Cooperation between Universities and Small and Medium-sized Firms as a Vehicle for the Regional Development:
A Mixed-Method Study in Brazilian Context

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Dedicatória

À minha família.

Agradecimentos

Chegar a esta fase do doutoramento faz-nos refletir sobre o quão especiais são as pessoas e redes que encontramos em nossa jornada. Sem elas, superar os desafios seria muito mais difícil. Uma palavra de apoio, um silêncio de espera, um lembrete de que o tempo está passando demasiadamente rápido e os prazos ficam cada vez menores para se alcançar o objetivo que nos propusemos no início da jornada, tudo isso torna essas pessoas muito especiais em nossa vida.

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Resumo

A cooperação universidade-empresa (U-E) investiga as relações formadas entre estes dois tipos de instituições/organizações como um veículo para o desenvolvimento regional, enfatizando a maior aproximação entre os resultados produzidos na universidade e as necessidades da sociedade, bem como as políticas de comercialização da pesquisa. De modo geral, este tema tem sido explorado sob três dimensões principais: motivações, obstáculos e canais de transferência de conhecimento. Estas abordagens capturam a complexidade desse tipo de cooperação U-E que se concentram nas interações com grandes empresas e onde é ignorado as particularidades da cooperação entre pequenas e médias empresas (PMEs) e pesquisadores académicos. Porém, este segmento de empresas representa uma importante fonte de integração entre a universidade e a região, pois estas PMEs estimulam as economias nacionais e regionais por meio da geração de empregos e inovação. Assim, esta investigação explora a cooperação entre universidade e PMEs numa região com baixo desenvolvimento tecnológico no Brasil.

Para atingir este objetivo geral, foram ainda definidos quatro objetivos específicos: (1) apresentar o relacionamento entre universidades e PMEs, através de uma revisão sistemática de literatura (RSL); (2) propor um modelo conceitual de análise da cooperação universidade-empresa com o desenvolvimento regional; (3) compreender a cooperação universidade-empresa numa instituição de ensino superior brasileira situada numa região de baixa intensidade tecnológica e; (4) explorar os relacionamentos formados entre a universidade e as PMEs localizadas numa região de baixo desenvolvimento socioeconómico. Assim, para dar resposta a estes objetivos seguiu-se uma metodologia de investigação mista, uma vez que as abordagens quantitativa e qualitativa são complementares uma da outra, nomeadamente, no tocante à validade interna e externa, em que se utilizaram diferentes técnicas de investigação de natureza dedutiva e indutiva.

Numa primeira fase, realizou-se uma RSL onde se identificaram as características da cooperação entre as universidades e as PMEs. Com este estudo identificou-se a ausência de exploração deste tema em regiões de baixo desenvolvimento tecnológico e a importância desse tipo de cooperação para o desenvolvimento regional. Por conseguinte, num outro estudo, foi proposto um modelo conceitual que procura identificar os benefícios da cooperação U-E para uma região, a partir da qualificação de recursos humanos, desenvolvimento de novos produtos ou processos, empregabilidade e, ainda, novas relações. Esta identificação é possível ser feita

a partir da perspetiva das partes envolvidas numa relação de cooperação: universidade e PMEs. A identificação dos benefícios a partir da perspetiva dos atores envolvidos, permite uma maior consciência sobre como esses resultados podem ser transportados para a relação de cooperação e beneficiar, de modo mais abrangente, a região.

Numa segunda fase, para dar resposta aos objetivos 3 e 4 foram realizados dois estudos empíricos. O primeiro, de natureza qualitativa, explorou as relações de cooperação entre investigadores e empresários de PMEs. Os dados foram recolhidos por meio de entrevistas virtualmente concedidas e analisados por meio da técnica Descending Hierarchical Classification (DHC) e com o apoio do software Iramuteq v. 0.7 Alpha 2. Os resultados mostram que, apesar de os investigadores estabelecerem relações de cooperação com as empresas e a instituição, não existe apoios no desenvolvimento desta atividade, ou seja, não é possível identificar uma política institucional direcionada para a cooperação U-PMEs. O ambiente institucional a que pertencem os pesquisadores e empresários é relevante tanto na formação das relações de cooperação quanto nos entraves subjacentes a esse tipo de processo. Contudo, a ausência deste tipo de política leva os investigadores a identificar os possíveis parceiros da cooperação por meio da proximidade geográfica, tecnológica e institucional. Já as empresas, encontram os seus parceiros na universidade a partir de suas relações sociais. As barreiras comuns encontradas por esses atores estão associadas ao tempo e à burocracia académica. De modo mais específico, os investigadores apontaram que o plano de carreiras a que eles são vinculados, os impede de estabelecer atividades de cooperação de forma mais rápida com as empresas, sendo esta situação uma barreira à cooperação. Já as empresas alegam um desconhecimento sobre as possibilidades de desenvolver cooperação com as universidades.

O segundo estudo, de cariz quantitativo, foi baseado num questionário adaptado a partir de estudos anteriores e distribuídos, eletrónica e pessoalmente, a uma amostra de PMEs, selecionada por meio da técnica bola de neve, composta por 336 empresas que havia realizado alguma relação de cooperação com universidades, nos últimos cinco anos. Os dados foram analisados com o auxílio do lavaan R-package, psych R-package, and Excel®. Os resultados mostram que as relações interpessoais interferem no tipo de cooperação formada, sendo estas um catalisador na formalização da cooperação. As empresas estabeleceram relações de cooperação com universidades que estão situadas no mesmo perímetro geográfico. Essas relações também interferem na percepção de barreiras e benefícios da cooperação para a empresa. Esses benefícios são mais intensamente percebidos por empresários que estabeleceram acordos de cooperação formais, sendo as barreiras menos intensas nestas situações. Os resultados mostram também que a cooperação U-E é percebida como um veículo

para o desenvolvimento regional. De modo específico, estes benefícios à cooperação resultam da transferência de conhecimento originada a partir das atividades de ensino, tanto pela absorção de mão-de-obra qualificada quanto da qualificação daqueles que já estão no mercado de trabalho, bem como do estágio de estudantes nas empresas e das consultorias, contratadas pelas empresas, para solucionar questões pontuais nos seus negócios e para o desenvolvimento de novos produtos e processos.

Por outro lado, verificou-se que as relações pessoais foram consideradas importantes para o início do processo de cooperação e influenciam o tipo de cooperação formada, bem como a perceção dos benefícios e das barreiras encontradas nesse processo. O tipo de cooperação, por sua vez, influencia a perceção dos empresários sobre os resultados que a cooperação U-PME fornece para o desenvolvimento da região.

Ao se estudar aqui a cooperação U-PMEs associada ao desenvolvimento regional, este estudo contribui também para o conhecimento neste tipo de relação de cooperação. Especialmente, neste estudo destaca-se que a formação da cooperação pode ser suportada a partir das relações pessoais, já estabelecidas entre as partes e a sua formalização, apesar desse relacionamento anterior ter surgido de modo informal. A formalização da cooperação evidencia-se importante não apenas pelo estabelecimento dos termos da cooperação, mas especificamente, pela perceção dos benefícios que a cooperação U-PMEs proporciona para a região.

Palavras-chave

Cooperação Universidade-Empresa; Tipo de cooperação; Relações interpessoais; Pequenas e Médias Empresas; PMEs; Desenvolvimento regional.

Abstract

University-firm (U-F) cooperation studies the relations formed between these two types of institutions/organisations as a driver of regional development, emphasizing the greater proximity between the results produced at the university and society's needs, as well as policies for commercializing research. In general, this topic has been explored in three main dimensions: motivations, obstacles, and channels of knowledge transfer. These approaches capture the complexity of this type of U-F cooperation, which is concentrated on interactions with large firms, but ignoring the particularities of cooperation between small and medium-sized enterprises (SMEs) and academic researchers. However, this firm segment represents an important source of integration between the university and the region, as these SMEs stimulate national and regional economies through job creation and innovation. Therefore, this research aims to explore the cooperative relation between a university and SMEs in a region of Brazil with low technological development.

To achieve this general objective, four specific objectives were defined: (1) present the relation between universities and SMEs through a systematic literature review (SLR); (2) propose a conceptual model of analysis of university-firm cooperation with regional development; (3) understand university-firm cooperation in a Brazilian higher education institution situated in a region of low technological density, and; (4) explore the relations formed between the university and SMEs located in a region of low socio-economic development. To respond to these objectives, a mixed research methodology was followed, since the quantitative and qualitative approaches complement each other, particularly regarding internal and external validity, where different research techniques of a deductive and inductive nature were used.

In the first stage, an SLR identified the characteristics of cooperation between universities and SMEs. This identified the absence of studies on this topic in regions of low technological development and the importance of this type of cooperation for regional development. Consequently, another study proposed a conceptual model seeking to identify the benefits of U-F cooperation for a region, setting out from human resources' qualification, the development of new products or processes, employability, and even new relations. This identification is possible from the perspective of those involved in a cooperative relation: university and SMEs. Identification of the benefits from the perspective of the actors involved allows greater awareness of how these results can be transported to the cooperative relation with more wide-ranging benefits for the region.

At the second stage, two empirical studies were made to respond to objectives 3 and 4. The first, of a qualitative nature, explored the cooperative relations between researchers and businesspeople in SMEs. The data were collected through interviews held remotely and analysed through the technique of Descending Hierarchical Classification (DHC) and using Iramuteq v. 0.7 Alpha 2 software. Although the researchers establish cooperative relations with firms and the institution, the results show there is no support to develop this activity, i.e., no institutional policy directed towards U-SME cooperation is identified. The institutional environment the researchers and businesspeople belong to is relevant both in forming cooperation relations and in the obstacles underlying this type of process. However, the absence of this type of policy leads researchers to identify possible partners for cooperation through geographical, technological, and institutional proximity. As for firms, they find their partners at the university from their social relations. The common barriers found by these actors are associated with the time taken and academic bureaucracy. More specifically, researchers indicate that their career plan prevents them from forming cooperative activities with firms more quickly, this situation being a barrier to cooperation. Firm profess a lack of knowledge about the possibilities of developing cooperation with universities.

The second study, of a quantitative nature, was based on a questionnaire adapted from previous studies and distributed electronically and personally to a sample of SMEs selected through the snowballing technique, formed of 336 firms that had entered any cooperative relation with universities in the last five years. The data were analysed using R-package, psych R-package, and Excel®. The results show that inter-personal relations interfere in the type of cooperation formed, these being a catalyst in formalizing cooperation. The firms formed cooperative relations with universities situated in the same geographical area. These relations also interfere in the perception of barriers and benefits of cooperation for the firm. These benefits are felt more intensely by businesspeople who formed formal cooperation agreements, with barriers being fewer in this situation. The results also show that U-F cooperation is perceived as a driver of regional development. Specifically, these benefits of cooperation result from the transfer of knowledge originating in teaching activities, both by absorbing a qualified workforce and qualifying those already in the labour market, as well as students' work placements in firms and consultancy hired by firms to solve occasional problems in their business and to develop new products and processes.

On the other hand, it was found that personal relationships were considered important for the start of the cooperation process, and influence the type of cooperation formed, as well as the perception of the benefits and barriers found in this process. The type of cooperation, in turn, influences the entrepreneurs' perception about the results that U-SME cooperation provides

for the development of the region. Overall, the study emphasizes the importance of personal relationships in all aspects of U-SME cooperation and the potential for these relationships to limit the scope of cooperation if they are not expanded beyond previous personal connections.

By studying U-SME cooperation associated with regional development, this research also contributes to knowledge of this type of cooperative relation. Especially, it highlights that the formation of cooperation can be supported by personal relations already established between the parts and its formalization, despite that previous relation arising informally. The formalization of cooperation is seen to be important not only through establishing the terms of cooperation, but specifically, through perception of the benefits U-SME cooperation brings to the region.

Keywords

University-Firm cooperation; Type of cooperation; Inter-personal relations; Small and Medium-Sized Enterprises; SMEs; Regional development.

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List of Acronyms

AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CI	Confidence interval
CMV	Common Method Variance
CR	Reliability Coefficients
DHC	Descending Hierarchical Classification
DWLS	Diagonally Weighted Least Squares
FIEC	Federação das Indústrias do Estado do Ceará
GDP	Gross Domestic Product
HEI	Higher Education Institutions
IBGE	Instituto Brasileiro de Geografia e Estatística
INEP	Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira
INPI	Instituto Nacional de Propriedade Industrial
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
RMSEA	Root Mean Square Error of Approximation
S&T	Science and Technology
SEM	Structural Equation Modelling
SMEs	Small and Medium-sized Enterprises
SRMR	Standardized Root Mean Residual
TLI	Tucker-Lewis Index
U-E	University-Enterprise
U-F	University-Firm
UF-C	University-firm cooperation
U-SME	University and Small and Medium-sized Enterprises
WoS	Web of Science

Chapter 1

1 Introduction

This chapter presents the justification and importance of the topic of University-Firm (U-F)[1] cooperation as well as the objectives, methodology adopted and the theoretical perspectives guiding this research. Finally, the general structure of the thesis is also presented.

1.1 Justification of the study: University-firms cooperation

The relation established between universities and firms has been designated in various terms, such as cooperation (Franco & Haase, 2015b), collaboration (Rybnicek & Königsgruber, 2019), partnership (Lascaux, 2019) and others. These terms reflect a formal or informal relation between the parts involved to extend the exchange of knowledge and technology in a mutually beneficial agreement (Galán-Muros & Plewa, 2016). In this study, that relation is called University-Firm cooperation, a two-directional relation formed to promote the spread of ideas, creativity and competences to create mutual value between higher education and business organisations (Chedid & Teixeira, 2020). In addition, this type of cooperation seeks to encourage the exchange of technology and knowledge between the parts (Bastos et al., 2021), modelling future paths of innovation between public and private actors (Giones, 2019).

U-F cooperation has become consolidated as a specific field of study (Galán-Muros & Davey, 2019) investigating the relations formed between the results of what is produced at the university and their application in society. The results of that cooperation can contribute to raising the level of economic and educational development of the region the partners belong to, and also the level of innovation (Acebo et al., 2021). In particular, U-F cooperation produces results in personal and institutional terms. In the personal domain, results are obtained by researchers, while the institutional domain refers to the university, firm and region where the cooperation occurs. However, the region has more indirect benefits from these results.

For researchers, U-F cooperation can increase reputation among peers and status within the institution, and increase the number of publications through more research opportunities (Franco & Haase, 2015b). The university can benefit from the cooperation process through private investment in research and development (R&D) access to firms' equipment and

[1] In Chapter 3 is used the terminology University-Enterprise (U-E) and in Chapter 4 is used University-Firm Cooperation (UF-C). However, they are about the same phenomenon: University-Firm Cooperation (U-F); and quite specifically, U-SME is used to refer exclusively to the focus of this thesis: cooperation between universities and small and medium-sized enterprises.

material, and through exchanging management experiences (Valentín, 2000). The firm, for example, benefits directly from the results of U-F cooperation when it manages to implement those outputs in its routine, depending on its capacity to absorb these results (Oguguo et al., 2020). As a result of that cooperation, the region can attract firms with greater competitive capacity and innovation infrastructure (Ierapetritis, 2019), entrepreneurship (Budyldina, 2018), the formation of institutional networks of knowledge in the regional and local business ecosystem, as well as more qualified and innovative human capital.

Knowledge creation and introducing new practices in a firm are results of U-F cooperation that benefit the region, together with employment and entrepreneurial opportunities generated from that relation (Osorno-Hinojosa et al., 2022). In more economically developed regions, the commercialization of knowledge, academic productivity and joint research are more frequent forms of cooperation (Perkmann et al., 2021) between universities and especially large firms (Thomas & Pugh, 2020). In regions with an emerging economy, for example, the result of cooperation is attained even when there are no direct incentives, apparently with an emphasis on non-commercial benefits (Roncancio-Marin et al., 2022), and this occurs in different ways from those in developed regions. Perkmann et al. (2021) emphasize that in more developed economies, technology transfer and the creation of value associated with U-F cooperation is more common, while in less developed regions, training and consultancy seem to be more present (Roncancio-Marin et al., 2022).

At its origin, the university mission is to contribute towards regions' development through excellence in teaching and research, and added to this is cooperation with public and private actors (Bonander et al., 2016) to develop innovation (Rantala & Ukko, 2019). Drucker and Goldstein (2007) highlight as a contribution of these institutions to development of their regions the creation and transfer of knowledge, technological innovation and knowledge infrastructure through laboratories and libraries. Furthermore, the presence of a university in a region contributes to the knowledge produced there being contextualized with regional economic needs (Brekke, 2020) and can attract human capital and innovative firms (Budyldina, 2018). These factors are elements contributing to a region's economic and social development (Harrison & Turok, 2017).

U-F cooperation in the context of regional development has been explored through teaching activities (Borah et al., 2021), work placements (Galán-Muros & Davey, 2019) research carried out in firms by master and Ph.D. students (Asplund & Bengtsson, 2019), training, consultancy and product testing (Roncancio-Marin et al., 2022), among others. The result of this type of activity, carried out in cooperation with firms, allows the formation of specific competences in developing technology and products for a practical context of action, increasing the specific

capacities of professional training (Borah et al., 2021). This proximity between the university and the firm gives the former greater involvement in the local situation, and the latter the opportunity to apply the knowledge created in the university in solving local problems, forming formal and informal connections (Pugh et al., 2018) between the actors.

Studies on U-F cooperation have concentrated on three major characteristics: motivation, obstacles and channels of knowledge transfer (Parmentola et al., 2020). In general, these approaches capture the complexity of this type of U-F cooperation, but they concentrate on interactions with large firms (Thomas & Pugh, 2020). Rajalo and Vadi (2021) stress that the literature on U-F cooperation has generally ignored the particularities of cooperation between small and medium-sized enterprises (SMEs) and academic researchers. However, this firm segment represents an important source for integration between the university and the region, as these SMEs stimulate national and regional economies through creating jobs and innovation (Manzoor et al., 2019).

Analysing cooperation between universities and SMEs is interesting, as the results obtained in studies made with large firms do not apply equally to SMEs, as this firm segment has very different capacities, needs and technology (Liu et al., 2020). Therefore, much remains to be explored in cooperation between universities and SMEs (Bellini et al., 2019), and essentially how it occurs in developing countries (Mascarenhas et al., 2018), such as Brazil. Understanding this topic of cooperation between universities and SMEs has aroused interest in the academic community and research in this field has grown over the last decades (Bhullar et al., 2019; Rõigas et al., 2018).

In general, relations between universities and firms are influenced by the environment they are part of (Garcia-Alvarez-Coque et al., 2019). Studies on U-F cooperation have been made in regions with high technological development (Nsanzumuhire & Groot, 2020) and with large firms (Parmentola et al., 2020). Parmentola et al. (2020) underline the importance of exploring U-F cooperation in regions with low technological intensity. That suggests the need for research that can analyse empirically this type of cooperation with SMEs in less developed regions (Vega-Jurado et al., 2020), with low technological intensity. Indeed, SMEs have heterogenous characteristics (Ranga et al., 2008) and more limited human and financial resources to invest in knowledge (Lin & Yang, 2020). Therefore, U-F cooperation can help these small firms to invest in knowledge and innovation more safely, using fewer resources and with less business risk.

A region's technological intensity can be defined by the industry present (OECD, 2011). Examples of high-tech industry are pharmaceuticals, chemicals, cars, optical products,

electronics and computers, while low-tech industry includes textiles, paper and cellulose, mining, food, etc. (OECD, 2011). This research is carried out in a region of Brazil. The geographical dimension of Brazil presents different levels of regional development, considering the concentration of income, population density and industrial development. The region subject to study here has its economy concentrated on the paper industry, mining, food and agri-industry (IBGE, 2021), and is therefore characterised as of low technological intensity.

In the Brazilian context, universities are seen to have an important role in promoting innovation. Nevertheless, universities are little involved in the market (Fischer, Moraes, et al., 2019). State universities are responsible for most scientific research in the country (Negri & Rauen, 2021), but the specialized literature on U-F cooperation in Brazil shows this phenomenon is little explored. Therefore, investing in knowledge and innovation in small companies by applying the knowledge produced in the university can bring benefits for firms and the surrounding region (Oliver et al., 2020).

The U-F cooperation that has been studied in Brazil focuses on regions where there is a greater number of universities and also firms (IBGE, 2021; INEP, 2022) and with more established industries in the country such as petrochemicals, aviation and agri-business (Dutrénit & Arza, 2015; Tatsch et al., 2022). The most explored topics within U-F cooperation in Brazil focus on Science and Technology (S&T) policies and the interactions of these policies, especially government ones, with the market (e.g., (Amaral et al., 2022; Gomes et al., 2015; Puffal et al., 2021)), on research groups' intermediation in forming cooperation and coming closer to firms (Caliari & Chiarini, 2018; Santos et al., 2021), and how that cooperation can stimulate those groups' productivity (Garcia et al., 2020), the results of cooperation, such as technology transfer (Fischer et al., 2021; Liboreiro et al., 2022) and firms' capacity to absorb the results of this type of cooperation (Silva et al., 2018). However, SMEs are found to be absent from these cooperative relations, despite such firms being the majority worldwide. In Brazil, around 99% of commercial businesses have no more than 249 employees, meaning they can be classified as SMEs (IBGE, 2021). This research adopted the number of employees (up to 249) as the main criterion for classifying commercial businesses as SMEs (European Commission, 2020; IBGE, 2021).

In developing countries such as Brazil, the research carried out in universities has been a way to make up for the lack of business investment in R&D (Garcia et al., 2019), which makes U-F cooperation an important factor of regional development (Franco et al., 2017; Mosayebi et al., 2020) and interesting to explore in this context (Fischer, Schaeffer, et al., 2019), since the regional context is important in forming patterns of U-F cooperation (Parmentola et al., 2020).

1.2 Objectives and research question

Considering the gaps identified in the literature on cooperative relations between the university and SMEs, in regions at an early stage of economic and social development, this research aims to explore the cooperative relation between a university and SMEs in a region of Brazil with low technological development. To respond to this general objective, four specific objectives were defined, corresponding to four different studies (articles), as follows:

a) To present the relationship between Universities and Small and Medium-sized Enterprises (SMEs), through a systematic literature review (Study 1);
b) To propose a conceptual model of analysis of University-Firm Cooperation with regional development (Study 2);
c) To understand University-Firm Cooperation in a Brazilian higher education institution (HEI) situated in a region of low technological intensity (Study 3);
d) To explore the relationship formed between a University and SMEs located in a region in Brazil characterized by low socio-economic development (Study 4).

Given this scenario, the aim is to answer the following research question: *How is cooperation between universities and SMEs established in a region with low technological development?*

1.3 Methodological procedures

This section presents the methodological path followed in this research. As mentioned, this thesis was formed from four different studies/articles. The articles were written from different methodological approaches which will be explained in this sub-section.

1.3.1 Research context

The Brazilian higher education system is formed of state (financed by the federal, state, or municipal government) and private (for profit or philanthropic purposes) institutions. This system comprises universities, university centres, faculties, and federal institutes. Universities, the type of higher education institution studied here, are predominately state-run (INEP, 2022).

The university chosen here is present in all regions of the state in which it is located (Maranhão, North-East Brazil). Over the last 10 years, this university has undergone great expansion in its physical structure, number of students (undergraduate and post-graduate courses) and research carried out (INEP, 2022). Regarding innovation, and in terms of patents, this university was in 22nd position among universities, in the ranking of patents and inventions registered (INPI, 2021). Then, SMEs that had cooperated with the region's universities in the

last five years were chosen. The criterion to define an SME was the number of employees (European Commission, 2020; IBGE, 2021).

The state where the organisations studied are located is still vulnerable economically and socially. Its socio-economic indicators are among the lowest in the country. This state has an illiteracy rate of around 16,6% of the adult population over 25, and only 9% of the population in this age-group have completed higher education. Formal employment for those over 14 is also weak, with only 34,6% of the population having a formal job[2] (IBGE, 2020).

The business sector in the state of Maranhão has 56.159 commercial establishments. The distribution of these establishments by number of employees is presented in Figure 1.1.

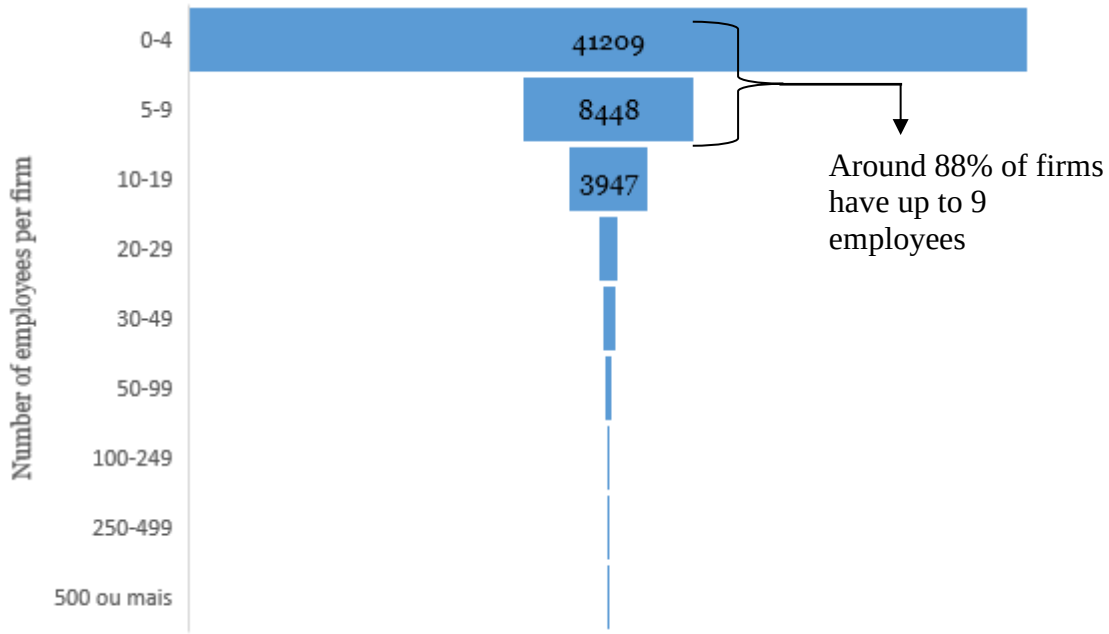

Figure 1.1. Number of employees by commercial business

Fonte: IBGE (2021).

However, in this universe of state-registered businesses, it was not possible to identify how many in fact establish a cooperative relation with universities. The absence of a specific database with the data necessary for the research led to adopting alternative strategies to identify the elements of study. In these circumstances, entrepreneurs and lecturers who acted directly in a U-F cooperation were identified.

[2] The concept of formal employment refers to signed contracts, including those of domestic workers, the military, civil servants, autonomous professionals and employers who contribute to social security (IBGE, 2020).

1.3.2 General research approach

The general research approach here is mixed (mixed-method study). This type of approach includes quantitative and qualitative methodological approaches in a single study. This can supply the necessary resources to analyse complex phenomena such as university and small and medium-sized enterprises (U-SME) cooperation (Bonaccorsi & Piccaluga, 1994). The intention is to define the strengths of each quantitative and qualitative approach for use in studying a phenomenon (Molina-Azorin et al., 2017).

Qualitative research aims to understand how the phenomenon occurs in a given context. This approach does not allow generalization of the results, as these can arise from the perceptions of those studied and are therefore valid only for that specific situation (Sampieri et al., 2013). However, this type of study can give more thorough knowledge of the problem analysed, showing nuances that quantitative research might not reveal.

On the other hand, quantitative research seeks to establish patterns from the data collected about an objective situation studied whose nature is not changed by the observations and measurements made (Sampieri et al., 2013). This research aimed to find out about the relations formed in the process of U-SME cooperation.

The mixed approach, in turn, includes the results of the quantitative and qualitative analysis in the same study so as to increase the understanding provided by each method (Creswell, 2010). A mixed-method approach can give a wide-ranging and contextual understanding of the phenomenon, by using data obtained through different techniques. This approach can consolidate the results found with more certainty, complementing them (Sampieri et al., 2013).

In this study, the mixed approach was followed sequentially in two stages (Sampieri et al., 2013). First, the qualitative data were gathered and analysed, then, from the results obtained in this phase, the data-collecting instrument for the next, quantitative, stage was formed. This sequential approach reveals the contextual factors in which the phenomenon of interest occurs (Fetters et al., 2013), before quantifying it.

In the field of U-F cooperation, some studies have adopted this type of mixed approach. Edgar and Kharazmi (2022) used the mixed method to develop a system of identifying barriers that affect U-F cooperation. The authors used a questionnaire survey and interviews that resulted in a model used to characterise U-F cooperation and explore the cause-effect relation of the barriers identified. To analyse the asymmetry between cooperating partners in U-F research, He et al. (2021) also used primarily interviews, in a qualitative data analysis, to reveal the orientations of asymmetries between partners, and used these results to identify the relations

between asymmetry of orientation, conflict within collaborating teams, asymmetry of perception of conflict and different types of successful collaboration (quantitative research).

1.3.3 Data-collection techniques and sample

In the first study, consisting of a systematic literature review, the data/articles were collected from the Scopus database. This database was chosen for its recognised scientific and geographical coverage (Mongeon & Paul-Hus, 2016). The search strategy was drawn up from the literature on U-F cooperation (Ankrah & Al-Tabbaa, 2015; de Wit-de Vries et al., 2018) and SMEs (Ribau et al., 2018). From the first result, documents in the form of articles, published in journals and in English were selected. Then the titles and abstracts were read to identify whether the documents did indeed deal with U-SME cooperation.

In the second study, an integrative review of the literature was carried out in order to propose a conceptual model of analysis. This type of literature review aims to provide a wide-ranging understanding of a particular phenomenon (Whittemore & Knafl, 2005). At this stage, two databases were used: Web of Science (WoS) and Scopus. Both databases are recognised for their quality and the scope of the publications indexed (Mongeon & Paul-Hus, 2016) and can complement each other. The bibliography used was identified through a search for words in titles and abstracts about U-F cooperation and regional development. After identifying the titles relevant for the study objective, the complete texts were retrieved.

In study three, qualitative data were collected. In this phase, semi-structured interviews were held to determine the context in which U-F cooperation occurs. Lecturers/researchers and entrepreneurs were interviewed. These subjects/participants were identified intentionally (Patton, 2015) due to having formed at least one cooperative relation in the last five years. Participants in the research were identified through the snowball technique (Moradi & Noori, 2020). The first subject identified was a researcher with previous experience of cooperation with SMEs. From this individual, the other researchers were identified, the same being done with the SME representatives.

The interviews were held remotely, by videoconference, and recorded with the interviewees' permission. This form of data-collection was chosen due to coinciding with a critical period of COVID-19 in Brazil (May/June 2021), when higher education institutions were still closed to comply with the sanitary measures adopted by the local government. These measures prevented personal contact between the researcher and the interviewees. The interviewees were informed previously about the reason for the interview and the anonymity of data was guaranteed.

The last (fourth) study obtained quantitative data. This phase aimed for better understanding of SMEs' perception of cooperation with the university, more precisely, to identify their motivations, and the benefits and obstacles encountered in a region of low technological intensity. Respondents were also identified through the snowball technique (Moradi & Noori, 2020). This technique identifies target-respondents randomly, from the relations formed between people. The choice of this technique was justified as the university does not have a public database with the necessary information to identify SMEs.

Data were collected through a questionnaire adapted from previous studies. The questionnaires were distributed in print and electronically, but without identifying any subject personally, through their name, e-mail, or any other means. When printed, each questionnaire received a sequenced number and electronic ones were numbered according to the order of reception. The printed data were destroyed after transcription to an electronic platform and analysis of the consistency of the transcribed data.

The first entrepreneurs were identified through contacts with universities' junior firms and organisations representing local business-people who supplied information about their members who had established cooperation with universities. From these data, the firms were contacted and those in charge of the cooperation identified. Generally, these people were SME owners. From them, other connections were made to identify possible research targets.

Participants were informed that their participation in the study was voluntary, and anonymity was ensured, and that the data would be used exclusively for the research, through a Statement of Free and Clarified Consent. This statement was presented in the first part of the questionnaire, with information about the researcher and the research. All the data stored electronically are held in a local database, with access through a specific password on a computer which could only be used by the researcher. These data will be kept in a legible format until this thesis is defended orally and then destroyed. No data will be sent to any other entity or given out by any other means.

1.3.4 Data analysis

The data obtained were subject to different types of analysis, according to the objective set for each study/article.

Article 1 consisted of a systematic review of the literature on cooperation between universities and SMEs. This theoretical study technique is characterised by criteria inherent to scientific practice: transparency, clarity, replicability, and synthesis (Briner & Denyer, 2012; Thorpe et al., 2005). The data were analysed using Bibliometrix R-Package software (Aria & Cuccurullo,

2017). Firstly, this involved descriptive data analysis, identifying the journals with the greatest number of publications, evolution over time, the most cited documents, and the authors with most publications in the set of data selected. Then, the topic was explored from a word cloud that measured the frequency of words in the titles and abstracts of the documents analysed. This word cloud guided content analysis of the complete texts, to identify the characteristics of the cooperation formed between universities and SMEs.

Through the literature, study/article 2 explores the characteristics of university-firm cooperation for regional development. To propose a model of analysis of U-F cooperation in regions with low technological development, an integrative review was formed from the analytical exploration of the selected documents.

Article 3 explores the relation between researchers and entrepreneurs. Here, the data were analysed using Iramuteq v. 0.7 alpha 2 software (Ratinaud, 2020), adopting the Descending Hierarchical Classification (DHC) technique. This technique groups text segments in categories based on the lexical forms presented. Grouping of these segments uses the chi-squared statistic (χ^2) to join similar lexical forms in categories, reducing the researcher's interpretation bias in classifying data (Illia et al., 2014). DHC groups lexical forms in categories representing concepts that are close to each other (Reinert, 1987). The text data were grouped in four categories that classified 99% of the text segments from the transcribed interviews. Text data presenting a χ^2 above 3,84 were used. This statistical result demonstrates the stability of the categories. One of the parameters to define that stability is the percentage of data extracted and significant χ^2. Illia et al. (2014) suggest that a result of extraction above 70% is sufficient to define the stability of a category.

Article/study 4 explores the formation of cooperation between SMEs and universities. A quantitative approach was adopted, with the data being analysed using lavaan R-package (Rosseel, 2012) psych R-package (Revelle, 2022) and Excel®. This began with a descriptive analysis of the data obtained. Then, these data were reduced into dimensions, using exploratory factor analysis to assess the convergent and discriminant validity of the dimensions analysed: types of cooperation, informal relations, motivation, trust, perceived benefits, barriers encountered, and results for regional development. Structural Equation Modelling (SEM) was used to validate the hypotheses. This is a robust multivariate analysis technique that uses path analysis, simultaneous equations and factor analysis in the same model (Rosseel, 2012), allowing analysis of the relations between the dimensions measured and assessment of the validity of the constructs in the proposed model (Hair et al., 2020).

1.3.5 Summary of the methodological procedures and publications

Table 1.1 summarises the objectives defined, and the methodological procedures followed in each study/article in this research.

Table 1.1. Methodological definition of the chapter of the thesis

Definition	***Chapter /Article***
Chapter 2 / Article 1	
Cooperation between Universities and SMEs: A Systematic Literature Review	
Theoretical support	Cooperative relationship between universities and SMEs
Objectives	To present the relationship between universities and small and medium-sized enterprises (SMEs) through a systematic literature review.
Keywords	Innovation system, knowledge transfer, small and medium-sized enterprises, SMEs, university–industry cooperation
Type of study	Theoretical
Research methodology	Systematic Literature Review (SLR) using content analysis
Unit of analysis	Scientific articles
Sample	71 documents analysed
Data collection	Scopus
Treatment of the data	Bibliometrix R Package
Publication	Pereira, R., & Franco, M. (2021). Cooperation between Universities and SMEs: A systematic literature review. *Industry and Higher Education*, *36*(1), 37-50. https://doi.org/10.1177/0950422221995114
Chapter 3 / Article 2	
University-Firm Cooperation and Regional Development: Proposal of a Model of Analysis	
Theoretical support	Regional development
Objective	To propose a conceptual of University-Firm Cooperation with regional development
Keywords	University-Firm Cooperation · Regional Development
Type of study	Theoretical
Research methodology	Integrative review
Unit of analysis	Scientific articles
Data collection	Web of Science (WoS) and Scopus
Publication	First version, presented in: Pereira, R., & Franco, M. (2021). Proposta de um Modelo de Análise da Cooperação Universidade-Empresa como Intermediária de Fomento ao Desenvolvimento Regional. *X Seminário Internacional sobre Desenvolvimento Regional*. Setembro 2021, Santa Cruz do Sul, SC, Brasil. (Virtual experience) Final version: Pereira, R., & Franco, M. (2022). University-Firm Cooperation and Regional Development: Proposal of a Model of Analysis. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-022-00947-6

Tabel 1.1. Methodological definition of the chapter of the thesis (cont.)

	Chapter 4 / Article 3
	The Engaged University and Regional Development: A Qualitative Case Study
Theoretical support	Interorganizational Networks, Regional development
Objective	To explore U-F cooperation in a Brazilian HEI situated in a region of low technological intensity
Keywords	University-Enterprise Cooperation, Small and medium-sized enterprises, SMEs, HEIs, Geographic proximity
Type of study	Empirical
Research methodology	Qualitative research
Unit of analysis	Researcher and entrepreneurs
Data collection	Interview
Sample	4 entrepreneurs and 3 researchers
Publication	First version: Pereira, R. & Franco, M. (2021). The engaged university and regional development: a case study. Presented in XIX Triple Helix International Conference, June 2021, São Paulo (Virtual experience) Final version: Pereira, R. & Franco, M. (2023). The Engaged University and Regional development: A Qualitative Case Study, *Industry and Higher Education*, under review.
	Chapter 5 / Article 4
	University-Firm Cooperation: How do Small and Medium-Sized Enterprises Become Involved with The University?
Theoretical support	Regional development, Institutional theory
Objective	To explores the relationship formed between a university and SMEs located in a region in Brazil characterised by low socio-economic development
Keywords	University-Firm Cooperation; Interpersonal Relations; Types of cooperation; Small and medium-sized enterprises, SME
Type of study	Empirical
Research methodology	Quantitative research
Unit of analysis	SMEs
Data collection	Questionnaire
Sample	336 SMES
Publication	Pereira, R. & Franco, M. (2023). University-Firm Cooperation: How do Small and Medium-Sized Enterprises Become Involved with The University? *European Business Review*, accepted. DOI: 10.1108/EBR-12-2022-0265

2 Theoretical Foundation

This section presents the main theoretical perspectives guiding this research: Inter-organisational network theory, institutional theory, and regional development.

2.1 Inter-organisational networks

Organisations belong to environments with other organisations and are involved in a number of norms and social values (Evan, 1965). They operate in a typically relational climate where their survival and performance depend on other organisations (Oliver, 1990). Therefore, external forces, the shortage of resources and intense pressure to perform can lead to forming networks (Ring & Van De Ven, 1994).

An inter-organisational network can be defined as highly coordinated cooperative interactions based on normative consensus and mutual respect (Benson, 1975). These cooperative interactions are characterised by sharing the contributions and rewards previously agreed between the parts to attain common objectives (Gulati et al., 2012), in a continuous and independent communicative process of hierarchical mechanisms (Hardy et al., 2003).

Kogut (2000) defines an inter-organisational network as a set of independent firms that support each other in specialization, learning and exploration, and where the relation does not impose a hierarchical organisational structure on its members. For Ahuja, Soda and Zaheer (2012), this type of network represents the connections between organisations or organisational units. Agostini et al. (2019) complement this definition, adding to those connections the way in which they occur: directly or indirectly, and the bonds established between parts, which can be formal or informal.

These definitions highlight the independence of network members, the results they seek, and the need to establish clear rules that govern the relation. These characteristics aim to establish harmonious relations between parts. Despite the literature indicating definitions for inter-organisational networks, Borgatti et al. (2009) suggest there is no clear, universally accepted definition, given the complexity involved in this type of relation. Possibly, the absence of a more universal definition is due to the multiple formats these inter-organisational relations can assume, with different characteristics and objectives (Franco & Haase, 2015a; Oliver, 1990).

In the organisational sphere, cooperation can be understood as a process occurring between two or more parts with mutually dependent, common or at least compatible objectives, to share and exchange resources and carry out joint activities (Hoffmann et al., 2018). This conceptualization shows an interactive dimension between parts to fulfil the objectives set (Castañer & Oliveira, 2020). Therefore, cooperation between organisations can be characterised by the presence of relations established between autonomous organisations for joint fulfilment of individual operational goals (Schermerhorn, 1975).

Cropper et al. (2008) state that inter-organisational relations have the following attributes: content, governance mechanism and structure. These attributes mark how the inter-organisational relation can be managed, defining the characteristics the relation can present.

Content reflects the information flows involved in the relation. According to Hardy et al. (2003), that flow can occur in different directions: unidirectional, bi-directional and multidirectional. It is unidirectional when an organisation sends information and the other learns; bi-directional when there is an exchange of information between the parts involved; and multidirectional, when that exchange of information goes beyond the inter-organisational relation and involves external parts (Hardy et al., 2003).

Governance of the inter-organisational network includes various mechanisms. These mechanisms are supported by the reasons and objectives when forming the network and the contractual structures established to organise the partnerships (Gulati, 1998). The mechanisms are grounded on the trust established between parts, on reciprocity and equity, on the structures to encourage participation in the network and the contractual forms established (Cropper et al., 2008).

The structure has characteristics related to the technology used in the industry, social norms and institutional factors that favour application of the rules. Technology can influence the firm's decision to cooperate or not. The type of technology used in the industry can also influence the choice of partner to cooperate. If a firm uses science-based technology, partnerships with research institutes and universities make all the difference (Kogut, 2000); if seeking internationalized markets, associating with multinationals can be a solution. The network structure can define the pattern of relations between actors (Borgatti et al., 2009) and exploit the diversity and intensity of relations (Cropper et al., 2008).

Besides the content, structure and governance presented by Cropper et al. (2008), Agostini et al. (2019) add the actors, the objective and the location as attributes in the sphere of inter-organisational relations. The actors are the partners participating in the relation, who give form to the structure and flow of the content; the objective reflects the reason for the relation, and location identifies its geographical proximity.

The actors involved in the cooperation can influence the variables of the cooperative process, such as the skills, resources, policies and procedures involved (Geringer, 1991), and thereby affect the transfer of knowledge between the parts and the risks of opportunism (Li, Eden, Hitt, & Ireland, 2008). The actors form the nodes of the inter-organisational network formed. The combination of skills, knowledge and resources in a cooperative relation can determine the

choice of actors. The attractiveness of a firm as a partner can be defined by the perceived complementarity of its actors in supplying skills or know-how (Sambasivan et al., 2013).

Definition of the objective reflects the reciprocity of the cooperation. It is something that motivates the cooperation (Oliver, 1990) and is closely linked to the choice of actors. Having a common aim is a fundamental reason for cooperation. The alignment between the objectives of the network and the parts' business strategy is considered a critical factor of the cooperation's success (Franco & Haase, 2015a). Evan (1965) emphasizes that organisations seek cooperation to achieve jointly individual objectives that they could not attain alone or that would otherwise not be possible. They also resort to cooperation when seeking more efficient ways to use some resource they already hold (Schermerhorn, 1975).

The other attribute mentioned, partners' geographical proximity, has been considered important in formalizing a partnership (Franco & Haase, 2015a). This attribute can benefit the relation between parts, especially at the time of identifying partners and forming the partnership, when face-to-face contact can be important (Knoben & Oerlemans, 2006). Geographical proximity is particularly sensitive to cooperating with small and medium-sized enterprises (Zubielqui et al., 2015), the type of knowledge sought, whether coded or not (Arundel & Geuna, 2004) and the firm's absorptive capacity (Laursen et al., 2011).

Therefore, organisations form networks to lower the costs associated with their business, improve their competitive position, and obtain critical knowledge from another organisation. These organisations inter-connect through social and economic relations, forming a social network of organisations (Gulati, 1998). These networks are important sources of knowledge creation, and not only knowledge that can be transformed between the parts, but mainly that which emerges from the social interaction implicit in the relation (Hardy et al., 2003).

Cooperation also reveals the benefits of the partnership in gains in competitive advantage, through sharing resources and practical solutions to problems (Rezazadeh & Nobari, 2017), reducing the time to create, produce and commercialize products and develop services, increasing quality and lowering costs, giving access to complementary resources and developing the firm's distinct qualities (Dacin et al., 2008). In addition, organisations that form inter-organisational networks can benefit from results such as value creation, improved performance, and access to their partners' knowledge, resources and capacities (Hoffmann, Lavie, Reuer, & Shipilov, 2018), obtaining a competitive advantage, stimulating local development (Giuri, Munari, Scandura, & Toschi, 2019), reducing costs and risks and gaining access to new markets (Rezazadeh & Nobari, 2018), among other possible results.

2.2 Institutional theory in inter-organisational cooperation

Institutional Theory allows a broad analysis of the organisation, as it reflects the normative and social pressures it is subject to, by the state, by the organisation itself or even the environment it belongs to (Zucker, 1987).

By forming these relations, organisations construct socially new institutional forms that are spread through their institutional fields (Knoben & Oerlemans, 2006). Following the conception of DiMaggio and Powell (1983), organisations cannot survive without complying with the social norms determined in a business environment. In forming cooperation networks, social norms are fundamental for the network's functioning. From the perspective of analysing the relation between organisations, network formation can be a way to consolidate institutional fields, since organisations and the relations between them are central approaches defining the research in inter-organisational relations (Cropper et al., 2008).

Dacin, Reid and Ring (2008) underline that an institutional approach to studying inter-organisational networks can be very useful in analysing intangible assets such as reputation and legitimacy within the network. As this study focuses on cooperative relations, a form of network, it is particularly relevant to follow Institutional Theory in the institutional field, which according to DiMaggio and Powell (1983) is structured in four elements: (1) extent of the interaction between organisations in the field; (2) dominant structures and defined standards of coalition; (3) increased information load that organisations must cope with within the field; and (4) mutual awareness among the participants involved in a common business.

These processes described by DiMaggio and Powell (1983) have relational characteristics. They reflect the extent of the interaction between parts, which is facilitated by the rules established, and these rules facilitate social relations. These relations are formed in a horizontal network structure, without hierarchies, but governed by agreements (formal or not) and where information is shared in the scope of these relations. Those characteristics are also reflected in bi-directional bonds of mutual recognition and observation (Powell & Oberg, 2018).

DiMaggio and Powell (1983) stress that Institutional Theory seeks answers to questions such as why organisations, even when competitors, behave in a similar way, and the answers bring concepts of isomorphism and the organisational field to deal with the organisation's relations with the environment. Organisations seek legitimacy in this institutional environment to access the resources and knowledge necessary to act within it (Anatan, 2018). This emphasis, especially on legitimacy, is important from the point of view of cooperation, as it helps the ways

this type of cooperation emerges, and this is one of the relevant topics in understanding inter-organisational networks (Gulati, 1998).

Institutional Theory has been applied to understand U-F cooperation. Anatan (2018) highlights that these two organisations are very different in terms of vision, mission and organisational culture, thereby contradicting the nucleus of that theory, which seeks to explain the homogeneity and stability of institutional components. However, these organisations complement each other when one uses the resources produced by the other, in a process of retro-alimentation. The university produces qualified workers, knowledge and innovation; the firm uses qualified workers and knowledge and complements the innovation. Cooperation between these two types of organisations can be a virtuous circle of regional development. This demonstrates the multiplicity of elements that can permeate these relations, as in this case, these organisations' actions are controlled by their social justification (DiMaggio & Powell, 1983).

It is emphasized that organisations enter an inter-organisational relation in search of results. Indicated among these results are gaining legitimacy (Oliver, 1990) in their operating environment and strengthening organisational reputation. In the case of higher education institutions, legitimacy can be represented by their need to satisfy social concerns and align with technology and the institutional environment they are part of (Anatan, 2018). Here, cooperation with companies can satisfy that need, consolidating the university's field of action, strengthening it as an agent of economic development (Lundvall, 2010). Reputation is related to partner selection and the result that U-F cooperation can produce, both individually and organisationally (Franco & Haase, 2015b).

2.3 Regional development

Regional development is a multidimensional concept referring to changes in regional productivity measured by population, employment, income and added value in industry, as well as the availability of, and access to resources, entrepreneurial culture and attitude, physical infrastructure, sector structure, and technological infrastructure and progress (Nelson, 1993). This concept is not of a static nature, as it refers to regions' space-time dynamics, which are characterised by spatial diversity, in relation to countries, for example (Nijkamp & Abreu, 2009).

By dealing with change, the development concept can be presented as a contextual alteration where the status of something changes to leave it in a better situation than before (Goulet, 1992). The word "development" is a vast concept. Due to its unrestricted conceptualization,

there is a need to describe this term in order to express the specific improvement to be highlighted. Therefore, it is characterised as economic, local, regional, exogenous and endogenous, among other forms appearing in the specialized literature (Amaral, 2001). In discussing U-F cooperation, endogenous regional development is a viable perspective, as it characterises the interaction between institutions that operate in one or more regions, and according to Shi et al. (2020), the results of U-F cooperation are influenced by the context in which it occurs, which can be technological, geographical or any other. Therefore, this approach allows understanding of the differences and specificities of diverging, regional patterns of development and growth, setting out from the institutions, actors' capacities, cultures and economic bonds in a regional context (Harfst et al., 2020).

Regional development from the endogenous perspective can be understood as a process of adding value to a region's production, emphasizing the maintenance and development of local potential (human, financial and institutional capital), and attracting excess resources from other regions (Amaral, 2001), improving the quality of life by using the region's social and economic potential (Kudełko, 2022). So there is a multidisciplinary perspective of regional development, which uses local capacities through the interaction between local firms and other agents to develop the economy and society, in order to manage development through innovation and the spread of knowledge (Vázquez-Barquero, 2000; Vázquez-Barquero & Rodríguez-Cohard, 2016).

So there is growing interest in knowledge, its production and exploitation in regional innovation. This is important as to produce and exploit knowledge and innovation, a qualified workforce is needed, which makes human capital essential for sustained competitiveness (Eriksson et al., 2017). This qualified workforce to exploit knowledge can be represented by the results originating in universities, such as professional training, research results and new ideas arising from that research (McMahon, 2018), among others. The knowledge generated in universities and transferred to companies, through U-F cooperation, is a source of regional development (Sá et al., 2019). The knowledge produced and improved absorptive capacity are sources of innovation and growth through U-F cooperation (Bagherianfar & Dolati, 2022; Rantala & Ukko, 2019). This is a way to stimulate entrepreneurship (Mahfoudh et al., 2021) and thereby promote regional development (Kempton et al., 2021).

With U-F cooperation, the transfer of knowledge and skills to the region can take place in various ways: the production and commercialization of knowledge (Barjak & Heimsch, 2020), implementation of new processes and products in a specific market (Asplund & Bengtsson, 2019), training of human resources who can act in new business or in developing existing business (Brekke, 2020), integrating teaching activities with business activities, through work

placements (Galán-Muros & Davey, 2019) and regular courses to train entrepreneurs (Hou et al., 2021), for example.

U-F cooperation can be structured as a tool of innovation infrastructure for the region and for the participating organisations, forming networks of innovative relations, and in this way raise the level of innovation and entrepreneurship (Rantala & Ukko, 2019). Such innovation networks can be structured systematically in the region and join the various social, institutional and economic resources (Aragon et al., 2014), contributing to regional development. The knowledge produced in the context of U-F cooperation can be directed to activities supporting innovation, and in the long term, contribute to the region's economic well-being, despite the individual interests of each participating organisation (Rantala & Ukko, 2019).

3 Thesis Structure

This thesis takes the form of articles/studies contained in different chapters. Choice of this model allows a response to the general research question and the previously defined objectives. Figure 1.2 presents the general research design.

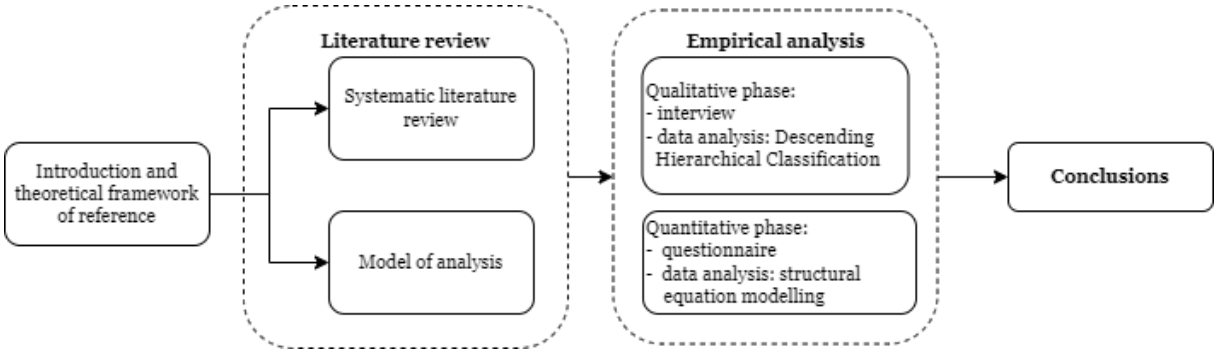

Figure 1.2. Research design

Source: Author's own elaboration.

Chapter 1 presents the justification and importance of the topic, defining the objectives, methodological procedures followed and the theoretical foundation used. Chapters 2 and 3 present the theoretical reviews carried out in order to produce the empirical articles. Chapters 4 and 5 present the empirical results found. Finally, Chapter 6 presents the conclusions, the theoretical and practical contributions and implications, the limitations, suggestions for future research and final comments.

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Chapter 2

Cooperation between Universities and Small and Medium-Sized Firms: A Systematic Literature Review

Abstract: This study aims to present the relation between universities and small and medium-sized enterprises (SMEs), through a systematic literature review. SMEs play an important role in economic development. Similarly, universities are a relevant actor in the innovation system. To fulfil this objective, data were collected from the Scopus database. The bibliometric results found, using Bibliometrix software, reveal that this topic first appeared in the literature in 1995 and entered a growth stage in 2014. Systematically, studies have been focused mostly on European countries and the emphasis in cooperation was on knowledge transfer. In addition, the results show that SMEs form cooperation relations with universities in search of competitive results. However, the main difficulty indicated in this forming that cooperation is lack of knowledge about programmes developed by the university that can reach those firms and forms of access to those programmes. Therefore, it is suggested that universities should establish more effective communication channels in order to reach this type of firm.

Keywords: University-Industry Cooperation; Small and Medium-Sized Enterprises, SMEs, Knowledge Transfer, SLR.

1 Introduction

Small and medium-sized enterprises (SMEs) are recognised as having a fundamental role in many countries' economies, as they represent a significant part of a country's business sector (Manville et al., 2019). This is the case in both developed and developing countries, as these firms are a source of employment, innovation and reduced inequalities (Manzoor et al., 2019). However, firms of this type do not have a tradition of research and development (R&D), and forming cooperation relationships (partnerships) is an important factor for their survival and competitive differentiation (Martin et al., 2019).

SMEs are characterised by their organisational agility (Liu, 2020), flexibility of interaction in the field of business and proximity to customers and suppliers (Ranga et al., 2008). However,

these small firms have limited resources (Partanen et al., 2018), liabilities of smallness (Aldrich & Auster, 1986), newness (Baum & Oliver, 1991) and connectedness (Rickne, 2006). Therefore, the formation of cooperation networks is essential to access scarce resources (Partanen et al., 2018), since SMEs have more difficulty dealing with fast technological change and product innovation than large companies (Hagedoorn, 1993).

Firm size is a factor influencing the formation of cooperative relations (Fontana et al., 2006). The resources SMEs have available to develop this type of cooperative relationship are more limited (Liu, 2020) compared to large companies, which, having more resources, are more able to exploit cooperative opportunities (Bellini et al., 2019). Cooperation is a mechanism that gives SMEs access to knowledge and innovation resources. Therefore, cooperation with universities can be of interest, as universities are known to be agents of influence in the knowledge-intensive economy (Etzkowitz & Leydesdorff, 2000; Muscio et al., 2012).

University-enterprise (U-E) relationships have been especially subject to systematic literature reviews. For example, Ankrah and Al-Tabbaa (2015) summarised the dominant themes in the literature on U-E cooperation, classifying them in organisational forms, motivations, operationalization of collaboration, facilitating and inhibiting factors and the results of cooperation. Rybnicek and Königsgruber (2019) emphasize the success factors of U-E cooperation, while Sjöö and Hellström (2019) relate the central factors that stimulate innovation in this type of cooperation. However, these studies do not systematize university - SME (U-SME) cooperation, despite firm size being an important factor to consider in a cooperation relationship (Lam et al., 2013).

These firms have different characteristics from large firms regarding resources and capacities (Luengo-Valderrey, 2018), which can hinder their insertion in financed innovation programmes sometimes promoted by universities. However, little is known about how cooperation occurs between these two types of organisations. Firm size is an element influencing cooperation, as stated by Fontana et al. (2006) and Lam et al. (2013), and can be a determinant of innovation capacity (Zubielqui et al., 2015). Larger firms, having more resources, have more options to develop internally independently and to establish cooperative relations with various organisations. On the other hand, SMEs need to establish cooperation in order to advance with research and development (R&D), and here the university is an important partner (Motohashi, 2008). Therefore, this study intends to explore the characteristics of U-SME cooperation presented in the literature. The study intends to contribute to the discussion about U-SME cooperation, by seeking answers to the following question: *What are the characteristics of U-SME cooperation?*

The answer to this question can classify research on U-SME cooperation, recognize patterns already established by the literature and outline new fields of exploration. From this perspective, this study is structured as follows: the next section presents a topic regarding U-E cooperation; then, the methodology applied to develop the study is described. This is followed by the bibliometric and systematic results and finally the conclusions and suggestions for future studies.

2 Small and Medium-Sized Enterprises and the Cooperation Process

In the organisational domain, cooperation can be understood as a process occurring between two or more parts with mutually dependent objectives, which are common to both or at least compatible, sharing and exchanging resources and carrying out joint activities(Hoffmann et al., 2018). This concept shows an interactive dimension between the parts, to achieve established objectives (Castañer & Oliveira, 2020).

Cooperation also reveals the benefits of partnership for gains in competitive advantage through resource-sharing and practical solutions to problems (Rezazadeh & Nobari, 2017), reduction in the time to create, produce and commercialise products and develop services, increased quality and cost reduction, access to complementary resources and development of the firm's own distinctive qualities (Dacin et al., 2008).

Agostini and Nosella (2019) highlight firm size as an important variable in analysing the characteristics of cooperation and the performance of firms involved in this type of relation. This variable can affect the firm's innovation capacity (Zubielqui et al., 2015).

Large firms are more able to understand the strategic differences involved in the different types of cooperation (Alunurm et al., 2020) and are therefore more likely to cooperate and form more diversified partnerships, including with universities (Jang et al., 2017). SMEs, compared to large firms, are challenged by limited access to resources and internal capacities, such as financial autonomy, technological capacity and qualified human capital. Therefore, cooperation can be a strategy used to mitigate these limitations (González-Benito et al., 2016). As argued by Cohen et al. (2002), large firms tend to interact more with universities, but SMEs, when they do so, have interactions of greater quality, due to their proximity to the university (Zubielqui et al., 2015).

In the SME context, cooperation allows this type of firm to benefit from strategic resources that can attract new customers and commercial partners in lasting relationships(Partanen et

al., 2018). As a result, these relations can help to attract partnerships able to aggregate long-term value for SMEs (Zahoor & Al-Tabbaa, 2020), in innovation, research and development activities that can influence their performance(Liu, 2020).

In general, SMEs form cooperative relations to innovate, learn, transfer and acquire knowledge, increase their operational capacity and competitive advantage, enter new markets or seek market power (Valentim et al., 2013). Fernandez-Olmos and Ramirez-Aleson (2017) highlight the launching of new products as a consequence of transferring existing knowledge within the space of cooperation, an inherent result of this type of firm's participation in cooperation networks. The relations of innovation in SMEs arising from cooperation are not always perceived through traditional measures such as publications and patents(Li et al., 2018).

3 Methodology

This study aims to present systematically the cooperation relationship between universities and small and medium-sized enterprises (U-SME). To achieve this, the systematic literature review is an appropriate technique due to its characteristics of transparency, clarity, equality, replicability and synthesis (Briner & Denyer, 2012; Thorpe et al., 2005). These criteria are inherent to scientific practice. The systematic review technique relates specifically to the applied form to locate and gather information about a phenomenon(Davis et al., 2014).

This technique follows three stages, according to Tranfield et al. (2003): (1) planning the review, (2) carrying out the review, and (3) reporting and disseminating the results. The first stage consists of elaborating the research question and the strategy to search for and retrieve articles/studies to form the research; the second stage refers to analysis of the articles selected; and the third is that of reporting the results for their dissemination.

The Scopus database was chosen to carry out this research due to its recognised coverage (Mongeon & Paul-Hus, 2016). The search strategy was elaborated from the literature on university-industry cooperation (Ankrah & Al-Tabbaa, 2015; de Wit-de Vries et al., 2018) and SMEs (Ribau et al., 2018), as presented in Table 2.1. This table also summarises the inclusion and exclusion criteria.

Table 2.1. Inclusion criteria

Phase of the study	Result
Database	Scopus
Search strategy	Keywords: (sme OR "small-medium enterprise" OR "small medium enterprise" OR "small-medium firm" OR "small medium-sized enterprise" OR "small firm" OR "medium firm") AND (university-industry OR university-firm OR university-enterprise) AND (alliance OR cooperation OR collaboration OR interfirm OR network OR partnership OR comercialisation OR engage* OR relation* OR collaborat* OR partner* OR exploitation OR bridge OR inter-organisational OR relationship OR interaction OR link*) N=131
Type of document	Articles N=89
Type of source	Journals N= 85
Language	English N=83
Preliminary thematic analysis	Reading of titles and abstracts to identify whether the articles dealt with the university-SME relationship. N=71
Thematic analysis	Content analysis
Software	Bibliometrix R package

The search was made in April 2020, retrieving 131 references. The search strategy on the database was made in the boxes of title, abstract and keywords. Next, book chapters, proceedings, editorials etc. were excluded. The option of including only articles was due to this type of work being peer-reviewed and giving easier access to the full text than with other types of scientific communication (Ramos-Rodríguez & Ruíz-Navarro, 2004). No time limit was set in order to understand the emergence of the topic in this U-SME relationship. It was decided to include only articles written in English (Gordin, 2017). Subsequently, the titles and abstracts were read to check whether the selected articles did indeed refer to the university-SME relationship. These filters resulted in 71 articles being included in the analysis.

4 Presentation of the Results

The initial sample (N=71) is distributed over 47 sources (among books, journals, etc.). The journals publishing most on the subject in question are *Industry and Higher Education* (n=6), *Education and Training* (n=5), *Technovation* (n=4), *International Small Business, Journal of Technology Transfer, Technology Analysis and Strategic Management* (n=3, each journal), *Entrepreneurship and Regional Development, Production Planning and Control and Journal of Small Business and Enterprise Development, Research Policy* (n=2, each journal) as

demonstrated in Figure 2.1. These journals account for around 40% of the articles selected for this study.

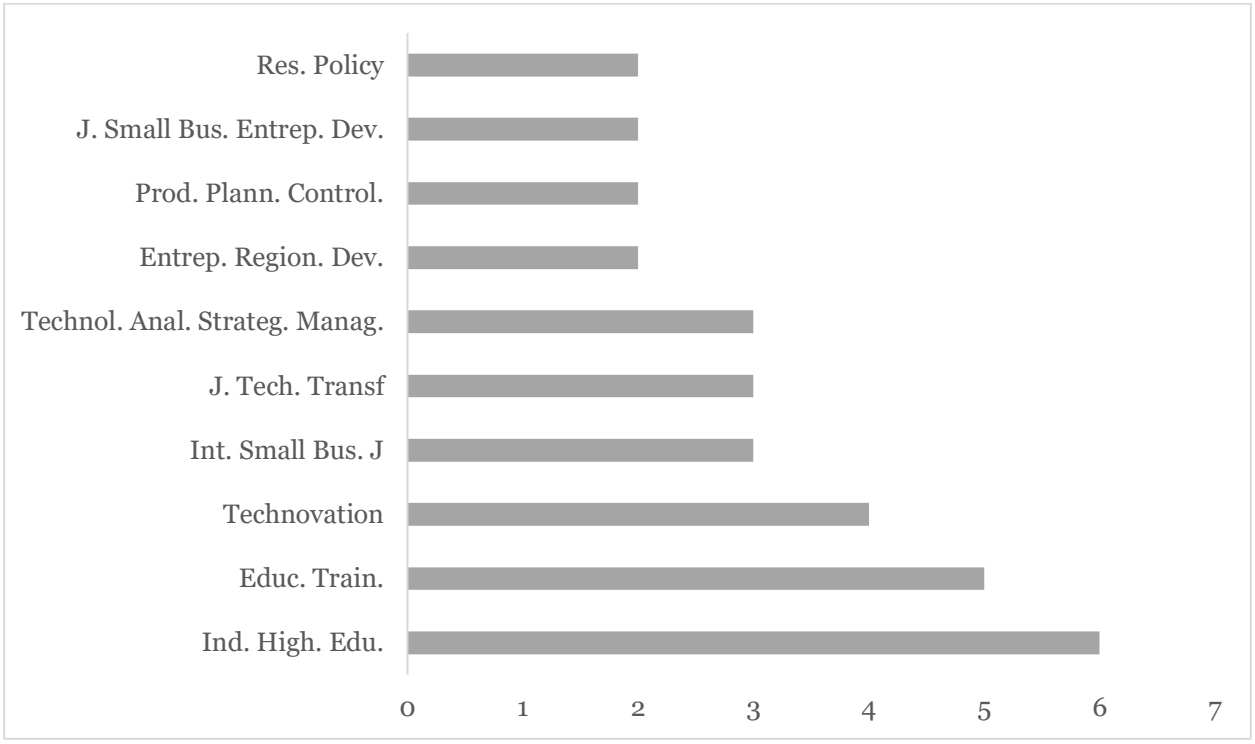

Figure 2.1. Most relevant source

Source: Search data, 2020.

The results indicate that studies on university-SME relations began around 1995, reaching a peak of growth in 2007-2009 (Figure 2.2). Thereafter, the theme takes off once again from 2014, with growth indicating a field in full development. This period coincides with the description by Ankrah and Al-Tabbaa (2015), whose research result indicates the 1990s as the start of more relevant studies on U-E cooperation.

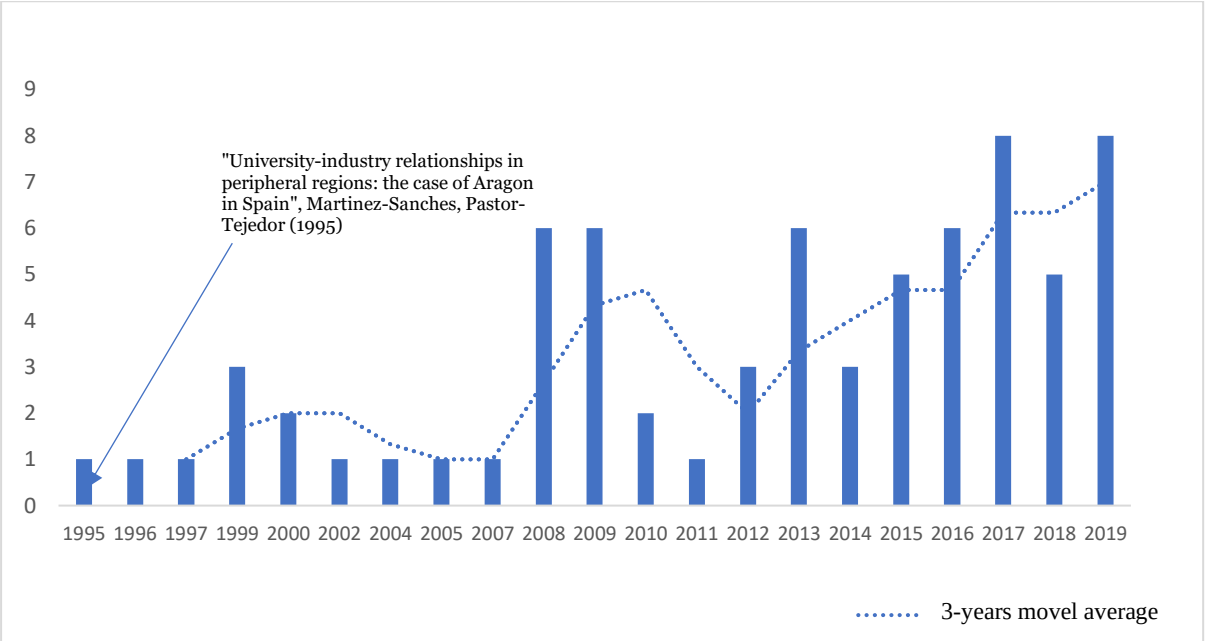

Figure 2.2. Scientific evolution of the theme

Source: Search data, 2020.

The most cited publications are presented in Figure 2.3. The larger the name of the author, the more citations of the document, considering its citation among the articles selected for this study, at the time of data collection. This figure demonstrates the theoretical foundation of the articles selected for the study. The colour of the circle represents the number of citations received by the article. The darker the colour, the more the document was cited. Only documents that were cited at least five times in the dataset were chosen here.

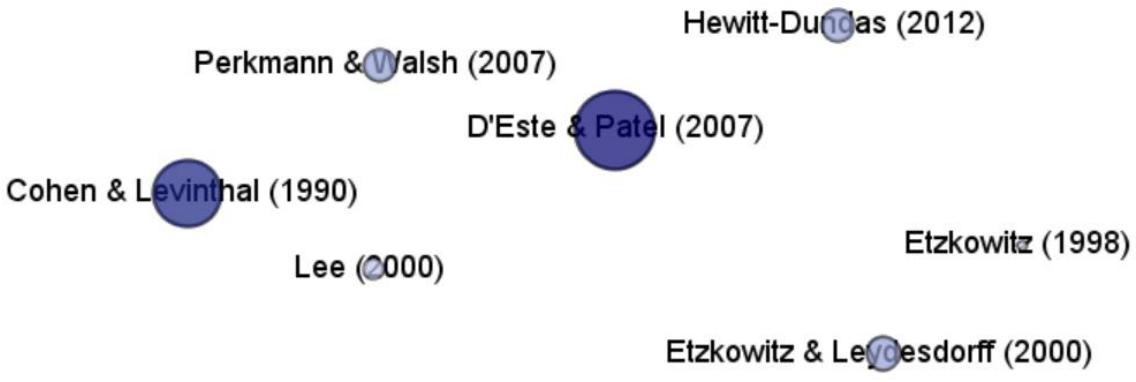

Figure 2.3. Most cited documents

Source: Research data, 2020.

D'Este and Patel, "*University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?*", Cohen and Levinthal "*Absorptive capacity: A new*

perspective on learning and innovation" and Perkmann and Walsh "*University-industry relationships and open innovation: Towards a research agenda*" are seen to be most cited in the articles selected. The first and the third authors focus on university-enterprise related questions, while the second is based on absorption capacity theory, and has been used in studies on U-E cooperation (de Wit-de Vries et al., 2018).

The triple helix theory, frequently used in discussions on U-E cooperation, is present in the arguments presented by Etzkowitz. Triple helix focuses on relations between the university, firms and the government, very applicable to U-SME cooperation, since government intervention in forming policies for innovation and to encourage cooperation in this type of firm can be important.

Lee (2000) lists researchers' motivations in U-E cooperation, and highlights that personal motivation is the individual's basis for long-term cooperation. These are the most cited documents in the dataset selected form this study. Hewitt-Dundas (2012) presents institutional differences in universities, such as the strategic variable for knowledge transfer between organisations.

Figure 2.4 shows the authors in the sample with the greatest number of citations. This figure was constructed based on authors rather than documents, and so there is repetition of documents due to co-authorship.

Figure 2.4. Authors with most publications

Source: Research data, 2020.

In Figure 2.4, the circles represent the number of articles published by author, and the lines show the periods. The intensity of the circle colour indicates the average citations per year attributed to those articles, among the articles selected for the study. In addition, the Table 2.2 relates the most cited articles and their main results, classified by the average number of citations in the period. Articles with average citations greater than 1 are listed.

Table 2.2. Most cited articles

Ref.	*Author*	*Approach*	*Methodology*	*Context*	*Results*	*Citation /year*
1	Motohashi (2005)	National Innovation System	Quantitative	Japanese national innovation system	Smaller firms have greater gains in productivity through U-E cooperation than large ones. When cooperating, SMEs have practical objectives, for example, product development.	9,68
2	Jones and Corral de Zubielqui (2017)	Knowledge transfer	Quantitative	Australian managers/ owners	SMEs use relational links to access knowledge, especially human resources, these being effective in promoting the results of innovation at the firm level.	4,25
3	Gordon et al. (2012)	Entrepreneurial education	Qualitative	English managers/ owners	Partnership with the higher education institution increased the effectiveness of SMEs involved in teaching programmes, with cultural change in the firm, increased trust and skills among the participating managers/ owners, and consolidated formation of firms' relationship networks.	4,22
4	Malairaja and Zawdie (2008)	Science parks	Quantitative	Technological SMEs belonging to the Malaysian technology park	Firms engaging in U-E cooperation have a government incentive to do so; relations between the two organisations are weak and the firm only seeks the university when in need of scientific knowledge.	3,92
5	Lockett et al. (2008)	Knowledge transfer	Qualitative	Academics and SMEs participating in a knowledge transfer programme in England	Difficulty in recognising knowledge transfer between universities and firms; knowledge transfer is more focused on commercializing in industry and little directed to public policy-makers for the production sector.	3,46
6	Johnston and Huggins (2018)	Joint research projects	Qualitative	Small English firms	The study emphasizes partner selection for cooperation. When seeking cooperation with the university, the small firm does so through trusting in the researcher rather than the university – informal, trusting relationship; credibility is an important variable for U-E cooperation.	3,33

Table 2.2. Most cited articles (cont.)

Ref.	Author	Approach	Methodology	Context	Results	Citation /year
7	Thatcher et al. (2016)	Research and consultancy for SMEs	Qualitative	Stakeholders (clients, academics, graduates) in an experience of U-E cooperation in England	U-E cooperation complements the university's agenda, the development of post-graduate courses with potential learning for all stakeholders involved in a U-E cooperation programme.	3
8	Padilla-Meléndez et al. (2013)	Open innovation systems	Qualitative	Academic and non-academic spin-off SMEs in Spain, large firm and R&D centres	Informal networks are important for successful knowledge transfer between parts involved; and knowledge transfer is an essential factor for continuous innovation.	2,38
9	Zubielqui et al. (2015)	Knowledge transfer	Mixed	Australian SMEs	Knowledge acquisition through the results of published research and new graduate employment, more common in geographically close institutions.	2,33
10	Johnston and Huggins (2017)	Knowledge transfer	Quantitative	English KIBS	Geographical proximity, firm size and the type of university are factors influencing knowledge transfer between KIBS and universities.	2,25
11	Bjerregaard (2009)	Collaboration in research and development	Qualitative	Danish SMEs financed through a government programme for U-E cooperation	U-E cooperation reinforced SMEs' position in the market and served as a source of learning and new relational contacts. Partners' experience of cooperation is a factor to consider in short and long-term strategies between parts, to establish cooperation.	2,17
12	Gordon and Jack (2010)	Social capital	Qualitative	English SMEs	Social capital was benefited by network formation. SMEs develop better from creation of the network, allowed by a U-E cooperation programme to develop leadership in SME owner-managers.	2,00
13	Temel et al. (2013)	SME performance	Quantitative	Turkish SMEs	The low level of collaboration is not enough for the benefits of U-E collaboration to be fully understood in the context studied.	1,62

Source: Research data, 2020

Table 2.2 shows that the most studies were made in economically more prosperous regions, such as Europe (Bjerregaard, 2009; Gordon et al., 2012; Johnston & Huggins, 2018; Lockett et al., 2008). It also reveals that U-SME cooperation is sometimes the result of partnerships encouraged by government programmes (Malairaja & Zawdie, 2008; Pickernell et al., 2019).

In developing countries, research does not produce expressive results due to the low level of cooperation between parts (Temel et al., 2013).

Also observed is the frequency of keywords in the selected dataset (Figure 2.5). These keywords are indexed from the titles and abstracts of articles. This figure demonstrates firstly the SME's relations with the university.

Figure 2.5. Word cloud of keywords and abstracts

Source: Search data, 2020.

It can be suggested that competitiveness, sustainability, commercialization, performance assessment, learning, networking and business development are topics characterising U-SME cooperation, and they can be seen as results of that cooperation. More generally, the subject is developed from innovation, technology transfer, knowledge transfer, technological development and research and development, and the formation of public policies, as ways to achieve the aims of the cooperation established. These keywords provide a valuable vision of how the literature on U-SME cooperation is supported on these concepts.

4.1 Exploration of the themes

Cooperation benefits SMEs particularly, as it allows solutions to particular problems, access to specific knowledge and obtaining competitive advantage (Garcia-Perez-de-Lema et al., 2017);

and the university provides research and application of knowledge in a specific, real context, close to the situation academics will find in the labour market (Lockett et al., 2008).

The SMEs found in universities a way to keep their employees up-to-date with the technology necessary for business development, and that partnership was established due to the low cost of fulfilling the project (Meldrum & de Berranger, 1999). Similar results were highlighted by Gordon (2013) and Gordon and Jack (2010), but with SME owner-managers. The results presented in these studies reflect the importance of entrepreneurial education in universities, directed towards executives, benefiting SMEs through consolidating relationship networks (Padilla-Meléndez et al., 2013).

Forming networks gives SMEs access to test laboratories in their areas of operation (Philipp et al., 2019), lets them seek new opportunities (Gordon, 2013) and business models to improve their resources (Lam et al., 2013). It is important to underline that SMEs have more difficulties in accessing universities' cooperation resources than large firms do (Luengo-Valderrey, 2018). So, the bonds formed between the university and SMEs, even if weak (characterised by informal relations), can be what leads to access to knowledge and the structures the university can provide to these firms (Sousa et al., 2015).

Universities are sources of knowledge for SME innovation and sustainability (Jones & Zubielqui, 2017). That knowledge is accessed mostly through the relations formed with the university, but not necessarily through formal channels such as research contracts. Padilla-Meléndez et al. (2013) point out that personal or informal relations are important for knowledge transfer and successful innovation promoted by U-SME cooperation. One way of consolidating these informal relations is by using specific teaching programmes directed to entrepreneurs.

These specific training programmes for entrepreneurs can help business development and to establish trusting relations and build social capital, important elements in consolidating U-SME cooperation (Gordon et al., 2012). Also in the context of education and informal relations, this is a primary source of contact for U-SME cooperation. Bjerregaard (2009) explains that entrepreneurs' previous educational experience, having studied at a given higher education institution, gives them contacts with those researchers, to establish initial cooperation contacts.

The training process developed in the scope of U-SME cooperation can stimulate social capital and can be benefited by network formation. That stimulation allows the formation of social capital aligned with the profile of entrepreneurs participating in the training. Here, the

exchange of experiences, for problem-solving, can be facilitated, not only in the relation with the university, but also among the other partners (Gordon & Jack, 2010).

Speaking of trust, Johnston and Huggins (2018) indicate that SMEs evaluate the partner's credibility, in the case of the university, through the results obtained from developing joint projects. Credibility can be assessed at an individual rather than organisational level, which reveals the importance of informal relations in forming cooperation. This result is also related to the geographical proximity found by Zubielqui et al. (2015), who state that SMEs tend to look for knowledge in institutions closer to where they are located.

By cooperating with universities, these companies seek to achieve practical objectives, such as development (Motohashi, 2005), product testing (Bellini et al., 2019) and their positioning in the market (Bjerregaard, 2009). They are looking for ways to expand their business through new relations created in cooperation (Gordon et al., 2012). Previous experience of cooperation is also important for SMEs, as consolidated learning from that experience can produce good results in new partnerships (Bellini et al., 2019).

The formation of U-SME cooperation to attain practical objectives shows the duration of the cooperation, suggesting a short-term process. However, Bjerregaard (2009) emphasizes that strategic use of cooperation, concentrated on learning and network formation, can be successful when constructed in the long term, as this gives partners experience of cooperation and promotes intangible results for the cooperation.

SMEs' performance was listed by Temel et al. (2013) as a result of U-SME cooperation. However, that result is more perceptible when the cooperation is more intense, suggesting that such benefits can take time to appear (Temel et al., 2013). So SMEs can increase their performance levels when they cooperate with a university. Consequently, that increased performance can encourage SMEs to embark on new U-SME cooperations (Jones & Zubielqui, 2017).

It stands out that the government is an important agent in the formation of U-SME cooperation. This actor sets regional development policies, to encourage innovation and stimulate SME growth. Government support for U-SME cooperation can stimulate the business development process (Gordon & Jack, 2010), since SMEs have fewer resources to invest in R&D. The role of public finance for research can make the difference for this type of cooperation (Johnston & Huggins, 2018).

However, U-SME cooperation brings difficulties, such as incompatibility between the university and SMEs, which can prevent the cooperation's development (Whah & Tiek, 2012).

Communication has been pointed out as a significant barrier in U-SME cooperation. Differences in communication can make SMEs lose interest, as they may not know what U-SME cooperation can result in for them (Malairaja & Zawdie, 2008), under-using that partnership merely as a source of trained human resources and not as a source of technology and knowledge (Ranga et al., 2008).

Another important characteristic of U-SME cooperation is its duration. This question may lead to conflict between the parts. Although SMEs tend to use U-SME cooperation for quite specific objectives, which may suggest short-term cooperation, universities tend to concentrate on long-term activities (Padilla-Meléndez et al., 2013).

Access to cooperation with the university can be a little more difficult for an SME. The lack of knowledge about forms of access to university cooperation (Saruchera et al., 2014) can limit the exchange of knowledge to absorbing new graduates (Zubielqui et al., 2015). The development of strategies to implement that exchange of knowledge is beneficial for both sides (Pickernell et al., 2019), both formally and informally, since the innovation processes developed in the university go beyond its limits (Sparrow et al., 2009). Research interests, both parts' perception of the potential of cooperation and the delay in developing the activity are listed as barriers to U-SME cooperation (Lockett et al., 2008). In addition, U-SME cooperation can involve universities' skills in consultancy and technical support for the implementation and fulfilment of SME business (Pittayasophon & Intarakumnerd, 2017), in order to establish new businesses and thereby promote regional development.

One way to lower the barriers to cooperation is to establish knowledge transfer channels based on relations, coded knowledge and trust in the network formed between the university and the SME (Garcia-Perez-de-Lema et al., 2017). Bergenholtz and Bjerregaard (2014) highlight that institutional conditions can influence successful formation of those networks and bring them different configurations.

5 Discussion of the Results

SMEs cooperate with other organizations to access various resources, such as those of innovation or research and development, in search of distinctive capacities (Liu, 2020). However, this can be a problem when it is a question of cooperating with universities, as these cooperate more with large firms (Bodas Freitas et al., 2013) or because the very structure of the SME is more directed towards the immediate solving of issues (Løkkegaard & Lykke, 2019).

One of the outstanding aspects of the results presented here is the geographical location where these studies were made. Studies carried out in Europe predominate, specifically in the United Kingdom(Gordon, 2013; Gordon et al., 2012; Gordon & Jack, 2010; Johnson & Tilley, 1999; Johnston & Huggins, 2017; Manville et al., 2019) and Spain (Luengo-Valderrey, 2018; Martinez Sanchez & Pastor Tejedor, 1995; Padilla-Meléndez et al., 2013).Studies detecting U-E cooperation in general point out that this has not yet reached less developed regions (Mascarenhas et al., 2018).

The situation other than in developing countries has been little studied. In the sample selected, Zimbabwe (Saruchera et al., 2014), Turkey (Temel et al., 2013) and Mexico (Merritt, 2015) have been subject to research. In Zimbabwe, the focus was on aspects related to teaching, especially further education, to promote a continuous flow of qualified workers for the local manufacturing industry, so that SMEs can play a bigger part in that sector. In Turkey, innovation strategies through U-SME cooperation were emphasized, and in Mexico, SMEs' absorptive capacity in cooperation of that nature. These studies reveal that U-SME cooperation is not yet a driving mechanism of major innovation in firms, being limited to solving problems that arise.

Another configuration highlighted in U-SME cooperation is knowledge management. One of the aspects addressed was the exchange of knowledge, which in the study by Manville et al. (2019) is consolidated through graduates' becoming employable in SMEs, with the university providing firms with qualified workers (Zubielqui et al., 2015) in line with market requirements. Knowledge transfer through human resources influences firms' innovation capacity, which in turn can affect SMEs' performance in increased productivity (Zubielqui et al., 2015).

U-SME cooperation can also promote improvement in these small firms' capacities, through information flows, learning capacity and resource-sharing (Xu, 2013), since SMEs do not have resources to invest in research and development (Motohashi, 2008). In fact, joint research can represent a lower cost, when carried out in cooperation, compared to doing so in isolation (Pittayasophon & Intarakumnerd, 2017).

U-SME cooperation is more restricted to practical involvement, directed towards product development (Motohashi, 2005) and differentiation (Lam et al., 2013), at the operational level (Rantala & Ukko, 2018) and with technology-based SMEs (Fukugawa, 2013). SMEs do not benefit from other aspects of cooperation such as patents, for example (Pittayasophon & Intarakumnerd, 2017), as they are more concerned about an immediate increase in their

competitive advantages (Han, 2017; Thatcher et al., 2016) and long-term projects remain outside cooperation.

A common element in analysing U-E cooperation concerns the barriers to cooperation (Franco & Haase, 2015; Galán-Muros & Plewa, 2016). In the scope of U-SME cooperation, one of the barriers identified was these firms' difficulty in establishing cooperation, as they do not know how to access the cooperation resources the university can provide (Luengo-Valderrey, 2018). Then again, the university may not be interested in this type of partnership, as SMEs are less likely to patent than large firms (Han, 2017).

Returning to the question guiding the study: What are the characteristics of U-SME cooperation? The main ones are as follows:

a) Knowledge transfer is the predominant characteristics in studies, and the most explored aspect is continuing education, both through absorbing a graduate workforce, or by owners' specialization;
b) The construction of relationship networks is the most visible result of U-SME cooperation, and this extends beyond the formal programmes established;
c) SMEs seek the university to solve immediate problems, which does not allow a long-term partnership to form more lasting programmes able to promote innovation besides products and services;
d) U-SME cooperation is formed, in principle, setting out from government incentives, reinforcing the importance of the triple-helix;
e) National innovation systems are fundamental to include SMEs in a virtuous process of innovation, forming partnerships with surrounding universities.

Therefore, the growth of studies on U-SME cooperation underlines the importance of this type of firm for regional/national economies. The most common characteristic found in this study was the search for specific knowledge to develop business, for improved human resources and the formation of partnerships to access new markets. U-SME cooperation is most frequently related to SMEs' operational process (Rantala & Ukko, 2018), to solve existing problems or situations in the company (Santoro & Chakrabarti, 2002). These characteristics differ from those found in cooperative relations with large firms. Generally, large firms have financial resources for investment, qualified human capital, infrastructure, innovative technology, appropriate information systems and skills to establish relations with external sources (Mora Castellanos et al., 2019). In these cases, cooperation is more related to development, innovation and commercialization.

It was also found that the literature tends to emphasize the barriers to U-SME cooperation. However, as highlighted by Ranga et al. (2008) and Jones and Zubielqui (2017), publicising the results of cooperation can stimulate the formation of other partnerships, overcoming the barrier of communication, also mentioned as an obstacle to U-SME cooperation (Malairaja & Zawdie, 2008).

6 Conclusions, Contributions and Future Agenda

This study aimed to systematize the literature on cooperation between universities and SMEs. The literature was formed in the period 1995-2019, with studies being more frequent from 2014 and concentrated in countries with more developed economies. The methodology most applied in the studies analysed was the case study method.

One of the conclusions drawn from this study is SMEs' difficulty in initiating cooperation relations with the university, due to not knowing the university's capacity to help them. On the other hand, the university may not be communicating programmes that can reach these firms, and so here there is a communication problem. These two types of actors are important for the ecosystem of regional innovation. So there is a need to establish effective communication channels between both parts, so that the knowledge produced in universities can be more accessible to SMEs.

This study aimed to contribute to the literature on U-E cooperation, specifically including U-SMEs in the discussion. This type of firm is very relevant for regional development, and so cooperation with universities can be an important mechanism to develop these organisations. Cooperation with firms of this size can go beyond immediate problem-solving and attracting and training a qualified workforce, being a source of innovation and development for industrial sectors.

Regarding research, this could pay more attention to U-SME relations. These firms can bring important insights to academic research in general. Understanding how these cooperation relations are formed can be a stimulating element of innovation ecosystems and effective network operation. These firms have management dynamics that are closer to consumers and suppliers, which can lead to carrying out research with innovation more related to regional issues.

In addition, university managers must go beyond supplying a qualified workforce and set up specific programmes for SMEs. Effective communication can be established, since some research indicates a lack of knowledge about programmes provided by universities that could

benefit SMEs. This type of initiative can break down this barrier to U-SME cooperation and contribute to effective relationship networks.

In turn, SME managers need to find out more about the programmes developed in universities and benefit from that knowledge. They need to know the university and get hold of the resources it supplies. The formation of cooperation networks with universities can be a virtuous relationship for regional development.

Public policy-makers need to align programmes to stimulate research in universities with the specific characteristics of SMEs. Similarly, they can encourage this firm segment's participation in cooperation programmes with the university. In this way, SMEs can benefit more from the knowledge produced in the university and thereby have greater access to information, research, and development.

This study also presents some lines of future research. SMEs' access to the university was indicated as one of the difficulties in achieving U-SME cooperation. However, little is known about the ways SMEs access the university to carry out this type of cooperation and about the effective elements when SMEs decide to seek university cooperation. Therefore, future studies should identify the elements highlighted by the university in accepting cooperation. Another subject for future discussion could be the longevity of U-SME cooperation. Previous experience of cooperation is an important element for the formation of new partnerships, but no long-lasting U-SME cooperative relations were found. This suggests studies to identify the reasons for such cooperation not being considered long-term.

Public announcements are a form of selecting companies, as indicated in the results, where some cooperation established arose from government-led programmes for regional development. However, this does not seem to be the only form of access, as informal relations also emerge as a form of cooperation. So partner selection in the scope of U-SME cooperation is a topic warranting wider discussion in the future.

Some studies were made in regions where access to the university and knowledge is already consolidated, and cooperation with SMEs to stimulate regional development is greatly encouraged by formal university programmes. However, this situation does not seem to be generalized, given the shortage of studies on less developed areas. Indeed, it is recognised that the effects of U-E cooperation can vary according to the institutional context in which it occurs (Liu et al., 2020), which implies finding out in the future how that cooperation occurs in developing regions.

This study is not without limitations. To find out how U-SME cooperation takes place, only one database was used, Scopus. While recognising the coverage of this database, many studies may have been excluded from the selection through not being indexed there or not being included in the filters established. Given this limitation, it is suggested that other studies could use more than one database, to include more documents and diversify the approaches found, thereby enriching the debate about U-SME cooperation.

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Chapter 3

University-Firm Cooperation and Regional Development: Proposal of a Model of Analysis

Abstract: University-firm cooperation (UF-C) is an important factor in regional development. This type of cooperation occurs through relations established to carry out research and teaching and develop products and processes. In this type of relationship, formal or informal channels are used. Analysis of these relations is through various approaches, such as national/regional innovation systems, triple helix and other helices and the entrepreneurial university. These approaches concentrate on the university's importance as an element inducing innovation and development through its actions and the relations formed with the institutional environment. Those analyses result in elements complementing the local production structure, such as qualified human resources, entrepreneurship, business and academic relationship networks, innovation and other aspects. Reflecting on how those relations affect regional development illuminates the discussion on the university's mission in society and the relations it forms with its surrounding environment, modifying its social structure. The model proposed emphasizes the UF-C relations established in regions with a production structure of low technological intensity. In those regions, patent and publication indicators may not be enough to capture the specificities of this type of cooperation.

Keywords: University-Firm Cooperation; Innovation system; Regional Development.

1 Introduction

Universities' cooperation with firms (UF-C) has become a specific field of research (Galán-Muros & Davey, 2019), emphasizing the closer connection between the results produced in the university and society's needs, as well as policies to commercialize research. This type of relation has had various designations, such as UF-C (Franco & Haase, 2015), U-F collaboration (Rybnicek & Königsgruber, 2019), U-F partnership (Lascaux, 2019), among others. This study

will use the term UF-C, understood as the interaction between those within the higher education system and firms (Ankrah & Al-Tabbaa, 2015).

UF-C is assumed to have the aim of increasing the exchange of knowledge and technology between these organisations (Ankrah & Al-Tabbaa, 2015), in a mutually beneficial agreement (Galán-Muros & Plewa, 2016), able to promote regional development, through various elements such as social research, environmental innovation and critical reflection (Harrison & Turok, 2017). Therefore, the university, in the context of a knowledge-based economy, has an important role in stimulating development. The firm, in turn, exploits that knowledge to develop its mission, to generate profit. Cooperation between these two organisations can generate the results necessary for the development of both, in fulfilling their strategic objectives and those of the surrounding region.

Through an inclusive review of the literature, the aim is to understand the role of UF-C in regional development. Studies summarising the literature on UF-C have been made in recent years. These highlight success factors of UF-C (Rybnicek & Königsgruber, 2019), and the key factors promoting innovation originating in that partnership (Sjöö & Hellström, 2019). However, Mascarenhas et al. (2018) underline the need for studies on the regional factors involved in this type of partnership. Thus, this study seeks to understand UF-C in regions with low technological development. In addition, there is a gap in the discussion about how UF-C is formed in the context of micro-, small-, and medium-sized enterprises located in low-income regions. The results obtained here can be perceived in regional development. In general, the literature on UF-C has been focused on more economically developed regions (Thomas & Pugh, 2020), where innovation and cooperation between these institutions (UF) is already established (Budyldina, 2018).

For the construction of the model to be proposed, we started from a literature review, which sought to identify the characteristic elements of the UF-C that can be found in regions of low technological development. Thus, the proposed model emphasizes cooperation through direct interaction between actors, such as consulting, internship programs, training of undertakers and other forms of interaction. Therefore, the results of this type of cooperation can be identified from the perception of entrepreneurs and show how this partnership can bring advantages to companies and to the region where they are inserted.

After the methodology, the paper is structured setting out from university-firm relations and the models of interaction between them, followed by discussion of the effects of UF-C on regional development. Finally, a model is proposed for future analysis of UF-C, joining

elements resulting from the cooperation on both the university and firm side and which can be reflected in regional development.

2 Methodology

In this study, we chose to perform an integrative review whose objective is to relate the UF-C with regional development. Integrative review is a useful approach when it is not sought to cover everything that is published in a given area (Snyder, 2019), but rather to understand, more comprehensively, a particular phenomenon (Whittemore & Knafl, 2005). This review aims to identify important elements for UF-C in regions with low development, in order to better understand this type of cooperation, especially, which is the case with micro, small- and medium-sized enterprises.

The databases to build this review were the Web of Science (WoS) and Scopus. These two databases are characterized by the scope and quality of indexed publications. More precisely, the identification of the publications that make up this review followed the phases described in Figure 3.1.

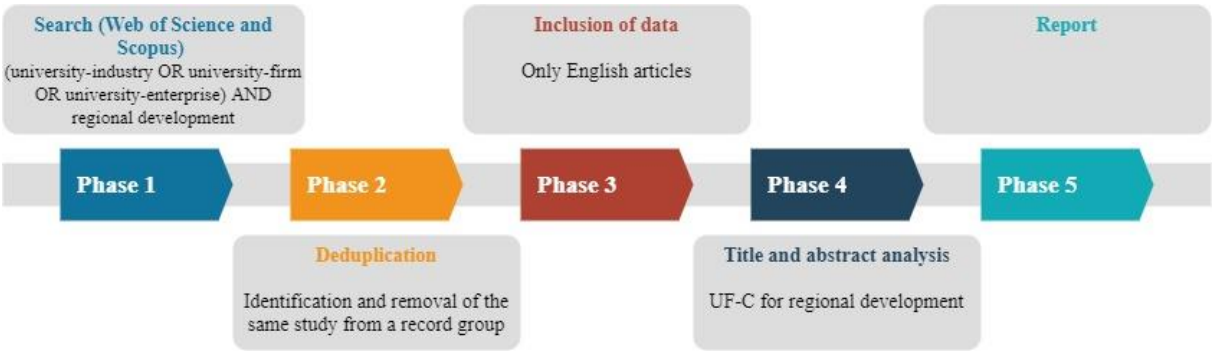

Figure 3.1. Phases of the integrative revision

Source: Own elaboration

The analysis of the articles allowed identifying the types of cooperation established between universities and firms and the possible results related to the development of a region. Thus, it was possible to identify appropriate elements for an analysis of UF-C in regions of low technological intensity.

3 UF-C Relations

The university's role in society extends beyond the creation and spread of knowledge (Bhullar et al., 2019), being directed towards the university's so-called "third mission". That mission reflects the contribution the university makes to society, through activities that promote entrepreneurial skills, innovation, social well-being and the training of human capital (Compagnucci & Spigarelli, 2020).

One way to achieve that third mission is through UF-C. That cooperation extends to carrying out joint projects, exchanging knowledge in both directions and forming those actors' future innovation paths, besides testing the practical application of academic research (Giones, 2019). The university broadens its concern to include social and business needs (Kapetaniou & Lee, 2017), in various forms of cooperation and through different channels of interaction.

Types of U-F interaction can be grouped in categories, such as the degree of formality, the degree of interaction, the flow of knowledge and the potential to apply results (De Fuentes & Dutrénit, 2012) or according to organisational forms, as suggested by Ankrah and Al-Tabbaa (2015), based on formal and informal personal relations, on the third mission, on formal and informal agreements, and on structure.

From the perspective of formality, D'Este and Patel (2007) highlight a variety of channels through which U-F cooperation takes place. These authors classify that cooperation in five types: (1) meetings and conferences, which consist of researchers participating in meetings sponsored by the firm, and firms participating in meetings promoted by the university; (2) consultancy and research contracts, where the university takes consultancy to the firm, which hires university research to develop solutions to specific problems; (3) the creation of physical facilities through research laboratories sponsored by the firm, the firm's access to the university's facilities and the university's access to the firm's know-how; (4) training, both carried out in-company, by the university to satisfy a specific demand, and joint co-orientation of work done in the university with practical application and development in the firm, and finally, (5) joint research, in the form of research agreements involving both parts.

From a relational perspective, Perkmann et al. (2013) group forms of UF-C in two types: research partnership and research services. The former are formal relations between both parts, aiming to cooperate in research and development activities, and often associated with subsidised public policy programmes; the latter, in turn, involve services provided by the university, such as consultancy and hired research, i.e., involving a specific demand for a type of service or knowledge, and this is performed for payment.

The consolidation of UF-C can take place through interaction channels. These channels take various forms such as: patents, academic entrepreneurship (Perkmann & Walsh, 2007), exchange of human resources, the creation of start-ups and spin-offs (Franco & Haase, 2015), the firm financing academic research (Perkmann et al., 2013), knowledge transfer through scientific publications, reports (Cohen et al., 2002), informal contacts (Siegel et al., 2003) and exploitation of intellectual property generated by academic research (Kirby & El Hadidi, 2019). This spill-over of resources can be a strategy for both the university and the firm (Lee, 2018).

In these circumstances, those relations occur in two dimensions: the type of agreement contracted and the objectives' degree of specificity (D'Este et al., 2019). The types of contract agreement include personal relations and market mechanisms. Personal relationships cover the social capital built throughout the process and relational arrangements involved in the process of transferring tacit knowledge; contracted agreements with market mechanisms are built with elements of less inter-personal interaction and more directed to the transfer of explicit knowledge, such as the formation of spin-offs, licensing, technology transfer and consultancy contracts. On the other hand, the dimension of the degree of objectives' specificity covers the results aimed for by the parts in UF-C. The more specific the objective established, the easier it is to measure, as the parts may have different expectations for the result of cooperation.

Those relations can be characterised by measurable elements, such as publications and patents in co-authorship, licensing, prototypes, research and consultancy contracts, firms' installation of laboratories in universities, collaborative research and development, and other mechanisms of knowledge transfer (Perkmann & Walsh, 2007). Other cooperative relations are established from informal bonds. Those bonds, in turn, are indicated as being more difficult to measure, such as meetings (Cohen et al., 2002), communication by e-mail, lectures and conferences that allow U-F interaction and may lead to a formal bond (Ahrweiler et al., 2011).

3.1 Models of U-F interaction

The most frequent approaches to U-F cooperation in the literature, according to Ierapetritis (2019), are national/regional innovation systems, the Triple Helix model, the entrepreneurial university and others. National/regional innovation systems were not initially conceived to model the U-F relation, but are important in understanding this type of relation.

National/regional innovation systems are one way to conceive UF-C. This view of innovation, as a national system, is based on Lundvall (2010), who indicates the following elements as part of that system: firms' internal organisation, relations between firms; the role of the public

sector; the financial sector's institutional arrangements; and the intensity and organisation of research and development (R&D). The interaction between these elements strengthens institutional and organisational bonds for regional development, through the relations that interact in the production, spread and use of knowledge (Lundvall, 2010). In this context, especially in R&D intensity, the university is an important agent of development.

This conception of Lundvall is inserted in a national context. However, some regional specificities can influence innovation. Therefore, regional innovation systems are formed. It is difficult to separate these two concepts, and they are sometimes used interchangeably (Doloreux, 2002). In the regional system, organisations are involved in interactive learning, integrated in the institutional environment (Cooke et al., 1998) to strengthen regional innovation bonds.

Another way to conceive U-F cooperation is through the Triple Helix model. This model implies the interaction between university, industry and government (Etzkowitz & Leydesdorff, 2000). The model highlights the interaction between these three elements, and each plays an independent role in an institutional arrangement involving innovation and entrepreneurship for regional development (Cai & Etzkowitz, 2020). That interaction reflects the formation of policies related to higher education in the region where universities are located, making them agents able to modify the socio-economic environment (Peer & Penker, 2016).

Besides the three helices proposed as a basis for the promotion of regional innovation, other helices have been added to strengthen the links in a knowledge-based society. Carayannis and Campbell (2009) propose a fourth helix to reach more elements forming the process of innovation and use of knowledge. That helix is formed of society and its values and cultures as an important element to stimulate innovation processes from the perspective of the user of that innovation (Miller et al., 2018). However, that interaction between knowledge production and integration with society is rather complex and other helices can be added to the model, according to the context (Leydesdorff, 2012).

The integration between knowledge and society, in the conception of Johnson (2008), needs an intermediary institution to support the triple helix, allowing it to reach the proposed objective: to stimulate innovation through knowledge. The university can take on this role of intermediary, since it has the mission to produce knowledge. One positive form of intermediation is through commercializing knowledge. In this conception, Carayannis and

Campbell (2009) suggest the term “entrepreneurial university”, which allows better understanding of the relation between the three parts.

The entrepreneurial university is a source of inspiration for entrepreneurial activities for all the publics forming it, since this is a knowledge-intensive institution (Audretsch, 2014). It covers various actions such as partnership with industry, the creation of undertakings, production, application, commercialization and capitalisation of knowledge through services, the search for more sources of finance, the contribution to social and economic regional development, and others (Schmitz et al., 2017). Those actions are in line with the requirements of the knowledge-based society, in an evolutionary concept of the university (Goldstein, 2010).

Those entrepreneurial activities are carried out with the aim to improve economic development, and therefore, create an economic advantage, even in the university context, where tradition does not emphasize profit as an essential element (Etzkowitz et al., 2000). According to Dalmarco et al. (2018), university entrepreneurship is grounded on three basic pillars: education, research and socio-economic development. These authors designed a framework based on university entrepreneurship, through external connections (researchers are linked in research centres of an applied domain in national and international centres); access to university resources (such as laboratories to test and experiment their resources, libraries and other structures); innovation arrangement – the university is an advisory body in terms of knowledge transfer; scientific research – a structure for research groups and post-graduate courses. These pillars form elements able to promote regional development (Audretsch, 2014).

From the above, the approaches presented are seen to form elements highlighting cooperation between organisations aiming to consolidate innovation, from the Triple Helix perspective, in the models joining other helices, in national/regional innovation systems or in the context of the entrepreneurial university. Here, the university has an important role, both in producing knowledge and as an intermediary in transferring that knowledge, specifically when it forms cooperation with firms.

4 UF-C and Regional Development

Universities contribute to the local and regional economy from excellence in research, teaching and cooperation with public and private actors (Bonander et al., 2016) and through innovation and development projects (Rantala & Ukko, 2019). The creation of knowledge, the training of human capital, knowledge transfer, technological innovation, capital investment, regional

leadership, knowledge infrastructure and the influence on the regional environment are fundamental elements of these institutions' contribution to society (Drucker & Goldstein, 2007).

As not all research results in direct financial return (Budyldina, 2018), the university can be a key actor able to improve local capacities through learning contextualized with the region's economic needs (Brekke, 2020), attracting human capital and innovative companies (Budyldina, 2018). That activity can be a crucial factor for regional development (Harrison & Turok, 2017).

In this context, UF-C has to do with commercial valorisation of the knowledge produced, technology transfer, co-production and the form of response as dimensions of cooperation. This approach is market-oriented (D'Este et al., 2019), in an institutional framework that contributes to entrepreneurship based on knowledge (Ezers & Naglis-Liepa, 2019). Through the university, the region has access not only to global knowledge, through formal channels of scientific communication accessible to all, but also local knowledge, produced in the sphere of the university and exploring regional specificities (Cooke & Leydesdorff, 2006). Therefore, universities are strategic elements of development for a knowledge-based economy, and UF-C is one of the strategies found to promote that development (Drucker & Goldstein, 2007) through teaching, research and innovation.

The innovation produced by UF-C brings economic benefits and contributes to increase industrial competitiveness (Tseng et al., 2020), through the knowledge generated and its application. The knowledge generated and transferred to the business environment has a relevant effect for regional development (Sá et al., 2019), because it develops skills and innovation, transfers technologies and promotes entrepreneurship (Mahfoudh et al., 2021). However, this knowledge needs to be exploited by firms and society to have an impact on regional development. This transfer of knowledge can be done through the marketing of research results, teaching activity, entrepreneurial training or on the basis of other means of knowledge sharing.

One of the ways to measure this impact of knowledge generated in a region is the registration of university patents and licensing revenues generated by those same patents (Yeo, 2018). The commercialization of research results also brings important challenges for the university. This activity, in the specific case of UF-C, involves patenting and licensing contracts, as well as academic entrepreneurship (Perkmann et al., 2013). Although this commercialization is an expected contribution of UF-C to regional development, universities and firms (Ankrah & Al-

Tabbaa, 2015), this process can be complex when it comes to regions where this type of knowledge has no demand, given the characteristics of the productive structure.

The commercialization of university patents can create important barriers, such as the low market potential that the patent can present, the absence of specific marketing to promote research and bureaucracy imposed by the university when negotiating with industry (Daniel & Alves, 2020). Another important aspect relates to the innovation generated within the university that cannot be measured equally in all areas of knowledge. In the area of Social Sciences and Humanities, for example, innovation is produced that is not always patentable, which can influence important technical decisions and thus contribute to the development of the region (Yeo, 2018).

The UF-C is a fundamental mechanism for the successful commercialization of technologies (Min et al., 2020). When this type of partnership takes place since the beginning of the process of creating marketable knowledge, barriers such as the difficulty of marketing are reduced (Daniel & Alves, 2020). The results of this type of cooperation, when aimed at the commercialization of the knowledge produced, may not be achieved as expected, in regions with low technological development, since in these regions this patentable knowledge is not sought.

Another variable that can be inserted in the context of UF-C analysis is the teaching activity. Despite being the typical function of universities, teaching is little explored in the cooperative context (Borah et al., 2021). However, this teaching activity can also be influenced by the cooperation strategy, with practical results for the development of specific skills of graduates, such as the development of technologies and related products for a practical context, of action, expanding the specific capacities of professional training (Borah et al., 2021).

One of the forms of exploitation of UF-C, in the field of education, is internships, since they allow students to enter companies, forming a link between these institutions (Galán-Muros & Davey, 2019). In the same way, the theses and dissertations with joint supervision can be another result of UF-C. These results can lead to the development of products and processes transformed into business and academic innovation (Asplund & Bengtsson, 2019). This is one way of transferring the knowledge produced in the university to firms and thereby strengthening the region's productive structure. In this way, the firm can benefit from innovative processes and products.

Teaching-based UF-C is an important link for a region (Borah et al., 2021). Hou et al. (2021) argued that in regions where universities have formal education programs for well-established

entrepreneurs, such as MBA, opportunities to form UF-C may be more frequent. Thus, the university can approach firms also through targeted education for entrepreneurs. University programmes directed towards supporting local entrepreneurs create a U-F connection (Sá et al., 2019). These specific programmes for the local situation involve the university in local problems, and firms, in turn, look to the nearby university for solutions to their problems, forming a relation network, through either formal or informal connections (Pugh et al., 2018).

Rampersad (2015) underlines the importance of that cooperation for students and firms. From the student perspective, the UF-C lets them form a network of professional relations and access applied technology used in the business environment but not available in university laboratories. On the other hand, as indicated by the author, the firm has access to the information available in the university and can subject the actions carried out in its area to academic scrutiny.

The results of the UF-C are reflections of the sociocultural context in which they occur (Sá et al., 2019). Thus, there are several ways of identifying the mechanisms that lead to regional development, based on the results of cooperation. Among these mechanisms, we mention the promotion of innovation and territorial entrepreneurship, innovative infrastructure and the intensity of research of universities (Budyldina, 2018). The joint development of research that can be transformed into processes and products within the company (Asplund & Bengtsson, 2019) and the qualification of the workforce and increased productivity (Lima et al., 2021) are other such mechanisms. These results expand to a region and may possibly modify it.

Shi et al. (2020) stress that the results of UF-C are not homogeneous and depend on the context in which the cooperation occurs. Associating those results with regional development is a challenge, essentially when classic economic data such as gross domestic product (GDP) are not used and from the point of view of innovation, patents and licensing. UF-C must be studied from various angles, since the influence of the institutional environment is an element that cannot be neglected in those analyses.

The UF-C analyses are based on the university as part of national and regional innovation systems, the multiple helixes, the entrepreneurial university, and other models. These interaction models have observable institutional characteristics (Leydesdorff, 2012) and are based on networking to establish themselves. In a society where knowledge is a fundamental resource for innovation, the university, as an organisation of knowledge, assumes a relevant role here in the context of innovation activities (Cinar & Benneworth, 2020).

The UF-C influences regional development in several ways: through the production and commercialization of knowledge; the implementation of new processes and products developed for a given business market; by the formation of human capital that will be used in the design of new businesses and in the development of existing businesses and, also, by the training of entrepreneurs already consolidated in the region.

Traditional innovation characteristics such as patents and licensing may not be sufficient to explain UF-C and regional development in areas of low technological intensity, such as the construction of institutional networks that strengthen entrepreneurship in a knowledge-based economy, the training of entrepreneurs with specific qualifications for regional needs and the development of technologies and solutions that serve small and medium-sized non-technology-intensive enterprises.

5 Model to Integrate U-F Cooperation with Regional Development

Setting out from the literature review, an integrative model of UF-C for regional development is proposed. UF-C connects to regional development through the cooperation channels used, the transfer of knowledge created in the university and the firm, the relations formed in the cooperation or the results for both parts.

The UF-C has been analyzed from elements such as patents, licensing, scientific and academic productivity, joint research and consultancies, among others (Perkmann et al., 2021). These elements bring advantages for both the university and the firm and can result in important advances for a region. However, part of the studies developed with these characteristics are carried out in contexts of more developed economies and with large companies (Thomas & Pugh, 2020). However, many of the regional economies are dynamized by micro-, small-, and medium-sized enterprises (Manzoor et al., 2019) and not always those elements applied to analyze UF-C with large companies will have satisfactory results when applied in this segment of small firms. Thus, the following analysis model of UF-C (Figure 3.2) is proposed.

This integration is shown in Figure 3.2.

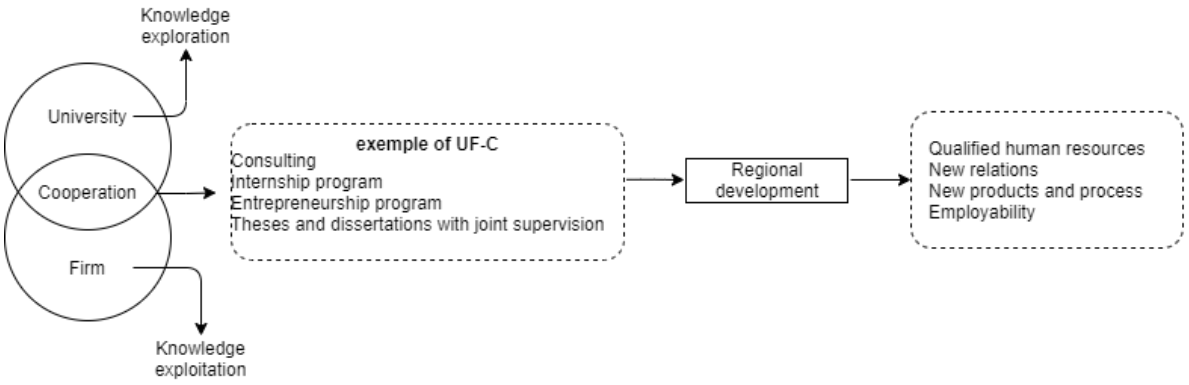

Figure 3.2. U-F integration in regional development
Source: Authors' elaboration.

This model shows that UF-C through its actions, when considered regionally, brings intrinsic results to both sides. These results, when seen as a whole, benefit all parts involved in the process, in a relationship that favours continued cooperation. The generation and spread of knowledge, inherent to the university, can also be seen from the point of view of the firm, which receives the knowledge and applies it. Similarly, that application of knowledge can produce new knowledge in the university. UF-C analysis following the model proposed here can capture the perceptions that individuals have of this context. An important perception in this context is that of micro and small entrepreneurs, whose enterprises significantly boost the regions (Manzoor et al., 2019). The model presented can also be empirically tested through surveys with micro, small and medium enterprise entrepreneurs.

This cooperation can result in increasing the regional innovation capacity. Garcia et al. (2019) highlight the intellectual, economic, and commercial benefits arising from this cooperation. Nevertheless, differentiating those benefits between what remains organisationally for the university or for the firm is found to be no easy task, as some of them are intangible (how to measure an insight for new research?). The region is modified by the results arising from this cooperation, through the commercialization of knowledge, network formation, qualified human resources and others. In addition, cooperation is shaped according to the university's area of research and the firm's area of operation (Schartinger et al., 2002).

This type of cooperation occurs in a complex institutional system, influenced by national regulations for higher education and policies to encourage research and development, financing agencies, regional entrepreneurship, the productive structure, and even local firms that need specific knowledge in terms of innovation and policy implementation. Knowing the

perception of the agents that make up this system is important for the implementation of specific policies to stimulate innovation and development.

6 Conclusions and Contributions

UF-C is an important link for regional development. The result of that cooperation can bring innovative elements to the region, for both firms and the university, through the exchange of knowledge and resources inherent to that process. Among the possible results are the commercialization of knowledge, qualified human resources, the creation of products and implementation of new processes, increased employability and new relationships involving both the university and firms.

The socio-economic context in which UF-C takes place can influence this type of cooperation established between the parts involved and the expected results. This cooperation, formed from teaching activities, student internships, training of entrepreneurs and consulting, can bring significant results to regions of low technological development. However, such cooperation relationships are still little explored in the university-firm context. Thus, a model that also privileges the perspective of micro, small and medium entrepreneurs can bring added value in relation to discussions about UF-C in contexts of less developed regions. Thus, the university goes beyond its traditional teaching and research functions and is part of the life of society improving the quality of life and social well-being.

On the other hand, these results may also influence the adoption of public policies of regional entrepreneurship and qualification of the workforce of a region. At the management level, understanding the results of UF-C can promote the formation of institutional development networks, contributing to increase the competitiveness of companies and increase interaction with the university and other institutions to foster regional development.

This study can contribute to the topic from the institutional aspect. The institutional environment can contribute to those relations, through higher education policies that encourage them and public policies to finance research, promoting the formation of these bonds, either due to firms' needs or those of the university in seeking cooperation to solve a problem.

The study also contributes to the literature on UF-C by showing regional development as a necessary result of that cooperation. More reflections on the subject are necessary since these results are presented from the university or firm perspective but pay little attention to the elements outside the environment in which cooperation occurs. This aspect is important as it

contributes to the discussion on the university's function in society, enhancing its image as a transforming institution.

The model proposed here contributes to analysis of UF-C by linking the regional specificities in which the cooperation can take place. This type of cooperation is sensitive to regional characteristics, the specificity of both firms and the universities located there. Elements commonly linked to this type of cooperation, such as joint patents and publications, may not be sufficient to understand how this cooperation occurs in all situations. Regions with a production structure of low technological intensity may require elements more connected to processes and emphasize their relational capacity to achieve success and extend the results to regional development.

Being based on theoretical suppositions, this study has limitations. As a literature review, the choice of texts to use reflects the authors' decisions and the objectives defined for the research. Therefore, it is possible that relevant documents have been omitted in favour of others. It is proposed that the model proposed here be empirically tested in regions with low economic development to assess its viability.

In this sense, there is potential here for future research lines related to the phases of UF-C (Plewa et al., 2013) and their potential results with less research-intensive universities. The interaction between the parts to the cooperation is fundamental to its success. Therefore, it is suggested that in the future, especially in developing regions, studies should be carried out that show how the partners are attracted to the university once they can have an explanatory potential for UF-C in those regions. It is also suggested that future studies explore the perception of entrepreneurs about the results of UF-C for a region and the barriers found in the formation of a partner of this nature.

Universities can adopt effective practices of knowledge transfer to a region, not only through their graduates, but also through specific and regular programs aimed at improving the regional productive structure, whether through applied research or university extension programs. Therefore, studies that address these aspects need future research. It is also suggested that universities encourage more research aligned with areas defined as priorities for the region in which they operate and thus foster innovation in their vicinity (Fonseca, 2019). In this way, cooperation between industry and the university is stimulated. In this context, the university can align itself with government priorities for regional development. Therefore, from the perspective of business, future research can verify the preferred ways in which these companies acquire knowledge and, as such, influence the establishment of UF-C.

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Chapter 4

The Engaged University and Regional Development: A Qualitative Case Study

Abstract: Cooperation between universities and enterprises in regions with low innovation intensity has received little attention from academics in recent years. This study aims to understand university-firm (U-F) cooperation in a higher education institution in a region of low technological intensity. To achieve this objective, a qualitative approach was used, and within this, the case study method. The case studied here is a university in Northeaster Brazil. Data were collected through semi-structured interviews with lecturers-researchers at the university and entrepreneurs-managers of small and medium-sized enterprises (SMEs). From descending hierarchical classification (DHC), carried out using IRAMUTEQ software, four categories/topics were identified: (1) selecting partners, (2) barriers, (3) the institutional environment, and (4) the effects of that cooperation on regional development. The results show that U-SME is still incipient. It is not possible for researchers to identify an institutional policy that would effect cooperation with this type of firm. However, researchers look for these small firms based on their geographical, technological, and institutional proximity. Firms, in turn, seek the university to cooperate, from the close social relations they already have with researchers and/or other actors linked to university who can help them form these partnerships. The barriers found by these actors are associated with the time taken and academic bureaucracy. The institutional environment that researchers and business-people belong to are relevant in both the formation of cooperative relations and the obstacles underlying this type of process. The perception of the results of cooperation for regional development emphasizes the qualification of human resources and retaining them in the region, as well as access to new knowledge. The actions developed by the university involving small companies in its surroundings allow also greater insertion of the university in the business environment.

Keywords: University-Firm Cooperation; Small and medium-sized enterprises; SMEs; HEIs.

1 Introduction

Higher education institutions (HEI) have been highlighted as contributing to regional economic development (Chatterton & Goddard, 2000). This situation reflects the university's cooperative capacity to produce regional knowledge and stimulate the connection between people and local institutions. That connection can stimulate competitiveness and development (Fonseca et al., 2020). It emerges from the university's so-called third mission, which implies the university's involvement with the local community, modifying the latter and contributing to its full development (Breznitz & Feldman, 2012).

One way to achieve that involvement is through university-firm (U-F) cooperation. Specifically, as it is a question of involvement with the local community, the interaction with small and medium-sized enterprises (SMEs) and micro-entrepreneurs is a priority. These small firms stimulate national and regional economies by generating employment and through the innovations they create and apply (Manzoor et al., 2019). Cooperation is a way for these SMEs to access knowledge resources and innovation that can stimulate their business (Liu, 2020). The university, in turn, by promoting knowledge and technology transfer, is important in stimulating growth and contributing to regional development (Mahfoudh et al., 2021). That role is activated by collaborative networks formed of firms, universities and governments (Etzkowitz & Klofsten, 2005). Here, U-F cooperation can be considered as a strategy to promote that development (Drucker & Goldstein, 2007).

U-F cooperation refers to the relations formed between HEIs and firms (Ankrah & Al-Tabbaa, 2015). Those relations have been presented from different aspects, linked especially to the economic value of academic knowledge (Perkmann et al., 2013; Pugh et al., 2016), applied in high-technology, research-intensive universities and large companies. However, approaches concentrating on economic aspects, such as commercializing knowledge, technology transfer, start-up and spin-off creation may not be sufficient to explain U-F cooperation in regions of low economic and technological development (Thomas & Pugh, 2020). Perkmann et al. (2021) emphasize that, in more developed economies, technology transfer and value creation associated with U-F cooperation is more common, while in less developed regions, training and consulting seem to be more present (Roncancio-Marin et al., 2022).

It is especially important to understand the university's role in regional development in peripheral areas, where universities tend to compensate for the institutional weaknesses of innovation systems (Fonseca et al., 2021). However, research on the U-F relation in regional development is centred on European and North American cases (Thomas & Pugh, 2020).

To fill that gap, this study explores U-F cooperation in a Brazilian HEI, from the perspective of two actors in that cooperation: university lecturers and entrepreneurs. The intention is to answer the following question: How does U-F cooperation occur in a region of low technological intensity? Technological intensity is a factor that implies a difference in the way of establishing U-F cooperation and in the perception of barriers to cooperation by enterprises (Parmentola et al., 2020). The technological intensity of a region can be defined by the industry installed there (OECD, 2011). For example, a region in which the installed industry is predominantly textil, pulp and paper, mining, food, etc. can be characterized as a region of low technological intensity (OECD, 2011).

Research on U-F cooperation in Brazil has been generated from established relationships with enterprises that represent high technological intensity, such as the pharmaceutical and biomedical industry and located in regions that concentrate a greater number of HEIs (Tatsch et al., 2022). In addition, Rajalo and Vadi (2021) emphasize that the literature on U-F cooperation has largely ignored the particularities of cooperation between low-tech SMEs and academic researchers, including in Brazil (e.g., Ribeiro et al., 2022; Silva et al., 2020), where SMEs represent 99% of the corporate fabric (IBGE, 2021).

Then, the study contributes to discussion on the topic, especially about how lecturers choose their partners to cooperate, and how these partners reach the university. It also identifies the barriers that can arise in this cooperation, and the perception the actors involved have of the result of the cooperation for regional development. In developing countries such as Brazil, the research carried out in universities has been a way to make up for the lack of business investment in R&D (Garcia et al., 2019), which makes U-F cooperation an important factor of regional development (Franco et al., 2017; Mosayebi et al., 2020) and interesting to explore in this context (Fischer, Schaeffer, et al., 2019), since the regional context is important in forming patterns of U-F cooperation (Parmentola et al., 2020).

2 Theoretical Background

2.1 University and regional development

Universities have adopted an important role as regional agents of change, creating solutions to social and economic problems in their surrounding environment (Thomas & Pugh, 2020). This conception is in line with the so-called engaged university. The engaged university is committed to direct interaction between the university and its surrounding entities through exchanging, exploiting and applying knowledge, experience, resources and information (Holland, 2001). That interaction is part of the university's commitment to regional

development, through extending the teaching and research mission (Etzkowitz et al., 2000), contributing to the university's political, civic, social role, and stimulating network formation (Trippl et al., 2015), resolution of regional problems, leadership and improvement of regional development through the strengthening of the regional economy and civil society (Goldstein et al., 2019).

The university's commitment to regional development involves cooperation with local institutions, through business consultancy, participation in community undertakings and developing inter-organisational networks (Kempton et al., 2021). One of the inter-organisational networks formed can be with SMEs. This firm segment is an important source of regional development, as it accounts for a great many of the jobs created in a region (Manzoor et al., 2019). Cooperation between these two types of organisations can have significant results for the region.

These results can be reported considering the innovation resulting from the cooperation, but also the social interaction between the parts (Kempton et al., 2021). This type of cooperation can create professional skills, improve entrepreneurship, and stimulate public and private investment in research and development (Mahfoudh et al., 2021), encouraging regional innovation and creating wealth for the region. However, Kempton (2015) highlights the difficulty in measuring impacts beyond those of publications and patents in areas that produce other impacts such as the Social and Human Sciences (Yeo, 2018). According to Mahfoudh et al. (2021) U-F cooperation is a relation where the results transcend the parts involved.

U-F cooperation in regions with low technological development is based on human resources training activities. Student internships and industry training are identified as relevant for strengthening this type of U-F cooperation (Ashraf et al., 2018; Nsanzumuhire et al., 2021). The students' internships are seen as an important source of knowledge exchange between the parts involved in the cooperation (Nsanzumuhire et al., 2021) and is often the first contact that enterprise has with the university to form this type of U-F cooperation (Guerrero, 2020). In addition to teaching activities, consulting activities are also an important tool for U-F cooperation in these regions (Roncancio-Marin et al., 2022). This interaction is favoured by proximity relations.

This proximity relations are classified by Boschma (2005) in five dimensions: cognitive proximity, where organisations share the same knowledge base, and learn together; organisational proximity, characterised by intra and inter-organisational relations, reducing uncertainty and opportunistic behaviour; social proximity, represented by social relations

between agents, with the trust already established between the parts facilitating the exchange of knowledge; institutional proximity, associated with institutions at a macro level, providing a stable environment for the exchange of knowledge; and finally, geographical proximity, referring simply to the physical distance between the institutions, which facilitates face-to-face contact between the parts (Chen & Xie, 2018).

Although U-F cooperation stimulates the formation of networks, some barriers can emerge in this type of cooperation. Some of them may be common to both parts, such as perceptions of the research focus and the time involved in spreading the results (Bekkers & Freitas, 2010), affecting the perception of both the firm and the university. Other barriers can be inherent to only one of the parts.

Barriers can be inherent to the institutional environment. The absence of partnerships and networks that bond researchers and firms, short-term contracts (firm turnover/friction), few firms in the region, access to capital, lack of academic compensation and spreading of the results are factors that can hinder U-F cooperation (Galán-Muros & Plewa, 2016). Also from this perspective, Muscio and Vallanti (2014) point out misalignment of objectives between researchers and possible business partners. That misalignment refers not only to the research activity but also to appropriation of the future benefits arising from the partnership.

Academic bureaucracy and the length of the cooperation are also indicated as barriers to U-F cooperation, especially in regions with low innovation intensity (Parmentola et al., 2020). The length of the cooperation was also understood as lowering barriers, as it can increase inter-organisational trust, which will facilitate entering into new cooperative processes (Muscio & Vallanti, 2014). Time is therefore a barrier but can also become an ally of successful U-F cooperation.

Some barriers encountered are related to the institutional environment of U-F cooperation. Among these barriers, one can point out: lack of public funding for research, low interest of companies in collaborating with HEIs, absence of business networks and universities with little structure and procedures related to interaction with private institutions (Nsanzumuhire et al., 2021). Therefore, U-F cooperation has an important role in regional development. Besides training a qualified workforce, it seeks integration with its surrounding region, interacting especially with the local production structure in seeking solutions that can stimulate the region's economy, culture and social well-being. However, that relation is not standardized. It depends on the region's conditions for its development.

If the U-F cooperation process was linear, with fixed, pre-defined stages, it could be represented by Figure 4.1.

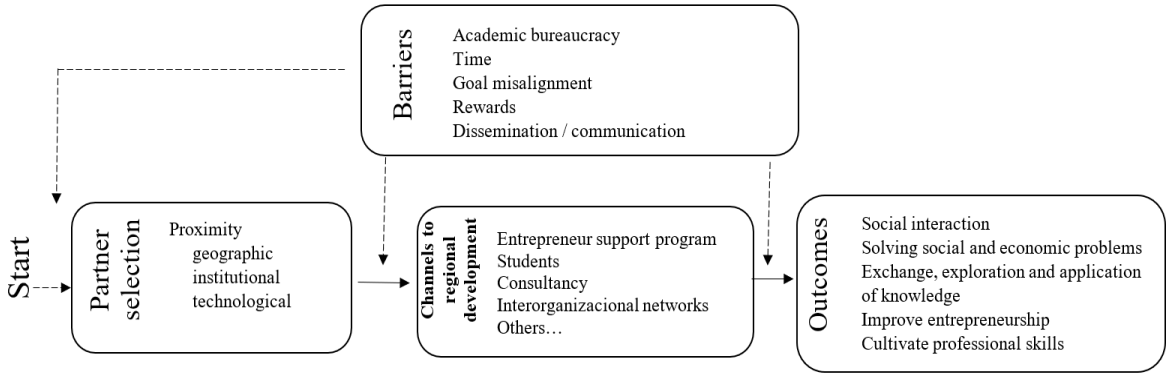

Figure 4.1. Stages of U-F cooperation

Source: Author's elaboration.

However, this process is seen to be dynamic, and some elements can occur in all stages of the process. For example, the barriers to cooperation can be found in all phases. One element that can lessen these barriers is a communication plan and specific programmes able to promote interaction between the university and the firm (Compagnucci & Spigarelli, 2020; Rybnicek & Königsgruber, 2019). These plans can be initiated by universities, and can be communicated to partners showing what the programmes offer to strengthen the partnership. The plans can also be initiated by intermediary institutions supporting firms' development, especially that of small firms. Finally, they can originate in governments, with stimuli for universities to carry out more actions including such businesses, with a view to promoting regional development.

Multiple interaction channels can promote U-F cooperation. For example, programmes to support entrepreneurs and students' work placement (Rampersad, 2015; Sá et al., 2019), which bring firms closer to the university. Similarly, students become an effective channel between the university and the market, as they connect to the labour market (Ashraf et al., 2018).

2.2 U-F cooperation in the brazilian context

In developing countries such as Brazil, it is mainly universities, and especially state ones, that are responsible for research. However, these institutions have had little involvement with the market (Fischer, Moraes, et al., 2019). In Brazil, state universities have an important role in carrying out scientific and technological research (Negri & Rauen, 2021), and in efforts to face social and economic challenges at the regional level (Thomas & Pugh, 2020).

In Brazil, U-F cooperation has grown in recent years, through policies for Science and Technology (S&T) and support for innovation (Negri & Rauen, 2021). However, this type of cooperation still presents a limited number of existing relations (Silva et al., 2020; Tatsch et al., 2022). The last national study on innovation in Brazil demonstrates that cooperation with the university is present in only around 6% of national industry, with a focus on chemical products (IBGE, 2020). Fischer, Schaeffer, et al. (2019) underline the dominance of low technological industries such as metallurgy and mining, in cooperative activities involving patents and U-F cooperation in general (IBGE, 2020).

Fischer, Schaeffer, et al. (2019) analysed U-F cooperation in Brazil from the perspective of technological innovation, measured through patents. One conclusion of their research is the concentration of patents in state universities in the South and South-East regions of the country. Of the ten universities registering most patents in the period studied by the authors, only one is situated elsewhere. This situation has changed over time, and in 2020, the ranking of universities registering most patents in Brazil is led by state institutions in the North-East (INPI, 2020). Tatsch et al. (2022) also emphasize the concentration of U-F cooperation relations in the same regions. They have greater economic development than the rest of the country, with the most scientifically productive state universities (Rapini et al., 2019), and are where the biggest national industries are based (IBGE, 2020).

This geographical concentration of U-F cooperation also has implications for partner selection. Tatsch et al. (2022) highlights geographical proximity as an element of such cooperation in Brazil. The authors found that the strongest relations between university and industry, in the context analysed, were with firms operating in the same geographical area as the university or research centre (Tatsch et al., 2022). This shows the importance of geographical proximity in establishing U-F cooperation. Colombo and Garcia (2021) conclude that the firms most likely to cooperate with a university or research group are those where there is already an underlying link between the firms' collaborators and the institution. This link is due to undergraduate teaching, emphasizing the role of social proximity in U-F cooperative relations. This type of proximity is relevant for SMEs in forming cooperation agreements with the university, as in establishing such partnerships, firms use existing contacts with university actors or other contacts connected to them (Østergaard & Drejer, 2022)

As for the barriers to U-F cooperation in Brazil, in the view of Fischer, Moraes, et al. (2019) these are influenced by a system of lecturer assessment that prioritizes scientific publications over technological production and market relations. There is still little awareness in national industry of interaction with the university, and a lack of incentives from the market for

investment in R&D. Corroborating these barriers, Tatsch et al. (2022) indicate that the cooperative relations established in Brazil are more directed towards scientific than technological development. Therefore, national industry's low innovative capacity is seen as one reason for industry's weak integration with the university. That is, there are barriers on both sides of U-F cooperation.

These obstacles can have consequences in the number of partners involved in U-F cooperation. Tatsch et al. (2022) study these barriers to relations through the network analysis methodology in the area of Health Sciences research. The authors indicate as a cause of this little interaction, in the context studied, the high specialization of research groups and the university's emphasis on scientific rather than technological development.

3 Methodology

3.1 Type of study and case selection

To achieve the objective proposed, this study adopted a qualitative approach, and within this, the case study method. The case studied here is a university in North-East Brazil.

The Brazilian higher education system is formed of public (financed by federal, state or local government) and private institutions (for-profit or philanthropic). This system includes universities, university centres, faculties and federal institutes. Universities, the type of higher education institution of interest in this study, are predominantly state-owned (INEP, 2022).

The university chosen is present in all regions of its state (Maranhão, North-East Brazil). Over the last 10 years, this university has undergone major expansion in terms of its physical structure, the number of students enrolled (on undergraduate and post-graduate courses) and the research carried out (INEP, 2022). This university had a 34% growth in the number of undergraduate courses and doubled the number of enrolments over a decade (2011-2020) (INEP, 2013, 2022). Concerning innovation, the university is in 22th position as regards the registering of patents and inventions. This corresponds to 0.44% of all invention patent applications that year - first place has a 1.82% share of total applications made (INPI, 2021). Nevertheless, the patent indicator may not be the most relevant in studying U-F cooperation, since it is not a frequent activity in regions with a predominance of industries characterised as low technological intensity or even with a predominance of SMEs (Marrocu et al., 2022)

This case is interesting as there has been little discussion about U-F cooperation in regions of low innovation intensity, such as the one studied here. The technological intensity of the region

studied here is based on the existing industry, concentrated on paper, mining and food-production (IBGE, 2021), which characterises it as a region of low technological intensity (OECD, 2011). Indeed, Parmentola (2020) highlights the importance of exploiting U-F relations in regions with low innovation intensity. Studies of that nature have been carried out in Brazil, but considering situations where U-F cooperation is more established (Brauner et al., 2020; Thomas & Pugh, 2020).

3.2 Characterisation of the participants

Selected for this study were the owner-managers of SMEs and researchers with experience of U-F cooperative relations. More precisely, the researchers who had contact with SMEs and the owner-managers of these firms had had more than one experience of this type of cooperation. At the time, the local universities did not have a public database with this information, and so subjects/participants were identified through the snowball technique (Moradi & Noori, 2020). One researcher was identified first, and through him others were contacted, the same procedure being adopted with the business-people. Therefore, the participants were selected intentionally as they represent an example of a phenomenon of interest (Patton, 2015), in this case U-F cooperation in less developed regions and with low technological intensity. The parts were also chosen due to having participated in U-F cooperation. The subjects are characterised in the following table:

Table 4.1. Characterization of interviewees

Code	Nº collaborators	Nº founders	Nº Cooperative relations	Age-group	Academic level
E1	4	1	4	25-30 years	Higher education
E2	3	2	3	>55 years	Ph.D.
E3	2	1	9	45-50 years	Higher education
E4	8	1	10	> 55 years	Secondary
I1	Not applicable	Not applicable	8	45-50 years	Ph.D.
I2	Not applicable	Not applicable	8	45-50 years	Ph.D.
I3	Not applicable	Not applicable	2	45-50 years	Ph.D.

E- SME entrepreneurs; I-Researchers linked to the university.

Source: Research data (2021).

Three researchers who carry out (or have carried out) university-firm cooperation were selected (the researchers are identified as I1, I2 and I3) and four entrepreneurs (E1, E2, E3 and E4). The researchers are aged between 40 and 50 and have been working at this university for an average of 10,33 years. Two have had previous experience of cooperation with other organisations, while for the third it is the first contact with U-F cooperation. This is important

as it modifies the view they have of the institutional environment. The researchers are from the area of Social and Technological Sciences. Concerning the type of cooperation established, the examples found are related to improving the qualifications of human resources, either by the university supplying that qualification or by exchanging knowledge with the firm, expanding the university's learning opportunities.

The entrepreneurs are between 25 and 60, and their firms belong to various areas: food and drink, educational technology, and services. Of the four SMEs studied, only one is less five years old and the entrepreneur did not complete a university course.

3.3 Data collection and treatment

Data were collected through semi-structured interviews with lecturers and researchers at the university/case selected and entrepreneurs who cooperate (or have cooperated) in some way with that university. This type of interview allows subjects to express their points of view more generally, compared to other more structured methods using a standardized interview or questionnaire (Flick, 2014).

The interviews were held electronically due to measures of social distancing, and recorded, with the interviewees' consent. Before each interview, participants were informed about the study's purpose and were ensured that their answers would be anonymous. They were encouraged to answer about their experiences of U-F cooperation, the barriers and incentives encountered, the institutional environment and the role of this type of cooperation for regional development (see interview script in Appendix 1). The interviews were held in May and June 2021. The interviews were recorded and transcribed integrally.

The data were analysed through descending hierarchical classification (DHC). This is defined as a grouping analysis of text segments, based on the lexical forms presented. The results of DHC indicate that the grouping of these similar lexical forms represents mutually close concepts (Reinert, 1987). One of the advantages of this method lies in the formation of classes/categories from the lexical proximity of the concepts, reducing bias in the researcher's interpretation (Illia et al., 2014). Class formation is through the chi-squared (χ^2) statistic, which reveals the associated strength between the lexical forms and the respective classes. The stability of classes is given by the percentage of terms extracted, from the main body of analysis. Illia et al. (2014) suggest that a measure from 70% of data extraction can represent stability of classes to continue with the analysis. This analysis was performed using Iramuteq v. 0.7 alpha 2 software (Ratinaud, 2020).

This resulted in four categories of analysis: partner selection; barriers; institutional environment of the cooperation; and the effects of cooperation on regional development. The terms characterising these categories/classes are represented in a word cloud (Figure 4.2). The terms selected presented a χ^2 above 3,84, and classified 99% of the text segments. The word cloud below represents the terms with greatest representation in each class.

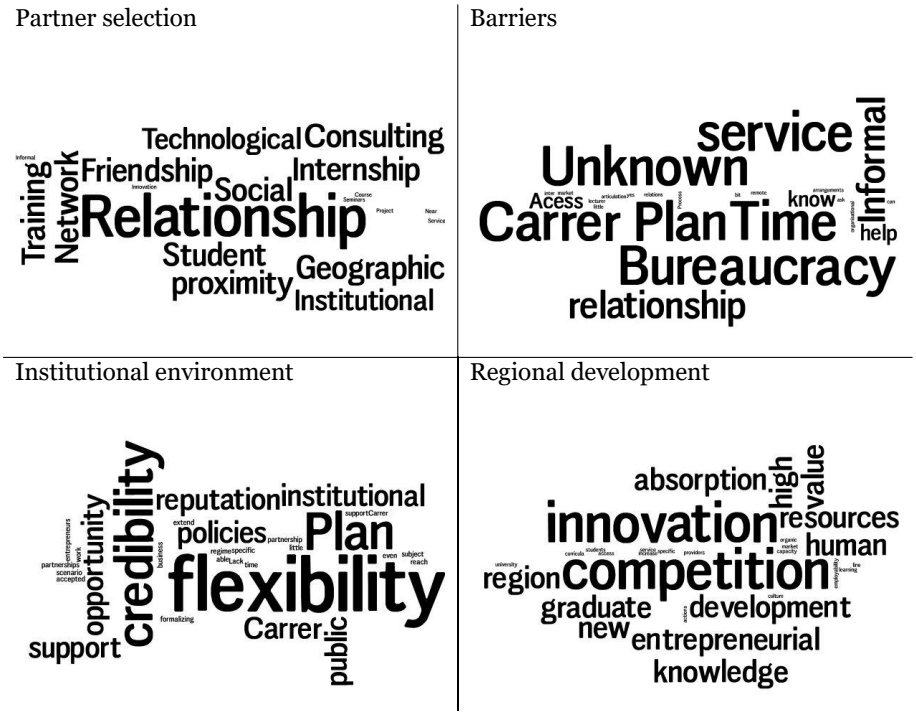

Figure 4.2. Categories of analysis and word cloud

4 Results and Discussion

"The engaged university" is a multi-faceted concept involving innovation and social entrepreneurship (Thomas & Pugh, 2020). This implies extending the university's role to include more active participation in the development process (Bellandi et al., 2020), with more effective involvement in local communities (Breznitz & Feldman, 2012). One way for that interaction to happen is through U-F cooperation, which follows various stages. Here, partner selection and the institutional environment in which this cooperation occurs are highlighted, in the context of an "engaged university". In this study, the categories/topics standing out in the cooperation process were (1) the way of selecting partners, (2) barriers, (3) the institutional environment of the cooperation, and (4) the effects of that cooperation on regional development.

4.1 Partner selection

Partner selection is a fundamental stage in U-F cooperation. It is reflected in this study by the university's involvement with its surrounding community. The criteria identified by the researchers as fundamental for partner selection are geographical proximity, technological proximity (Yu & Yuizono, 2021) and institutional proximity. The concept of proximity is widely used in inter-organisational studies (Knoben & Oerlemans, 2006) and these criteria agree with Park et al. (2015) and Balland (2012). The criteria for selecting partners adopted by the business-people differ from those indicated by the researchers. The entrepreneurs interviewed indicate personal relations formed with the university and contracting services as sources of partner selection to form cooperative relations with the university.

The results highlight geographical proximity in forming a cooperation project with micro-entrepreneurs near the university. Physical proximity between the university and the partners considered for cooperation made it easier for the entrepreneurs to accept U-F cooperation. I1 highlights the importance of that proximity: *"... nothing more important than experiencing the same situation as the cooperating partners, or being inside their situation [...] for that integration [...] from the point of view of sensitivity, but above all, from the point of view of the connection, trust*". Similarly, I2 shows the importance of that proximity, since sometimes micro-entrepreneurs are not aware that cooperation can be established. The relation of proximity was also mentioned as important for the researchers involved to understand the need to get inside that situation, *"[...] understanding what they need"* (I2). This type of proximity, although not determinant in establishing cooperation between universities and firms, seems to influence the flow of innovative resources between the cooperating parts (Chen & Xie, 2018).

Rybnicek and Königsgruber (2019) indicate geographical proximity as an ally of the cooperation's success. This type of proximity and has been considered an important factor in formalizing a partnership (Johnston & Huggins, 2016). It allows the university to be an agent of change promoting human interaction, transferring know-how, building trust and a common purpose among the various actors in a cooperation process (Harrison & Turok, 2017). That factor was shown in this study, and for one respondent it was predominant in establishing cooperation with micro-entrepreneurs. That proximity can also influence the type of relation established, either formal or informal. SMEs benefit most from this type of proximity, as it facilitates meetings between the parts, problem-solving (Messeni Petruzzelli & Murgia, 2021), knowledge transfer, the creation of social networks and face-to-face interaction, besides promoting trust and interaction (Johnston & Huggins, 2016).

Another type of proximity emerged from the interviews: technological proximity. This refers to the exchange of technological knowledge among the actors involved (Knoben & Oerlemans, 2006). The technological proximity refers to the technical similarity between the actors involved in the cooperation (Yu & Yuizono, 2021). This type of proximity can be used as a way to connect partners located in a large geographical area, allowing them to identify and absorb new knowledge (Chen & Xie, 2018). This is reflected in extending the flows of knowledge between organisations (Knoben & Oerlemans, 2006). This type of proximity is particularly beneficial for the result of cooperation, as it allows the parts involved to identify new knowledge, and does not necessarily depend on them being geographically close (Chen & Xie, 2018).

The cooperation established by I3, seeks to bring the university closer to firms able to absorb the specialized workforce trained in the university. One of the results indicated by the researcher, arising from that partnership, is the intention to take on students from the course that sought cooperation with the firm. The researcher states that firms' involvement in the university's educational projects encourages the "*exchange of knowledge and consolidation of a future entrepreneurial market in that area*" (*I3*). In this case, geographical distance was not a factor observed in the cooperation formed. The firm in question is located in another region of the country. As highlighted by Rybnicek and Königsgruber (2019), cooperations that involve research and development or technical advice do not necessarily depend on geographical proximity. The technological proximity between the university and the firm can be enough to identify and incorporate new knowledge among the parts (Chen & Xie, 2018).

Institutional proximity, in turn, is what I2 uses to recognise cooperation partners. This type of proximity is based on similarities in the region's institutional framework (Knoben & Oerlemans, 2006). The form of cooperation developed by this researcher (I2) includes other organisations as intermediaries of the elements belonging to the cooperation. The objective of the cooperation is to establish a training programme appropriate for those firms' development, in a regional context, getting away from "*... standardized training in different geographical contexts*" (I2). To do so, the researcher uses intermediary organisations to join the greatest possible number of micro-entrepreneurs in the cooperation process established. That aggregation considers entrepreneurs' similarities in forming a team of companies able to increase access to specialized knowledge and promote entrepreneurship in this inland area of the state. This results in an informal knowledge network for professionalization of the region.

From the entrepreneurs' perspective, the partnership with the university arises from the relations they have established with the university or for a specific purpose. Here formal and

informal relations in the cooperation are defined. Firms mention especially that they form partnerships by offering work placement to university students, and acquire consultants to solve occasional problems in the firm.

Regarding formal relations, one entrepreneur highlights their participation in an action to stimulate SME development, promoted by local government, which foresaw formalization of an agreement with the university to exchange knowledge, and this was duly carried out:"*we formalized an agreement regarding work placements [*with that] *we had three on work placement with grants* [financed by the promotion agency], *after that, we continued with the agreement, with others on work placement ... this time financed by the company*" (E1). Students' work placement in firms can be important in stimulating U-F cooperation, since students can form a network of important relationships for this type of cooperation (Alunurm et al., 2020; Guerrero, 2020). The cooperation established through work placements lets firms access the knowledge produced in the university and apply it directly according to their needs (Apa et al., 2020). U-F cooperation formalized through work-placements in the company is also mentioned by E2: "[...] *the work-placement is a less bureaucratic form of cooperation and quicker to arrange with the university [...] and we also form new relations with the university and with future workers*".

Another statement refers to the university being hired by the entrepreneur. One of them says: "*whenever I needed it, I contracted consultancy from the university. I asked for the university's help right from conception of the business project [...] and then, the university, strangely, offered to help me manage the company. They gave support"* (E3). This entrepreneur has experience of cooperating with the university, acquired through personal contacts made while studying there, and already knew the resources the university could develop together with the firm. Consultancy is one of the ways to meet the firm's possible requirements and so is an important form of knowledge transfer between parts (Siegel et al., 2003).

In the sphere of informal relations, there is the exchange of knowledge between the parts, through seminars where the entrepreneur goes to the university to recount their experience and at the same time their firm is used for fieldwork. Entrepreneur E4 says: "*... it's always like that, as I know some lecturers, I turn to them when I have some problem in the firm. I take them to the company to transform this into an interesting case for the classroom. There, they draw up solution strategies and hand me it back ready to use"*. This statement reflects informal cooperation and this type of cooperation can increase the stability and productivity of the business (Braga et al., 2016). E2 also highlights participation in seminars organised by

the university as a form of U-F cooperation: *"... it is important for the firm to learn at the university, exchange experiences, and seminars and short courses organised by the university go in this direction, that is, they bring firms to participate, and there we strengthen the bonds with the knowledge being produced there, and with the people too*." These statements demonstrate that the business-people interviewed here recognise this partnership as a source of knowledge for business.

So there is seen to be a difference in perspectives when establishing cooperation between researchers and entrepreneurs. While the former prioritize close relations to carry out U-F cooperation, the latter set out from their specific needs and personal relations to do so. Informality is important for relations based on proximity, as this favours face-to-face communication between the parts (Chen & Xie, 2018).

4.2 Barriers to cooperation

Some barriers to these cooperation relations were mentioned, the respondents indicating the following as barriers to U-F cooperation: time, micro-entrepreneurs' unawareness of the possibility of establishing cooperation partnerships with the university, and institutional characteristics. The institutional characteristics mentioned involve the specificity of the university lecturer career and the bureaucracy involved for these cooperative relations to take place.

The perception of time is a recognised barrier to cooperation, as highlighted by Bekkers and Freitas (2010). The researchers interviewed here stated that time was a barrier they faced in previous cooperations. One of them reports the "... *misalignment between the firm and the university, it's not at the same time*" (I3). That misalignment caused them to abandon an important cooperation in the past, and may discourage establishing new cooperations.

This perspective of time is corroborated by the entrepreneurs interviewed. One of them stresses: "... *sometimes, even with hired consultants, the results take some time to arrive. The lecturers are dedicated, but they have a lot of commitments; the students, who help the lecturers, also. The answer doesn't always arrive as quickly as we'd like, but I can't deny it, that answer is very efficient, with an excellent cost/benefit ratio, and so the result makes up for the wait (*E4*)."* The entrepreneur recognises the benefit of the cooperation, but the response time can discourage partnerships when the firm's needs are more urgent.

Another statement shows that the bureaucratic processes imposed by the university cause a gap between the firm's needs and what the university can produce: "*the market is changing all*

the time, ... and the university, sometimes there's this gap between what the market demands and what we manage to supply, due to time" (I2). Another respondent illustrates this barrier through the various stages a cooperation project must go through to be approved: "*... it took a long time to approve the project, when we did so, the firm's problem had already been solved*" (I3). Bureaucracy as a barrier to cooperation was something already shown by Siegel et al. (2003).

This bureaucratic process is also recognised by the entrepreneurs, who say it hinders the formalization of specific cooperation agreements: "*the electronic management system ... it's not the least bit intuitive or user-friendly...let's just say that the basic information is difficult to obtain... so you feel like giving up... the university should facilitate that relationship* [with the firm]*"* (E1). Another entrepreneur also mentions formalization of the cooperation as a major barrier: "*even the question of that formalization which, as you know, the firm is small, so we don't meet certain criteria suddenly that a large firm could*" (E2). These statements reveal the possible difficulty in establishing formal cooperation with the university.

Nevertheless, that bureaucratic barrier was also identified as stimulating informal cooperation. Informal cooperation is defined by Apa et al. (2020) as non-contractual interaction between stakeholders. One researcher mentions that due to facing a bureaucratic barrier in the past, which prevented cooperation from taking place, he started to look for firms informally, from a university-market approach "*... to professionalize the student who's still at university".* (I3). Informal cooperation is frequent when involving SMEs. The relation that begins informally can evolve into a formal relationship. Even so, the results emerging from cooperation depend on it having been established formally or informally (Apa et al., 2020). However, as pointed out by Benneworth and Fitjar (2019), that search for partners to cooperate with the university can depend on the individual who will become involved in the cooperation.

Micro-entrepreneurs' unawareness of the possibility of cooperating with the university is something that emerges from the interviews. One of them says: "*..they don't know how to get there* [the university]*, they don't even know if they could get access, at the same time, to the university [...] it can be a bit remote from the market with little articulation, inter-organisational relations that would help those arrangements*" (I2). The entrepreneurs highlight that if they had not had a previous relationship with the university (having studied there or knowing the lecturers), they would not have established cooperation, probably through not knowing about the possibility. This is seen in the following statements: "*... I'm sure that if I wasn't part of the university community I wouldn't have this idea to bring the student to learn with us* "(E1); another entrepreneur complements this: "*in its everyday life, the*

company doesn't go after the university to form an agreement; the university has to go to the firms, presenting its products" (E2). Another entrepreneur says: "*...I studied at that university, so I knew how to go about getting consultancy"* (E3); and also: "*... yes, if I didn't know a lecturer there, I wouldn't know how to ask them for help..."* (E4).

The lack of knowledge about the university's actions emerging in the statements can reflect a distance between the university and the firms in its surrounding area. This corroborates the study by Alpaydin and Fitjar (2020). These authors highlight the urgent need for the university to break down the barriers and let firms access its knowledge space, promoting the exploitation of knowledge and technology by these firms, in a fruitful exchange of actions.

These difficulties in knowing about channels of access to the university are found by Alunurm et al. (2020), who underline that small firms need to find appropriate channels for cooperation and recognise the benefits of that cooperation, which can be economic, social, technological and others (Jaouen & Gundolf, 2009). The results of this study show that both lecturers-researchers and entrepreneurs realize there is a barrier to accessing U-F cooperation, an entry barrier, which can prevent cooperation from taking place more frequently and with a greater number of entrepreneurs.

4.3 Institutional environment

Reputation and institutional support are fundamental aspects ensuring the seriousness of a cooperation project for all participants (Brauner et al., 2020). This is corroborated by one of the interviewees: "*reputation and institutional support were essential to join partners, including from other local higher education institutions, and to be accepted by entrepreneurs [...]. Also, the university's reputation in its surrounding area allowed the researchers to form cooperation with SMEs more easily*" (I1). Another statement reinforces the matter of reputation: "*this partnership gives us credibility when I participate in fairs and events, presenting my product. Not just because it's something really innovative, but the university takes us to events outside the business scenario, to academic events, and shows that academia can go alongside the firm"* (E1). Institutional reputation is one of the elements favouring cooperation (Franco & Haase, 2020). The university is recognised in its region, and that recognition gives entrepreneurs confidence to accept cooperation with it as part of their businesses' development. Trust and reputation are important characteristics for inter-organisational cooperation (Franco & Haase, 2015a).

The result can be a reflection of the institutional structure available for entrepreneurs and researchers. That structure favours U-F cooperation through elements able to encourage

cooperation (Ramos-Vielba & Fernández-Esquinas, 2012), a factor indicated by the researchers. Once the cooperation programme is established, the university provides resources to allow the development of this type of inter-organisational relationship, such as reducing the teaching timetable of the lecturers involved in order to reconcile teaching and cooperation activities. This reflects the direct benefits mentioned by the researchers: "*so within my work timetable, I have hours devoted to developing this inititative. To some extent, that is a big incentive for carrying out this action"* (I1). Nevertheless, that benefit can be limited by the lecturers' work regime. The career of lecturers in federal public universities can also be a barrier to establishing U-F cooperation. One of the interviewees says "*... if we had a little more flexibility at the time of formalizing some partnerships, or even in the work regime we are subject to, perhaps we would be able to extend our reach a bit."*(I3)

Another aspect of the institutional environment mentioned concerns the overlapping of actions, which involves not only the university's internal environment but also other institutions competing in the same area. Through that competition of actions within the same territory, if coordinated in a strong inter-organisational environment "*...within the municipal, state or federal domain, we could create even more solid cooperation, stronger in institutional terms, producing increasingly solid results, above all for those that are the target public of those actions."*(I1). This reflects an environment of "*... extremely low inter-institutional cooperation"*, as pointed out by another interviewee (I2). However, that can be remedied through intermediary institutions such as university support agencies and associations, which can create an environment favourable to U-F cooperation (Franco & Haase, 2015b)

The researchers also highlight the absence of an institutional policy in favour of cooperation with SMEs. This perception is reflected in the words of one interviewee: "*more coordinated actions are needed [...] there's an overlapping of projects with the same public, in the same area*" (I1). Another researchers says: "*it's the research that tries to come closer to the firm*" (I3). The absence of an institutional policy is a barrier to U-F cooperation, and mistrust can arise among entrepreneurs when they receive similar proposals for cooperation coming from the same institution. "*Entrepreneurs are overloaded with multiple actions*" (I2). Effective, formal, U-F cooperation has the potential to coordinate specific programme and thereby avoid the overlapping of programmes (Mahfoudh et al., 2021).

From the entrepreneurs' point of view, the institutional environment is somewhat hostile. They say that they established, even if informally, partnerships with the university, through their personal contacts. One entrepreneur states: "*I think the universities need to have closer*

relations with entrepreneurs, especially micro-entrepreneurs" (E1). Another underlines the importance of formalizing these relations: "*... it really needs that formalizing of the agreement, because in fact people are entering the company, and as I said, it's a big responsibility, so companies may be reluctant to formalize the cooperation. This needs to change, and principally by the university* (E2).

Another entrepreneur states: "*firms don't know they can ask the university for help, at a low cost for firms' problems, especially at the beginning of the undertaking"* (E3). Similarly: "*even knowing people at the university, I don't know the full potential I could have from it, as I don't know many people; I know more from my own needs and I go there, knock on their door; if there was a more formal support programme, we could have more holistic knowledge of those processes, and more business-people would have access to the knowledge that I benefit so much from"* (E4).

These statements show there is a potential for knowledge to be exploited in a more active relationship between the university and firms, especially small firms. The university structure encourages lecturers to devote themselves exclusively to academic activities, hindering cooperation activities with firms. From another aspect, the absence of coordinated programmes for U-F cooperation, especially with SMEs, can lead to wasted actions and the results of others having less reach.

4.4 Regional development

U-F cooperation is perceived by respondents as a way to stimulate regional development. The main aim of the cooperation they establish is to encourage entrepreneurial actions able to closer to firms that can absorb qualified human resources from the university. These actions stimulate regional development, as they encourage the creation and transfer of knowledge and formation of a knowledge infrastructure in the region, either by creating new businesses or by innovating in established ones (Drucker & Goldstein, 2007). Rantala and Ukko (2019) emphasize that the teaching, research, innovation projects and development resulting from U-F cooperation are instruments that help in the process of regional development.

Bringing courses closer to the labour market is one reason for cooperation, as highlighted by one interviewee: "*...the idea is that human resources, having completed a course here, and enhanced their training through this project, can act directly as service providers in the region"* (I3). Training qualified people is something highlighted in order to strengthen regional development (Chatterton & Goddard, 2000), in this case, specialized technological training, with very specific requirements for professional activity. This perspective of the cooperative

relation aims for students to be absorbed by the firm and setting up of a unit in the region. This reflects the importance of U-F cooperation in stimulating the region's production structure.

Taking on graduates in the region contributes to increasing the level of education and employability of high-level staff in companies. This result is intrinsic to the university's primary mission. In this context, U-F cooperation can affect students' employability, in the form of work placements or in updating university curricula in line with the market, allowing a strong model of human resource development for the region (Ashraf et al., 2018). That teaching-employability relation promoted by U-F cooperation can form a relationship network, through formal or informal connections (Pugh et al., 2018). One interviewee states: "*... I'd like to take on all the students who had work placements with me, but I can't. Nevertheless, I'm pleased to know I contributed to this learning. Later, I'll meet these students as suppliers, competitors or even as customers."* (E2).

In addition, there is interaction with the SME for the entrepreneur training programme, aiming to develop their companies. This aspect of cooperation is what one entrepreneur defined as "*organic development* [that is]*, not just in the economic sphere, but also in the social, cultural sphere ..., contributing to the entrepreneur developing their knowledge, changing their situation, through an entrepreneurial culture in small businesses"* (I1). In another statement: "*if more companies had access to that knowledge, management would be more professional and undertakings would have fewer 'deaths', that is, they would last longer; The sector would be more profitable and even competition would be more interesting*"(E3). This statement strengthens the conception of the university's role in the region's economic development (Breznitz & Feldman, 2012), and underlines the university's role in reinforcing local entrepreneurship (Ierapetritis, 2019).

Another interviewee speaks of the importance of cooperation for his firm: "*After I started asking the university for help, my problems in the firm got smaller and I managed to innovate my processes, I gained space in relation to the competition by optimizing my operational routines" (E4)*. Another highlights the opportunity to develop something innovative "*... it gives the opportunity for people to think, create and produce, as this will have an impact on regional development*"(E1). These statements demonstrate that the partnership established with the university, if extended to other firms in the region, can effectively modify the regional production structure, improving it.

In modifying the situation from what can be implemented in managing the "*... business, in how the customer has a perception of value*"(I1), universities are sources of knowlege for SME

innovation and sustainability (Jones & Zubielqui, 2017). That knowledge is generally accessed through relations formed with the university, but not necessarily though formal channels such as research contracts. One way to consolidate these informal relations is through specific teaching programmes directed to entrepreneurs. Pugh et al. (2018) argue that the effect of the entrepreneurial education provided by the university promotes firms' growth and development, the region's attractiveness and creation and development of the entrepreneurial spirit.

4.5 Summary of the results

The empirical evidence reveals that the university does not yet have a specific programme involving SMEs in their cooperation routine. However, the results highlight initial experiences able to establish a cooperation programme that can include this type of company. Programmes of this nature have already been developed in Brazilian universities (Brauner et al., 2020) and can become a more powerful catalyst for greater university involvement in the region.

The absence of specific programmes for U-SME cooperation may be a consequence of the barriers indicated in the evidence found: academic bureaucracy, misalignment between the time taken by the university and the time needed by firms to establish cooperation. Being unaware of the possibility of forming cooperation with the university is also an obstacle mentioned by entrepreneurs, and which should be remedied.

Even so, the actions carried out in the university do reach firms to some extent: either through informal partnerships or work placements. Knowledge is exchanged between the parts and the results contribute to regional development, in the form of qualified human resources and more professional SME management. Actions should be implemented to strengthen regional entrepreneurship and professionalize SME management through formal education; implementing knowledge developed in the classroom and allowing firms that seek U-F cooperation to access specific knowledge for their businesses. These actions bring the university closer to local issues, forming a network with formal and/or informal connections (Pugh et al., 2018).

The researchers in this study seek their partners in U-F cooperation through proximity, which can be geographical, technological or institutional. The literature suggests that firms are more likely to interact with universities if they are in the same geographical area (Yu & Yuizono, 2021). On the other hand, when considering partnerships for cooperation in research and development, geographical proximity is less relevant (Park et al., 2015). Institutional proximity reflects interactions of exploitation and knowledge, support for human capital development in

firms and removal of barriers to U-F cooperation. Opening up universities to involvement with firms, interactions to improve the competences of firms' human capital and consultancy provided to firms by universities are elements allowed by institutional proximity (Alpaydın & Fitjar, 2020). Entrepreneurs set out from informal relations to establish partnerships (Apa et al., 2020), since SMEs can give more emphasis to informal cooperation (Johnston, 2021). Only one entrepreneur mentioned a specific project to stimulate innovation, foreseeing cooperation with the university as a requirement, the others forming cooperation from previous relations with the university. It stands out that the types of U-F cooperation established are characterised by what Alpaydın and Fitjar (2020) call "competence enhancement interactions" and "advice-seeking interactions", i.e., activities giving priority to teaching (at the university and firm level) and consultancy. This result relates to the conclusion of Silva et al. (2020), who indicate the lack of qualified personnel as one of the obstacles to innovation in SMEs, and the relevance of seeking to fill this knowledge gap at the university.

The barriers to U-F cooperation affect development of the cooperation. The results obtained reveal a barrier of misalignment of time between the company's needs and the university's response, academic bureaucracy and entrepreneurs' lack of knowledge about the possibilities of cooperating with the university. These results had already been recognised as barriers to U-F cooperation (Bekkers & Freitas, 2010; Siegel et al., 2003). The results suggest that such barriers can be lessened through informal cooperation between the parts. That informal approach may lead to formal cooperation in the future (Apa et al., 2020). The barriers found may be influenced by the institutional environment in which the U-F cooperation is established. These barriers may be more evident, because the cooperative activities mentioned can set out from the firm's needs rather than a formal programme by the university (Goel et al., 2017) or other institutions including these firms and universities in a common project.

The institutional environment was indicated as both hindering and facilitating U-F cooperation. As a barrier, besides the points mentioned above, the lack of coordination of U-F cooperation actions was an institutional element mentioned. This means overlapping of actions and reflects the absence of an institutional policy on cooperation with SMEs. Another factor indicated as hindering U-F cooperation is lecturers' career structure. In the specific case analysed, cooperation activity should be closely linked to academic activity. The career structure defines that lecturers in federal state universities should concentrate exclusively on academic activities in the university. In this context, the institutional environment is seen to be favourable, when indicating the university's support for researchers' cooperation activities and the trust this conveys through its reputation in the region, allowing greater researcher involvement in the surrounding social situation (Ramos-Vielba & Fernández-Esquinas, 2012).

However, this institutional environment becomes a barrier to cooperation when researchers are assessed according to scientific production and neglecting cooperation with the market (Fischer, Moraes, et al., 2019).

Universities need to be accessible to firms for interactions of knowledge exploitation to occur, removing the barriers separating them from firms (Alpaydın & Fitjar, 2020). Concerning the removal of barriers, Balland (2012) argues that this type of proximity increases the exchange of information between the actors involved in the U-F cooperation, allowing interactive learning to achieve professional returns (Chen & Xie, 2018).

The results arising from U-F cooperation can favour regional development. Specifically, U-F cooperation was found to bring students closer to the labour market and develop entrepreneurship, either by absorbing new graduates or by improving the knowledge base of entrepreneurs for management and innovation in their businesses. However, understanding of these results may be contextual. Roncancio-Marin et al. (2022) argue that in developed countries, the climate seems to be more conducive to U-F cooperation, since this is stimulated by specific policies, institutional norms and socio-economic conditions. On the other hand, in developing countries, this institutional context is still at an early stage.

Figure 4.3 summarises these results.

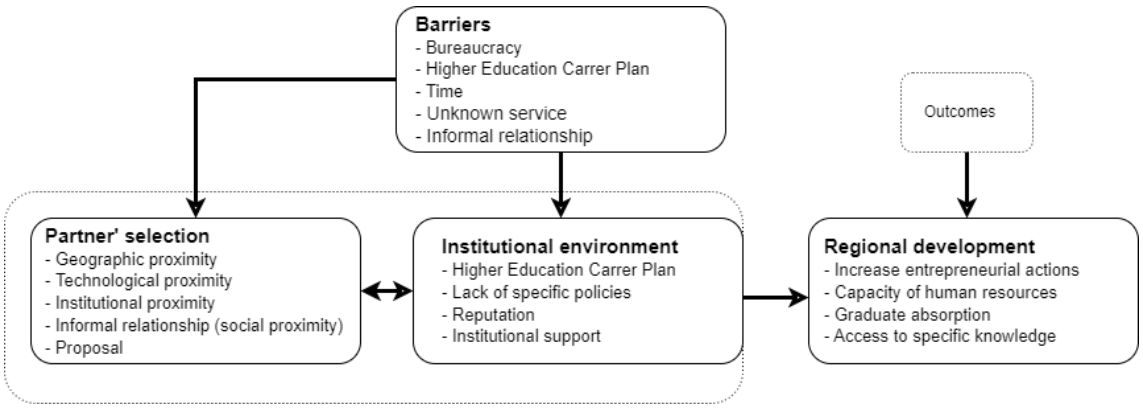

Figure 4.3. Summary of the results

Summarising, the perceptions of researchers and entrepreneurs do not diverge greatly. Particularly, time and bureaucracy are felt as barriers by both parts. Another element emerging is informal relations. At the beginning, informal relations are indicated by entrepreneurs as a way for them to access the university. However, they recognise this can

be a barrier to access, as not all entrepreneurs have a network allowing that relationship. The institution's reputation is also a factor considered by both parts. Standing out is the researchers' perception of an element of the institutional environment: higher education lecturers' career plan. This is recognised as a facilitator, but also as a barrier to formalizing cooperation. Among the aspects indicated as contributing to regional development, there is no discrepancy in the interviewees' opinions. The institutional environment is considered more relevant by researchers than by entrepreneurs.

Generally speaking, the firm should turn more to the university and the university should come closer to the entrepreneur, not only by training human resources but also by providing consultancy, services and knowledge transfer. Simplifying and clarifying processes in the university, in forming U-F cooperation, also deserves mention. Academic research is important to generate new knowledge, but that knowledge needs to be activated in daily practice, reaching companies.

In general, SMEs benefit from the results of U-F cooperation, since they depend on knowledge resources due to their limited human and financial resources, and even have difficulty managing this type of process. Limited human resources does not necessarily refer to their qualifications but to the number of people available in the firm. Large firms, on the contrary, have more resources to carry out research and development independently (Bellini et al., 2019), with cooperation with the university being just one more partnership option.

5 Conclusions and Implications

The elements of U-F cooperation, especially tangible ones, are more closely associated with institutions that carry out more intensive research (Abreu et al., 2016). However, these externalities can also be found in universities that do not have fully developed research (Bonaccorsi et al., 2014). This study aimed to explore how U-F cooperation is formed in a university which is not yet technologically intensive situated in a region of low technological intensity.

The question guiding this study was how U-F cooperation occurs in a region of low technological intensity. The aim was to find out how partners are chosen to cooperate, on both the university researcher and SME side. One factor identified is how researchers seek out firms to form partnerships. Researchers consider the dimensions of proximity in establishing their

cooperative relations: geographical, technological, and institutional proximity. These forms of proximity were fundamental in carrying out U-SME cooperation, whether formal or informal. In turn, entrepreneurs use their network of personal relations to approach the university and establish cooperation.

The cooperation formed in the university studied is directed towards teaching: to professionalize small entrepreneurs who do not have the necessary resources and knowledge to manage their businesses; and the exchange of knowledge between students and firms, in forming a promising labour market for highly specialized human resources in the region; and from the firm perspective, they offer students work placements and seek solutions to their problems, through the entrepreneur's personal contacts.

The results indicate entrepreneurs' unawareness of the possibility of this type of cooperation, which may imply the university is not yet sufficiently open to cooperation with small firms. Less research-intensive universities, i.e., more focused on teaching-learning activities, can play an important role in promoting regional development, since they can encourage the formation of networks able to stimulate innovation through knowledge transfer (Abreu et al., 2016).

Universities with a good reputation in their communities can expand the possibilities of forming U-F cooperation. The researchers interviewed are connected to a university whose reputation is recognised by business-people in the region, and they highlight this as a factor facilitating the formation of U-F cooperation. Academic managers can use that institutional quality to reinforce their bonds with small firms in their area, modifying the situation of these businesses. This could give the university a greater social role in strengthening the local entrepreneurial system.

Overall, this study contributes to the literature by demonstrating the initial steps to U-F cooperation in a region with a relatively low rate of development. There is a long way to go to modify that situation, and so specific policies should be drawn up in the institution to encourage scholars to participate in this type of cooperation (Benneworth & Fitjar, 2019). The study shows, especially, that both business-people and researchers use relations of proximity to undertake U-F cooperation. Nevertheless, this situation can limit new partnerships, especially for those that use personal relationships to begin a cooperative relationship.

Universities can be more active in cooperation with SMEs. This firm type is predominant in production and economic systems. These teaching institutions are a major player in the regional economic system and a strong ally in exploiting the knowledge produced, through consultancy, absorption of qualified human resources or other forms of knowledge exchange.

Adopting specific programmes bringing these firms closer to the university can bring multiple benefits for all involved, which can be extended to the local community. Johnston (2021) underlines that universities can become more receptive to social demands and implement activities that stimulate entrepreneurship. It is also important that the university promotes, recognises and values cooperation with SMEs.

Government is a source of finance for universities, especially public ones, and can encourage policies in favour of SMEs. One form of incentive is through specific actions to stimulate SME development. In this type of cooperation, government support can make SMEs' access to universities, especially public ones, more democratic, and thereby encourage more firms to form this type of cooperation. The role played by government can lead to lasting relations between firms and universities and promote a favourable environment for the development of innovations (Bellini et al., 2019).

As for SMEs, these firms must be aware of the ways to access university resources, besides personal relations. These can be traditionally recognised paths, such as consultancy and using the firm for students' workplacement, but also formal education programmes for entrepreneurs promoted by universities, among other possibilities. In general, investment in research and development is more limited in this type of firm (Messeni Petruzzelli & Murgia, 2021), and so it is important for them to access university resources. Indeed, U-F cooperation is one way for a firm to innovate.

Overall, this study contributes to the literature on this area of knowledge, discussing how U-SME cooperation can be established when there is no formal cooperation process. In this case, cooperation is seen to be formed from particular, isolated initiatives, on both sides, which emphasizes the barriers faced in establishing cooperation. The obstacles found here seem to be intrinsic to the institutional environment, such as researchers' career path, university bureaucracy and SMEs' lack of knowledge about the possibilities of this type of U-SME cooperation. Staff shortages contribute to this situation.

This study has some limitations. One of the most significant lies in being restricted to just one university, and so the results cannot be generalized, and cooperation only with small and medium-sized enterprises. The number of interviewees is also a limitation. The same applies to the research method adopted, whose results cannot be extended to the region but characterise the case studied. A suggestion is therefore to extend the universe of research to all public and private universities in the region studied, to give a broader understanding of the results, extending the scope to all sizes of firms. A quantitative approach is also suggested,

especially with entrepreneurs, to find out more about their needs and motivations for cooperating with the university or not, as well as the barriers and success factors in the relations of cooperation established. Knowledge of these elements in regions of low technological intensity can contribute to greater university involvement in the region, going beyond the knowledge produced internally.

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Appendix 1: Interview script

☐ Researcher ☐ Entrepreneur

1- How did the cooperation begin? (from a specific programme, through knowing the people involved, some company owner etc.).

2- Is it your first experience of University-Firm cooperation?

3- What criteria are used for partner selection? (possibly the area of activity, geographical proximity, a positive previous relationship etc.)

4- What type of cooperation was established? (joint research, consultancy, research contract, training, etc.). How did this relation develop?

5- Was this relationship formal, setting out from a pre-established programme? Or did it begin through informal relations?

6- What benefits can be indicated from this partnership (at the individual, organisational, etc. level)? Did the partnership contribute to solving a specific problem in the firm?

7- Was there any difficulty in establishing the partnership (bureaucratic, legal, etc)?

8- Did this cooperation result in any new product or process for the firm? And for the university?

9- How have the knowledge / skills acquired from this cooperation been used in developing work activities (teaching, research, etc)?

10- Was there institutional support to develop this cooperation (financing, study grant etc.) or only approval of the project in terms of compliance with internal regulations?

11- How does this cooperation contribute to regional / sector development?

Chapter 5

University-firm cooperation: How do Small and Medium-Sized Enterprises become Involved with the University?

Abstract: University-firm cooperation consists of the interaction between these two types of organisations to pursue a previously defined, common objective. This type of cooperation has been explored from the perspective of academics but the perception of small and medium-sized enterprises regarding cooperative relations with universities is still little explored. Therefore, this study explores the relationship formed between a university and SMEs located in a region in Brazil characterised by low socio-economic development. To do so, a quantitative approach was adopted, using a sample of 336 SMEs that had undertaken some cooperation with universities in the last five years. From SEM technique, results show that interpersonal relations interfere in the type of cooperation formed, these being a catalyst in formalizing the cooperation. These relations also interfere in the perception of barriers and benefits of cooperation for the firm. However, the results are clearer in the firm domain and less so in the region, implying that U-SME cooperation does not yet present clearly disseminated benefits so that firms can be more aware of the results. The barriers to cooperation seem to be overcome by interpersonal relations, but also by the contracts established, since they were more evident in the informal type of cooperation.

Keywords: University-Firm Cooperation; Interpersonal Relations; Types of cooperation; Small and medium-sized enterprises, SME.

1 Introduction

University-firm (U-F) cooperation has been widely studied. However, the growing interest in this type of cooperation has focused more on regions with high technological development (Nsanzumuhire & Groot, 2020) and large companies with more intensive research and development (R&D) (Parmentola et al., 2020). This suggests a gap in need of empirical research regarding the practices and challenges of U-F cooperation in the special case of small and medium-sized enterprises (SME) situated in less developed regions (Vega-Jurado et al., 2020). Universities' cooperation with SMEs (U-SME) is particularly interesting, as this firm

segment has heterogenous characteristics, making it difficult to present generic solutions (Ranga et al., 2008). In addition, SMEs have fewer financial and human resources to engage in cooperation with universities and assume risks (Lin & Yang, 2020).

In these regions, U-F cooperation has been explored through teaching activities (Borah et al., 2021), work placements (Galán-Muros & Davey, 2019) research carried out in firms by master and Ph.D. students (Asplund & Bengtsson, 2019), training, consultancy and product testing (Roncancio-Marin et al., 2022), among others. This study focuses on analyzing the relation formed between a university and SMEs located in a less developed region of Brazil. There is some evidence that in regions with low R&D, universities tend to cover deficits in technological infrastructure and the region benefits more from the presence of this type of higher education institution (Garcia-Alvarez-Coque et al., 2019). U-F cooperation can benefit SMEs, as universities can be an instrument with which these firms can face up to their limitations and uncertainties (Bellini et al., 2019).

Here, Figueiredo and Ferreira (2021) emphasize the need for quantitative research discussing the motivations for, and barriers to U-F cooperation in developing countries such as Brazil. Consequently, the dimensions (e.g., motivations, benefits, barriers and regional development) proposed here have been explored in the scope of U-F relations, but more so from the university perspective and have not yet been explained sufficiently in all types of companies (Garcia-Perez-de-Lema et al., 2017; Parmentola et al., 2020). In addition, interpersonal bonds have been studied in different contexts, such as Korean (Hemmert, 2019) and Argentinian firms (Arza & Carattoli, 2016), but are not yet explored in Brazil, nor regarding U-SME cooperation. One of the reasons for addressing the theme, in the Brazilian context, is the importance of geographical proximity (Tatsch et al., 2022) and social proximity (Colombo & Garcia, 2021) between universities and companies as facilitating elements for U-F cooperation to be established.

To fill these gaps, this study aims to investigate how SMEs perceive the benefits and obstacles of U-F cooperation, for themselves, and for regional development, setting out from the personal relations the parts have formed. In this way, it provides more empirical evidence about these relations in a context of low socio-economic development, a topic which is still under-explored in the field of U-F cooperation. In general, universities relate differently to their environment, following characteristics that are particular to the university and the environment (Garcia-Alvarez-Coque et al., 2019). Here, SMEs are fundamental for a region's development and it is important that they should reach relevant levels of competitiveness and innovation.

The article is structured as follows: following this introduction, a literature review leads to defining the research hypotheses and structural model, and the methods used to identify, gather and analyse the data obtained. Then the results are presented and discussed, followed by the conclusions arising from them. It ends with the implications and suggestions for future research in this area.

2 University-Firm Cooperation

U-F cooperation is a type of inter-organisational relation in which various organisations join forces to share knowledge and resources with a common purpose (Steinmo & Rasmussen, 2018). These relations can be influenced by the organisations' institutional characteristics and can use various channels to achieve the aims of the cooperation (D'Este & Patel, 2007). Here, social relations and trust can facilitate this type of cooperation (Alunurm et al., 2020). In general, the motivations, benefits and barriers have guided studies on U-F cooperation, but how these aspects can influence the firm's perception of the effects of that cooperation, for regional development, has been little studied.

2.1 Personal relations, motivations and benefits in U-F cooperation

U-F cooperation can be influenced by the type of relations formed between the parts involved, and these can be formal or informal (Perkmann & Walsh, 2007). Formal relations are marked by contracts and formal exploitation of knowledge, whereas informal relations focus on non-contractual relations, where mutual trust and social bonds between the parts are important conditions to form this type of cooperation (Apa et al., 2020).

Social relations, especially informal ones, are considered important for interaction between individuals, and for the results of business activities (Hemmert, 2019). In SMEs, those interpersonal relations are important in letting firms face up to globalization and competition (Lin & Lin, 2016) and acquiring new knowledge (Hemmert, 2019). Arza and Carattoli (2016) explore personal relations in U-F interactions, underlining the strength of the personal relation as driving interaction between the parts. In the same connection, Steinmo and Rasmussen (2018) say that individual relations can be important to establish cooperation with universities, and in the SME context, informal relations usually precede formal ones (Apa et al., 2020). This gives rise to the first research hypothesis:

H1: Personal relations have a positive influence on the type of U-SME cooperation (formal and informal).

The cooperation strategy can be perceived by SMEs from their motivation to cooperate with universities. Rajalo and Vadi (2021) highlight that motivations have an important role in the U-F cooperation process, and the motives can explain its perceived success. Based on this type of cooperation, SMEs can access new opportunities and business models to strengthen their resources (Gordon, 2013; Lam et al., 2013), develop new products and technology (Motohashi, 2005), and expand their business through new relations created from cooperation (Gordon et al., 2012), at a relatively low cost (Meldrum & de Berranger, 1999).

Cooperation with universities is particularly important for SMEs, as through this type of relation, they can access strategic, high-investment resources in workforce and/or capital that can generate sustainable value for the company in the long term (Partanen et al., 2018). When cooperating with universities, SMEs try to compensate for their technical shortcomings, their low investment in research activities and speed up their innovation process (Buganza et al., 2014), and thereby obtain strategic resources requiring major investment in human and/or capital resources (Partanen et al., 2018).

SMEs can be motivated to cooperate with universities for financial, technological and network reasons. Financial motives refer to financial support to develop or improve technology or product lines; technological motives imply keeping the firm as a leader, developing competences in a specific field of interest to the business and acquiring knowledge or techniques to solve problems; network motives include increasing the number of partners (consumers and suppliers), access to knowledge and relations in the firm's specific area and raising the firm's image in the eyes of stakeholders (Oguguo et al., 2020).

Firms seek to develop research on products and solve technical problems, and feel the need to identify new technology and/or develop new products or processes. Raising the quality of existing products, generating new ideas and seeking specialized staff are also essential motivations for a firm cooperating with universities (Asplund & Bengtsson, 2019; Lee, 2000; Parmentola et al., 2020). Access to specific knowledge, originating in research carried out in universities and that can be applied in the company, are other reasons for cooperating (El Hadidi & Kirby (2017).

Personal relations can lead to SME business-people/managers being interested in cooperating with universities. Galán-Muros and Plewa (2016) stress that personal relations facilitate U-F cooperation. These relations allow interaction with other business-people, thereby building social capital; better understanding of how other similar organisations operate in practice; and are also a way to promote and commercialize their own products and services, publicizing their

own organisations (Rantala & Ukko, 2018), and forming a network of U-F relations. Personal relations can also involve social contacts among the parts (Yli-Renko et al., 2001). If long-lasting, these relations can help to attract more partnerships able to add long-term value for SMEs (Partanen et al., 2018). From the above, the following hypothesis is formulated:

H2: Personal relations have a positive influence on SMEs' motivations to cooperate with the university.

The benefits of U-F cooperation are revealed through sharing resources and practical solutions to problems (Rezazadeh & Nobari, 2017), recruiting students, developing new products or processes, new patents and increasing product quality (Lee, 2000). Moreover, companies can benefit from results such as value creation, improved performance, access to knowledge, resources and partners' capacities (Hoffmann et al., 2018), and obtaining a competitive advantage, which stimulates local development (Giuri et al., 2019). The acquisition of R&D complementarities, the use of resources provided by the partner, technology transfer and greater capacity to identify and absorb technological information are other benefits of U-F cooperation listed by Fuentes and Dutrénit (2012).

Extending the capacity to use the results of research carried out in the university for improved business is also identified by Fuentes and Dutrénit (2012) as a benefit of U-F cooperation. These benefits arising from R&D can extend over a long period in the firm (Arza & Vazquez, 2010). The results can originate or improve a product or process, lead the company to acquire new knowledge (Bellini et al., 2019), and improve its position with customers, suppliers and competitors, in a process of organisational innovation and marketing (Jones & Zubielqui, 2017). Cooperation can let SMEs achieve these results, as well as reducing the risks of business and process failure, and raising the quality of the products and services supplied, increasing the firm's relationship network and participation in new markets (De Fuentes & Dutrénit, 2012).

Actors' previous personal relations in U-F cooperation can influence partners' perception of its results. Personal relations, especially informal ones, generally established face-to-face, also reinforce trust between partners (Gulati, 1995). This type of relation favours the acquisition of knowledge and the firm's perception of the positive results of cooperation (Apa et al., 2020). Therefore, trust is an important element of U-SME cooperation, making the parts more able to absorb the competences involved (Bellini et al., 2019). Consequently, the next two sub-hypotheses are formulated:

H3a: Personal relations have a positive influence on perception of the benefits of U-SME cooperation.

H3b: Type of U-F cooperation, mediated by trust, have a positive influence on perception of the benefits of U-SME cooperation.

2.2 Type of U-F cooperation, barriers and regional development

U-F cooperation can involve various aspects, such as the commercialization of knowledge (El Hadidi & Kirby, 2017) and relational aspects (Perkmann & Walsh, 2007). Therefore, Vedovello (1997) presented a classification distinguishing U-F cooperation into formal, informal and human resources. Formal cooperation refers to consultancy hired by the firm, analysis and tests made by the university, research contracts and joint research, while informal cooperation considers personal contact with lecturers, access to specialized literature, academic research and university equipment, participation in seminars and conferences and participation in education programmes promoted by the university. Cooperation through human resources involves recruiting recent graduates and more experienced scientists, and training organised by the firm and carried out in the university (Vedovello, 1997). In this study, only formal and informal channels are considered.

U-F cooperation, in itself, brings benefits for the organisations that decide to cooperate and for their surrounding region. Nevertheless, there are also barriers to the success of this relation. These barriers are common elements in analyses of U-F cooperation (Galán-Muros & Plewa, 2016). Concerning U-SME cooperation, one of the obstacles identified in the literature is these small firms' difficulty in establishing any type of cooperation with universities, due to a lack of awareness of how to access the resources a university can supply (Luengo-Valderrey, 2018). So it is important to perceive these obstacles, in order to overcome them and achieve the goals of the cooperation.

From the firm perspective, Bruneel et al. (2010) analysed the barriers affecting U-F cooperation, and classified them in barriers related to the orientation and the transaction of cooperation. Barriers related to orientation refer to the parts' objectives, the production and spread of knowledge and results, and the chronogram and expectations of work practices. Those related to transaction have to do with the contractual aspects that regulate the relation. The authors suggest these barriers can be lessened through the trust established between researchers and the firm, and both parts' experience of cooperation. These barriers are influenced by experience of cooperation, the extent of the interaction channels and the trust formed between organisations (Bruneel et al., 2010).

Bjursell and Engström (2017) identified six categories of barriers to U-F cooperation, related to the competence, concept, performance, resources, systems and value of the cooperation. These categories are classified at the individual, inter-organisational and intra-organisational level and include the individual's capacity to cooperate, the understanding given to the cooperation and the expected results, as well as the resources necessary to carry out the cooperation, the organisational systems available and the values connecting the firm to the university.

Misalignment between parts in defining the objectives of cooperation is identified as a significant barrier to establishing a U-F cooperative relation (Alunurm et al., 2020). This misalignment of objectives can be influenced by factors such as perception of the time and institutional processes involved in the cooperation (Parmentola et al., 2020). Ranga et al. (2008) emphasize that the institutional bureaucracy perceived, together with different timelines in defining the aims of cooperation and effective communication between the parts can seriously hinder successful cooperation. The lack of communication between the parts is also identified by Nsanzumuhire and Groot (2020) as a barrier, as this can hinder understanding of the institutional norms and regulations guiding cooperation (Silva et al., 2020). Smirnova (2014) shows that acquiring new knowledge can have a high cost for SMEs, and the cost of cooperation is something to be considered (Meldrum & de Berranger, 1999). The lack of information about U-F cooperation and about the research done at universities that could benefit firms can make it difficult to identify a potential university partner with whom to cooperate (Alunurm et al., 2020).

Although the barriers to U-F cooperation have been widely studied, there is still work to be done on how barriers are effectively perceived by SMEs, in the context of cooperation with universities. Indeed, Bruneel et al. (2010) underline that perception of the barriers can be influenced by the type of interaction established between parts in the cooperation. Therefore, the following hypothesis is formulated:

H4: The type of U-F cooperation (formal or informal) influences perception of the barriers to U-SME cooperation.

U-F cooperation is a complex activity (Lendel & Qian, 2017), where the benefits and barriers are perceived in a particular way by each partner in the process, according to the context in which the cooperation takes place. More specifically, U-F cooperation is an instrument that can help in the process of regional development, through teaching, research, cooperation with public and private actors, and innovation and development projects (Rantala & Ukko, 2019).

Lendel (2010) pointed out that U-F cooperation contributes to economic development, through products developed in the sphere of the university which can satisfy regional needs. These products can be grouped in three areas: educational services, business services and technological services. Educational services are part of the university's intrinsic mission and their benefits are perceived in the long term, raising the level of education and adding to the region's human capital. Business services can improve individual technological development, which stimulates the local economy, cultivating a regional entrepreneurial culture. Finally, technological services can imply the transformation of knowledge created in the university into firms' effective actions (Lendel & Qian, 2017). These activities contribute to developing the regional production sector (Fuster et al., 2019), through local innovation, production and other elements of the value chain (Lendel, 2010).

Lima et al. (2021) classify the results of U-F cooperation in three dimensions: economic, social and financial. The economic dimension involves infrastructure, processes and production, and scientific development. Infrastructure reflects the investment and share of resources among the parts involved; processes and production include more measurable activities such as commercialization of knowledge, increased productivity, new products and processes, increased sales etc.; scientific development involves activities inherent to scientific dissemination, such as the relevance of scientific publications, seminars and congresses and academic excellence. The social dimension is associated with consolidating the results in higher quality jobs, increased salaries, workforce skills and qualifications, work placements, students' training etc. Finally, financial results involve the generation of income arising from that cooperation, such as purchases, taxes, investment, funding, increased regional GDP, etc. These dimensions proposed by Lima et al. (2021) tie in with the Triple Helix conception (cooperation at the industry, university and government level).

In this context, U-F cooperation can lead to regional development, through the cooperation channels used, the transfer of knowledge created in the university and in the firm, the relations established or the results achieved by both parts. Mahfoudh et al. (2021) also emphasize that U-F cooperation is essential to develop competences, generate and adopt knowledge, promote entrepreneurship, improve the efficiency of innovation, and therefore, develop the regional economy. From the above, the last two hypotheses are presented:

H5: The benefits achieved from U-SME cooperation have a positive influence on regional development.

H6: The barriers to U-SME cooperation have a negative influence on regional development.

3 Research Methodology

In this study, the unit of analysis is the SME that has formed at least one cooperative relation with a university in the last five years, and the geographical context is a state in the north-east of Brazil, Maranhão. This region has four state universities and one private university. In general, it is a state with a low rate of innovation, since according to the innovation index compiled by the Industrial Federation of the State of Ceará (FIEC, 2021), Maranhão is in the 22nd position in the national innovation ranking (of 27 possible positions) and in the 7th regional position (of 9 possible positions). This innovation index has two dimensions: capacities and results. Capacities are assessed by indicators including human capital, public investment in R&D, institutions, infrastructure, and cooperation. The results dimension is formed of global competitiveness, technological intensity, intellectual property, scientific production and entrepreneurship. This overview characterises the region where the study was carried out.

It is generally recognised that regions with low levels of R&D tend to take greater advantage of the technological infrastructure and knowledge supplied by universities (Garcia-Alvarez-Coque et al., 2019). Therefore, to investigate how SMEs perceive the benefits and obstacles of U-F cooperation, for themselves, and for regional development, setting out from the personal relations the parts have formed. Finding out how these small firms perceive the results of cooperation for regional develop is another specific aim of the research.

3.1 Sample

The sample for this study was formed of 336 SMEs that had established a cooperative relation with universities in the last five years. The snowball sampling technique was adopted to identify subjects for study (Moradi & Noori, 2020). This technique allows random identification of target respondents from the relations they have with each other. The first SMEs were identified through contacts with organisations representing local business-people and personal contacts with researchers at the university. These actors provided information about the cooperative relations established by their members. After identifying these subjects, other connections were made to find other potential research targets.

SMEs are not very clearly defined in the literature and it may be difficult to define this firm segment. However, the number of employees can be a reasonable choice to define company size (European Commission, 2020). For that reason, this study used the concept of SME where the main criterion is staff numbers, i.e., up to 250 employees, as also defined by the Brazilian Institute of Geography and Statistics (IBGE, 2021).

3.2 Measures and data-collecting instrument

The regional development variable was adapted from Lima et al. (2021). This variable is based on SMEs' perception of how the results of U-F cooperation spill over to the region. The other variables/dimensions are based on the type of cooperation established, the personal relations necessary to form a cooperative relation, the resulting benefits, the motivations to cooperate and the barriers that may arise in the process. These variables were identified and measured from the review of previous studies and are summarised below in Table 5.1.

Table 5.1. Dimensions and variables analysed

Dimension	Variables/items	Based on:
Formal cooperation	v1. hired consultancy v2. hired the university to test a product v3. hired the university for technical assistance with a product, service or process (technological consultancy)	(Perkmann & Walsh, 2007; Vedovello, 1997)
Informal cooperation	v4. made informal contacts with the university to solve occasional matters (informal consultancy) v5. shared physical premises (or the firm used the university premises, or the university used the firm's physical premises to develop something) v6. applied the results of university research (in any process or product) in the firm	(Perkmann & Walsh, 2007; Vedovello, 1997)
Inter-personal relations	v7. has an informal relation, of friendship, with the partner from the university v8. knows the university partner personally v9. someone in the firm has a personal relation with the university partner	(Hemmert, 2019)

Table 5.1. Dimensions and variables analysed (cont.)

Dimension	Variables/items	Based on:
Trust	v10. The academic partners were open with us at all times v11. The academic partners did not make unjustified allegations v12. We felt that our academic partner(s) was(were) on our side v13. Our academic partners understood our needs, even when these were not described in detail v14. We can share our concerns and problems freely with our academic partner(s) v15. The firm and the university partner have the same commercial values	(Hemmert et al., 2014)
Motivations	v16. solved a specific problem v17. drew up market research v18. identified business opportunities v19. increased the firm's competitiveness v20. sought knowledge about specific technology v21. developed a product or service v22. developed a new work process v23. accessed technology that can be applied in the firm v24. accessed public funding to develop something for the firm v25. explored technology with future commercial potential	(Asplund & Bengtsson, 2019; Lee, 2000; Motohashi, 2005; Oguguo et al., 2020; Parmentola et al., 2020)
Benefits	v26. solved specific production problems v27. used the university structure to solve a specific problem v28. tested a product or process v29. carried out quality control of our product or service v30. extended our capacity to absorb technology v31. accessed new knowledge and/or skills v32. reduced business risks v33. reduced the firm's costs v34. reduced failings in the firm's processes	(Bellini et al., 2019; El Hadidi & Kirby, 2017; Lee, 2000)

Table 5.1. Dimensions and variables analysed (cont.)

Dimension	Variables/items	Based on:
Barriers	v35. universities seem very distant from firms v36. there are language differences between the university and the firm v37. we find it difficult to understand the norms, standards and regulations established in the cooperation v38. the knowledge produced in the university is too general to respond to our specific needs v39. practical application of the knowledge produced in the university is expensive v40. some bureaucratic process of the university hindered cooperation v41. the benefits of cooperation were not very clear at the beginning v42. it is difficult to find a partner at the university v43. university staff do not seem very motivated to cooperate with small firms v44. the timetabling of cooperation actions makes it difficult to achieve the expected results	(El Hadidi & Kirby, 2017; Parmentola et al., 2020)
Regional development	v45. increasing the number or consultancies the university can supply v46. launching new products in the market v47. creating new values in the firm v48. creating new companies v49. increasing income and profits v50. access to new investment v51. job creation in areas of high technology v52. hiring more people v53. more qualified workforce v54. increasing the number of suppliers/customers v55. reducing the time of response to consumption and market needs v56. increased firm productivity v57. improved products, processes, and services v58. developing new products, processes, and services v59. access to new local/national suppliers	(Lima et al., 2021)

Source: Own elaboration.

A questionnaire was used as the data-collecting instrument. The questionnaire is a data-collecting technique that has the advantage of reaching a large number of respondents and ensuring their anonymity, leading to more efficient answers (Marshall, 2005). The questionnaire is structured in nine sections: characteristics of the firm and the respondent, type of cooperation established, personal relations between the parts, trust, motivations, benefits and barriers, and results for regional development. The variables were presented on a 7-point Likert-type scale, which varies from "strongly disagree" to "strongly agree". Noar (2003) underlines that this type of scale allows sufficient variance and co-variance for data analysis. The questionnaire aimed to identify the relations between the SME and the university and the effects on regional development.

The data-collecting instrument was pre-tested. To do so, four entrepreneurs were selected with different levels of education (one with primary education, one with secondary and three with a higher qualification) and from different sectors of activity (agriculture, services, commerce and industry - one from each). The pre-test served to check the suitability of the language used in the questions and respondents' understanding when completing the questionnaire. After the pre-test, adjustments were made to the wording in three questions, so that they could be fully understood by individuals with all levels of education and in different areas of business. Another pre-test was carried out with the same number of subjects with similar characteristics to the first group to check the effectiveness of the alterations made.

At a first stage, the questionnaire was sent as an electronic form by e-mail. However, of 110 e-mails sent, only two were answered. This meant a change of strategy was required, and so the data would be obtained by telephone and personally, whenever possible. Data-collection by telephone resulted in 91 completed, valid questionnaires. The strategy of visiting firms was implemented by making an appointment, which resulted in 119 completed, valid questionnaires. However, answers from 140 firms identified via the snowball technique were still missing. They were contacted once again, and 126 more questionnaires were obtained. To have more reliable opinions, it was ensured that the questionnaires would be answered by the owners or employees responsible for the firm's production. The data were collected from October to December 2021 (210 questionnaires) and in March 2022 (126 questionnaires), giving a final sample of 336 SMEs.

3.3 Data analysis

To achieve the objectives and validate the research hypotheses, different statistical analyses were applied to the data obtained. This began with descriptive statistical analysis of the

possible criteria able to measure the relations formed between SMEs and the university. Each questionnaire was answered by just one representative from each company, as suggested by Podsakoff and Organ (1986), i.e., Harmon's single factor test, to check the possibility of common method variance (CMV). If the data present CMV, factor analysis of all the items will result in a single factor, or else one factor will be responsible for most of the covariance of the variables (Podsakoff & Organ, 1986). The result of factor analysis with all the items of interest showed that no isolated factor is responsible for most of the variance. The first factor to emerge captures only 22.71% of the variance, which suggests there is no problem of CMV.

Though CMV has not been identified, procedural remedies were applied potentially to avoid it. A pre-test was conducted with four entrepreneurs of different levels of education (one with primary education, one with secondary and two with a university qualification) and from various sectors of activity (agriculture, services, commerce, and industry - one from each) to verify complete understanding of the items. Through this process, it was able to rule out any potential issues with the questionnaire's language. To prevent replies from being offered to follow socially unacceptable patterns, it was further emphasised the anonymity of the information given and the lack of any "right" or "incorrect" answers (Chang et al., 2010).

The normality of data was also checked through the Kolmogorov-Smirnov and Shapiro-Wilk tests, finding that the data did not present normal distribution. Therefore, in the following analyses, estimators supporting violation of the assumption of data normality were applied.

The next step was to reduce the number of variables in factors, using factor analysis. Factor analysis reveals the inter-relations between the variables observed, reducing them into dimensions or factors, with the minimum loss of information (Hair et al., 2020). The 61 variables were reduced to eight dimensions: Formal cooperation, Informal cooperation, Inter-personal relations, Trust, Motivations, Benefits, Barriers, Regional development. Then confirmatory factor analysis (CFA) was carried out. CFA aims to identify whether the proposed model is able to explain the hypotheses formulated (Hair et al., 2020).

To validate the research hypotheses, structural equation modelling (SEM) was adopted. This type of analysis is a robust multi-variate technique that uses path analysis, simultaneous equations and factor analysis in the same model (Rosseel, 2012), emphasizing how these dimensions are related to each other (Hair et al., 2020). SEM followed two steps: the measurement model, built through the factor analysis and analysis of the structural model, with test of the hypotheses (Anderson & Gerbing, 1988). This data analysis was carried out using the R lavaan (Rosseel, 2012) R psych (Revelle, 2022) and Excel® packages.

4 Results

4.1 Characterisation of the sample

Descriptive statistics, applied to the 336 SMEs in the final sample of the study (Table 5.2), show that most respondents are owners (77.68%). This result may indicate the reliability of opinions and the initiative to undertake U-SME cooperation, since decision-making power in SMEs is mostly centred on the founder-owner. These business-people have been in their post for less than 10 years (67.86%), have completed higher education (67.56%) and are over 40 years old (60.12%). The firms, in turn, belong to the sectors of Commerce, Services, Industry and Agriculture. Most of them have been in existence for up to 10 years (64.88%), have up to nine employees (79,17%) and are situated close to the partner university (75,60%). These data are presented in Table 5.3.

Table 5.2. Characterisation of respondents (N=336)

Variables		N	%
Respondents' gender			
	Female	158	47.02%
	Male	178	52.98%
Education			
	Basic education	47	13.99%
	Secondary education	62	18.95%
	Degree	125	37.20%
	Post-graduate	102	30.36%
Age group			
	20 to 29 years	56	16.67%
	30 to 39 years	78	23.21%
	40 to 49 years	79	23.51%
	50 to 59 years	92	27.38%
	over 60 years	31	9.23%
Post occupied			
	Project director	29	8.63%
	Manager	32	9.52%
	Production manager	14	4.17%
	Owner	261	77,68%
Length of time in the post			
	under 5 years	97	28.87%
	6 to 10 years	131	38.99%
	11 to 15 years	31	9.23%
	16 to 20 years	55	16,37%
	over 20 years	22	6.55%

Source: Research data.

Table 5.3. Characterisation of the firms (N=336)

Variables		N	%
Sector of activity			
	Agriculture	73	21.73%
	Commerce	85	25.30%
	Industry	61	18.15%
	Services	117	34.82%
Firm age			
	under 5 years	113	33.63%
	6 to 10 years	105	31.25%
	11 to 15 years	33	9.82%
	16 to 20 years	56	16.67%
	over 20 years	29	8.63%
Number of employees (firm size)			
	up to 4 employees	114	33.93%
	5 to 9 employees	152	45.24%
	10 to 19 employees	46	13.69%
	20 to 29 employees	5	1.49%
	30 to 49 employees	19	5.64%
Geographically close	No	82	24.40%
	Yes	254	75.60%

Source: Research data.

Most of the SMEs have established some type of cooperation with the university on more than two occasions. Those in the areas of Commerce (83) and Services (117) have established cooperation more frequently, as shown in Figure 5.1.

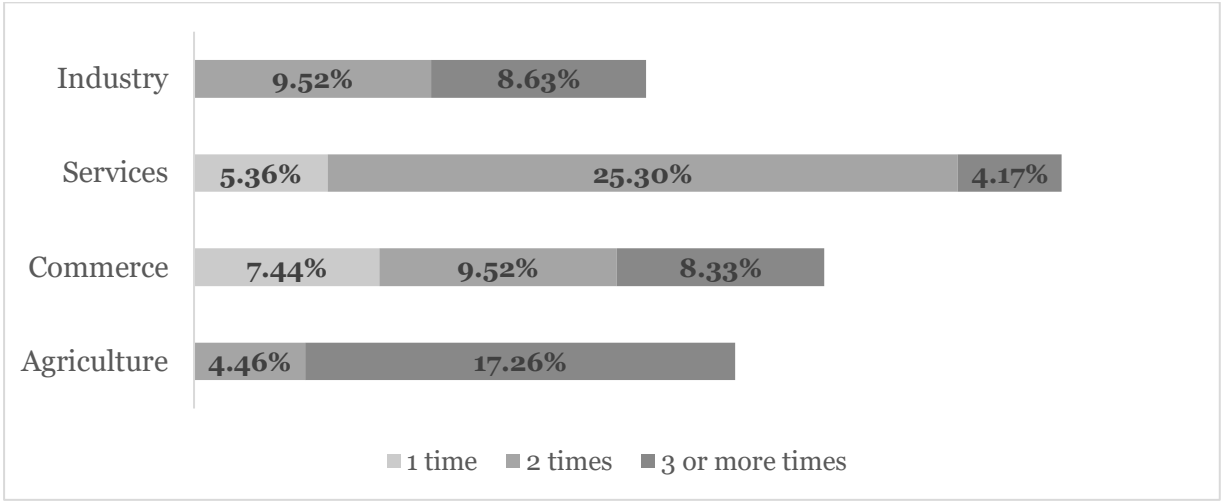


Figure 5.1. Number of cooperations established, by sector of activity (N=336)

Source: Research data.

4.2 Analysis of the dimensions

As mentioned above, factor analysis was performed for factor retention in each dimension (types of cooperation, informal relations, motivation, trust, perceived benefits, barriers encountered, and results for regional development). The descriptive result of each of these dimensions is presented in Appendix 1. Factor retention was carried out through parallel analysis, a statistical procedure of simulation (Brown, 2015). The reliability of the dimensions was confirmed through the Cronbach α (α = 0.856) and McDonald ω (ω = 0.77) for all items. The dimensions analysed present an α value varying from 0.692 to 0.944 and ω from 0.733 to 0.924. The α and ω values vary from 0 to 1, with 0.6 being the minimum acceptable value for factor analysis (Hair et al., 2020).

The result of factor analysis confirms the convergent validity of the measures (Hair et al., 2020). The factor loadings of the variables are positive, significant (Kline, 2015) and above 0.40, which allows them to be grouped in dimensions (Hair et al., 2020). Fornell and Larcker (1981) demonstrate that the ideal values of average variance extracted (AVE) and composite reliability coefficients (CR) are above 0.7, but values above 0.5 are acceptable. The factor loadings of each dimension are presented in Appendix 2.

CFA assessed the plausibility of the one-dimensional structure of the dimensions proposed. This was analysed through the oblimin orthogonal rotation method, using the Diagonally Weighted Least Squares (DWLS) estimator, with bootstrapping sub-sampling of 10000 samples. This is a robust estimation method, suitable for data that can violate normality, such as ordinal data arising from Likert-type scales. Moreover, this estimator supports a small sample size (Gana & Broc, 2019).

The proposed model converged on the proposed dimensions, according to the adjustment indices found. The adjustment indices used were: χ^2; χ^2/gl; *Comparative Fit Index* (CFI); *Tucker-Lewis Index* (TLI); *Standardized Root Mean Residual* (SRMR) and *Root Mean Square Error of Approximation* (RMSEA). Values of χ^2 should not be significant; χ^2/gl should be $\leq$ than 5 or preferably $\leq$ than 3; Values of CFI and TLI should be $\geq$ than 0,90 and preferably above 0,95; Values of RMSEA should be $\leq$ than 0,08 or preferably $\leq$ than 0,06, with a confidence interval (upper limit) $\leq$ 0,10 (Brown, 2015). The resulting adjustment indices for each dimension of the factor model proposed are described in Table 5.4.

Table 5.4. Model's adjustment index

Dimension	N factors	χ2 (df)	χ2/df	CFI	TLI	SRMR	RMSEA (95% IC)
Cooperation	2	8.18 (3)	2.72	0.99	0.98	0.03	0.05 (0.00 – 0.10)
Relations	2	3.09(3)	1.03	1,00	1,00	0.05	0.00 (0.00 – 0.09)
Trust	2	3.12(3)	1,04	1.00	1.00	0.01	0.00 (0.00 – 0.17)
Motivation	2	34.75(18)	1.93	0.95	0.93	0.08	0.08 (0.06 – 0.10)
Benefits	2	10.66(12)	0.88	0,98	0.96	0.09	0.08 (0.06 – 0.12)
Barriers	2	16.64(7)	2.37	0.98	0.97	0.09	0.08 (0.06 – 0.09)
Regional development	3	28.26(15)	1.88	0.95	0.93	0.10	0.06 (0.04 – 0.08)

Note: χ^2 = chi-squared; df = degrees of freedom; *CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation.*

Source: Research data.

The result of the model confirms the convergent validity of the measures (Hair et al., 2020). The items' factor loadings are positive and significant (Kline, 2015), and the items were confirmed as factors presenting factor loadings above 0.40 (Hair et al., 2020). The data present possible results for SEM. These results are presented in the next section. To test the hypotheses, in the "Cooperation" dimension, the corresponding factors were used: formal cooperation and informal cooperation, to be able to analyse the relations from the type of cooperation established. In the "Relations" dimension, only informal relations were used, as proposed in the research hypotheses.

The dimensions analysed through SEM, resulting from factor analysis, are summarised in Table 5.5.

Table 5.5. Mean, standard deviation, and correlation matrix among the dimensions analyzed

	Mean	s. d.	v1	v2	v3	v4	v5	v6	v7	v8
v1	3.25	1.09	1							
v2	3.82	1.53	0.16**	1						
v3	5.82	1.45	0.00	-0.04	1					
v4	4.00	1.37	0.27***	0.56***	-0.4**	1				
v5	5.43	0.84	0.18***	-0.16**	0.17**	-0.04	1			
v6	4.52	1.51	0.49***	0.52***	-0.47**	0.74***	0.02	1		
v7	3.86	1.69	0.02	-0.34***	0.31**	-0.18***	-0.35***	-0.21***	1	
v8	5.56	0.79	0.22***	0.32***	-0.59**	0.62***	0.09*	0.6***	-0.28***	1

Notes: N = 336; *** p<0.00; **p< 0.05, * p<0.10. s. d. : standard deviation; v1: Formal cooperation; v2: Informal cooperation; v3: Personal relations; v4: Motivation; v5: Trust; v6: Benefits; v6: Barriers; v7: Regional development.

Source: Research data.

Table 5.5 summarises the dimensions, whose variables are described in Table 5.1. The mean of the dimensions suggests that entrepreneurs have little perception of the type of cooperation they form. For these individuals, personal relations may not seem to be determinant in forming cooperative relations. However, by establishing cooperation, they trust the partner, as they perceive the benefits of cooperation (at the firm level and for regional development), as well as the difficulties of cooperation, i.e., the barriers that can arise along the way. The standard deviation found in each dimension suggests there is little dispersion of data.

4.3 Test of the hypotheses

As mentioned, the hypotheses were tested through structural equation modelling. This is a robust method that aggregates the measures and structure of the model, i.e., in the same structure, the constructs and the relations between them are analysed.

The solution presented demonstrates that the proposed model converged without problems. The model solution is presented in Table 5.6.

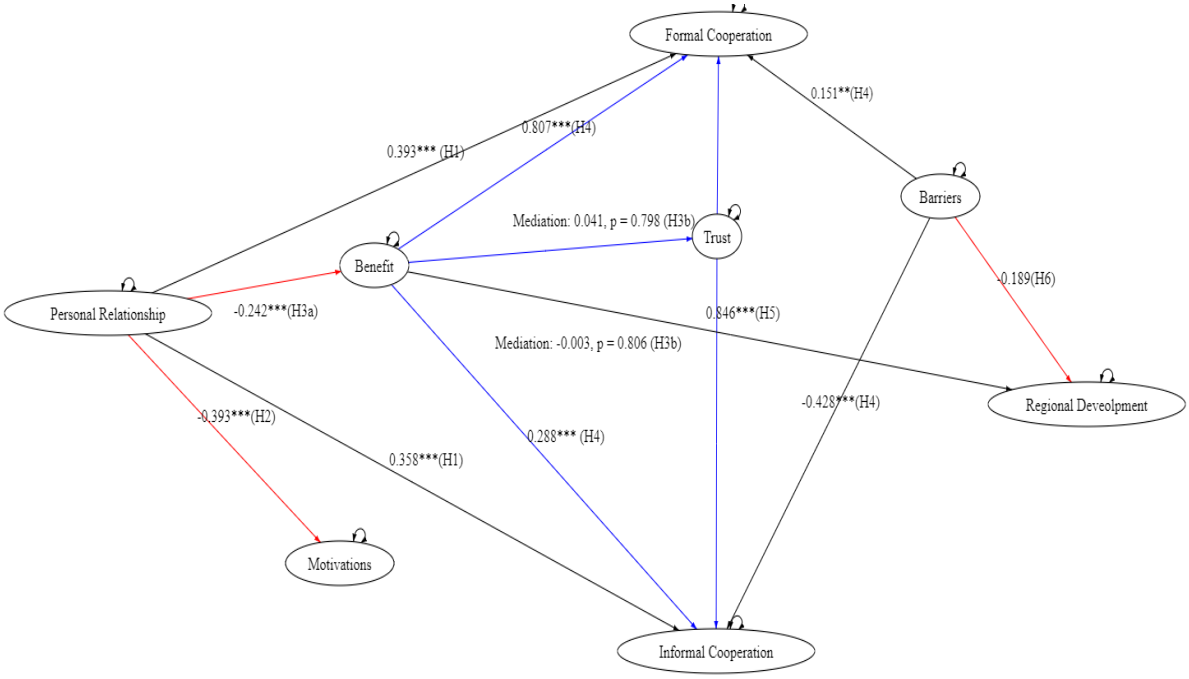
Table 5.6. Adjustment measures of the theoretical model

	χ^2	df	χ^2/df	CFI	TLI	RMSEA (95%)	SRMR
Adjustment measures	6.801	5.000	1.36	0.997	0.990	0.033 (0.000 – 0.077)	0.042

Note: χ^2 = chi-squared; gl = degrees of freedom; *CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation.*

Source: Research data

The measurements of the theoretical model proposed are shown to be adjusted to the data. The expected values were CFI ≥ 0.95, TLI ≥0.95, RMSEA ≤ 0.08 and SRMR ≤0.08 (Gana & Broc, 2019) and the model solution presented suitable values. Therefore, the U-SME relation was tested through the entrepreneurs' understanding of that relation. The model included dimensions that can influence U-SME cooperation, such as the informal relations formed, business motivations, benefits obtained and barriers encountered, and how these benefits and barriers influence the results of U-SME cooperation for regional development. These relations are shown in Figure 5.2.



Note: *** p<0.00; **p< 0.05, * p<0.10.

Figure 5.2. Structural model estimated

Source: Research data.

The structural model estimated is demonstrated in Figure 5.2 through the resulting paths between the variables. The relation was considered significant if the limits of the confidence intervals did not include zero, i.e., these limits, upper and lower, could not be positive and negative for the same relation (Cohen, 1988). The hypotheses were tested in confidence intervals (CI) of 95% and bootstrapping with 10000 re-samples. Using confidence intervals implies recognising that, with the same estimation method, and in the same estimated population (SME), these results will be found in 95% of the occasions tested.

Based on these criteria, trust was expected to mediate perception of the benefits of cooperation, but the result was not significant for any type of cooperation (formal: β=0.041, [95% CI: -0.008, 0.004]; informal: β= -0.003, [95% CI: -0.004, 0.019]), not supporting hypothesis H3b. Personal relations and SMEs' motivations for cooperating with the university (β=-0.393, [95% CI:-502, -0.284]), despite having a significant result, did not support the hypothesis of motivation to cooperate being influenced positively by personal relations (H2). Similarly, a positive result was expected for hypothesis H3a (personal relations and the perception of benefits), but a negative significant relation was found between the dimensions analysed (β= -

242, [95% CI: -0.315, -0.168]), contradicting the hypothesis proposed, which expected a positive relation between the dimensions.

Hypotheses H1, H4, H5 and H6 are supported by the data of the structural model. Therefore, personal relations have a positive influence on the formation of U-SME cooperation, irrespective of being formal or informal (informal cooperation β=0.358 [95% CI: 0.253, 0.462], and formal cooperation β= 0.393, [95% CI: 0.277, 0.509]), therefore accepting hypothesis 1. The barriers encountered are influenced by the type of cooperation formed (informal cooperation: β = -428, [95% CI:-0.051, -0.347] and formal cooperation (β=0,190, [95%, CI: 0.135, 0.470]. This result was expected, since cooperative relations are marked more by informal than formal relations, corroborating H1. The benefits for firms in this cooperative relation have a positive influence on extending these results to regional development (β=0.81, [95% CI:0.379, 0.492]), and when the barriers are greater in this relation, this perception is negative (β=-0.154, [95%, CI: -0.117, -0.037).

The hypotheses are summarised in Table 5.7.

Table 5.7. Summary of the hypotheses

Hypothesis	Path	□	Se	z stat	p-value	CI 95%	Supported
H1	Personal Relationship -> Formal Cooperation	0.393	0.059	6.658	0.000	[0.277, 0.509]	Yes
	Personal Relationship -> Informal Cooperation	0.358	0.053	6.718	0.000	[0.253, 0.462]	
H2	Personal Relationship -> Motivations	-0.393	0.056	-7.073	0.000	[-0.502, -0.284]	No
H3a	Personal Relationship -> Benefits	-0.242	0.038	-6.423	0.000	[-0.315, -0.168]	No
H3b	Benefits -> Trust -> Formal Cooperation	0.041	0.011	0.256	0.798	[-0.018, 0.024]	No
	Benefits -> Trust -> Informal Cooperation	-0.003	0.011	-0.246	0.806	[-0.024, 0.019]	
H4	Benefits ->Formal Cooperation	0.807	0.095	8.525	0.000	[0.621, 0.992]	Yes
	Barriers ->Formal Cooperation	0.151	0.053	2.853	0.004	[0.047, 0.255]	
	Benefits ->Informal Cooperation	0.288	0.068	4.223	0.000	[0.154, 0.422]	
	Barriers ->Informal Cooperation	-0.428	0.042	-10.243	0.000	[-0.051, -0.347]	
H5	Benefits -> Regional Development	0.846	0.040	21.159	0.000	[0.768, 0.924]	Yes
H6	Barriers -> Regional Development	-0.189	0.040	-4.728	0.000	[-0,267, -0,110]	Yes
Other relations found							
	Trust -> Formal cooperation	0.217	0.052	4.187	0.000	[0.115, 0.319]	Significant
	Trust -> Informal cooperation	-0.317	0.065	-5.760	0.000	[-0.502, -0.247]	Significant
	Benefits -> Trust	-0.135	0.063	-2.148	0.032	[-0.258, -0.012]	Significant
	Barriers-> Trust	-0.346	0.045	-7.717	0.000	[-0.434, -0.258]	Significant
	Motivation -> Formal cooperation	-0.444	0.095	-4.694	0.000	[-0.629, -0,259]	Significant
	Motivation -> Informal cooperation	0.412	0.076	5.437	0.000	[0.263, 0.560]	Significant

CI: Confidence interval

Source: Research data.

5 Discussion

Personal relationships are an important way of initiating cooperation between firms and universities. The results of this study highlight the importance of this relationship to form U-SME cooperation, whether formal or informal cooperation. SMEs and universities need their network to form the cooperation, in context analysed. SMEs can gain access to the expertise and resources needed to produce innovative products and services, as well as grow their markets and reach, by collaborating with universities. The network linkage formed by entrepreneurs and academics, in previous relationships such as those between former students who went on to become industrial managers and their former professors or former classmates who went on to become professors, may frequently contribute to the development of U-SME cooperation (Arza & Carattoli, 2016; Hemmert, 2019). Relations between SMEs and universities are based more on people-to-people relationships, through the provision of technical services and training, and less on the grounds of basic research (Fernández-Esquinas et al., 2016).

Access to specific knowledge to be applied in the firm (El Hadidi & Kirby, 2017), process improvement, and technical problem solving (Asplund & Bengtsson, 2019) are motives of U-SME cooperation that imply social contacts (Asplund & Bengtsson, 2019; Yli-Renko et al., 2001). However, the study did not find a positive relation between personal relations and motivations for SMEs cooperating with the university. Personal relations seem to be a link to form cooperation, but do not motivate it in the context studied here. The reasons for SMEs cooperating with the university are influenced negatively by the personal relations between the parts. Therefore, this result contradicts the study by Galán-Muros and Plewa (2016), which stresses that personal relations are seen as an element motivating cooperation. Nevertheless, these same reasons have significant relations with the type of cooperation formed, being positive for informal cooperation and negative for formal cooperation. This implies that firms that establish formal cooperation seems unclear about their reasons for cooperating, but once formalized, they seem to have greater perception of the benefits of that cooperation. In general, formal cooperation involves a well-established contractual relation and some monetary resources (Martin et al., 2019), and this can give clarity about the perceived benefits. In addition, it seems that proximity between the parts, arising from informal cooperation, can be an element motivating cooperation. It was observed that the investigated SMEs were geographically close to the partner university, and this can bring them closer to form the partnership.

Similarly, personal relations have a negative influence on perception of the benefits of cooperating with the university, particularly for formal cooperation. However, once cooperation is established, irrespective of the type, the resulting benefits are well perceived by all, particularly when the type of cooperation is formalized. In other contexts, this type of relation has favoured perception of the benefits of cooperation (Apa et al., 2020). Kolade et al. (2019) underlines that formal cooperation and networks let the parts involved complement each other in various skills and competences, and this aspect can favour perception of these benefits, as shown in the context analysed here. Once U-SME cooperation is formalized, the benefits seem clear to the entrepreneur. SMEs need to better understand the importance of expanding their cooperation network, especially with academic institutions, and forming as many long-term relationships as possible. The purpose of universities is to promote knowledge, innovation, and research. SMEs can greatly benefit from joint work in this area, to improve their production systems and pursue growth.

The results obtained also demonstrate that both formal and informal cooperation originate in the firm's personal relations, where trust is an essential element in establishing organisational cooperation (Gulati, 1995). However, the results do not show trust to be a mediating dimension for perception of the benefits of U-SME cooperation, i.e., there was a significant relation associated with the type of cooperation established (positive for formal cooperation and negative for informal cooperation). This result contradicts those of Apa et al. (2020), who highlight trust as an important assumption for informal cooperation. Furthermore, this result can suggest that when beginning formal cooperation, firms trust in the regulatory conditions established for this type of relation.

Perception of the barriers encountered is influenced by the type of cooperation established, formal or informal. This result is clearer in formal cooperation, since these relations were formed from the respondents' personal relations, and the trust established between the parts influences that perception (Bruneel et al., 2010). Rajalo and Vadi (2021) indicated bureaucratic processes as one of the most important barriers, and in informal cooperation, such processes may be less evident. Formal cooperation is permeated by contractual resources, which may lead to the emergence of barriers to consolidation of these structures and greater perception of the costs involved in the cooperation (Meldrum & de Berranger, 1999). In this aspect, inter-personal relations can help SMEs to break down institutional barriers in formalizing cooperation, corroborating the results of Martin et al. (2019). Trust is shown to be a key factor

in lowering barriers to cooperation (Bruneel et al., 2010) and is inherent to inter-personal relations (Gulati, 1995). In the results presented here, this can mean that by establishing informal cooperation, trust is already present in the relation, and so is related negatively to this type of cooperation. O'Dwyer et al. (2022) emphasize that the network connections formed, from the cooperation established, can contribute to overcoming the barriers faced. Even so, there is little perception of the barriers, even in formal cooperation.

U-SME cooperation spills its results over to regional development (Lendel, 2010). Benefits such as the generation and transfer of knowledge (Mahfoudh et al., 2021), increased productivity, qualified human resources and, improved products, processes, and services (Lima et al., 2021), are perceived as results of U-SME cooperation. Both parties can profit from each other's skills and knowledge by working together, exchanging resources, and consequently expanding the results throughout the region. Universities, for example, can provide access to research and development (R&D) expertise as well as funding opportunities to SMEs, while SMEs can provide universities with real-world applications and the opportunity to test and refine their research. This study shows that the benefits acquired by firms from cooperating with universities are perceived as sources of regional development. On the other hand, the barriers encountered diminish perceptions of the results of U-SME cooperation for regional development.

Furthermore, the type of cooperation formed has a negative influence on regional development. This empirical evidence may suggest that, in seeking U-SME cooperation, the greatest emphasis is effectively on the firm and with less perception of how the results can benefit the region. This perception of regional development is subjective and perceived according to each participant (Rantala & Ukko, 2019). However, this is an intriguing aspect, as this negative indicator can suggest that firms do not perceive that their growth, in competitiveness and innovation, can be a catalyst of regional development (Oliver et al., 2020). This lack of perception can become a barrier to the search for U-F cooperation, as already shown by El Hadidi and Kirby (2017). For U-SME cooperation to be more effective, its results must be perceived, not only in the firm domain but also in the region. Therefore, the knowledge produced in the cooperation context can be used more widely..

5.1 Implications for management

Personal relations are important in forming U-F cooperation. However, the overlapping of this type of relation in establishing U-SME cooperation can be a barrier to forming a greater number of cooperative agreements with this type of small firm. There is clearly a gap in forming cooperation programmes allowing firms greater access to these cooperative relations, since they arise from social relations between the parts. A possible solution would be through institutional incentives to transfer knowledge and technology to these companies, via partnership programmes involving universities – government – wider society.

U-SME cooperation promotes the growth of relationships with other partners, which results in success, growth, and the acquisition of complementary information or abilities. They also place more emphasis on R&D at the same time. The connecting between partners in those relationships is the knowledge. When they form cooperation relations with people who share their objectives and maximize market opportunities, change happens.

The results of U-SME may need to be more explicit for firms and for their surrounding region. These results can motivate businesspeople to seek partnerships with universities (Rajalo & Vadi, 2021). SMEs have the capacity to enjoy the benefits of cooperation, in the long term, since cooperative relations involve human resources and innovation, preparing companies to absorb new knowledge and adapt to competitive scenarios presented by the market (Vega-Jurado et al., 2021). Therefore, SMEs need to be alert to these opportunities and recognize the possibilities for competitive, sustained growth that U-SME cooperation can provide. The results are positively perceived when formal cooperation is established. Thus, the creation of formal cooperation programmes with SMEs by universities can broaden this type of cooperation. Here, the contribution of governments in supporting these programmes can be fundamental given that, in the context analysed, universities are mostly public.

Universities, in turn, need to be more open to cooperating with SMEs. Firstly, this type of firm is present in a wide variety of economic and market segments, which can diversify the spread of knowledge produced by universities. Secondly, in some regions, universities are the main bodies responsible to produce knowledge, innovation, and technology, and are therefore, SMEs' route of access to these resources (Rajalo & Vadi, 2021). Thirdly, state universities are responsible for creating knowledge and innovation, and have a social role of transfer knowledge to the region. In this respect, promoting cooperation with small firms can bring universities

closer to the situation of the region they are part of. In addition, universities benefit from this relationship by bringing practical application of knowledge to themselves, creating internship and job opportunities for students, giving them the chance to gain practical experience in their areas of study, and ensuring they are conveying relevant knowledge for the job market (Borah et al., 2021).

In turn, society benefits from U-SME cooperation through the formation of social capital and innovation produced and transferred through such cooperation. These results drive competitiveness and regional development by solving social and economic problems (Thomas & Pugh, 2020) and connecting the various actors that make up the cooperation.

The Table 5.8 summarizes the management implications of U-SME cooperation, for firms and university.

Table 5.8. Summary of the management implication for firm and university

Firm	University
To participate in formal cooperation incentive programs promoted by governments, academic institutions, or other institutions. To recognize U-SME cooperation as a safe source of innovation for the firm. To maintain cooperation with the university in long-term projects.	To promote cooperation programs with companies around the university. To publicize the socio-economic benefits of U-SME cooperation. To reduce bureaucracy to formalize U-SME cooperation. To encourage the transfer of technology and knowledge to SMES.

Source: Own elaboration

5.2 Implications for theory

In responding to the objective proposed, this study makes contributions to theory on inter-personal relations and cooperation between universities and SMEs. It advances the study of interpersonal relations as a catalyst of formal U-SME cooperation, especially in the case of micro-firms.

The results also add evidence for theory in U-SME cooperation in less developed regions, which have not been the subject of much research ((Negri & Rauen, 2021); Dutrénit and Arza (2015). The study shows the importance of formalizing cooperation, since this was the type of cooperation in which business-people were most aware of the resulting benefits, for both the

firm and the region. Consequently, this result can stimulate public policies to promote cooperation programmes between universities and SMEs, increasing the results for regional development.

6 Conclusions

This study examined the characteristics of U-SME cooperation in a region of low economic development, in the emerging economy of Brazil. Inter-personal relations were found to influence the type of cooperation formed, especially formal cooperation. It is concluded that this situation can be the consequence of the barriers faced by this type of small firm in approaching the university and its results. In addition, these inter-personal relations influence perception of the benefits and barriers encountered, lower important barriers and raise the benefits obtained. The reduction of bureaucratic aspects related to identifying partners and formalising cooperation could expand relationships with SMEs.

The U-SME cooperation studied here presented particular characteristics, such as the trust in formalizing the cooperative process; perception of the benefits of cooperation for the firm and for regional development, this perception depending on the type of cooperation established, formal or informal; the significant and negative influence of motivations to cooperate and the personal relations forming the cooperation; the importance of personal relations in perceiving the barriers to cooperation. Inter-personal relations are found to be important in all the dimensions of the U-SME cooperation process. However, relationships based only on previous personal relationships can reduce the scope of U-SME cooperation and limit the potential that this type of cooperation has for regional development.

Personal relations were explored as a driver of U-SME cooperation in a context of low innovation development. Those relations were found to be important in establishing formal cooperation. In addition, it is relevant to understand how cooperation is formed, from the SME perspective, and that formalization is an opportunity to clarify the benefits of cooperation and break down the barriers that can arise during the cooperative process.

6.1 Limitations and future directions

The limitations of the study are inherent characteristics of the fieldwork. The main limitation is the geographical boundaries of the sample, one region in Brazil. Concentrating on a state with low socio-economic development, the results cannot be generalized to the whole country. Further research on the topic in regions with these characteristics is suggested, in order to define more effective policies of cooperation between universities, knowledge, innovation and

technology centres, and SMEs, as well as major representatives of regions' socio-economic development. Another limitation concerns the sample selected, which included only SMEs that had already established some type of cooperation with the university. This prevented the possibility of exploring the reasons for other firms, in the same sectors, not cooperating, something that can be studied in the future. Knowing the reasons for not cooperating can reinforce the provision of more cooperation programmes in universities. It is noted that only the SME perspective was studied, suggesting that future research can also examine the university perspective. This joint vision, of university and SME, could provide a broader picture of this type of cooperation relation.

The results demonstrated the importance of personal relationships in forming U-SME cooperation. The absence of such relationships presents itself as a barrier for this type of cooperation to be more widely formed. Thus, intermediaries can play an important role in this context, facilitating U-F cooperation. There is a need for more detailed analysis of how intermediaries can support these partnerships, particularly in terms of knowledge transfer from university to SMEs. There is also a need for research that examines the long-term sustainability of U-SME cooperation, particularly in regions of low socio-economic development. This type of research could help to identify the factors that contribute to the success or failure of these partnerships over time.

The literature points out that the relationship between university and SMEs is based on interpersonal relationships (Partanen et al., 2018), which was found in this study. However, more needs to be investigated in this context, such as the personal relationships brought by employees of these firms to form and execute this type of cooperation.

Finally, more research is needed on SMEs' motivations for cooperating with universities since this study contradicts some important results in this field. Therefore, the topic should be studied in other places with socio-economic development like the one analysed here, for deeper exploration of these issues, as well as in different cultural contexts.

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Appendix 1: Descriptive statistics of the variables

	Mean	Standard Deviation	Median	Mode
v1	4.110	1.873	5	5
v2	2.801	2.274	1	1
v3	4.548	2.011	5	5
v4	2.780	2.302	1	1
v5	2.438	2.172	1	1
v6	1.845	1.750	1	1
v7	3.952	2.215	4	1
v8	4.229	1.911	4	4
v9	3.387	2.159	3	1
v10	5.976	0.874	6	6
v11	5.682	1.440	6	7
v12	5.658	1.405	6	7
v13	5.506	0.959	6	6
v14	5.488	1.133	5	5
v15	4.551	1.564	5	5
v16	4.182	2.493	5	7
v17	4.333	2.322	5	6
v18	4.580	2.815	7	7
v19	3.229	2.436	2	1
v20	3.685	2.450	3	1
v21	3.940	2.251	5	1
v22	2.283	1.910	1	1
v23	2.167	1.791	1	1
v24	4.851	1.960	5	5
v25	5.408	2.174	6	7
v26	5.161	1.981	6	7
v27	6.137	1.283	7	7
v28	5.021	2.139	6	7
v29	3.354	2.548	1	1
v30	3.586	2.567	4	1
v31	5.238	1.860	6	6
v32	5.574	1.686	6	7
v33	5.304	2.155	6	7
v34	4.716	1.809	5	5
v35	2.580	2.373	1	1
v36	3.985	2.257	4	1
v37	4.735	2.016	5	7
v38	3.798	2.219	4	1
v39	3.991	2.171	5	5
v40	3.973	2.183	5	1

	Mean	Standard Deviation	Median	Mode
v41	3.759	2.328	3	1
v42	3.405	2.019	3	1
v43	4.360	1.738	5	5
v44	3.104	2.330	2	1
v45	2.443	2.200	1	1
v46	2.417	1.983	1	1
v47	4.786	1.672	5	5
v48	5.530	1.951	6	7
v49	6.429	1.099	7	7
v50	4.946	1.857	5	6
v51	6.542	0.952	7	7
v52	6.616	0.711	7	7
v53	4.946	1.857	5	6
v54	5.726	1.215	6	7
v55	5.604	1.217	6	5
v56	5.613	1.480	6	7
v57	6.229	0.900	6	6
v58	5.065	1.649	5	6
v59	4.646	1.780	5	5
v60	5.753	1.023	6	6
v61	5.926	1.097	6	6

Appendix 2: Factor loadings

Dimension			**Standardized factor loadings**	**AVE**	**CR**	**DV**
Formal cooperation α = 0.822 ω = 0.842		v1	0.887	0.652	0.843	0.807
		v2	0.934			
		v3	0.544			
Informal cooperation α = 0.692 ω = 0.733		v4	0.483	0.506	0.734	0.711
		v5	0.992			
		v6	0.541			
Inter-personal relations α = 0.777 ω = 0.779		v7	0.619	0.562	0.786	0.750
		v8	0.606			
		v9	0.968			
Trust α = 0.811 ω = 0.815		v10	0.585	0.594	0.894	0.771
		v11	0.506			
		v12	0.761			
		v13	0.943			
		v14	0.553			
		v15	0.841			
Motivations α = 0.807 ω = 0.814	Competitiveness	v16	0.733	0.507	0.908	0.712
		v17	0.610			
		v18	0.664			
		v19	0.797			
	Strategic	v20	0.989			
		v21	0.782			
		v22	0.575			
		v23	0.786			
		v24	0.513			
		v25	0.875			
Benefits α = 0.858 ω = 0.869	Strategic	v26	0.556	0.605	0.930	0,778
		v27	0.706			
		v28	0.910			
		v29	0.946			
	Financial	v30	0.797			
		v31	0.719			
		v32	0.724			
		v33	0.969			
		v34	0.543			
Barriers α = 0.940 ω = 0.924	Relational	v35	0.907	0.591	0.926	0.768
		v36	0.947			
		v37	0.873			
		v38	0.490			
		v39	0.680			
		v40	0.574			
	Bureaucratic	v41	0.839			
		v42	0.970			
		v43	0.531			
		v44	0.836			
		v47	0.597			
Regional development	Economic	v48	0.756	0.506	0.938	0.711

α = 0.860 ω = 0.865		v49	0.612			
		v50	0.882			
		v51	0.675			
		v52	0.656			
		v53	0.624			
	Social	v54	0.604			
		v55	0.801			
		v56	0.800			
		v57	0.679			
		v58	0.688			
	Competitiveness	v59	0.653			
		v60	0.762			
		v61	0.683			
		v62	0.734			

Chapter 6

6 Conclusions and Implications

This research aimed to explore cooperation between universities and small and medium-sized enterprises (SMEs) as a driver of regional development. More precisely, the study was made in a region of Brazil where this topic is little explored either in the literature or empirically. This is a region where SMEs dominate the production structure, with approximately 88% of these firms having up to nine employees and only 9% of the population over 25 years of age having completed higher education (IBGE, 2020). The region where the study was made (State of Maranhão, North-East Brazil) has five higher education institutions (HEIs) classed as universities, with four of them being state-controlled and one private (INEP, 2022).

In aiming to fulfil the general objective, four specific objectives were defined, with each corresponding to a different type of study. To respond to these objectives, a mixed-method methodology was followed, since quantitative and qualitative approaches complement each other, particularly regarding internal and external validity, where different research techniques of a deductive and inductive nature were used.

Regarding the first objective - to present the relationship between universities and small and medium-sized enterprises, – a systematic literature review was carried out, from a sample of publications on this topic taken from the Web of Science (WoS) database. This review showed that SMEs seek to cooperate with the university to solve immediate issues, keep up to date with the technology applicable to their business, through formal teaching and absorbing graduates and those on work placement in the firm, as well as forming relationship networks, testing products, and seeking technical support to develop some product or process. Turning to this type of immediate solution could mean a short-term relation, but as stressed by Bjerregaard (2009), this type of relation can be of a strategic nature and lead to continuous University-Firm (U-F) cooperation. Cooperation originating in previous relations between the parts involved often results in formal cooperation programmes with government incentives, reinforcing the importance of the triple helix. The benefits indicated for SMEs resulting from cooperation with universities include resource sharing, continuous learning, differentiating the firm in the market, increased productivity, and the exchange of consolidated knowledge, through hiring human resources coming from these universities. However, initiating

cooperation is a barrier emphasized, since SMEs have little knowledge of the resources that a cooperative relation with the university can provide. Besides this barrier, this study reveals the difficulty of communication between parts, insufficient dissemination of the benefits of this type of cooperation for SMEs and asymmetry in the partners' perception of the time for the results of cooperation.

The second objective - to propose a conceptual model of analysis of U-F cooperation with regional development – took as a reference the literature on U-F cooperation in regions characterised as rather undeveloped. It is important to establish this relation, as the socio-economic context in which U-F cooperation occurs can influence the perceived results of that relation, especially when dealing with SMEs. In many cases, this firm segment gives dynamics to the regional economy (Manzoor et al., 2019). The proposed model also highlights that U-F cooperation has been formed from teaching activities, students' work placement, business training and consultancy. Through U-F cooperation, a region has access to global knowledge applicable at the local level. The proposed model also seeks to identify the benefits of U-F cooperation for a region, from qualifying human resources, developing new products or processes and employability, as well as new relations. This identification can be made from the perspective of those involved in a cooperative relation: university and SMEs. Identification of the benefits from the actors' perspective gives greater awareness of how those results can extend beyond the cooperative relation and benefit the region more generally.

Another study explored U-F cooperation in a region of low technological intensity. This led to the conclusion that in this geographical context in Brazil, cooperation is formed from existing informal relations between SMEs and the university, caused by geographical, technological, and institutional proximity, as well as social proximity between people. These forms of proximity are fundamental for both formal and informal U-F cooperation. Business-people use their personal relationship network to come closer to the university and form this type of cooperative relation. Starting through informal relations is one way for SMEs to cooperate with the university, and later, more formal cooperation can be established. Nevertheless, forming cooperation from informal relations can also be seen as a barrier, since it excludes those not belonging to the network of close relations. Still regarding barriers, common to those involved was the misaligned perception of time between the firm's needs and university's response, university bureaucracy and the absence of specific policies to stimulate U-SME cooperation. The researchers indicated their stipulated career structure as a specific barrier to cooperation, as this prevents them from establishing cooperative activities with firms more quickly. However, once cooperation is established, the university gives the necessary support to develop this kind of relation. On the firm side, one of the barriers is business-people's lack of knowledge

about the possibilities of cooperation with the university, which limits the number of firms seeking this type of higher education institution to cooperate. The lack of a formal programme in the university to attract firms also hinders this type of relation from beginning less informally.

From the perspective of how U-F cooperation contributes to regional development, human resource training and access to knowledge applicable to business are found to be important factors in that development, i.e., a greater focus on teaching-learning activities and knowledge transfer, through qualified human resources. Through these activities, U-F cooperation can result in developing innovation that stimulates regional development (Rantala & Ukko, 2019). U-F cooperation linked to teaching activities contributes to firms having a qualified workforce, as well as more formal and informal connection between the firm and the university (Pugh et al., 2018) and access to the knowledge produced at the university.

As for the last objective defined for this study - to explore the relationship formed between a university and SMEs located in a region characterized by low socio-economic development – the final study, of a quantitative nature, explored the relationship formed between a university and SMEs located in same region. From a sample of 336 SMEs which, in the last 5 years, had established some form of cooperation with the university, firms were found to enter into cooperation with universities located in the same region, with personal relations influencing the type of cooperation formed. Informal cooperation is influenced more by personal relations where there is a degree of trust between the parts involved. Although trust is not presented in this research as an element mediating perception of the benefits, it is an important dimension in the cooperative relations formed. We could expect a firm's motivation for forming a cooperative relation with the university to be influenced by personal relations, as business-people had already made contact with the university, something which was not confirmed by the results obtained. On the contrary, this study found that motivations are influenced negatively by personal relations, despite the latter being considered a strong link to establish cooperation. Nor do these personal relations influence a positive perception of the benefits of U-F cooperation among business-people, as the benefits of cooperation are perceived better by those who enter into formal cooperation.

This final study also found that barriers are influenced by the type of cooperation formed, being perceived most by those choosing formal cooperation. This was expected, as bureaucratic issues are more present in formal processes, despite the existing personal relations between the parts. Regarding the results of cooperation, these are found to extend beyond the firm and the university. The results demonstrate that firms absorb the results of U-F cooperation as a

vehicle for regional development. Specifically, these benefits result from the transfer of knowledge originating in teaching activities, through absorbing a qualified workforce, qualifying those already in the labour market, students' work placements in firms and consultancy hired by firms to solve occasional business issues and develop new products and processes.

Finally, to answer the research question proposed: "*How is cooperation between universities and SMEs established in a region of low development?*", personal relationships are found to be a point of entry to this type of cooperation. Although firms establish more informal cooperation, it is formal cooperation that gives SMEs a better perception of the benefits, for both the business sector and the region. Due to involving human relations, knowledge transfer and innovation, improving human resources and the shortage of these resources in SMEs, U-SME cooperation allows these firms to benefit from the results of cooperation in the long term. With this strategy of cooperation, SMEs prepare themselves to absorb new knowledge and adapt to competitive scenarios in the market (Vega-Jurado et al., 2021). However, the barriers to forming cooperation arise from these small firms' lack of knowledge about possible partnerships. That lack of knowledge is caused partly by the lack of formal programmes for cooperation with firms promoted by universities or even governments, and institutional bureaucracy, which hinders the search for a cooperation strategy.

6.1 Implications for theory

Studies on U-F cooperation have increased in regions of low economic development. Nevertheless, SMEs have not yet often adopted cooperation as a mechanism to strengthen their competitiveness, despite this firm segment representing strong regional economic agents. This study contributes to theory in this area of research, since cooperation between universities and SMEs was guided by theory: interorganizational networks, institutional and regional development. This research adds the discussion about how SMEs form cooperative relations with universities, especially in the absence of formal programmes for cooperation and where cooperation of this type emerges from personal relations between those involved. Here, personal relations are an important tool to establish U-F cooperation. Therefore, the research shows how exploitation of inter-personal relations can be a catalyst for formal cooperation between SMEs and universities, especially when no formal programmes for cooperation are available.

From the perspective of Institutional Theory for the study of inter-organisational networks, Dacin, Reid and Ring (2008) highlight that an institutional approach can be useful in analysing intangible assets such as reputation and legitimacy within the network. This research showed

that the university's reputation is important to bring firms and the university closer in forming this type of cooperation. When cooperating with the university, firms seek legitimacy and reputation in the eyes of the market. However, this area needs more research in relation to SMEs located in a region of low technological intensity, such as the one studied here. Indeed, legitimacy and reputation are among the motivations to cooperate, and it seems these firms are not yet very clear about this in this type of region. Moreover, considering that Institutional Theory is based on relational characteristics (DiMaggio & Powell, 1983), this research adds evidence, by including personal relations as an element in the formation of U-F cooperation, reflecting bi-directional bonds of mutual recognition and observation (Powell & Oberg, 2018) that strengthen a cooperation process.

U-F cooperation does not bring homogeneity, as these are organisations with different objectives. However, it produces results that can lead both parts to a virtuous circle of regional development. This relation shows the multiplicity of elements permeating these relations, as in this case, these organisations' actions are controlled by their social justification (DiMaggio & Powell, 1983). For a company, the results of cooperation arouse the interest of other firms in the same branch to achieve the same results and look for similar strategies. Therefore, the institutional environment can contribute to these relations, through higher education policies that stimulate them and public policy on financing research, promoting the formation of these bonds, for firms or universities' needs in seeking cooperation to solve a given problem.

By studying here the dimension associated with regional development, this research adds evidence of the cooperative relation established between SMEs and universities from the business-people's point of view. The results contribute to theory about U-F cooperation in less developed regions, which have not been the subject of much research (Dutrénit & Arza, 2015; Negri & Rauen, 2021). In particular, this study underlines that cooperation can be formed through personal relations that are already in place and subsequent formalization, despite the previous relation having emerged informally. The formalization of cooperation is seen to be important not only to establish the terms of cooperation, but specifically, for perception of the benefits U-F cooperation brings to the company and the region.

6.2 Implications for management of SMEs, universities, and public policies

The evidence found regarding cooperation between universities and SMEs shows that some difficulties can arise in forming this type of relation. Barriers to cooperation were found to be related to the institutional environment in which this type of process occurs. Some of these

barriers, intrinsic to the university environment, require greater efforts to be modified, such as changes to researchers' career plans, so that they can establish cooperation more freely. Others may be remedied more quickly, such as better communication between the university and companies, and forming specific programmes for cooperation with SMEs. There is clearly a gap regarding the formation of cooperation programmes that would allow firms greater access to this type of cooperative relation, since some arise from social relations between those involved. One possible solution would be the creation of institutional incentives to transfer knowledge and technology to these small firms. i.e., partnership programmes involving universities and government more widely.

This research also shows SME owners-managers that the results obtained from cooperation with universities can be far-reaching for firms in the same branch of activity and for the surrounding region. SMEs can enjoy the benefits of cooperation in the long term, since cooperative relations involve human resources and innovation, preparing companies to absorb new knowledge and adapt to competitive scenarios in the market (Vega-Jurado et al., 2021). Consequently, SMEs should be alert to these opportunities and recognise the possibilities for competitive, sustained growth provided by U-F cooperation. This study indicates the importance of personal relations in forming U-F cooperation, so SMEs must seek partnerships with universities. These partnerships can favour the transfer of skills, knowledge, technology and also financial resources to SMEs, which can be optimized with the results of partnerships. Cooperative relations with universities can help SMEs to generate ideas, develop products and economize on resources, making them more innovative and competitive. The use of external technology and knowledge, such as that obtained from U-F cooperation, can lead to improved, long-term results in the firm.

This study can also influence the adoption of public policies for regional entrepreneurship, qualifying the workforce and regional innovation. Concerning SME management, the results of U-F cooperation can promote the formation of institutional development networks, contributing to firms' increased competitiveness and increased interaction with the university and other institutions to stimulate regional development. Mechanisms must be developed to connect SMEs' needs with projects developed in universities, to favour an external context of knowledge and technology transfer and sharing between these institutions. Here, the involvement of other actors, such as local and regional government and other institutions associated with SMEs, can stimulate these relations and their results.

Universities, in turn, need to be more open to cooperation with SMEs, since this type of company is present in a great variety of economic and market segments which can diversify

the production of knowledge in these educational institutions. It is a question of improving the dissemination of knowledge, so that smaller firms can be reached and encouraged to contribute to the process of creating and applying the knowledge generated in the university through cooperation. In some regions, universities are the main bodies responsible for producing knowledge, innovation and technology, and so they are a vehicle for SMEs to access these resources (Rajalo & Vadi, 2021) in their own region. Consequently, this study can also stimulate public policies to promote cooperation programmes between universities and SMEs, increasing the results for regional development.

Study of how U-F cooperation occurs in various cultural and economic contexts contributes to identifying and understanding specific facilitators and barriers to these cooperative relations, which is crucial when projecting the formulation of specific policies for each region, and including companies from various sectors and of different sizes. It is also important for universities to strive to extend the role they perform in their region, focusing not only on training qualified personnel, but giving dynamics to the local production system, through interacting with firms in their surrounding area.

6.3 Limitations and indications for future research

When concluding research, despite having achieved the aims proposed, there are always limitations. Indicating these limitations opens up possibilities for new objectives, and consequently, future studies. Some limitations encountered during this research are presented, together with some suggestions to continue the study of U-SME cooperation.

One limitation has to do with the geographical context of the study. It was carried out in just one region, which prevents generalization of the results. Nevertheless, it portrays how U-SME cooperation emerges in a little-developed region and in an emerging economy such as Brazil. This portrayal may or may not be found in other regions, as this type of cooperation depends on the context in which it occurs (Garcia-Alvarez-Coque et al., 2019). Therefore, more studies about U-SME cooperation are suggested in other regions with similar characteristics to the one chosen here. Extending the research to other regions will allow a greater perception of the results found here, allowing comparisons, to corroborate them or otherwise.

The effects of U-SME cooperation can vary according to the institutional context in which it occurs (Liu et al., 2020). Therefore, another recommendation is to enlarge the samples to include firms of various sizes and determine whether, in this context, firm size affects the choice of type of cooperation, the reasons to cooperate and perception of the benefits and obstacles. Firm size is an important factor to consider in forming cooperation, since companies

can have different knowledge needs (Lam et al., 2013). So, including more firms of different sizes could be something else to explore in the future.

One of the barriers to cooperation indicated was SMEs' access to the university, i.e., beginning cooperation. Therefore, future studies could indicate viable solutions to be implemented in both the university and the firm, to favour the start of this type of cooperative relation. Another point for discussion is the duration of U-SME cooperation. This study revealed that SMEs use cooperation with universities to solve occasional problems, but little is known about the extent of that cooperation. Temel et al. (2013) indicate that the result of U-F cooperation is more perceptible when cooperation is more intense, suggesting that the benefits take time to appear, and so it is important to know the duration of the cooperation formed. In connection with starting cooperation, it would also be interesting to discover SMEs' preferred ways to acquire knowledge and how those influences establishing cooperation with universities. This seems a topic to be explored in the literature and one that can contribute to forming public policies to encourage U-F cooperation, for both universities and firms, especially SMEs.

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