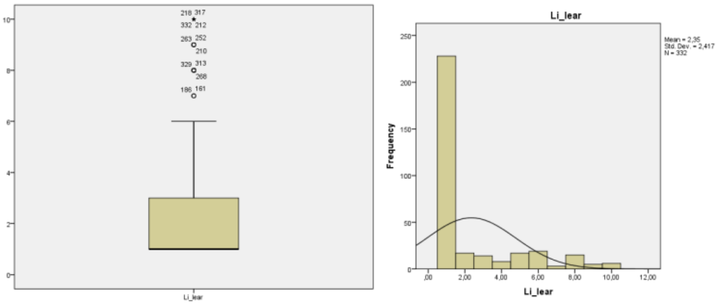

Figure 113. Li_lear, boxplot and histogram

Joint_RD

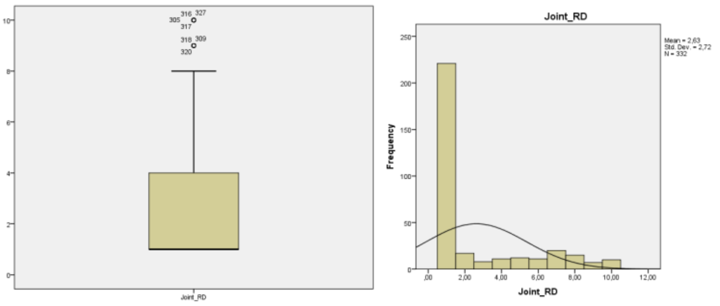

Figure 114. Joint_RD, boxplot and histogram

Cons

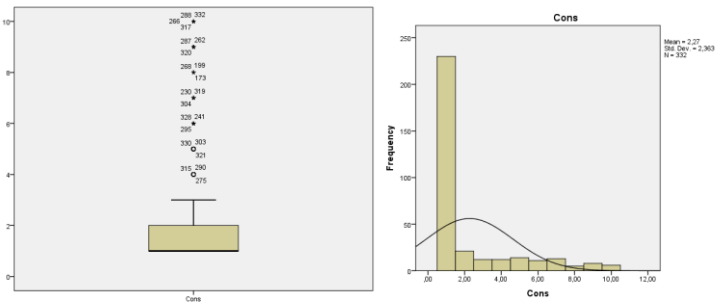

Figure 115. Cons, boxplot and histogram

Staff_mob

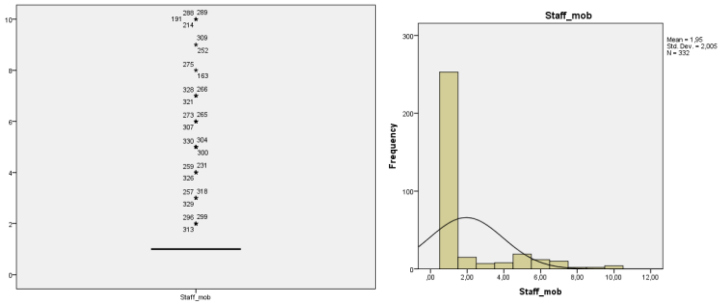

Figure 116. Staff_mob, boxplot and histogram

Commer

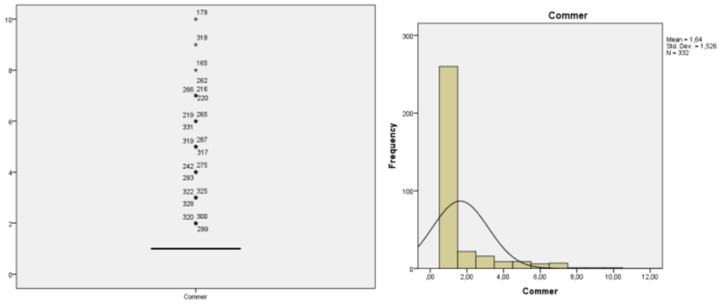

Figure 117. Commer, boxplot and histogram

Ac_ent

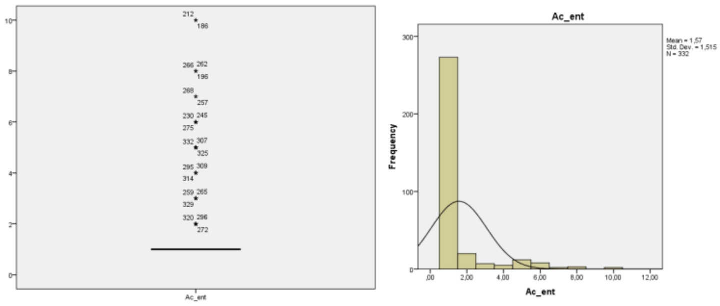

Figure 118. Ac_ent, boxplot and histogram

Stu_ent

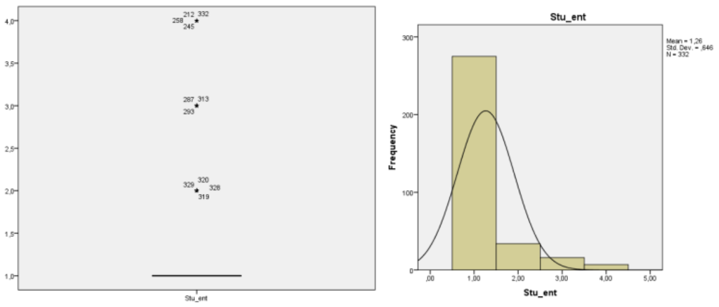

Figure 119. Stu_ent, boxplot and histogram

<u>*Gov*</u>

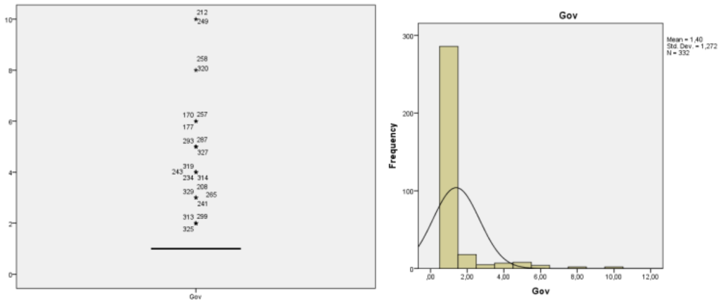

Figure 120.Gov, boxplot and histogram

<u>*Shared_res*</u>

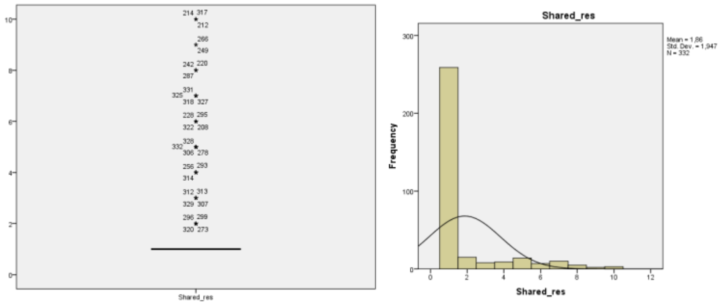

Figure 121. Shared_res, boxplot and histogram

<u>*Support*</u>

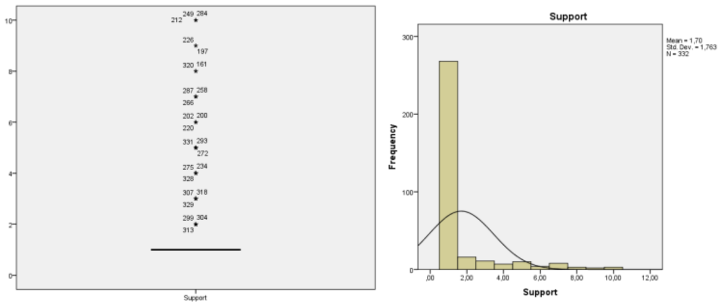

Figure 122. Support, boxplot and histogram

10.8. Appendix VII: Specific objective 1

General business characteristics	
Variable	**Statistic**
Location	Pearson's Chi-Square: 2.15, (df):2; Exact Sig. (2-sided): p>0.05
Legal form	Pearson's Chi-Square: 3.93, Exact Sig. (2-sided): p>0.05
Headquarters	Pearson's Chi-Square: .159, Exact Sig. (2-sided): p>0.05
LLL	
Variable	**Statistic**
LLL development	Pearson's Chi-Square: 3.82, df(1); Exact Sig. (2-sided): p>0.05
LLL commitment	Difference: .05, BCa 95% CI [-.11, 2,] not significant at *t*(312.17)=.62, p>0.05

Table 151. Specific objective 1: non-significant variables

10.9. Appendix VIII: Specific objective 2

10.9.1. Data adequacy

Variable	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Business group	11.640[a] a. 0 cells (0.0%) have expected count less than 5. The mínimum expected count is 43.8	1	.001
Turnover	38.336[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 37.59.	2	.000
Technological level	8.462[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 53.49.	1	.004
Cooperation in R&D	53.576[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 28.92	2	.000
Cooperation in LLL	29.441a a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.75.	3	.000
Cluster association	16.074[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 44.34.	1	.000
Informal interactions	59.363[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 70.84.	1	.000
R&D development	52.828[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 63.61.	1	.000
R&D continuity	72.896[a] a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 4.34.	3	.000
R&D program knowledge	37.556[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 45.78.	1	.000
R&D program participation	48.583[a] a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 64.10.	1	.000

Table 152. Specific objective 2: data adequacy analysis: contingency tables and Chi-Square test

10.9.2. Correlation analyses

10.9.2.1. General business characteristics

				Business_group	Size	Turnover	Market_BC	Tech_scale	HD_emp	Female
Business_group	Pearson Correlation			1	.301**	.302**	-.275**	.080	.257**	.076
	Sig. (2-tailed)				.000	.000	.000	.147	.000	.167
	Bootstrap[c]	Bias		0	-.001	-.002	.000	.000	.000	.002
		Std. Error		0	.054	.053	.049	.055	.056	.056
		95% Confidence Interval	Lower	1	.186	.195	-.377	-.035	.144	-.037
			Upper	1	.397	.399	-.175	.189	.366	.187
Size	Pearson Correlation			.301**	1	.548**	-.333**	.121*	.162**	.076
	Sig. (2-tailed)			.000		.000	.000	.027	.003	.167
	Bootstrap[c]	Bias		-.001	0	.002	.001	.000	-.002	.001
		Std. Error		.054	0	.034	.044	.059	.057	.046
		95% Confidence Interval	Lower	.186	1	.479	-.419	.003	.050	-.007
			Upper	.397	1	.615	-.242	.240	.273	.168
Turnover	Pearson Correlation			.302**	.548**	1	-.480**	.190**	.338**	.028
	Sig. (2-tailed)			.000	.000		.000	.000	.000	.612
	Bootstrap[c]	Bias		-.002	.002	0	.002	-.001	-.001	.001
		Std. Error		.053	.034	0	.046	.056	.046	.056
		95% Confidence Interval	Lower	.195	.479	1	-.567	.078	.246	-.071
			Upper	.399	.615	1	-.380	.295	.426	.143
Market_BC	Pearson Correlation			-.275**	-.333**	-.480**	1	-.254**	-.401**	-.153**
	Sig. (2-tailed)			.000	.000	.000		.000	.000	.005
	Bootstrap[c]	Bias		.000	.001	.002	0	-.001	-.001	-.004
		Std. Error		.049	.044	.046	0	.052	.043	.060
		95% Confidence Interval	Lower	-.377	-.419	-.567	1	-.358	-.484	-.277
			Upper	-.175	-.242	-.380	1	-.152	-.311	-.040
Tech_scale	Pearson Correlation			.080	.121*	.190**	-.254**	1	.331**	.160**
	Sig. (2-tailed)			.147	.027	.000	.000		.000	.003
	Bootstrap[c]	Bias		.000	.000	-.001	-.001	0	.001	.001
		Std. Error		.055	.059	.056	.052	0	.056	.052
		95% Confidence Interval	Lower	-.035	.003	.078	-.358	1	.222	.065
			Upper	.189	.240	.295	-.152	1	.442	.262

Table 153. Specific objective 2: correlations, General business characteristics

				Business_group	Size	Turnover	Market_BC	Tech_scale	HD_emp	Female
HD_emp	Pearson Correlation			.257**	.162**	.338**	-.401**	.331**	1	.286**
	Sig. (2-tailed)			.000	.003	.000	.000	.000		.000
	Bootstrap[c]	Bias		.000	-.002	-.001	-.001	.001	0	.001
		Std. Error		.056	.057	.046	.043	.056	0	.057
		95% Confidence Interval	Lower	.144	.050	.246	-.484	.222	1	.176
			Upper	.366	.273	.426	-.311	.442	1	.397
Female	Pearson Correlation			.076	.076	.028	-.153**	.160**	.286**	1
	Sig. (2-tailed)			.167	.167	.612	.005	.003	.000	
	Bootstrap[c]	Bias		.002	.001	.001	-.004	.001	.001	0
		Std. Error		.056	.046	.056	.060	.052	.057	0
		95% Confidence Interval	Lower	-.037	-.007	-.071	-.277	.065	.176	1
			Upper	.187	.168	.143	-.040	.262	.397	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
c. Unless otherwise noted. bootstrap results are based on 1000 bootstrap samples

Table 153. (cont.) Specific objective 2: correlations, General business characteristics

10.9.2.2.Business openness

			RD_coop=0.0	RD_coop=Internally	RD_coop=Ext_coop	RD_coop_tot	LLL_coop=0.0	LLL_coop=Internally	LLL_coop=External_coop	LLL_coop=Internally_External_coop	LLL_coop_tot	Clus_yes_no	Inf_int_yes_no	Inf_int_tot
RD_coop=0.0	Pearson Correlation		1	-.382**	-.694**	-.571**	.185**	.075	.242**	-.344**	-.350**	-.269**	-.315**	-.303**
	Sig. (2-tailed)			.000	.000	.000	.001	.175	.000	.000	.000	.000	.000	.000
	Bootstrap[c]	Bias	0	.001	.001	.000	.000	-.001	-.001	.000	.001	.001	-.001	-.001
		Std. Error	0	.028	.031	.027	.056	.054	.056	.053	.049	.047	.049	.045
		95% Confidence Interval Lower	1	-.435	-.756	-.626	.075	-.032	.132	-.443	-.442	-.360	-.414	-.386
		Upper	1	-.330	-.630	-.517	.290	.179	.351	-.239	-.250	-.174	-.216	-.207
RD_coop=Internally	Pearson Correlation		-.382**	1	-.401**	-.330**	-.090	.057	-.080	.095	.026	-.011	-.025	.009
	Sig. (2-tailed)		.000		.000	.000	.102	.298	.147	.083	.636	.842	.654	.868
	Bootstrap[c]	Bias	.001	0	-.001	-.001	-.001	.001	.001	-.001	-.001	.000	.002	.002
		Std. Error	.028	0	.029	.024	.038	.061	.046	.049	.053	.053	.054	.059
		95% Confidence Interval Lower	-.435	1	-.458	-.377	-.153	-.058	-.162	-.010	-.076	-.112	-.127	-.100
		Upper	-.330	1	-.346	-.285	-.006	.176	.021	.187	.131	.102	.089	.129
RD_coop=Ext_coop	Pearson Correlation		-.694**	-.401**	1	.824**	-.113*	-.118*	-.178**	.267**	.327**	.275**	.332**	.293**
	Sig. (2-tailed)		.000	.000		.000	.040	.031	.001	.000	.000	.000	.000	.000
	Bootstrap[c]	Bias	.001	-.001	0	.001	.000	.001	.001	.000	.000	-.001	-.001	-.001
		Std. Error	.031	.029	0	.018	.049	.043	.049	.049	.050	.053	.051	.052
		95% Confidence Interval Lower	-.756	-.458	1	.790	-.205	-.193	-.272	.169	.226	.168	.231	.192
		Upper	-.630	-.346	1	.859	-.011	-.026	-.082	.363	.428	.377	.431	.393
RD_coop_tot	Pearson Correlation		-.571**	-.330**	.824**	1	-.144**	-.136*	-.161**	.280**	.431**	.273**	.275**	.272**
	Sig. (2-tailed)		.000	.000	.000		.008	.013	.003	.000	.000	.000	.000	.000
	Bootstrap[c]	Bias	.000	-.001	.001	0	.001	.000	.000	.000	.000	-.001	-.001	,000
		Std. Error	.027	.024	.018	0	.036	.023	.043	.040	.048	.057	.051	,056
		95% Confidence Interval Lower	-.626	-.377	.790	1	-.206	-.179	-.238	.198	.336	.169	,173	,156
		Upper	-.517	-.285	.859	1	-.068	-.088	-.072	.362	.523	.386	,372	,376

Table 154. Specific objective 2: correlations, Business openness

		RD_coop=0.0	RD_coop=Internally	RD_coop=External_coop	RD_coop_tot	LLL_coop=0.0	LLL_coop=Internally	LLL_coop=External_coop	LLL_coop=Internally_External_coop	LLL_coop_tot	Clus_yes_no	Inf_int_yes_no	Inf_int_tot
LLL_coop=0.0	Pearson Correlation	.185**	-.090	-.113*	-.144**	1	-.065	-.136*	-.482**	-.481**	-.072	-.190**	-.164**
	Sig. (2-tailed)	.001	.102	.040	.008		.238	.013	.000	.000	.188	.001	.003
	Bootstrap[c] Bias	.000	-.001	.000	.001	0	.001	.001	.002	.001	.003	-.001	-,001
	Bootstrap[c] Std. Error	.056	.038	.049	.036	0	.010	.015	.042	.038	.048	.041	,036
	Bootstrap[c] 95% Confidence Interval Lower	.075	-.153	-.205	-.206	1	-.085	-.167	-.564	-.552	-.158	-,262	-,230
	Bootstrap[c] 95% Confidence Interval Upper	.290	-.006	-.011	-.068	1	-.044	-.107	-.396	-.400	.033	-,104	-,090
LLL_coop=Internally	Pearson Correlation	.075	.057	-.118*	-.136*	-.065	1	-.092	-.327**	-.326**	-.063	-.097	-.087
	Sig. (2-tailed)	.175	.298	.031	.013	.238		.093	.000	.000	.253	.079	.112
	Bootstrap[c] Bias	-.001	.001	.001	.000	.001	0	.001	.001	.001	.002	.002	,001
	Bootstrap[c] Std. Error	.054	.061	.043	.023	.010	0	.014	.044	.042	.043	.048	,042
	Bootstrap[c] 95% Confidence Interval Lower	-.032	-.058	-.193	-.179	-.085	1	-.120	-.410	-.404	-.134	-,181	-,157
	Bootstrap[c] 95% Confidence Interval Upper	.179	.176	-.026	-.088	-.044	1	-.064	-.236	-.238	.033	,005	,004
LLL_coop=External_coop	Pearson Correlation	.242**	-.080	-.178**	-.161**	-.136*	-.092	1	-.686**	-.178**	-.109*	-.229**	-.210**
	Sig. (2-tailed)	.000	.147	.001	.003	.013	.093		.000	.001	.048	.000	.000
	Bootstrap[c] Bias	-.001	.001	.001	.000	.001	.001	0	.001	.000	-.001	.001	,000
	Bootstrap[c] Std. Error	.056	.046	.049	.043	.015	.014	0	.037	.040	.047	.048	,041
	Bootstrap[c] 95% Confidence Interval Lower	.132	-.162	-.272	-.238	-.167	-.120	1	-.757	-.262	-.192	-,322	-,290
	Bootstrap[c] 95% Confidence Interval Upper	.351	.021	-.082	-.072	-.107	-.064	1	-.609	-.096	-.011	-,132	-,123
LLL_coop=Internally_External_coop	Pearson Correlation	-.344**	.095	.267**	.280**	-.482**	-.327**	-.686**	1	.588**	.161**	.346**	.311**
	Sig. (2-tailed)	.000	.083	.000	.000	.000	.000	.000		.000	.003	.000	.000
	Bootstrap[c] Bias	.000	-.001	.000	.000	.002	.001	.001	0	.001	-.001	.000	.001
	Bootstrap[c] Std. Error	.053	.049	.049	.040	.042	.044	.037	0	.033	.047	.047	.040
	Bootstrap[c] 95% Confidence Interval Lower	-.443	-.010	.169	.198	-.564	-.410	-.757	1	.522	.060	.252	.231
	Bootstrap[c] 95% Confidence Interval Upper	-.239	.187	.363	.362	-.396	-.236	-.609	1	.653	.249	.438	.391

Table 154. (cont.) Specific objective 2: correlations, Business openness

		RD_coop=0.0	RD_coop=Internally	RD_coop=Ext_coop	RD_coop_tot	LLL_coop=0.0	LLL_coop=Internally	LLL_coop=External_coop	LLL_coop=Internally_External_coop	LLL_coop_tot	Clus_yes_no	Inf_int_yes_no	Inf_int_tot
LLL_coop_tot	Pearson Correlation	-.350**	.026	.327**	.431**	-.481**	-.326**	-.178**	.588**	1	.240**	.401**	.392**
	Sig. (2-tailed)	.000	.636	.000	.000	.000	.000	.001	.000		.000	.000	.000
	Bootstrap[c] Bias	.001	-.001	.000	.000	.001	.001	.000	.001	0	-.003	.000	.000
	Bootstrap[c] Std. Error	.049	.053	.050	.048	.038	.042	.040	.033	0	.052	.045	.045
	Bootstrap[c] 95% Confidence Interval Lower	-.442	-.076	.226	.336	-.552	-.404	-.262	.522	1	.131	.311	.306
	Bootstrap[c] 95% Confidence Interval Upper	-.250	.131	.428	.523	-.400	-.238	-.096	.653	1	.338	.485	.479
Clus_yes_no	Pearson Correlation	-.269**	-.011	.275**	.273**	-.072	-.063	-.109*	.161**	.240**	1	.275**	.293**
	Sig. (2-tailed)	.000	.842	.000	.000	.188	.253	.048	.003	.000		.000	.000
	Bootstrap[c] Bias	.001	.000	-.001	-.001	.003	.002	-.001	-.001	-.003	0	-.002	-.001
	Bootstrap[c] Std. Error	.047	.053	.053	.057	.048	.043	.047	.047	.052	0	.054	.054
	Bootstrap[c] 95% Confidence Interval Lower	-.360	-.112	.168	.169	-.158	-.134	-.192	.060	.131	1	.163	.183
	Bootstrap[c] 95% Confidence Interval Upper	-.174	.102	.377	.386	.033	.033	-.011	.249	.338	1	.375	.395
Inf_int_yes_no	Pearson Correlation	-.315**	-.025	.332**	.275**	-.190**	-.097	-.229**	.346**	.401**	.275**	1	.861**
	Sig. (2-tailed)	.000	.654	.000	.000	.001	.079	.000	.000	.000	.000		.000
	Bootstrap[c] Bias	-.001	.002	-.001	-.001	-.001	.002	.001	.000	.000	-.002	0	.000
	Bootstrap[c] Std. Error	.049	.054	.051	.051	.041	.048	.048	.047	.045	.054	0	.010
	Bootstrap[c] 95% Confidence Interval Lower	-.414	-.127	.231	.173	-.262	-.181	-.322	.252	.311	.163	1	.842
	Bootstrap[c] 95% Confidence Interval Upper	-.216	.089	.431	.372	-.104	.005	-.132	.438	.485	.375	1	.881
Inf_int_tot	Pearson Correlation	-.303**	.009	.293**	.272**	-.164**	-.087	-.210**	.311**	.392**	.293**	.861**	1
	Sig. (2-tailed)	.000	.868	.000	.000	.003	.112	.000	.000	.000	.000	.000	
	Bootstrap[c] Bias	-.001	.002	-.001	.000	-.001	.001	.000	.001	.000	-.001	.000	0
	Bootstrap[c] Std. Error	.045	.059	.052	.056	.036	.042	.041	.040	.045	.054	.010	0
	Bootstrap[c] 95% Confidence Interval Lower	-.386	-.100	.192	.156	-.230	-.157	-.290	.231	.306	.183	.842	1
	Bootstrap[c] 95% Confidence Interval Upper	-.207	.129	.393	.376	-.090	.004	-.123	.391	.479	.395	.881	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 154. (cont.) Specific objective 2: correlations, Business openness

10.9.2.3. R&D

				RD_yes_no	RD_int	RD_prog_know	RD_prog_partic
RD_yes_no	Pearson Correlation			1	.768**	.493**	.664**
	Sig. (2-tailed)				.000	.000	.000
	Bootstrap[b]	Bias		0	.006	.001	-.002
		Std. Error		0	.038	.050	.030
		95% Confidence Interval	Lower	1	.701	.396	.604
			Upper	1	.848	.589	.724
RD_int	Pearson Correlation			.768**	1	.360**	.533**
	Sig. (2-tailed)			.000		.000	.000
	Bootstrap[b]	Bias		.006	0	.006	.006
		Std. Error		.038	0	.066	.056
		95% Confidence Interval	Lower	.701	1	.218	.425
			Upper	.848	1	.481	.641
RD_prog_know	Pearson Correlation			.493**	.360**	1	.450**
	Sig. (2-tailed)			.000	.000		.000
	Bootstrap[b]	Bias		.001	.006	0	.002
		Std. Error		.050	.066	0	.037
		95% Confidence Interval	Lower	.396	.218	1	.377
			Upper	.589	.481	1	.522
RD_prog_partic	Pearson Correlation			.664**	.533**	.450**	1
	Sig. (2-tailed)			.000	.000	.000	
	Bootstrap[b]	Bias		-.002	.006	.002	0
		Std. Error		.030	.056	.037	0
		95% Confidence Interval	Lower	.604	.425	.377	1
			Upper	.724	.641	.522	1

**. Correlation is significant at the 0.01 level (2-tailed).
b. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 155. Specific objective 2: correlations, R&D

10.9.2.4. Innovation

				ID	IC_med
ID	Pearson Correlation			1	.581**
	Sig. (2-tailed)				.000
	Bootstrap[b]	Bias		0	.000
		Std. Error		0	.039
		95% Confidence Interval	Lower	1	.504
			Upper	1	.654
IC_med	Pearson Correlation			.581**	1
	Sig. (2-tailed)			.000	
	Bootstrap[b]	Bias		.000	0
		Std. Error		.039	0
		95% Confidence Interval	Lower	.504	1
			Upper	.654	1

**. Correlation is significant at the 0.01 level (2-tailed).
b. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 156. Specific objective 2: correlations, Innovation

10.9.2.5. UBC willingness and support

				UBC_resources	Cogni_closeness	UBC_beliefs
UBC_resources	Pearson Correlation			1	.605**	.520**
	Sig. (2-tailed)				.000	.000
	Bootstrap[b]	Bias		0	.000	.000
		Std. Error		0	.038	.042
		95% Confidence Interval	Lower	1	.525	.439
			Upper	1	.676	.605
Cogni_closeness	Pearson Correlation			.605**	1	.561**
	Sig. (2-tailed)			.000		.000
	Bootstrap[b]	Bias		.000	0	.001
		Std. Error		.038	0	.046
		95% Confidence Interval	Lower	.525	1	.469
			Upper	.676	1	.649
UBC_beliefs	Pearson Correlation			.520**	.561**	1
	Sig. (2-tailed)			.000	.000	
	Bootstrap[b]	Bias		.000	.001	0
		Std. Error		.042	.046	0
		95% Confidence Interval	Lower	.439	.469	1
			Upper	.605	.649	1

**. Correlation is significant at the 0.01 level (2-tailed).
b. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 157. Specific objective 2: correlations, UBC willingness and support

10.9.2.6.Inter-group analysis

				Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	Inf_int_tot	Clus_yes_no	LLL_coop_tot	RD_int	IC_med	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Business_group	Pearson Correlation			1.00	.301**	-.275**	.08	.257**	.08	.193**	.117*	.09	.112*	.191**	.10	.180**	.159**	.07
	Sig. (2-tailed)				.00	.00	.15	.00	.17	.00	.03	.09	.04	.00	.06	.00	.00	.20
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.00	.05	.05	.06	.06	.06	.05	.06	.05	.05	.05	.05	.05	.05	.05
		95% Confidence Interval	Lower	1.00	.19	-.37	-.03	.15	-.04	.09	.01	.00	.02	.10	-.01	.08	.07	-.03
			Upper	1.00	.41	-.17	.19	.36	.19	.31	.23	.20	.22	.30	.21	.29	.25	.17
Size	Pearson Correlation			.301**	1.00	-.333**	.121*	.162**	.08	.237**	.218**	.276**	.213**	.232**	.160**	.185**	.239**	.143**
	Sig. (2-tailed)			.00		.00	.03	.00	.17	.00	.00	.00	.00	.00	.00	.00	.00	.01
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.05	.00	.04	.06	.06	.05	.05	.06	.04	.06	.05	.04	.05	.04	.05
		95% Confidence Interval	Lower	.19	1.00	-.41	.02	.06	-.01	.14	.11	.19	.09	.13	.09	.08	.16	.05
			Upper	.41	1.00	-.25	.23	.28	.17	.35	.34	.36	.34	.32	.24	.28	.32	.23
Market_BC	Pearson Correlation			-.275**	-.333**	1.00	-.254**	-.401**	-.153**	-.264**	-.293**	-.226**	-.275**	-.270**	-.185**	-.204**	-.207**	-.09
	Sig. (2-tailed)			.00	.00		.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.11
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00
		Std. Error		.05	.04	.00	.05	.04	.06	.05	.05	.05	.06	.05	.05	.05	.06	.06
		95% Confidence Interval	Lower	-.37	-.41	1.00	-.36	-.48	-.28	-.36	-.39	-.33	-.40	-.36	-.29	-.30	-.32	-.20
			Upper	-.17	-.25	1.00	-.15	-.31	-.04	-.17	-.21	-.12	-.15	-.16	-.08	-.09	-.10	.03

Table 158. Specific objective 2: correlations, inter-group analysis

				Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	Inf_int_tot	Clus_yes_no	LLL_coop_tot	RD_int	IC_med	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Tech_scale	Pearson Correlation			.08	.121*	-.254**	1.00	.331**	.160**	.116*	.00	.132*	.229**	.195**	.172**	.10	.159**	.03
	Sig. (2-tailed)			.15	.03	.00		.00	.00	.04	.95	.02	.00	.00	.00	.08	.00	.53
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.01	.00	.00	.00	.01	.00	.00	.00	.00	.00
		Std. Error		.06	.06	.05	.00	.05	.06	.06	.05	.06	.06	.05	.05	.05	.05	.05
		95% Confidence Interval	Lower	-.03	.02	-.36	1.00	.23	.06	.00	-.09	.03	.13	.10	.07	-.01	.06	-.07
			Upper	.19	.23	-.15	1.00	.44	.27	.22	.11	.25	.35	.29	.27	.20	.25	.13
HD_emp	Pearson Correlation			.257**	.162**	-.401**	.331**	1.00	.286**	.315**	.125*	.192**	.400**	.358**	.233**	.230**	.331**	.07
	Sig. (2-tailed)			.00	.00	.00	.00		.00	.00	.02	.00	.00	.00	.00	.00	.00	.18
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.06	.04	.05	.00	.06	.05	.05	.05	.06	.05	.05	.05	.05	.06
		95% Confidence Interval	Lower	.15	.06	-.48	.23	1.00	.17	.20	.02	.09	.27	.27	.13	.14	.24	-.04
			Upper	.36	.28	-.31	.44	1.00	.40	.42	.23	.30	.51	.45	.34	.32	.42	.19
Female	Pearson Correlation			0.08	.08	-.153**	.160**	.286**	1.00	.134*	.00	.08	.138*	.08	-.09	.06	.07	.10
	Sig. (2-tailed)			.17	.17	.01	.00	.00		.01	.98	.16	.01	.13	.11	.29	.18	.08
	Bootstrap[c]	Bias		.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.05	.06	.06	.06	.00	.05	.05	.06	.06	.06	.06	.06	.06	.06
		95% Confidence Interval	Lower	-.04	-.01	-.28	.06	.17	1.00	.04	-.09	-.03	.03	-.03	-.21	-.05	-.03	-.02
			Upper	.19	.17	-.04	.27	.40	1.00	.24	.09	.20	.25	.19	.03	.18	.19	.20

Table 158. (cont.) Specific objective 2: correlations, inter-group analysis

				Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	Inf_int_tot	Clus_yes_no	LLL_coop_tot	RD_int	IC_med	ID	UBC_resources	Cogni_closeness	UBC_beliefs
Inf_int_tot	Pearson Correlation			.193**	.237**	-.264**	.116*	.315**	.134*	1.00	.293**	.392**	.179**	.264**	.197**	.344**	.343**	.231**
	Sig. (2-tailed)			.00	.00	.00	.04	.00	.01		.00	.00	.00	.00	.00	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.05	.05	.05	.06	.05	.05	.00	.06	.04	.06	.05	.05	.04	.05	.05
		95% Confidence Interval	Lower	.09	.14	-.36	.00	.20	.04	1.00	.18	.31	.08	.17	.10	.25	0,25	.13
			Upper	.31	.35	-.17	.22	.42	.24	1.00	.40	.48	.29	.36	.29	.43	0,43	.32
Clus_yes_no	Pearson Correlation			.117*	.218**	-.293**	.00	.125*	.00	.293**	1.00	.240**	.155**	.154**	.137*	.143**	.201**	.150**
	Sig. (2-tailed)			.03	.00	.00	.95	.02	.98	.00		.00	.00	.01	.01	.01	.00	.01
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.06	.06	.05	.05	.05	.05	.06	.00	.05	.05	.05	.05	.05	.05	.06
		95% Confidence Interval	Lower	.01	.11	-.39	-.09	.02	-.09	.18	1.00	.13	.07	.06	.04	.03	.10	.03
			Upper	.23	.34	-.21	.11	.23	.09	.40	1.00	.35	.28	.25	.23	.25	.30	.25
LLL_coop_tot	Pearson Correlation			.09	.276**	-.226**	.132*	.192**	.08	.392**	.240**	1.00	.279**	.272**	.216**	.264**	.314**	.201**
	Sig. (2-tailed)			.09	.00	.00	.02	.00	.16	.00	.00		.00	.00	.00	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.05	.04	.05	.06	.05	.06	.04	.05	.00	.06	.05	.05	.05	.05	.06
		95% Confidence Interval	Lower	.00	.19	-.33	.03	.09	-.03	.31	.13	1.00	.16	.17	.11	.16	.22	.10
			Upper	.20	.36	-.12	.25	.30	.20	.48	.35	1.00	.41	.37	.32	.36	.42	.31

Table 158. (cont.) Specific objective 2: correlations, inter-group analysis

				Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	Inf_int_tot	Clus_yes_no	LLL_coop_tot	RD_int	IC_med	ID	UBC_resources	Cogni_closeness	UBC_beliefs
RD_int	Pearson Correlation			.112*	.213**	-.275**	.229**	.400**	.138*	.179**	.155**	.279**	1.00	.357**	.344**	.154**	.332**	.10
	Sig. (2-tailed)			.04	.00	.00	.00	.00	.01	.00	.00	.00		.00	.00	.00	.00	.07
	Bootstrap[c]	Bias		.00	.00	-.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.05	.06	.06	.06	.06	.06	.06	.05	.06	.00	.05	.04	.06	.04	.05
		95% Confidence Interval	Lower	.02	.09	-.40	.13	.27	.03	.08	.07	.16	1.00	.26	.27	.02	.25	.00
			Upper	.22	.34	-.15	.35	.51	.25	.29	.28	.41	1.00	.47	.43	.27	.42	.20
IC	Pearson Correlation			.191**	.232**	-.270**	.195**	.358**	.08	.264**	.154**	.272**	.357**	1.00	.581**	.357**	.476**	.280**
	Sig. (2-tailed)			.00	.00	.00	.00	.00	.13	.00	.01	.00	.00		.00	.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.05	.05	.05	.05	.05	.06	.05	.05	.05	.05	.00	.04	.05	.05	.06
		95% Confidence Interval	Lower	.10	.13	-.36	.10	.27	-.03	.17	.06	.17	.26	1.00	.50	.26	.38	.16
			Upper	.30	.32	-.16	.29	.45	.19	.36	.25	.37	.47	1.00	.66	.45	.56	.38
ID	Pearson Correlation			.10	.160**	-.185**	.172**	.233**	-.09	.197**	.137*	.216**	.344**	.581**	1.00	.262**	.371**	.213**
	Sig. (2-tailed)			.06	.00	.00	.00	.00	.11	.00	.01	.00	.00	.00		.00	.00	.00
	Bootstrap[c]	Bias		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error		.05	.04	.05	.05	.05	.06	.05	.05	.05	.04	.04	.00	.06	.06	.06
		95% Confidence Interval	Lower	-.01	.09	-.29	.07	.13	-.21	.10	.04	.11	.27	.50	1.00	.14	.26	.08
			Upper	.21	.24	-.08	.27	.34	.03	.29	.23	.32	.43	.66	1.00	.37	.47	.34

Table 158. (cont.) Specific objective 2: correlations, inter-group analysis

			Business_group	Size	Market_BC	Tech_scale	HD_emp	Female	Inf_int_tot	Clus_yes_no	LLL_coop_tot	RD_int	IC_med	ID	UBC_resources	Cogni_closeness	UBC_beliefs
UBC_resources	Pearson Correlation		.180**	.185**	-.204**	.10	.230**	.06	.344**	.143**	.264**	.154**	.357**	.262**	1.00	.605**	.520**
	Sig. (2-tailed)		.00	.00	.00	.08	.00	.29	.00	.01	.00	.00	.00	.00		.00	.00
	Bootstrap[c]	Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error	.05	.05	.05	.05	.05	.06	.04	.05	.05	.06	.05	.06	.00	.04	.04
		95% Confidence Interval Lower	.08	.08	-.30	-.01	.14	-.05	.25	.03	.16	.02	.26	.14	1.00	.52	.43
		95% Confidence Interval Upper	.29	.28	-.09	.20	.32	.18	.43	.25	.36	.27	.45	.37	1.00	.68	.60
Cogni_closeness	Pearson Correlation		.159**	.239**	-.207**	.159**	.331**	.07	.343**	.201**	.314**	.332**	.476**	.371**	.605**	1.00	.561**
	Sig. (2-tailed)		.00	.00	.00	.00	.00	.18	.00	.00	.00	.00	.00	.00	.00		.00
	Bootstrap[c]	Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error	.05	.04	.06	.05	.05	.06	.05	.05	.05	.04	.05	.06	.04	.00	.05
		95% Confidence Interval Lower	.07	.16	-.32	.06	.24	-.03	.25	.10	.22	.25	.38	.26	.52	1.00	.46
		95% Confidence Interval Upper	.25	.32	-.10	.25	.42	.19	.43	.30	.42	.42	.56	.47	.68	1.00	.65
UBC_beliefs	Pearson Correlation		.07	.143**	-.09	.03	.07	.10	.231**	.150**	.201**	.10	.280**	.213**	.520**	.561**	1.00
	Sig. (2-tailed)		.20	.01	.11	.53	.18	.08	.00	.01	.00	.07	.00	.00	.00	.00	
	Bootstrap[c]	Bias	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		Std. Error	.05	.05	.06	.05	.06	.06	.05	.06	.06	.05	.06	.06	.04	.05	.00
		95% Confidence Interval Lower	-.03	.05	-.20	-.07	-.04	-.02	.13	.03	.10	.00	.16	.08	.43	.46	1.00
		95% Confidence Interval Upper	.17	.23	.03	.13	.19	.20	.32	.25	.31	.20	.38	.34	.60	.65	1.00

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 158. (cont.) Specific objective 2: correlations, inter-group analysis

10.9.3. Logistic regression models

10.9.3.1. Business general characteristics

Regression analysis without leverage points

Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 1	Step	1.371	1	.242
	Block	1.371	1	.242
	Model	79.564	6	.000

Table 159. Specific objective 2: Business general characteristics, regression analysis without leverage points, Omnibus Tests of Model Coefficients

Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	371.583[a]	.217	.289
a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001 for split file $bootstrap_split = 0.			

Table 160. Specific objective 2: Business general characteristics, full model, regression analysis without leverage points, Model Summary

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	108	47	69.7
		Yes	59	112	65.5
	Overall Percentage				67.5
a. The cut value is .500					

Table 161. Specific objective 2: Business general characteristics, regression analysis without leverage points, Classification Table

		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% C.I.for EXP(B)**	
								Lower	**Upper**
Step 1[a]	Business_group(1)	.063	.310	.042	1	.838	1.065	.581	1.954
	Size	.018	.006	10.611	1	.001	1.019	1.007	1.030
	Market_BC	-.096	.039	5.986	1	.014	.909	.841	.981
	Tech_scale(1)	.005	.286	.000	1	.987	1.005	.574	1.759
	HD_emp	.344	.100	11.859	1	.001	1.410	1.160	1.715
	Female	.095	.082	1.369	1	.242	1.100	.938	1.291
	Constant	-1.206	.517	5.447	1	.020	.299		
a. Variable(s) entered on step 1: Female.									

Table 162. Specific objective 2: Business general characteristics, regression analysis without leverage points, Variables in the Equation

10.9.3.2. Innovation

Regression analysis without leverage points

Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 1	Step	1.027	1	.311
	Block	1.027	1	.311
	Model	23.018	2	.000

Table 163. Specific objective 2: Innovation, regression analysis without leverage points, Omnibus Tests of Model Coefficient

Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	431.088[a]	.068	.090
a. Estimation terminated at iteration number 4 because parameter estimates changed by less than ,001 for split file $bootstrap_split = 0.			

Table 164. Specific objective 2: Innovation, regression analysis without leverage points, Model Summary

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	90	67	57.3
		Yes	53	118	69.0
	Overall Percentage				63.4
a. The cut value is .500					

Table 165. Specific objective 2: Innovation, regression analysis without leverage points, Classification Table

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	IC_med	.248	.081	9.319	1	.002	1.282	1.093	1.503
	ID	.070	.069	1.023	1	.312	1.072	.937	1.227
	Constant	-1.743	.418	17.380	1	.000	.175		
a. Variable(s) entered on step 1: ID.									

Table 166. Specific objective 2: Innovation, regression analysis without leverage points, Variables in the Equation

10.9.3.3. UBC willingness and support

Regression analysis without leverage points

Omnibus Tests of Model Coefficients				
		Chi-square	df	Sig.
Step 1	Step	2.080	1	.149
	Block	2.080	1	.149
	Model	131.362	3	.000

Table 167. Specific objective 2: UBC willingness and support, regression analysis without leverage points, Omnibus Tests of Model Coefficients

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	327.352[a]	.329	.439
a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001 for split file $bootstrap_split = 0.			

Table 168. Specific objective 2: UBC willingness and support, regression analysis without leverage points, Model Summary

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	112	48	70.0
		Yes	38	134	77.9
	Overall Percentage				74.1
a. The cut value is .500					

Table 169. Specific objective 2: UBC willingness and support, regression analysis without leverage points, Classification Table

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	UBC_resources	.521	.086	36.884	1	.000	1.683
	Cogni_closeness	.398	.092	18.634	1	.000	1.489
	UBC_beliefs	-.128	.091	1.966	1	.161	.880
	Constant	-3.890	.548	50.438	1	.000	.020
a. Variable(s) entered on step 1: UBC_beliefs.							

Table 170. Specific objective 2: UBC willingness and support, regression analysis without leverage points, Variables in the Equation

10.9.3.4. Inter-group analysis

Regression analysis without leverage points

Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 1	Step	189.879	15	.000
	Block	189.879	15	.000
	Model	189.879	15	.000

Table 171. Specific objective 2: Inter-group analysis, regression analysis without leverage points, Omnibus Tests of Model Coefficients

Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	261.267[a]	.441	.589
a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001 for split file $bootstrap_split = 0.			

Table 172. Specific objective 2: Inter-group analysis, regression analysis without leverage points, Model Summary

Classification Table[a]					
Step 1	Observed		Predicted		
			Coop_yes_no		Percentage Correct
			No	Yes	
	Coop_yes_no	No	124	31	80.0
		Yes	30	141	82.5
	Overall Percentage				81.3
a. The cut value is .500					

Table 173. Specific objective 2: Inter-group analysis, regression analysis without leverage points, Classification Table

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Business_group	-.097	.398	.059	1	.808	.908	.416	1.982
	Size	.019	.008	6.513	1	.011	1.019	1.004	1.035
	Market_BC	-.121	.051	5.629	1	.018	.886	.802	.979
	Tech_scale	-.042	.356	.014	1	.906	.959	.477	1.926
	HD_emp	.135	.132	1.057	1	.304	1.145	.884	1.482
	Female	.134	.104	1.687	1	.194	1.144	.934	1.401
	Inf_int_tot	.368	.186	3.912	1	.048	1.445	1.003	2.081
	Clus_yes_no	.139	.379	.133	1	.715	1.149	.546	2.416
	LLL_coop_tot	.194	.127	2.344	1	.126	1.214	.947	1.557
	RD_int	.516	.251	4.247	1	.039	1.676	1.026	2.739
	IC_med	-.323	.123	6.910	1	.009	.724	.569	.921
	ID	-.004	.093	.002	1	.962	.996	.830	1.194
	UBC_resources	.577	.102	31.758	1	.000	1.781	1.457	2.177
	Cogni_closeness	.309	.116	7.136	1	.008	1.362	1.086	1.708
	UBC_beliefs	-.085	.106	.645	1	.422	.919	.747	1.130
	Constant	-3.860	1.038	13.830	1	.000	.021		
a. Variable(s) entered on step 1: Business_group, Size, Market_BC, Tech_scale, HD_emp, Female, Inf_int_tot, Clus_yes_no, LLL_coop_tot, RD_int, IC_med, ID, UBC_resources, Cogni_closeness, UBC_beliefs.									

Table 174. Specific objective 2: Inter-group analysis, regression analysis without leverage points, Variables in the Equation