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TESI DI LAUREA

"INTERNATIONALIZATION AS LEARNING OPPORTUNITY DRIVING COLLABORATIVE INNOVATION PERFORMANCE IN EUROPEAN REGIONS"

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Firma dello studente

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INTRODUCTION

In the modern competitive environment, innovation is one of the key determinants of companies' competitive advantage. Competitive pressures drive companies to innovate (Vives, 2008) but in such a dynamic and uncertain environment characterized by rapid progress, it is becoming increasingly challenging to address innovation process with only internal sources as input (Lerner & Lin, 2012). Therefore, internal resources and know-how may no longer be sufficient to keep up with competitors. As a result, there is a growing need to seek valuable resources outside the company and to integrate them in order to sustain a competitive advantage. Hence, concepts such as open innovation and network become more and more important. The innovation process is increasingly developed through collaborative networks in which companies establish multiple relationships that facilitate connections between different entities. In addition, the process of globalization has intensified the commercial trade and consequently the competition has increased to a global, rather than a national level. The elimination of trade barriers, the enhancement of transportation and the improvement of technology provide new opportunities to exploit in terms of collaboration with distant partners. In this context, internationalization strategies play a crucial role in determining cross-borders collaborations.

The focus of this research is on the European regions involved in international collaborations. EU policies promote cooperation and encourage the share of knowledge between member States, but only since 2007[1] it has started to issue programmes to support international cooperation of EU regions. Recent literature has focused on intra and inter regional collaborations (e.g. De Noni et al., 2018; Sebestyén & Varga, 2013), but less attention has been directed to the collaboration between EU regions and Extra-EU countries. In this light, the present research is focused on the capacity of the European firms to build global collaboration networks and engage in innovation. More in detail, the purpose of this thesis is to study the effect of a specific mode of entry in international markets: greenfields. They are included in FDI (foreign direct investments) definitions together with mergers and acquisitions. Greenfields investments are represented by the establishments of subsidiaries in a targeted market from the ground up. It can be argued that this kind of establishments can affect collaborations as distance may affect collaboration and they can be a way to overcome this obstacle.

[1] https://ec.europa.eu/regional_policy/it/policy/cooperation/european-territorial/cross-border/#6

The objective of the research concerns the impact of greenfields on collaborative innovations of 300 EU regions (NUTS2 classification) towards developed and emerging countries. More in detail, greenfields investments are analysed in both directions: inward and outward while the foreign countries considered are United States and Japan for developed countries and BRICS countries representing the most important for the emerging ones.

The thesis is structured in five chapters. The first chapter presents the importance of innovation and collaboration in the competitive environment analysing the main dichotomies of collaborations. Knowledge base, relationships, learning modes, and proximity are elements to address in order to understand the complexity of collaboration choices. The second chapter explores the learning process associated with internationalization strategies. In this chapter, in addition to describing the main theories of internationalization under a learning perspective, foreign direct investment is emphasized as a mode of entry that allows reducing geographical distance and fostering interactions. The research question and hypothesis are described in the third chapter, which is followed by an explanation of the methodology through which the analysis is carried out. The fourth chapter goes into the details of the analysis by studying the relationship from different perspectives. At first, a descriptive and correlation analysis is performed to get a first idea about the diagnosis of the research hypotheses and finally, the panel regression analysis is performed which led to important results. To conclude my dissertation, an in-depth analysis is conducted to go into the detail of EU regions to investigate the different level of innovative collaborations.

The results of the research give evidence on the relative importance of distance in innovative collaborations. In particular, the importance of geographical proximity change in relation to the development of a country and on the direction of investments. As a result, foreign direct investments impact differently on innovative collaborations.

1. INNOVATION AND COLLABORATION IN COMPETITIVE ENVIRONMENT

1.1. The importance of collaborative innovation

In a highly competitive market, innovation and collaborations are considered key elements in order to deal with a dynamic environment (Asheim & Coenen, 2005). Competitive pressure of many firms in the broader market foster innovation (Vives, 2008), it creates incentive to explore new opportunities and enter emerging markets to differentiate (Levinthal & March,1993; Nieto & Santamaría, 2007). In other words, innovation, in a modern competitive and fast changing environment, is one of the tools for keeping up with the competition and increase the likelihood to succeed. Companies need to build a competitive advantage in order to emerge from the intense competition. According to the resource-based view theories, firms focus on internal resources to build the competitive advantage: in particular, in presence of a valuable, rare, inimitable and non-substitutable (in the literature VRIN framework) resources a firm can develop a sustainable competitive advantage (Barney, 1991). However, in a dynamic environment characterised by unpredictable changes and rapid progresses, relying only on internal resources may no longer be the way to sustain a competitive advantage and support the innovation process in the market (Lerner & Lin, 2012). Thus, in such a scenario, organizations need to quickly revisit their value propositions to adapt and meet the ever-changing customers' needs (O'Reilly & Tushman, 2004). When new technologies and innovative features are implemented, companies can adjust their offerings in order to maintain or improve their market position. The revision of the value propositions by a firm in the market is a crucial aspect to consider, particularly where competition is so fierce that it creates pressure to differentiate. In this context, organizations need to develop "dynamic capabilities" (Eisenhardt & Martin, 2000; Kotabe & Kothari, 2016; Teece, Pisano, & Shuen,1997) in order to reach an adequate degree to responsiveness with the ever-changing business arena and to match effectively the market needs with the product and services offered. Dynamic capabilities refer to the ability of managers to 'integrate, build, and reconfigure internal and external competencies to address rapidly changing environments' (Teece et al., 1997; p.516) in order to achieve a sustainable competitive advantage. According to Eisenhardt & Martin (2000), these capabilities are embedded in organizational processes that companies use to alter the resource base in order to adapt to the changing market conditions, create new value and drive performances.

The increasing complexity of the knowledge base and the more sophisticated products demanded by end-users have a lasting and crucial impact on the value creation of organisations. However, the self-reinforcing characteristics of learning make easier for organizations to sustain their current focus (Cecere et al., 2014; Levinthal & March,1993) with the current technologies, following a path-dependent trajectory: this could, on the other hand, represents an obstacle for organizations that aim at progressing. Nevertheless, according to Cohen & Levinthal (1990), accumulated knowledge increases the ability to generate new knowledge, recalling layered notions and using them via associative learning, allowing to build links between pre-existing knowledge and new concepts. Hence, from a cognitive perspective, the new knowledge is unlikely to find resistance, contrary to the learning perspective characterised by self-reinforcing nature. The real threat is represented by exogenous changes to the environment: as result, the organization risk to remain stuck in their familiar and consolidated knowledge (Levinthal & March,1993). When uncertainty kicks in, entrepreneurs tend to rely on the certainties that they had already mastered: the existing knowledge (Capello,1999). However, organizations pertaining to a dynamic industry face challenges within their own environment so that, they are required to search for new knowledge to take advantage of the emerging opportunities in the market (Lavie, Stettner & Tushman, 2010). The existing knowledge must be in part closely related to the new knowledge and in part diverse enough to enable the effective and varied use of the new knowledge (Cohen & Levinthal, 1990). In the current competitive environment, where shorter product life cycles (Herstad et al., 2014), technological obsolescence and increasing product complexity bring ongoing changes, it is mandatory to have a heterogeneous knowledge, an optimal mix between new one and established one.

Following this approach, it is therefore crucial for organizations to distinguish between the key assets, resources and know-how already within the organizational structure that can be leveraged, from the ones that firms should explore externally, as currently weak or insufficient. In this respect, sources of innovation can come also from the outside, but the firm should be able and ready to integrate them (Teece, Pisano, & Shuen, 1997). If the organisation realises the shortage of some important resources, the inefficiency of internal processes, the lack of skills that some other companies in the market have, it can rely on external sources of knowledge to compensate them (Chesbrough, 2003). This is confirmed by Dahlander and Gann (2010): according to them, external knowledge and relationships together with internal capabilities are complements rather than substitutes.

According to the Open Innovation paradigm, in a "world of widely distributed knowledge and competence" (Chesbrough, 2003, p.57), new valuable ideas can be originated both internally and externally. For this reason, an organization should be able to integrate them in order to succeed (Chesbrough H. W., 2003; Teece, Pisano, & Shuen, 1997). In a globalized and inter-connected economy, it is proving more and more difficult for an organization to achieve its innovative goals in isolation. The previously mentioned characteristics of such a dynamic environment translates into a complex and costly R&D process: developing it internally would now require a great effort to differentiate, therefore, companies should engage in open innovation (Chesbrough, 2003; Enkel et al., 2009). Some years earlier, Kuemmerle (1997) stated that a centralized R&D will not be enough in order to compete effectively, because of the greater sources of knowledge available around the globe and a faster time to market needed to have a competitive advantage. The potential of the multitude of valuable sources of knowledge around the world and the desire to explore them, encourages companies to establish a global presence in multiple parts of the world to access and absorb this knowledge. Learning from external sources, as well as internally, is essential to make progress (Asheim & Coenen, 2005) and encourage the absorption of new knowledge to complement existing knowledge base. What Cohen & Levinthal (1990) calls "absorptive capacity" involves the understanding of valuable external ideas, their subsequent assimilation and finally their exploitation within the organization. Absorptive capacity is required to enact an effective transfer of knowledge. It is considered by Zahra & George (2002) one of the dynamic capabilities and it includes acquisition, assimilation, transformation and exploitation. The authors underlined how the identification of the external valuable knowledge and their subsequent assimilation enriches the recipient company. When external knowledge is context-specific, the transformation component of absorptive capacity enables firms to interpret and recodify the acquired knowledge to facilitate the combinations with the existing knowledge (Zahra, Ireland, & Hitt, 2000). Finally, exploitation of the knowledge refers to the incorporation of the new know-how into routines (Zahra & George, 2002). Furthermore, the authors distinguish realised (RACAP) from potential (PACAP) absorptive capacity by defining the latter as the ability of the company to evaluate and acquire external knowledge, but not to guarantee its exploitation.

It is evident that open innovation entails collaboration that provides the opportunity to learn from external knowledge. According to Capello (1999), from a time point of view, the transfer of knowledge occurs over time, with continuous accumulation of knowledge, know-how and experience; from a space point of view, the creation of dynamic synergies among actors that collaborate.

External and internal know-how should be involved in an interactive process (Chesbrough, 2003; Gassmann and Enkel, 2004). The boundaries of a firm should be permeable to allow new ideas to flow in and out with the purpose of creating opportunities for co-operative innovation processes along the value network (Dahlander & Gann, 2010; Gassmann and Enkel, 2004). This translates into creating vertical links in the value chain within and outside the organizations with suppliers and customers, and horizontal links by way of collaborating with partners in the competitive environment.

The concept of open innovation goes in two directions: outside-in processes, referring to the enrichment thanks to external collaborations with suppliers, customers, partners to integrate new knowledge and inside-out processes, that consider the opposite direction: externalization of company's knowledge to deliver ideas to the market faster with respect to their own internal development. The combined approach, called coupled processes, considers processes involving both inward and outward innovations, linked by strong relationships among organizations that collaborate (Gassmann and Enkel, 2004). Outside-in processes allow firms to enhance the existing business model for open innovation whereas the inside-out approach explores a new business model (Bogers et al., 2019).

According to Dahlander and Gann (2010), the integration of new external knowledge can be both pecuniary, based on the acquisition of new knowledge, following a payment for the acquired inputs; or not pecuniary involving the sourcing of external ideas and adapting them inside the organization to solve problems or innovate from a different external perspective. In the same way, outbound innovations can be pecuniary or not, depending on the appropriability (Herstad et al., 2014; Teece, 1986) and commercialization of the knowledge to external firms. As per the most recent literature, in the initial stages of open innovation, an outside-in approach is enacted to foster the absorption of new knowledge from the collaboration with partners (Enkel et al., 2020). In order to effectively and efficiently apply these type of innovation processes, the organization need specific capabilities. In particular, in the outside-in process the ability to listen to the external signals and process them is an indicator of knowledge application. The multiplicative capability is needed when inside-out processes are put in place and it results in the ability to transfer outside the knowledge created, after having codified it and, consequently, it is possible to share it with external entities through instruments such as licence, patent, acquisition, open source. Finally, in the coupled process, relational capacity is paramount to build and maintain relationships with partners (Gassmann and Enkel, 2004).

The open innovation approach is implemented with different degree of openness, depending on several factors such as corporate strategy, industry speed of adoption, market positioning, level

of technology of the industry (Enkel et al., 2009). There are certain industries in which close collaboration and the creation of a network is fundamental in order to be innovative. Valuable ideas can originate from the collaboration between companies belonging both to the same sector and different industries (Enkel et al., 2020). Complementary industries, for example, can provide insights to the company for the improvement of its offerings. The more a company uses open innovation in its strategy, the more it needs dynamic capabilities (Teece, Pisano, & Shuen, 1997) to effectively ripe full benefits of open innovation (Bogers et al., 2019). Different approaches of management, organizational flexibility models, strong commitment and deep capabilities in the technology's integration are required to align the business model and consequently, develop a strategy of open innovation (Bogers et al., 2019).

In the digitalisation era, open innovation is reflected in a more transparent and more accessible information, easier and faster connection, induced review of business models and reconfiguration of strategies to stay ahead of the competition. Furthermore, digitalisation gives the chance to integrate otherwise dispersed and diversified external knowledge (Enkel et al., 2020). The spread of advances in technology, a more easily knowledge access and the possibility of sharing information in a timely manner is facilitated by the Internet. Easy access to information gives companies the opportunity to formulate a more mindful strategy by already knowing their competitors' moves. A company, monitoring what the firms producing complementary assets are doing, can gain a strong element of competitive advantage (Bogers et al., 2019) in order to formulate a strategy that is in line with them to offer a compatible product or service to stay abreast with technology development. Competitors, complementary product companies and firms in the value chain can form a more thoughtful collaboration by having access to lots of information. In addition, digitalisation offers the possibility to build collaborations that previously were not feasible because they were expensive to manage (Enkel et al., 2020).

If Schumpeter (1934) thought that entrepreneurs are whom make the difference in the innovation process combining different types of knowledge, nowadays it is the network of collaborative partners that distinguish innovative performances in competitive environments (Faems et al., 2005). Collaboration gives access to new and diversified knowledge, involving third entities and consequently, the management in a series of relationships between partners, characterised by strong interdependencies (Gray, 1985). In a collaborative environment, management needs to handle a series of relationships that are to be coordinated in order to reach the desired level of efficiency. Any activity, where two or more partners contribute differential resources and know-how for agreed complementary aims, enables knowledge creation

(Boschma, 2005). The more heterogeneous the partners' knowledge bases are, the more organisations have access to additional new resources to initiate innovation and sustain a competitive advantage (Anzola-Román et al., 2019; Kraaijenbrink & Wijnhoven, 2008).

Collaboration agreements are pursued by firms for several reasons. According to Hagedoorn (1993), reduction of uncertainty constitutes the main reason to collaborate. The unknown likelihood of success of a R&D discovery may bring companies to share their efforts in joint research in order to create economies of scale, reducing and sharing costs of R&D. Risk sharing is important, especially where the product to develop is expensive, has uncertain knowledge requirements (Grant & Baden-Fuller, 2004) or it has a short life cycle (Powell, 1990). In fact, one of the elements that increase the likelihood of innovation in an industry is the short product lifecycles (Herstad et al., 2014) and a reduced research and development time. To keep up with the competition and in order not to lose its market position, a company should collaborate to reduce risks and share expenses that would be otherwise impossible to bear (Lerner & Lin, 2012; Powell, 1990). In this way, a large number of collaborating companies makes it possible to invest in expensive technological innovations. Another reason is the possibility to have a faster access to complementary assets (Rothaermel, 2001), new crucial resources or skills (Nieto & Santamaría, 2007; Teece, 1986) or access to additional capabilities without acquiring them (Grant & Baden-Fuller, 2004). There may be external companies specialised in a specific sector that have unique skills that, combined with the assets of another company, generate profits. Alliances can also enhance the speed at which a company can access new combinations of knowledge for the creation of new products. Teece (1986) underlined the advantage of keeping up with component technologies in which the company does not specialise. Moreover, collaboration fosters the knowledge acquisition enabling the transfer of both codified and tacit knowledge, that would otherwise require time to build up (Ahuja, 2000; Grant & Baden-Fuller, 2004). According to Hagedoorn (1993) a point in favour of collaboration is the monitoring of environmental changes and opportunities in a joint effort. A different perspective is given by Gray (1985), who claims that there are some problems that exceed the capacity of a single company to deal with and control them. Thus, collaboration provides the opportunity to identify and solve a problem that is too big to be solved individually by a single organisation. Finally, in order to obtain better access to markets and to tap into the know-how of external companies, international collaboration is stimulated by the company's lack of control and skills to manage globalisation independently (Hagedoorn, 1993).

As previously said, firms can obtain mutual benefits from the collaboration such as reduction of uncertainty, sharing of costs and risks (Powell, 1990), the possibility to implement more

complex technologies (Hagedoorn, 1993; Lerner & Lin, 2012), the creation of important synergies through the sharing of knowledge and complementary resources (Nieto & Santamaría (2007). Collaboration allows a firm to benefit of different perceptions about a problem, in order to have a clear understanding of the issue (Gray, 1985), get to know different perspectives and consider different approaches to adopt.

1.2. The strength of network forms in collaboration

Collaboration can be both vertical and horizontal, meaning that we consider both collaboration in the production value chain, and collaboration between competitors, that consequently, become partners. Supplier co-development and customers integration in the innovation process are examples of vertical collaborations, whereas the alliances with partners from complementary firms or competitors relate to horizontal linkages (Gassmann and Enkel, 2004). According to Faems et al. (2005), innovative performances are enhanced by a portfolio approach of interorganizational collaborations aiming at fully exploiting advantages deriving different types of collaboration. The distinction between horizontal and vertical collaboration is no longer so prominent, as network collaboration has become increasingly relevant. Many players are involved in the network and the value creation depends on the interactions among them (Peppard & Rylander, 2006). Networks systems engage collaborations with different actors, not only along the value chain and competitors, but also external entities such as universities, public institutions, private R&D etc. Each partner has a different impact on the network and on the innovation process. According to Nieto & Santamaría (2007), the more heterogeneous and diversified the network, the more diverse sources of information and the higher the degree of innovation.

The overall set of skills, resources and information requires a coordination system that can connect each company to its partners in a dynamic context, where the actions of a participant in the network can influence other members (Peppard & Rylander, 2006). Hierarchy and market, the two pure traditional types of organizing factors of production, are no longer efficient for all firms. The global competitive landscape and the turbulent and uncertain environment have led companies to abandon traditional forms and to adopt a form of network (Miles & Snow, 1992; Powell, 1990). The creation of a network could be considered as a different way of coordinating activities. It provides a degree of flexibility that results in a major adaptability to market changes and a strong communication network, ensuring a better coordination among firms (Podolny & Page, 1998).

The network facilitates the circulation of information and promotes further innovation, combining different perspectives and logics to generate new knowledge (Powell, 1990). The more information circulating in the network enables more flexibility and a more rapid shift toward new tastes in the market. Collaboration increasingly involves the bi-directional exchange of knowledge, since, according to Powell (1990), all the participants contribute managerial and technological expertise: it is not a flow of knowledge in one direction only. Each actor in the network has a proactive role and recognize its interdependence within the network, so actors are willing to share information and cooperate with each other (Miles & Snow, 1992). The relationships in the networks are paramount to create an environment in which there is a valuable exchange of ideas. Partners allocate their resources simultaneously and consequently synergies emerge where the combined effect of the energies is greater than the individual contribution (Gray, 1985). Parties involved in the network are engaged in a mutually supportive actions (Powell, 1990). Reciprocity and trust are the two fundamental elements that characterize the relationship among organizations engaged in the network. As evidence suggests, actors in the network are willing to commit in relationship-specific investments, although without guarantees because they will not expect opportunistic behaviours from the counterparty (Podolny & Page, 1998). Each member is not interested in taking advantage from relationships with others, they are guided by a sense of trust, which is considered by Koza & Lewin (1998) the crucial element that determine the success of an alliance. This type of relationship is built with a perspective of long-term horizon and to develop a valuable exchange of information and knowledge over the years. According to Powell (1990), the intangible asset corresponding to tacit knowledge is difficult to codify (Liu et al., 2013; Moodysson et al., 2008) and consequently difficult to transfer or purchase (Johanson & Vahlne, 2009; Teece, 1986). Capabilities that are developed by individuals as tacit knowledge are difficult to be governed by markets of hierarchies. Networks, employing lateral forms of communication and mutual obligations, make it possible to create long-term relationships based on the exchange of information and the transfer of skills. Cooperation, sustained over the long run, translates into an incentive for learning among firms (Gupta, Smith, & Shalley, 2006; Powell, 1990) in two main ways: promote the rapid transfer of information and encourage novel syntheses of information that create new knowledge (Podolny & Page, 1998). Therefore learning depends also on the network relationships, as Johanson & Vahlne (2009; p.1414) argue that "knowledge does not accrue only from the firm's own activities, but also from the activities of its partners, and since those partners also have other relationship partners with whom their activities are coordinated, the focal firm is indirectly engaged in a knowledge creation process that extends far beyond its own horizon". Moreover, progress in the technological field reduces

distances and facilitates effortless interactions among partners and co-inventors. The technology developments make it possible to reduce the relevance of physical distance (Knoben and Oerlemans, 2006). The wider and faster connection resulted in new patterns and forms of collaboration: companies can reach large and global communities and interact with them in order to find out the changes that have occurred in the targeted markets and quickly adopt solutions (Bogers et al., 2019). Digitalisation changes the rules of the collaboration environment. The players in the ecosystems can benefit from a high connectivity in order to create a bilateral or multilateral collaboration. A deep dive into the complexity of collaborations, such as knowledge base, relationships, learning modes and proximities will follow.

1.3. Codified vs tacit knowledge: analysis on the knowledge base

The nature of the collaboration changes according to the type of knowledge owned by the company and diffused in the industry. There are industries dominated by analytical knowledge and others in which prevail synthetic knowledge (Asheim & Coenen, 2005; Liu et al., 2013; Moodysson et al., 2008). Analytical knowledge refers to the codified and universal scientific one (Asheim & Coenen, 2005), in which the exchange of valuable information occurs even across long distances as it can be easily transferred by communication technologies such as Internet (Liu et al., 2013). The outcomes of this kind of knowledge are documented in journal articles, project reports (Moodysson et al., 2008), electronic files or patent descriptions (Asheim & Coenen, 2005). In this case, the replication of knowledge allows the creation of economies of scale and, consequently, economies of scope (Grant & Baden-Fuller, 2004).

According to Liu et al. (2013), the analytical knowledge creation stem from a deductive rational process, thereby refers to the application of scientific laws. R&D usually plays an important role in developing technologies and innovations (Asheim & Coenen, 2005). Innovation is realized by creation of new knowledge (Liu et al., 2013), usually radical innovation (Asheim & Coenen, 2005) from well-known scientific principles (Moodysson et al., 2008).

Synthetic modes of knowledge creation relate to tacit knowledge that are difficult to codify. They are incorporated within an inductive process (Liu et al., 2013) because the focus of knowledge creation is solving specific problems that are context specific (Liu et al., 2013; Moodysson et al., 2008). For this reason, face-to-face interactions are fundamental for the creation of this type of knowledge, which should take into consideration also that national rules and regulations that differ from country to country and customers have different specific needs

depending on the institutional systems they belong to. Synthetic knowledge results from the experiences, through learning by doing, using practical skills and problem-solving capabilities (Asheim & Coenen, 2005). Innovations in this instance, are generated from the application or a new combination of existing knowledge (Liu et al., 2013; Moodysson et al., 2008), thus, this is reflected in incremental innovations (Asheim & Coenen, 2005).

These two different types of knowledge creation have a spatial implication as well. The knowledge creation process influences the structure of the network. Codifiable knowledge is not affected by spatial distance, the geographical proximity is not a requirement for its transferability, while tacit knowledge is more spatial sensitive (Moodysson et al., 2008). In the latter case, the interactive learning process of synthetic knowledge leads to consider the importance of proximity to customers and suppliers (Boschma, 2005) for organisations that utilize this type of knowledge. Geographically close partners are crucial for the exchange of knowledge, the network here is likely to be locally organized. In fact, companies where competitive advantage is based on context-specific knowledge are less involved in international collaboration and less likely to establish a global network structure (Herstad et al., 2014). On the contrary, analytical knowledge can promote radical knowledge in a globally organized network (Liu et al., 2013). The authors analysed the innovative networks in multinational companies and found that they are globally spread but they are organized differently, the structure strongly depends on the knowledge base.

1.4. Weak vs strong ties: analysis on collaboration relationships

Network relationships are a key element of collaboration because they constitute the underlying web on which partners build collaboration. They provide the structure for interactions between actors: according to Audretsch & Feldman (1996), highly skilled employees across all the level of the organization are not sufficient to promote innovative activities, while communications and interactions are pivotal in promoting knowledge transfer across networks.

The objective of inter-organisational systems is not only to exchange information but also to facilitate the establishment of different types of relationships (Peppard & Rylander, 2006). Relationships are classified in the literature based on whether they are characterized by strong or weak ties (Granovetter, 1973; Jack, 2005) depending on the level of interactions and types of knowledge of firms involved in the relations. According to Granovetter (1973), tie strength determines both intensity and quality of relations. On the one hand, strong ties refer to close relationships characterised by frequent interactions in which there is a solid trust between

partners. More interaction is beneficial to partner reliability and promote the transfer of tacit knowledge. According to Aral (2016), strong ties perform better when complex knowledge is exchanged. Jack (2005) argues that these types of ties give the opportunity to the company to enhance reputation in the network. In addition, these ties inevitably push companies to link with more technologically and culturally closer partners with cognitive proximity, operating at a local presence (Jack, 2005). This means that less diversification is created because companies have the tendency to ally with partners with similar knowledge. Thus, the risk of lock-in increases and the innovation process tends to slow down.

On the other hand, weak ties relate to the possibility of connecting with other social systems (Granovetter, 1973; Jack, 2005), they provide access to heterogeneous knowledge because they are likely to connect two socially distant networks (Aral, 2016). Relationships of weak types can be built even over large distances and with culturally different partners. Thereby, weak ties provide access to novel knowledge, non-redundant information (Aral, 2016) and resources (Jack, 2005) conducting to an efficient knowledge sharing (Granovetter, 1973). Trust is not as crucial as in strong ties relationships and, as a result, the risk of opportunism increase. As a consequence, companies need to focus their efforts on tools for controlling partners in order to avoid opportunism. In addition, knowledge transfer usually concerns codified knowledge that is easily transferable over long distances, hence, physical proximity is not so important, therefore technologies can help to establish these relationships by means of communication technologies (Peppard & Rylander, 2006). The presence of both types of ties improve effectiveness, as the two forms provide distinct resources (Jack, 2005).

1.5. Exploration vs exploration: analysis on the learning modes

The competitive advantage of a company is enhanced by its ability to reconfigure internal strong competencies of advantage and develop new capabilities (Teece, Pisano, & Shuen, 1997). The literature uses the terms “exploitation” and “exploration” to define these two concepts (e.g. Lavie, Stettner & Tushman, 2010; March, 1991; O’Reilly & Tushman, 2004;). On the one hand, internal resources and know-how, similar external knowledge, routines and procedures, past experiences, established knowledge, path dependence are hallmarks of exploitation. On the other hand, exploration encompasses the development of new ideas, experimentation of new technologies, accumulation of knowledge and learning from other organizations. The essence of exploitation is captured as “the refinement and extension of existing competences, technologies, and paradigms” (March, 1991, p.85), associated with “building on the

organization's existing knowledge base" (Lavie, Stettner & Tushman, 2010, p.114), while exploration is defined as "experimentation of new alternatives" (March, 1991, p.85) that "entails a shift away from an organization's current knowledge base and skills" (Lavie, Stettner & Tushman, 2010, p.114). As a result, an organization is continuously learning. Therefore, learning is a common basis of the two approaches and the difference lies in the trajectory, that may remain in the existing trajectory or take a new and different path (Gupta, Smith, & Shalley, 2006). Moving through the already established trajectories means learning "via local search, experiential refinement, and selection of existing routines" while, "learning gained through processes of concerted variation, planned experimentation, and play" refers to a process using an explorative approach (Baum, Li, and Usher, 2000, p. 768). The former trajectory follows a sort of incremental learning path (Gupta, Smith, & Shalley, 2006) where past experiences and established routines form the basis for a gradual increase in knowledge.

Exploitation improves immediate performance in the short-term even if organizations that implement exclusively this approach could suffer from obsolescence (Levinthal & March, 1993). Exploitation can lead to suboptimal routines (March, 1991), whereas exploration is characterised by uncertain returns related to the high costs of experimentations, long-time horizon and more risks related to future returns (Baum, Li, and Usher, 2000; March, 1991). In a turbulent environment, adaptation is essential (Teece, Pisano, & Shuen, 1997), allowing an organization to learn from external responses and, as a result, it can learn also from past experiences how to better allocate resources between the two approaches (March, 1991) in order to find the right equilibrium. According to Lavie, Stettner & Tushman (2010), exploring is a transition phase that culminates in exploiting: at the beginning, the organization experiments new technologies but only after applying the acquired technology several times, these procedures become familiar concepts and routines "stored" in the knowledge base of the firm.

The firm should balance exploitation and exploration (March, 1991), finding the right trade-off to prosper and survive (Levinthal & March,1993). The literature is split in two schools of thought: one sees exploitation and exploration as a continuum, the other one considers them as a choice (Burgelman 2002; Lavie, Stettner & Tushman, 2010). The two main ideas in the literature about how to balance these two approaches are: "ambidexterity" (Benner & Tushman, 2003¸ O'Reilly & Tushman, 2004) and "punctuated equilibrium" (Burgelman, 2002; Levinthal & March,1993), known also as "temporal separation" (Lavie, Stettner & Tushman, 2010).

The "ambidextrous organization" can at the same time pursue exploration and exploitation (O'Reilly & Tushman, 2004). The simultaneity of the mechanism varies according to the size of the firm. Whilst in small-medium firms this aspect could be reached through functions that

exploit the knowledge base and functions that explore the external competences and experiment new processes, in large companies this difference is seen between units. In a multinational company, this translates into allowing cross-fertilization among business units, enabling new units to share crucial resources from the traditional business but, at the same time, preventing cross-contamination to ensure that new units maintain their distinctive resources, structures and processes (O'Reilly & Tushman, 2004). It is easier to find this approach useful in large multinationals with multiple and poorly connected domains (Gupta, Smith, & Shalley, 2006).

The other school of thought (Burgelman, 2002) deems a choice between the two ways of learning as necessary. As a matter of fact, the "punctuated equilibrium" considers the temporal perspective of the balance where a company switches through periods of exploitation and periods of exploration, establishing a more practicable way to stay ahead the technology enhancement. This represents a more appropriate approach for a single domain, such as a single firm (Gupta, Smith, & Shalley, 2006). In this instance, proactive management is essential to coordinate transitions from periods of exploitation to periods of exploration (Lavie, Stettner & Tushman, 2010). Furthermore, management has an active role in recognising periods in which to explore new knowledge and periods in which it is appropriate to exploit existing skills.

The dichotomy between exploration and exploitation need to be considered in the network of alliances, as any firm can be involved in a variety of alliances (Rothaermel, 2001) with different objectives depending on the underlying motivation (Koza & Lewin, 1998). Exploitation alliances, often in form of licensing, franchising and networks, concern the creation of synergies with existing resources combined together among partners and, therefore, fostering "joint maximization of complementary assets by sharing in the residual returns from a business activity" (Koza & Lewin, 1998, p.256). The authors differentiate them from explorative alliances in which the intent is the discovery of new opportunities, usually through co-operative learning networks. Faems et al. (2005) found that exploitative and explorative collaborations have different implications for innovation performance. Exploitation alliances are characterised by clear job responsibilities and centralized procedures, whilst exploration refers to experimentation supporting novelty more than efficiency, in which roles are less clear and partners rely on personal and informal coordination. As changes occur in strategy, internal management or external environment, the objective of the alliances co-evolves as well in order to meet the objectives being pursued at that time (Koza & Lewin, 1998).

1.6. Global vs local: a proximity analysis

In addition to all the dichotomies dealt with above, the importance of proximity plays a crucial role in determining a global expansion rather than a regional one. Digitalisation opens up connections even over long geographical distances requiring limited resources (Enkel et al., 2020; Porter, 1996) and enabling the creation of a global innovation network. Codified knowledge is more easily transferred over long distances, but this is not the case for tacit knowledge, which is more suitable to expand locally, as it requires more interactions. It is clear that global relationships are more prone to exchange codified knowledge, resulting in a heterogeneous knowledge base, thanks to interactions with even culturally distant countries. However, it is important to consider that global expansion entails weak ties among partners where trust is not the key element of collaboration.

In contrast, local relationships are characterised by frequent interactions that convey strength to ties between network players, where trust holds sway. In such a context, tacit knowledge is more easily transferred. A potential downside of local expansion to be wary of is the similarity of knowledge that might determine a less innovative output from these relationships. In order to work efficiently, collaborations between firms in the network should involve both types of relationships for different functions. The choice of the network composition determines the degree of the innovation process: to fully exploit the positive impact from collaborative networks, the different types of partners should be as diverse as possible (Nieto & Santamaría, 2007). Furthermore, the different objectives of collaborations determine the strategies that organizations can adopt. For instance, if an organization needs to acquire new analytical knowledge in the market, it can exploit weak ties developing partnerships. On the contrary, if the knowledge has to be tacit and more context specific, the company should develop strong ties and adopt other strategies to acquire them, such as acquisition or the establishment a local presence with greenfield investments.

In order to understand the extension of a network, it is necessary to take into consideration the concept of proximity. It should be analysed in depth to understand how and with which tools a collaboration can work effectively. Proximity is considered by Boschma (2005) as a feature that reduces uncertainty by promoting more effective coordination. Proximity can be perceived from the point of view of geographical and cultural distance, institutional proximity, technological advancement, social proximity etc (Anzola-Román et al., 2019; Knoben and Oerlemans, 2006). Usually, proximity enables an easier exchange of knowledge (Capello,

1999), enhances the performance of a firm and determines its survival in inter-firm collaborations (Knoben and Oerlemans, 2006).

Geographical proximity facilitates collaboration between partners, as a matter of fact, physical proximity enhances the frequency of contact (Gray,1985) and foster the transfer of knowledge and innovation (Knoben and Oerlemans, 2006). When two organisations are geographically close, it is easier to transfer both tacit (Boschma, 2005) and codified knowledge (Knoben and Oerlemans, 2006). The closer the two countries are geographically, the more likely it is that their culture is similar and consequently, the possibilities for an effective collaboration increase, favoured by social interactions and trust (Boschma, 2005). The geographical distance between two countries that want to collaborate is not only relative to objective measures such as actual distance, costs and time, but it also includes the different perceptions of the distance that the actors may have (Torre and Rallet, 2005). The geographical limits and transport constraints, enclosed by Kirat and Lung (1999) in the meaning of "physical proximity", are not the only factors impacting on collaborations, as also perception of distance by actors plays an important role. According to Johanson & Vahlne (2009), the farther apart two countries are, the more difficult it is to build relationships.
However, geographical proximity favours collaboration, but this is not a distinguishing feature of it, as in many cases long distances are offset by temporary activities and face-to-face meetings (Torre and Rallet, 2005), avoiding the high costs of permanent co-location. The authors underlined that globalization favoured workers mobility thanks to a development in transport, translating into reduction of costs and faster connections. On top of that, globalization forced communication technology improvement, resulting in a quick process and transfer of information. These improvements strengthened the coordination between distant countries. Therefore, the importance of geographical proximities as an element of network, depends mainly on the type of knowledge that characterize a company and on the phases of industry life cycle.

In synthetic knowledge creation, close interaction is a crucial element for the effective functioning of a network. Strong linkages with production, suppliers and customers support network collaboration at a regional level, even if the company is operating on a global scale (Liu et al., 2013). In the case of analytical knowledge, a global innovation network is organized through communications even at a long distance without compromising collaboration. In this case, globalisation reduces distances between countries and if combined with digitalisation, it favours the creation of links over long distances and the preservation of constant interaction. The engagement in innovative activities involving tacit knowledge, typical of the early stage of

an industry life cycles, increases the importance of geographical proximity and the trend for the firms to cluster (Audretsch &Feldman, 1996). The authors suggest that in the early stages of the process, standards are not yet established, and the dominant design has not yet emerged.

In some cases, the global inventor network does not necessarily require geographical proximity because coordination is driven by common norms, standards (e.g. ISO 9000 standards) and shared procedures. According to Torre and Rallet (2005), in the implementation of a collective project, the tasks are clearly defined and divided between units in different countries with coordination of the technical aspects. In this respect, geographical distances are not considered an issue for interactions that does not requires certain types of close face-to-face relationships or co-location of partners. However, geographical distance cannot be evaluated on its own as, in some cases, it is offset, or eventually substituted, by other types of proximity (Boschma, 2005). Nevertheless, companies are often used to establish a presence in the nearby markets as a first step and, only when they have enhanced their resources, they broaden their horizon of expansion, reaching also distant and different countries (Johanson & Vahlne, 1977).
The issue that may occur in the first step of the expansion process is pointed out by Boschma (2005): the possible negative effect of collaborating only with close countries, especially in high tech regions, translates into the risk to remain stuck in one region and, in the long term, it can result in a loss of flexibility, creativity and openness. In general terms, geographical proximity favours constant interactions, face-to-face relationships, increases trust and reduces opportunism but, as companies expand outside the region, they also look to increase diversification, reaching the aimed level of flexibility, creativity and openness.

Cultural differences can have a great impact on collaboration between two or more organizations. Thus, another proximity to take into account is the cultural proximity. It refers both to the cultural differences between organisations from different Continents, States, Regions, and to the cultural differences between the actors of the same organisation (Knoben and Oerlemans, 2006). The latter refers to organizational culture and some scholars categorized it as “organizational proximity” (e.g. Boschma, 2005; Kirat and Lung, 1999). In organisations that share similar cultures, habits and values, interactions are expected to be facilitated by common interpretations and routines (Boschma, 2005). In addition, partners might be located in different parts of the world, and consequently, they may have a different culture. The cultural context in which companies operate affects the way firms deliver outcomes. In general, when a company wants to expand globally, not only does the geographical distance increase but also the cultural diversity tends to be greater. Cultural proximity is strongly linked with cognitive proximity (Knoben and Oerlemans, 2006). It is referred to analogies in the interpretation,

understanding and evaluation of situations among the actors (Wuyts et al. 2005). Different skills and competencies involved in a process of innovation create a diversity that need to be combined in order to achieve the common objectives of the firm. Cognitive distance should reach an optimal level (Wuyts et al., 2005), in the sense that it should be not too distant (Boschma, 2005; Torre and Rallet, 2005) to allow a common understanding and an easier coordination but, at the same time not too homogeneous, because otherwise the advantages of novelty and the value of partner's knowledge are lost (Wuyts et al., 2005) endangering the output of innovation (Boschma, 2005).

Another type of proximity to address relates to the technological advancement. The highly evolving nature inherent to technological development requires the R&D function to continuously adjust to the dynamic nature of the environment by integrating external knowledge and know-how. The recognition of the value of new technologies is related to the previously mentioned "absorption capacity" (Cohen & Levinthal, 1990), as it provides the organisation with the ability to identify more accurately the potential of new technologies in order to proactively incorporate new opportunities. Technological proximity concerns the common technological understanding, similarities in technology used in processes (Cantner & Meder, 2007). With physical and cultural distance out of the picture, two technologically close companies are more likely to cooperate, even on a global scale, than two technologically distant companies. Indeed, technological proximity facilitates collaboration between organizations because of greater understanding and common interpretation (Knoben and Oerlemans, 2006). Technological proximity, as well as the cognitive proximity, should reach an optimal balance, enabling firms to comprehend technology aspects but, at the same time, different enough to innovate (Cantner & Meder, 2007; Knoben and Oerlemans, 2006). With the connections of different know-how better results can be achieved by keeping up with technological progress. Furthermore, the authors Anzola-Román et al. (2019), have pointed out that the importance of technological proximity depends on the phase the innovation process is currently going through. In the initial stage, some degree of technological overlap with their innovation partners is necessary. However, in the consequent phases, too close technological proximity may prevent the development of innovative performances. Cognitive proximity and technological proximity are similar concepts, but the latter refers to the level of effective understanding between the actors, not only to the efficiency of communications (Knoben and Oerlemans, 2006).

The last type of proximity that influence collaboration is institutional distance. According to Teece, Pisano, & Shuen, (1997), institutions are critical elements in business environments. Institutional proximity includes formal institutions, the ones that Kirat & Lung (1999, p.30)

called “institutional matrix”, such as legislative conditions, laws and regulations at the national and international level, that influence informal institutions such as cultural norms, habits and practices at organizational level (Boschma, 2005; Kirat and Lung, 1999). Informal dimensions often have a stronger impact as an impediment to internationalisation than formal rules and regulations, especially in distant countries (Yamin & Kurt, 2018), which are most likely to have a different culture. In contrast, similarity in the institutional environment leads to an easier coordination of inter-company activities. Common space of representation based on similar legislative rules and procedures facilitates knowledge transfer and collective learning (Capello, 1999). Collective learning consists in a dynamic and cumulative learning process that persist over time for the creation of new knowledge through transfer and exchange of knowledge (Cantner et al., 2010). Such knowledge is then institutionalised as rules, routines, norms that will guide future research actions. The institutional structure should guarantee stability but, at the same time, openness and flexibility to avoid possible situations of inertia (Boschma, 2005). In addition, Wang, Hong, Kafouros, & Wright (2012), provide evidence that institutional environment influences the international collaborations and acquisitions offering advantages, but also imposing different constraints. In this context, it is clear that internationalization become a fundamental aspect to consider in order to possibly mitigate the effects that have proximity on the transfer of knowledge for collaborations.

2. INTERNATIONALIZATION AS A FORM OF LEARNING

2.1. Learning advantages in internationalization

Internationalisation is a process in which a company establishes its presence abroad in a variety of way, choosing the target markets, timing and entry modes. The process of internationalisation enables firms to grow and to develop a range of collaborations, establishing networks in order to reach different types of knowledge.

The main reasons that justify the internationalisation process are: exploitation of different types of advantages such as strategic resources and key assets (Luo & Tung, 2007; Mathews, 2006), creation of new value from other markets, possibility to reach different customers or suppliers and enhancement of productivity through economies of scale (Bartlett & Ghoshal, 2000). Furthermore, Bartlett & Ghoshal (2000) argue that in a globalised and dynamic environment, it is not internationalisation that makes a firm face global international competition because, sooner rather than later, large multinationals will reach the firm's competitive environment. Learning and adaptation can be the solution to cope with the increasing number of competitors (Hitt, Ireland & Lee, 2000; Johanson & Vahlne, 2009).

However, the growing need for innovation in the marketplace is driving companies to expand abroad in search for new resources or missing skills to compete on an equal ground. International expansion offers companies new opportunities to spread their skills and competences and develop new capabilities by learning from those of other countries (Bartlett & Ghoshal, 2000). International collaboration involves organizations from many parts of the world enabling growth and improvement of performance (Zahra, Ireland, & Hitt, 2000) the base for a powerful network. According to the authors, expansion offers a great learning opportunity which is higher the more foreign markets are accessed. Companies can have access to a variety of knowledge that may be more or less related to existing knowledge.

The learning opportunity is reflected not only in the acquisition of new skills, but also in the knowledge resulting from the interactions between companies, which in turn generate new and valuable skills on the basis of existing ones (Johanson & Vahlne, 2009). In addition, the ability to internalize new diversified knowledge fosters technological learning, i.e. the ability to build, preserve and enhance dynamic core competencies, and foster innovations (Hitt, Ireland & Lee, 2000). The international diversity of knowledge is positively related with depth and breadth of technological learning (Zahra, Ireland, & Hitt, 2000). However, according to the authors, the

diversity of knowledge is negatively related to the speed of technological learning, due to information overload.

The knowledge stock of a firm that decide to expand internationally is enriched as a result of local interactions and the exposure to different innovation systems (Zahra, Ireland, & Hitt, 2000). Another fundamental element of internationalisation is the set of relationships that arise between companies from different backgrounds. It is through relationships that the company learns, builds trust and creates commitment - all fundamental elements of internationalisation (Johanson & Vahlne, 2009).

Internationalisation, on the one hand, provides the opportunity to expand networks of collaboration and, on the other hand, to access more knowledge, either codified, tacit, related or not. The current interlinked globalised economy described by Mathews (2006) as "worldwide web of interfirm connections" (p. 9) affects the internationalisation process and create new patterns for the expansion.

However, the process of internationalisation requires some efforts in order to create an efficient coordination of resources, flow of information and knowledge. This entails an effort from the companies including the investment of dedicated resources, the awareness of opportunities and problems that need be solved and the knowledge of relevant and influent factors in the foreign market where the company intends to establish (Johanson & Vahlne, 1977). According to Eriksson, Johanson, Majkgård, & Sharma (2015), the costs associated with internationalisation are influenced by the experiential knowledge, which refers to the knowledge of customers, markets and institutional factors that can be acquired by carrying out activities abroad, through presence in the host countries. "These costs are related to collecting, encoding, transferring, and decoding knowledge, as well as changing the resource structures, processes and routines in the organization" (p. 352).

Considering the points made so far, the decision to expand abroad can take two main directions. Companies could want to expand abroad in developing countries to exploit low-wages, tax advantages available raw materials or cheaper assets. In contrast, the choice of internationalization could be undertaken in order to acquire new knowledge in developed and knowledge-intensive regions. In both cases, the global value chain is fragmented into activities that are dispersed but interconnected around the globe (Cano-Kollmann et al., 2018). In this thesis the focus is on companies that want to expand in developed and emerging countries in order to create collaborative innovation through collaboration.

More than thirty years later, Johanson & Vahlne (2009) refined their classic theory (1977) with the aim of emphasizing the importance of network collaboration in internationalization. The

network provides easier market access, a more flexible financing system, an extended distribution channel and intensified contacts with international partners (Coviello, 2006).
The activities of innovation is originated mainly by R&D functions that, especially in large companies, play the pivotal role of knowledge accumulation, subsequently integrated into routines and then, transferred in the form of tacit knowledge to support search for new innovations (Capello,1999). A firm can benefit from economies of scale when establishing an R&D department in a single country, thus avoiding duplications of research programmes or the setup of several foreign departments in order to be closer to the main places where it creates value (Torre and Rallet, 2005). However, the choice of the establishment of R&D departments depends on several factors such as strategies adopted, types of knowledge involved, learning modes; all aspects that will be analysed later in this chapter.
In order to better understand the impact of collaboration and innovation on the internationalisation process, it is deemed necessary to start from the main international expansion theories.

2.2. Main theories of internationalization

Internationalization entails different aspects, but the two focal points are why companies internationalise and what are the favourable conditions to do so. There are many theories that take into account different patterns and scenarios, distinguishing between multinationals, small and medium-sized enterprises, developing and developed countries, and firms that were born globally, operating in the global market from day one. After a review of the literature, for the purpose of this work, the most interesting models to be analysed are: OLI paradigm, Uppsala model, LLL theory and Springboard perspectives. They will be briefly illustrated to outline their main features.

- *OLI model*

The OLI model explains the internationalisation process of European and American multinationals corporations in the post-war period. According to the eclectic paradigm (Dunning, 1977), also called OLI model, where OLI stands for Ownerships, Location and Internalisation, a company needs to consider these three key features in order to choose how the expansion will take place. A company should attain ownership, location and internalisation advantages in order to engage in Foreign direct investments (FDI). Ownership refers to a valuable resource owned by the company that provides it with a

competitive advantage, for example the brand name (reputation), organizational capabilities to learn, organizational practices or transfer of managerial skills (Zeheer, 1995).

However, there may be some obstacles in the transferring process, such as foreign languages, cultural diversity, lack of understanding of customer needs and institutional barriers. Dunning (2000) splits the "O" advantages in static, referring to the income generated by resources and capabilities owned by a firm at a given point in time, and dynamic, as the ownership advantages represented by resources and capabilities which not only generate but also increase the income from these assets. They tend to be context-specific, differing from country or industry.

Location advantage refers to characteristics of the geographical area in which the company wants to expand, such as presence of low-cost raw materials, tax advantages and cheap labours. If the company does not identify the advantage of localisation, it is more efficient to produce in the home country and then export goods and services to foreign markets rather than to make large investments abroad (Dunning, 2001). Furthermore, institutions will play a crucial role in determining the location advantages, fostering or discouraging foreign investments (Dunning, 2001).

Internalisation refers to the advantage brought by outsourcing some of the value chain activities in a foreign market that consequently requires coordination efforts to link multiple diverse economic activities. For some activities, i.e. non-core ones, there is a clear advantage in transferring them to another country, where they can be performed at a lower cost or given the presence of specific skills and competences in the host-country.

When all the above-mentioned advantages are simultaneously present, then a company may have convenience in committing to foreign direct investments. Moreover, this theory argues that the investing firm that owns the previously described three advantages must be able, not only to exploit them abroad, but also to effectively access and combine them with the resources and capabilities of the foreign market (Dunning, 2001). Otherwise, the companies should opt for a different mode of entry, a less costly alternative such as export, licencing, franchising.

These advantages vary from sector to sector, region to region and company to company. In particular, it is important to note that different contexts with different organisational, economic and political characteristics, influence the configuration of the OLI paradigm (Dunning, 2000).

Furthermore, Dunning (2001) explores the importance of digitalization and relational assets. He argues that the increasing importance of accessing external resources and

integrating them internally with the existing ones, requires the company involved to build harmonious and strong links that can add value to the exchange relationship.

- *The Uppsala model*

Another relevant model to consider is the Uppsala model. It focuses on small-medium enterprises' process of internationalisation. There are several modes of entry to expand abroad and companies should choose the most appropriate one taking into account different factors. A group of Swedish researchers from the Uppsala University developed a model of internationalization describing the phases that a firm usually adopt in order to internationalise. The Uppsala internationalisation model (Johanson & Vahlne, 1977) theorises the internationalisation process as a series of sequential steps that companies usually follow in order to intensify their presence abroad by gradually increasing their commitments to foreign markets. The model identifies the two main elements to be considered when deciding whether to internationalise: market commitment and market knowledge. The former refers to the degree of commitment and resources deployed in terms of investment, while the latter addresses the knowledge of opportunities and relevant aspects of the foreign market (Johanson & Vahlne, 1977; 2009). According to the authors, the knowledge of opportunities or problems in the foreign market allow companies to take decisions of investment in that market.

The Uppsala framework is a dynamic model in which experience builds knowledge of the foreign market that influences future decisions on commitment which, in turn, affect outsourced activities that lead to learning through experience, reinforcing once again the virtuous circle (Johanson & Vahlne, 2009).

With the aim of properly handle international activities, according to the model, an incremental learning process is followed before establishing a stable presence in the foreign country. The Uppsala model stresses the reason why the internationalisation process needs to be a gradual one: this is because it may take time to develop, as a company needs to fulfil a process of learning of the foreign market, as well as it needs to determine the way and the degree of commitment to the foreign market. The internationalisation efforts develop in an incremental way: as soon as bilateral interactions between the parties translate into consolidate knowledge of each other's resources and capabilities, a process of cumulative learning is initiated (Johanson & Vahlne, 2009). According to this theory, companies enter new markets through export or agents before establishing a foreign subsidiary for sales, production or R&D.

Experiential knowledge of the foreign markets enables companies to grasp the concrete opportunities of the market (Johanson & Vahlne, 1977).

Johanson & Vahlne updated their model in 2009, focusing more on the set of interdependent relationships forming the network and on the learning process. The latter develops through experiences in the foreign market that will contribute to overcome the difficulties arising from not being a local business. The revised model argues that commitment is related to the strength of the relationships in the network. The level of commitment is defined by a decision change in the mode of entry, the amount of investments, the organisational changes and the degree of dependency from the partners. According to the authors, a change in commitment determines the strengthening or weakening of the relationship. Internalisation process entails an important implication: a company involved in a network characterized by strong relationships with partners, it is facilitated to expand abroad if it sees interesting opportunities to exploit in the valuable network developed by the partner in the foreign markets.

Finally, the beginning of internationalisation process is not strictly dependent on the incremental process of entry modes, but it relies on the knowledge, trust and commitment to the firm's specific relationships, i.e. existing connections of partners in foreign markets can be used for expansion. Thus, the relationships become the link to acquire knowledge and resources from foreign markets and the presence on the market can be crucial to build those relationships.

Multinational enterprises from emerging countries, such as Asian multinationals, began to internationalize in Europe and some scholars started to theorise their development of internationalisation process in the developed countries. The two main relevant theories are LLL framework and Springboard model.

- *LLL framework*

The LLL framework (Mathews, 2006), which stands for Linkage, Leverage and Learning, envisages a totally different approach to internationalisation.

A company entering the process of internationalisation aims at seeking strategic assets through the acquisition of complementary resources and competences from outside, in order to overcome the limitations and internal constraints of the domestic market. In this case, a network is created in order to acquire resources and know-how, otherwise absent in the organization, to succeed in the global market (Buckley et al., 2007). The

multinationals referred to in the model are what the author called 'Dragon Multinationals', i.e. Asian multinationals that expand their presence abroad from a weak background, without specific skills, resources or knowledge, without proximity to knowledge-intensive regions, but which successfully internationalise. The creation of a global market, i.e. free trade, deregulation, integration of financial systems and high mobility, allowed Asian firms to grasp the opportunities that this new scenario was offering: these firms "regard the world market as their home" (Mathews, 2006, p.7). This model redefines the boundaries of the organizations, creating a valuable network of actors beyond the domestic market with the aim of gaining more sophisticated knowledge. These firms in developing country are latecomers in the global economy and they are using a reverse perspective in order to accelerate the internationalisation process: pull from abroad to adapt and keep up with technological and innovation factors (Mathews, 2006). The pull approach implies going abroad to develop interactive relationships, engaging in an active role. This translates into not just being a passive listener to the foreign environment but being a proactive investor in foreign markets. According to this view, companies need to send executives, important representatives abroad to develop credibility and trust in prospective partners and, furthermore, make greater investments to deal with the host-countries (Bartlett & Ghoshal, 2000). In their article, the authors brought the successful example of Ranbaxy, a company where the senior executive decides to commit resources to create an organisation in which managers from other parts of the world participate in the key decisions of the company. These multinationals perceive the market as a reservoir of resources from which to tap into and they do not consider it as a place full of competitors: the final goal of internationalisation process is the exploitation of these resources (Mathews, 2006). The change of mindset consists in finding strategies where being a late mover is an advantage rather than a disadvantage (Bartlett & Ghoshal, 2000). This quest for lacking resources outside the home-country create a network of knowledge between partners from different countries.

Thus, the Linkage between different countries allows to build a knowledge sharing process across the network and internalize the knowledge through learning from existing players. Companies are continuously learning from the new information acquired in foreign markets such as the pattern of demand, differences in local consumers needs and preferences, challenges and opportunities that they will have to deal with. Depending on where the innovation is carried out, according to this theory, companies do not focus on internal R&D, but rather seek outside the lacking resources

(Anderson & Sutherland, 2015). In a broader way, this reflects the concept of open innovation (Chesbrough, 2003) where valuable ideas should flow in the market in order to create useful knowledge. Integrating external knowledge to internal one and combining them (Bogers et al., 2019; Zahra, Ireland, & Hitt, 2000), allow organizations to create new products or services and improve the efficiency of processes. Companies in developing countries, especially those in Asia, which want to acquire the missing resources, enter a new market mainly through mergers, acquisitions of existing firms or via partnerships with local firms that already have accumulated experience with the market (Mathews, 2006). According to the author, the internationalization of firms from developing countries have three distinctive features. Firstly, the accelerated process of internationalisation exploits existing connections to reach other foreign markets and leads to a gradual growth of global presence, adding one country after another. Secondly, the organizational innovation is pursued maintaining a global orientation, using common rules and guidelines to maintain a common vision and strong coherence, but also giving autonomy to the establishments in the foreign markets. This allows to create local responsiveness that fosters relationships and valuable connections. Finally, the strategic innovation is implemented by relying on resources of other firms, in particular, creating connections with local companies (e.g. using joint ventures, licensing new technologies) allow them to enter markets even without a strong knowledge base. In Mathews' words, the latecomers should find a strategy to "complement" strategies of incumbents in the foreign market. International expansion entails different modes of entry, in this model they are chosen accordingly to resource linkage, leverage and learning. Moreover, the way in which companies decide to enter the new market also depends on the degree of uncertainty in the market, which has a different impact depending on the size of the company. Small and medium-sized enterprises will expand abroad mainly through joint ventures and partnerships with large firms to enhance reputation (Lu & Beamish, 2006), to reduce uncertainty and investment risk. On the contrary, large multinationals by definition have more resources and can make larger investments, so that they can engage in more expensive and strong forms of commitment, including greenfields and acquisitions (Luo & Tung, 2007).

Accelerated internationalisation expansion is facilitated by the linkages with partners to access external resources and the ability to leverage already existing connections in the foreign market in order to learn, and consequently improve, organizational learning (Mathews, 2006).

- *Springboard theory*

The last theoretical framework considered is the Springboard theory, developed by Luo & Tung (2007), which refers to the internationalisation process of enterprises from emerging countries. As in the previous theory, companies from those countries use overseas expansion as a springboard to emerge in the global marketplace. Many multinationals (MNEs) overcome their status of latecomer using "aggressive, risk-taking measures by proactively acquiring or buying critical assets from mature MNEs" (Luo &Tung, 2007, p.482) to offset their weaknesses (Kotabe & Kothari, 2016). The high-risk entry practices such as acquisitions, enable these firms to secure them the lacking assets and prevent competitors from accessing the crucial resources (Luo & Tung, 2007).

The strategic assets needed to compensate the competitive disadvantages should be acquired through rapid market expansion (Deng, 2009). The appealing strategic assets are technologies, R&D, know-how, managerial expertise, distribution channels, brand names, human resources, different target of customers, natural resources to exploit in risky countries. In this way, they can acquire the entire package of resources and systems of innovations from foreign firms (Luo & Tung, 2007).

Their intent to expand is also driven by the desire to reduce the influence of the national institutional context and its constraints. Sometimes, the institutional context obstacle the process of internationalization due to the restrictive policies, bureaucracy, corruption, lack of intellectual legal protection for proprietary rights, judicial systems etc (Buckley et al., 2007). The reasons to internationalise are several, such as dynamic nature of technological change, pressure of global competitors, avoidance of restrictions imposed by exporting, support from the domestic government by means of privileges and benefits for foreign expansions (Deng, 2009; Luo & Tung, 2007; Wang, Hong, Kafouros, & Wright, 2012). Moreover, gaining preferential financial treatments by home and foreign markets, increasing company size and reputation (Luo &Tung, 2007) are further objectives pursued by these MNEs to internationalise.

The theory refers to the outward FDI, in detail acquisitions and mergers, adopted by emerging market multinationals aiming at having the full control of the sub-units. The acquisitions pertain to a systematic and recurrent process with which the company seeks to establish a global presence (Luo & Tung, 2007). Outward activities are strongly linked with internal activities and, in a dynamic capabilities' perspective (Deng et al., 2018), to be successful, the emerging multinationals need to simultaneously exploit core

competences while exploring new opportunities (Luo & Tung, 2007; Teece et al., 1997). A kind of ambidextrous internationalisation strategy should be adopted by companies in emerging countries to consolidate their domestic position, while exploring new opportunities abroad (Deng et al., 2018). In the international context, exploitation strategies refer to the ability complement and reshape resources allocation within the international environment; the benefits from the internal market (e.g. institutional assistance) can foster the embedding of new foreign assets. Instead, exploration international strategies concern the capacity to build new capabilities and enhance existing ones by means of accelerated process of internationalisation with acquisitions mainly in developed economies (Deng et al., 2018). These two perspectives ensure survival and growth of the multinationals in the global market (Kotabe & Kothari, 2016).

To sum up, we can see that FDI can give several advantages. In the former theories like OLI model (Dunning, 2001) and Uppsala framework (Johanson & Vahlne, 1977), companies internationalise with a logic of exploiting their knowledge abroad in different markets in order to leverage the advantages of internal resources. In the Uppsala model (Johanson & Vahlne, 1977; 2009), FDI is one of the final steps of the internationalization process because it requires more resources that most of the time small-medium enterprises cannot reach because of limited resources owned. In contrast, large enterprises are more prone to FDI because they have more resources to invest. The accelerated pace of technological progress, the dynamic environment and globalisation have created new opportunities for companies to expand more rapidly across borders and collaborate with other firms for innovation (WIPO, 2019). The perspectives have changed, as the need to already possess the competitive resources in the domestic knowledge base is no longer a requirement for internationalisation: companies can find resources to compete in the market through closer connections with external partners who provide the lacking resources. The creation of multiple connections throughout the world provides a company with the opportunity to be involved in a knowledge network, an aspect that is increasingly taken into account by recent theories.

In addition, nowadays MNEs are engaged in a global value chain in which the various functions are dispersed among different countries (Cano-Kollmann et al., 2018). As a consequence, more recent theories, such as the LLL theory (Mathews, 2006) and the Springboard model (Luo & Tung, 2007), have seen foreign direct investments as particularly important modes of entry as

they provide direct access to different contexts, establish direct linkages, foster trust-building and intensify communications.

2.3. Implications of internationalization process

Internationalisation implies managing a variety of relationships in the global market, which involves managing diversity in terms of culture, technological advancement, innovativeness, social and economic development. The more a company is exposed to different cultures and institutions, the more its openness and the opportunities of learning are enhanced (Zahra, Ireland, & Hitt, 2000).

In order to deal with international partners, a company is confronted with a series of frictions that are defined as opposing thoughts or actions, arising from implicit beliefs and organisational norms with respect to the international transactions (Luo & Shenkar, 2011). Cultural distance, political and societal environment between countries act as a friction for the establishment of foreign firms. In this sense, engaging in FDI means facing greater frictions than engaging in contractual agreements (e.g. franchising, licensing, co-partnerships etc), where the responsibilities and tasks are clearly attributed contractually. In contrast, companies committing to FDI will be engaged in daily activities, routines and interactions with foreign firms abroad coping with a challenging environment.

In general, doing business in different countries is not easy because each country has its own specificities in terms of culture (Hofstede, 1994). Cross-cultural collaborations require a careful analysis of organizational and national contexts (Jensen, 2015). According to Hofstede (1980), differences at national level are identified along four cultural dimensions: uncertainty avoidance, tolerance of power distance, individualism vs collectivism and masculinity vs femininity. Later the author added the fifth dimension: the time horizon (Hofstede, 1994). These factors are worth to be kept in mind as they can affect collaboration especially in countries that differ significantly from the domestic one.

In countries characterized by high levels of uncertainty avoidance (the tendency to not tolerate uncertain and ambiguous situations), organisations are inclined to follow societal norms, using centralized structure; while in low uncertainty avoidance countries, proactive thinking is promoted and people are willing to take risks and responsibilities.

According to Hofstede (1980), another element characterising the culture of a country is power distance, which refers to the level of acceptance of power differences in hierarchies, thus, the tolerance of non-equal distribution of power in society. Countries with high power distance

have strong respect of the relevant supervisor-subordinate relationships (Basabe & Ros, 2005) and tend to utilize tall hierarchies and tight control (Luo & Shenkar, 2011), whereas low power distance emphasise flat structure and participative supervision (Hofstede, 1980).

Individualistic nations are characterised by the importance of the personal achievements and independence. These are characteristics of developed and Western countries (Hofstede, 1994), while in high collectivistic countries, for example Confucianist Chinese countries and African countries (Basabe & Ros, 2005), there is a strong organizational commitment, conformity, interdependence, sense of belonging and cooperation (Hofstede, 1980) where relationships prevail over tasks (Hofstede, 1994). These aspects have several consequences on innovation and cross-cultural collaboration.

Feminine countries emphasise relationships, compromises and negotiations, while masculine countries focus on achievement, decisiveness and competition (Hofstede, 1994). In order to deal with an international market, organizations should embrace cross-cultural collaboration for the connection of global and local knowledge to create a shared culture of innovation (Jensen, 2015) and make a cultural assessment.

Furthermore, Zaheer (1995) coined the word "liability of foreignness" to identify the additional costs MNEs incur in doing business abroad, which translate into a disadvantage for their subunits, which face unfamiliarity of the foreign environment, cultural, economic, political diversity and the need to coordinate across geographical distances. In addition, the liability of foreignness encompasses costs related to the spatial distance, such as costs of travel, coordination over distances, transportation; firm-specific costs deriving by the lack of roots in the foreign environment; costs associated with the lack of legitimacy in the host-country and costs imposed by the home-country such as particular restrictions (Zaheer, 1995). Yamin & Kurt (2018) associated the liability of foreignness to lack of foreign institutional knowledge. As a result, local firms' profitability can be higher compared with foreign subunits of MNEs. According to Johanson & Vahlne (2009), the more distant two countries are, the higher the liability of foreignness is.

To overcome this liability and cope with the competition of local firms, MNEs need to provide their foreign subunits with some firm-specific advantages (Dunning, 1977) in order to make the competitive advantage sustainable (Barney, 1991) or to replicate the advantages of successful local companies (Zaheer, 1995). In this way, they will be able to offset the liability. In terms of strategy, the conundrum here is the trade-off between global integration and local responsiveness (Bartlett & Ghoshal, 1989).

According to the revised Uppsala model (Johanson & Vahlne, 2009), the business environment is seen as a web of relationships where the network creation is emphasized. As claimed by the authors, the main obstacle affecting the choice of internationalisation is the “liability of outsidership”: this concept is associated by Yamin & Kurt (2018), to the lack of foreign business knowledge, thus referring to a more restricted concept of foreignness. The above-mentioned ideas of liabilities are related and engender uncertainty (Yamin & Kurt, 2018). The new concept identifies the specific difficulty an enterprise encounters when joining a network within a country or a region due to their status as non-local enterprises, compared to enterprises already in the network (called "insiders"). In the revised version of the model, the authors underline that the difficulties tackled by companies in the international environment are determined by issues relating to the relationship and the network specificity rather than the peculiarities of the country itself. In other words, they replaced market commitment with network indisership (Yamin & Kurt, 2018). They refer to the complexities of the learning process when a company enters a foreign market network. Initial contacts, requests of services, learning opportunities represent chances to enter the network and overcome the liability of outsidership. Being part of a network enables companies to enter in a series of relationships that facilitate the connections among different countries, even distant markets (Johanson & Vahlne, 2009; Powell, 1996). Nevertheless, collaboration between companies from different countries, as outlined above, can be hindered by several factors.

The different paths that lead to internationalization impact differently to innovative collaboration. According to the literature review proposed above, it seems that proximity is critical in fostering innovation, increasing the chances to collaborate. Among the numerous modes of entry in the global market, FDI are the ones that could reduce the geographical distance and thus facilitate interactions and cooperation.

2.4. The role of FDI in matching spatial proximity and global openness

International expansion provides an opportunity for a company to enter new markets and to work with different partners with varying degrees of intensity. Different ways of entry can be adopted in order to expand, ranging from exports, international agents, joint ventures, alliances, partnerships to the most committing forms that are Foreign Direct Investments (FDI). They are characterised by two types of investments: greenfield investments and Mergers & Acquisitions. In the former types, a firm establishes its presence in the foreign market from scratch with new facilities and operations undertaken by a company, while in the second type the expansion is

characterised by the acquisition or merger with an existing foreign company involving already existing facilities and organizations. FDI strategies can be tailored in response to the cultural differences faced by the firm at multiple levels, i.e. national, organizational, teams, individuals, translating into different decisions regarding timing and size of investment (Luo & Shenkar, 2011).

Core activities involving tight control require an entry strategy such as FDI because there is a specific need of more frequent interactions and a direct supervision of the operations. These types of entry in the foreign market influence positively the breadth, depth and speed of technological learning (Zahra, Ireland, & Hitt, 2000). This is reflected in an easy access to the peculiarities of the local market, direct contacts with local suppliers and customers, the possibility to have a close observation of the strategic moves of other companies and consequently access to tacit knowledge. A local presence in the territory in which a firm wants to invest is sometimes necessary to fully understand the dynamics of the cultural and behavioural background. In such a scenario, it is increasingly important to implement a decentralized structure where responsibilities are shared. As a result, more and more decisions are taken at a local level. Companies might prefer to directly own foreign activities rather than licensing or leasing the right to use the advantages to foreign agents or firms (Dunning, 2000). Collaboration through FDI enables the company to fully commit to a new environment, therefore the side effect of institutional distance is mitigated as well due to the immersion in another context, sometimes a completely different one.

In addition, the proximity to the local market enables rapid learning by obtaining timely feedback, allowing to adapt and to face changes in a timely manner. Dunning (2000) argues that the innovation in technological field made possible to codify and transfer knowledge: as a result, firms increasingly engage in licensing agreements instead of FDI. In contrast, there are cases in which, as seen for tacit knowledge, companies should establish a stable presence in the foreign market in order to fully comprehend the dynamics of the host-country. In addition, the literature recognises the presence of market failures such as bounded rationality, information asymmetry and opportunism. As a consequence, a company will not rely on arm's length transactions, rather it will prefer a stable presence in the foreign country in order to have more stable and lasting relationships with partners, institutions and consumers (e.g Buckley et al., 2007). Using FDI, companies can engage in collaborations sharing knowledge and building relationships based on a high degree of trust with stakeholders, resulting in more advantageous transactions. Trust is of the uttermost importance in uncertain environments (Johanson & Vahlne, 2009), as it can determine the level of commitment. FDIs represent a way to balance the various types of proximities and, at the same time, to develop a global presence abroad.

In this context, an FDI could be a moderator to balance these two tendencies, as in this way the company develops the global network reaching even culturally distant countries and, at the same time, ensures the spatial proximity to work with local partners reaching tacit knowledge. Foreign Direct Investments imply strong commitment in foreign markets in order to acquire different types of knowledge (Zahra, Ireland, & Hitt, 2000). Moreover, a high investment is required to establish the firm's presence in many countries.

National and regional authorities that sees internationalization as a source of opportunities will foster the foreign direct investments in order to encourage innovation across foreign firms. Some countries try to attract FDI for several reasons: enhance technologies and progress of the regions, increase employment, bring investments in the territory and attract consumers. According to Dunning (2000), the reasons for engaging in FDI fall into four main strands: *market search* (demand-driven), to satisfy a particular foreign market or set of foreign markets with peculiar characteristics; *resource seeking* (supply-driven), to gain access to natural resources or cheap labour; *efficiency seeking,* where the main reason for investing in a foreign market is to promote a more efficient division of labour or specialisation of existing assets and finally, *strategic asset seeking*, designed to protect or increase the competitive advantage of the firm. The latter is dependent on intellectual capital located in more that one country, often convenient to acquire or create these assets outside.

At a firm level, size, attitude to risk and strategies influence the choice whether investing or not in an FDI (Dunning, 2000). According to Anderson & Sutherland (2015), strategic assets are intangible assets accessible mainly through FDI such as brand names, managerial capabilities and protected technologies.

The so-called "Liability of Foreignness" (Zaheer, 1995) cited before and conceptualized as the disadvantage faced by foreign companies in host countries, because of their non-native status, is one of the difficulties that can be overcame using this mode of entry. However, FDI provides substantial support of financial capital, technological know-how, managerial expertise to the host country and creates a positive spillover effect, fostering innovation. In addition, countries that are geographically and culturally distant should cooperate in a more efficient way, due to a better knowledge of the host country, thanks to a stable presence of the foreign company.

There are many ways to establish an FDI, it could be a manufacturing subsidiary (offshoring), known as vertical FDI, or a replication of a part of the value chain (e.g. sales, R&D, after sales, logistics) abroad, this second way is known as horizontal FDI. According to Su (2017), foreign direct investments have become a crucial element for international R&D innovative collaborations. In the case of R&D, companies could decide to directly establish R&D abroad

instead of in the domestic market to reach more advanced technologies, more specialized knowledge and skills (WIPO, 2019) and better connections with institutions. According to Kuemmerle (1997), there are two main reasons why firms establish a Research and Development centre in another country: home-base-augmenting to allow foreign laboratory to access and transfer new knowledge to central home laboratory. In this instance, the foreign direct investment is made to gather new knowledge from knowledge-intensive regions. The second order of reason is home-base-exploiting R&D, where FDI is undertaken to support manufacturing facilities in foreign countries, to better adapt product to local needs or enhance the commercialization of its R&D in the foreign markets.

Thus, FDI can be seen as a mode of entry not only for increasing spatial proximity of various kinds and overcoming uncertainties, but especially for developing opportunities (Johanson & Vahlne, 2009).

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Relationship between FDI and collaborative innovations: hypotheses of research

The previous chapters depicted a general scenario describing the crucial role of innovation in a highly competitive environment, where companies that cultivate the culture of innovation are more likely to make greater investments to achieve more effective, even disruptive, innovation to keep up with the competitors. The growing importance of network formation, where many organizations are involved in the innovation process, stresses the additional value of synergies for the creation and the subsequent sustainability of a competitive advantage. In the vast international market, collaborations go even beyond national borders by involving third parties from different foreign markets, sometimes interacting with completely different realities. Hence, understanding the dynamics of a context other than the one in which a company regularly interfaces with, is crucial to ensure that collaboration successfully works. As a result, internationalization involves different ways of accessing collaborations with foreign partners through stronger or weaker relationships, ranging from exports, partnerships and joint ventures to greenfields and acquisitions. It is clear that foreign direct investments, including both greenfields and acquisitions, have advantages in terms of spatial proximity to the cooperating country, but the other side of the coin is represented by high costs and more efforts. On the one hand, collaborative innovation should benefit from the proximity of countries while on the other hand, digitalization and faster connections allow firms to collaborate as well, even across large distances. The types of knowledge, the learning modes, the strength of relationships and consequently the decision on whether to go global or local, can be the discriminating factors in understanding the level of importance of proximity. The stable presence of a company in a foreign territory implies closeness of partners, an element which, according to what has been analysed above, has an influence on relationships and consequently on collaborations. In addition, reducing distances with geographical proximity between collaborating companies implies engaging in day-to-day operations and fostering interactions with a different context, which in turn stimulates collaborative innovation between different market players.

The research question, therefore, is to explore whether the use of a strong and stable mode of entry into the international context, as foreign direct investment, favours innovative collaborations. Collaborative patents will be used as a proxy of estimating innovative collaborations and greenfields will represent the form of foreign direct investment.

Given the learning perspective of collaboration adopted and the above described research question, we can formulate the following hypotheses:

1. *The higher the foreign direct investments, the higher is the probability of engaging in collaborative innovations.*

   In the literature, several studies argue that the spatial distance between partners can be an element that affect the collaboration, as it reduces uncertainty (e.g. Boschma, 2005, Knoben and Oerlemans, 2006). The opportunity to deal directly with the foreign territory can be an important basis for a company to get to know better the environment in which it will operate and to establish a series of relationships with different actors and, consequently, to create innovation by cooperating with local actors. The geographical proximity involves the benefits of building stronger relationships with local suppliers, customers and competitors as well as a better understanding of formal and informal institutions. The knowledge of institutions allows firms to establish deeper and stronger ties with the country. By expanding abroad, companies can access institutions other than the ones in its home country and, consequently, learn about the specific rules and regulations governing foreign establishments. Moreover, Yamin & Kurt (2018) emphasize that formal institutions are important but, most of the times, informal institutions such as cultural norms, national habits, best practices and customs affect the importance of proximity in a stronger way.
   Partnerships and joint ventures with distant countries may imply the establishment of weak relationships and thus, the exposure to the risk of not seizing the opportunities offered by that market to create collaborative innovations with local companies.
   In this sense, some of the major difficulties that companies face in collaborating with different countries can be reduced through physical proximity in the partner's home country (Johanson & Vahlne, 2009). Following this line of reasoning, reducing geographical distances and consequently, cultural barriers and cognitive differences, could positively affect the innovative performances of a firm.

2. *The greater the spatial and cultural distances between countries, the more critical is the role of FDI in supporting innovative collaboration.*

   As Hofstede's studies demonstrate, cross-cultural collaborations imply knowledge of the countries with which one collaborates, specifically identifying the macro factors to be considered in order to have a better understanding of the environment in which the

company will operate. In addition, once a cultural assessment has been carried out, a company can make informed decisions in terms of collaborating with many different companies and thus improve innovative performance. The specificities of each countries can be better recognized when a company is directly committed to the foreign context. For instance, the time horizon and the style of negotiations with Chinese countries can only be understood through direct connections and daily interactions with the Chinese market. Communication and direct interactions are considered vital elements in order to deal with Chinese firms (Zhu et al., 2007).

Therefore, when collaborating with companies from very different countries, proximity can have a great impact on innovative collaboration. This is reflected in the knowledge of the implicit and non-verbal practices and communication style that can be gathered mainly from the context and the conversations. In sum, entering these distant countries through greenfield investments can facilitate market knowledge and, consequently, engage firms in innovative collaborations agreements (collaborative patents).

On the contrary, proximity might not play a key role to collaborate successfully, when considering countries that share a similar culture. Many different countries and a variety of cultures characterise the international environment, but one country may share similar aspects with others. The higher the similarity of values and principles, the easier it is, for companies from different countries, to cooperate. Neighboring countries tend to have similar cultures (Boschma, 2005) and consequently cognitive proximity, therefore neighbours collaborate easily due to a mutual understanding and a common background. In such cases, direct links and interactions are not as important and crucial as in collaborations between very different countries thanks to a common space of interpretation. For instance, western countries share similar cultures because of their origins and, as a result, collaboration between them is easier and require less effort. This is the reason why we often witness collaboration among companies forming agglomeration: the proximity in term of geographical distance and consequently cultural similarity tends to encourage collaboration with relatively less effort compared with distant and different countries.

3. *Inward and outward foreign direct investments can be motivated by different internationalization strategies.*

Foreign direct investments are considered in both directions: inward investments referring to investments arriving in the considered market (in this case European and

EFTA regions) from foreign firms, whereas outward investments refer to those investments that domestic firms undertake in the foreign countries. The directions of investments are taken into account as they can be determined by different internationalization strategies. Different logics drive companies to internationalize with foreign investments, specifically, depending on the reasons why they internationalize. The theories analyzed in the second chapter stress this point. In particular, in the OLI theory it is underlined how companies with a strong competitive advantage tend to expand abroad to exploit their own competitive advantage also in a foreign market. These companies are typically operating in developed countries where they have built a strong competitive advantage (e.g. recognized brand that strengthens reputation, particular managerial skills and organizational capabilities). On the contrary, the LLL framework and Springboard theory focus on the perspective usually embraced by firms operating in emerging countries. These companies see the world as a tank full of resources to draw from and, as a result, their processes of internationalization are driven by the will to reach assets and resources otherwise absent in their organizations. The decision to expand abroad lies specifically in keeping up with new technologies, reaching new skills and compensating the lacking assets with foreign resources. The two different perspectives of internationalization of firms from developed countries and emerging countries have different consequences in terms of where companies will invest abroad. To sum up, companies from developed countries are expected to reach both developed and emerging countries to exploit their competitive advantages, while companies from emerging countries will tend to expand in developed ones to reach the benefits offered from them.

4. *The innovative collaborations are not equally distributed among the countries, in particular, between regions.*

   Innovation activities are not equally distributed across Europe, as many factors can influence the development of innovation: national, regional and local characteristics such as infrastructure, governance, employment, R&D, protection of intellectual property rights, competition and many others (Maraut et al., 2008). This is the reason why in this research collaborative innovation is analysed at the regional level. European regions are not cohesive and equally developed in terms of collaborations efforts to innovate. Innovation is unequally spatially distributed, in fact, it can be described like a regionally bound phenomenon, as economic development and innovation differ from

one region to another (Cantner et al., 2010). More specifically, De Noni et al. (2018), distinguish between knowledge-intensive and lagging-behind regions. On the one hand, the location of core activities in some regions is carefully chosen by firms to take advantage of the regional infrastructure, resources and connections available to support innovative activities and create an efficient production value chain. On the other hand, regional institutions play a key role in defining incentives and subsidies to foster collaborative innovations. This is in line with the literature, which considers regions as entities that have their own governance and determine their own specific norms and regulations independently from their national environment. This is particularly evident in the federal systems in which regions have their autonomous governance structures.

5. *The effects of foreign direct investments on collaborations might be delayed in the time horizon.*

   Foreign direct investments may need time to establish and, consequently, it may take time for a company to develop network relationships and thoroughly enter in the targeted context. The establishment of FDI is itself a lengthy process, and therefore it follows that possible collaborations with local companies may emerge once the company is fully established. Hence, given the structured nature of foreign direct investments, we might assume that their effects in terms of innovative collaborations could be spread over a medium to long time horizon. In this sense, companies establishing a stable presence in a foreign country may require some time to enter into the logics of a different context and understand its main characteristics (e.g. informal rules, tacit knowledge and implicit behaviours). The time needed could differ depending on many variables, such as: cultural barriers, cognitive distance, organizational differences, different level of technological enhancement, negotiation time, establishment of relationships with players in the market etc. Greenfields, which are the type of FDI studied in this research, can require even more time than acquisitions to build up, as the structure is completely established from scratch, and more efforts are required to settle into a completely different environment.

Hereafter, this chapter deals with the description of databases, variables, and methodologies of analysis. The first part gives an overview of the databases and variables used in the model,

while the second one enters in depth detailing the methodology of data analysis for the research question.

3.2. Data collection and sample description

In this section, databases utilized for the analysis are described as well as the variables involved. In the end, critical issues encountered in data collection are highlighted. For the purpose of empirically testing the research question, a quantitative analysis is performed. The database utilized results from the merger of three different databases. Data are collected from three different sources to obtain more complete and useful information for the goal of the research. The two main databases under consideration are the OECD (Organisation for Economic Co-operation and Development) RegPat database and FDI Markets database. The former is a public database which contains information about patents (number of patents, year of filing the patent etc), inventors (identity and address of inventors) and applicants (name and address of the organisation or of the inventor if it is an individual and personal patent). The latter is a global database launched in 2003 and deals with the provision of data to gain insights on the degree of internationalisation of companies. In addition, in order to comprehend the external context in which firms operate, several other variables are considered, i.e. gross domestic product, number of people involved in tertiary education, number of universities, employment in industry and population: these data are taken from Eurostat database. In the following subsections, after a brief presentation of the database employed, the set of variables used will be analysed in depth and then, the criticalities experienced in the collection of data and the limitations of the research will be explained.

3.2.1. Databases and sample description

Data relative to patents are taken from the Organisation for Economic Co-operation and Development (OECD) RegPat database (release version February 2020), relative to the European Patent Office business patent applications published up to December 2015. OECD is an intergovernmental economic organization composed by 37 member States[2] that has a

[2] Information retrieved in OECD website (http://www.oecd.org/)

persuasive role and a significant influence as an advisory body[3] promoting economic development policies regarding economic growth, employment, financial stability, sustainable green growth etc. The organization gathers data in order to provide statistics for the application of policies aiming at favoring the international economic growth in four major topics: demographics, regional accounts, labour market and social issues per regions. It provides public databases that include data referring to member States but, this thesis considers only data pertaining to European and EFTA countries patents.

The available patent data cover a period from 2003 to 2015. The variable taken from this database is the number of patent applications per year and region to the main patenting office of the country as a measure of regional innovation. The total number of patents includes also the co-patents, which represent the object of the research: the collaborative innovation. More in detail, co-patents are the number of collaborative patents developed in a specific region involving the contribution from one or more inventors coming from different regions. Data on co-patents are specified in terms of co-inventions proportionally assigned for the number of co-inventors, indicating in which European or EFTA region the collaborative patent is located and with which other inventor (indicating the States chosen for the research: China, US, Japan) it was made.

The data relative to foreign direct investments are retrieved from FDI Markets database. It is an online global database that contains data about greenfield investments, and it tracks them in all sectors and countries worldwide. The database is provided by the FDI Markets, a branch of FDI Intelligence, a specialist division of investment services provided by Financial Times Ltd. From this dataset, it has been extrapolated a subset of the database regarding the flows of inward and outward FDI since 2003. The Foreign Countries considered are both developed and emerging countries: in particular, the focus is on US, Japan and China, which are the Countries recipients of the largest amount of foreign direct investments in 2019, according to UNCTAD (2020)[4]. BRICS have been considered given their increasing importance in influencing innovative processes across the world. According to Su (2017), emerging countries have high influences on innovative collaborations.

External variables retrieved by Eurostat database are considered in order to complement the analysis. Eurostat is the Statistical Office of the European Union that collects and processes data from the Member States for statistical purposes, promoting the process of harmonisation

[3] For further information see https://www.britannica.com/topic/Organisation-for-Economic-Co-operation-and-Development
[4] https://unctad.org/system/files/official-document/tdstat45_en.pdf

of statistical methodology among the Member States and candidates for joining the European Union. Its objective is to provide the EU with a high-quality statistical information service, with data that are comparable across countries and regions. Its main activities include the definition of two types of data: macroeconomic data (e.g. GDP, population, employment, surface of regions etc), that support the decisions of the European Central Bank when defining the monetary policies for countries adopting Euro, and regional data. The latter includes the Nomenclature of Territorial Units for Statistics (or NUTS) that supported the definition of European regional policies and structural funds. In particular, Eurostat attributes nomenclatures in order to provide a single uniform breakdown of territorial units to produce regional statistics that can be easily compared with other set of data deriving from different sources.
Eurostat attributes this classification to three main types of countries:

- States of the European Union;
- EFTA (European Free Trade Association) member States which are Iceland, Switzerland, Norway and Liechtenstein;
- Candidate countries for admission to the European Union

The regions of the above-mentioned States are categorised at three hierarchical levels: from the macro regions (NUTS1) to the local administrative units (LAU)[5]. The classification of regions into different levels takes into account the territorial administrative division of Member States, in order to have easier access to data produced by different regions.

In this research we refer to the second level classification namely NUTS2, referring to regions with a population ranging from 800.000 to 3.000.000 inhabitants[6]. This choice is driven by three main reasons:

a) It divides Europe into regions where European policies focusing on issues such as sustainable development, job creation, innovation, economic and financial growth find consistent application. R&D policies are developed both at a regional and national level (Su, 2017), but, for the aim of this research, the regional level seems to be the better fit.

b) Regions are considered key aggregates in the literature, an important site of innovation and competitiveness, providing a context in which innovation and knowledge sharing are promoted and knowledge flows in the form of inter-firm collaborations, labour

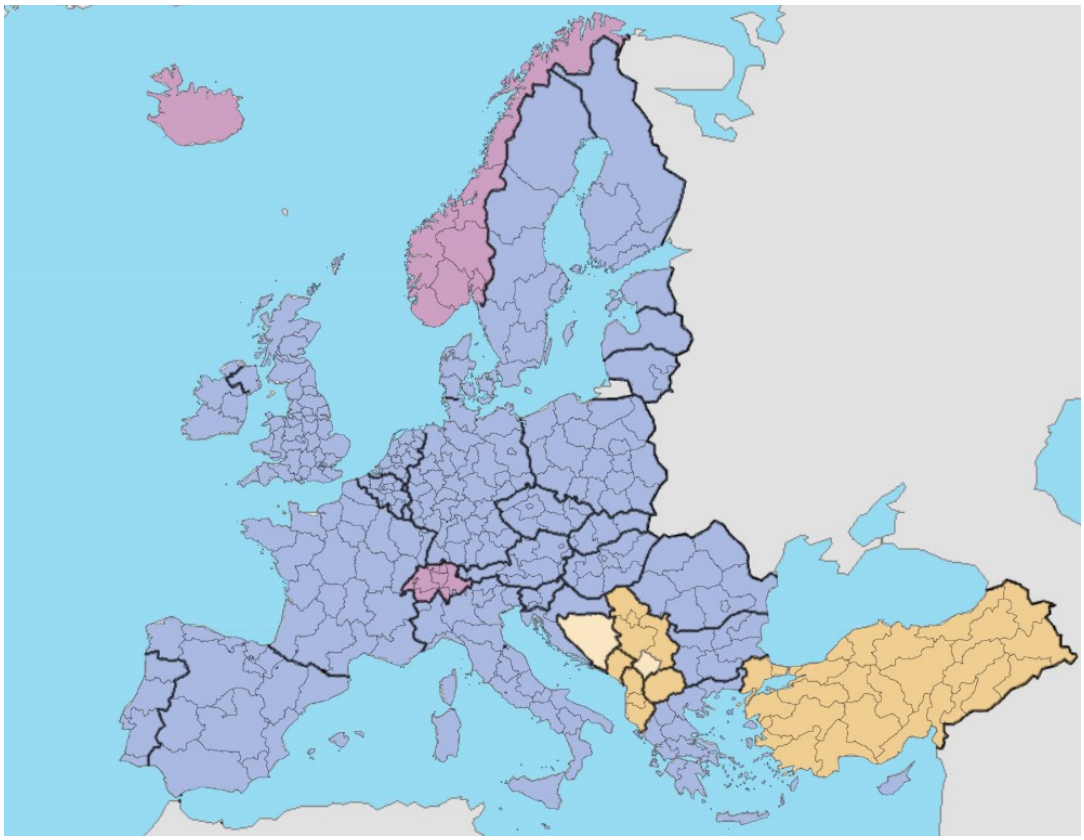
[5] See https://ec.europa.eu/eurostat/web/nuts/nuts-maps for further information
[6] See https://ec.europa.eu/eurostat/web/nuts/principles-and-characteristics

mobility and involuntary spillovers occur (Jaffe et al., 1993). In the literature, Cooke et al. (2004, p.3) address the importance of regional sites of innovation defining the "Regional Innovation Systems" as "interacting knowledge generation and exploitation subsystems linked to global, national and other regional systems".

c) Inventors might live and work in different areas (even neighbourhood) of the same large city thus, for large urban areas composed of several smaller detailed regions, it might be better to work with data at a more aggregated level (e.g. level 2 instead of level 3). For instance, this is the case for the London or Paris area (Maraut et al., 2008) where the third level of NUTS classification would be too detailed for the goal of this research.

The map in *Figure 1* shows the regional classification according to NUTS2 codification defining regions of 28 EU Member State, 4 EFTA countries and 5 candidates Countries for admission to EU in total. The merging of the three databases was possible by using the NUTS2 classification in order to match data from different sources and, as a result, obtaining a homogeneous set of data to deal with. In this way it is possible to highlight the specific regional and territorial aspects in order to analyse subsequently the patterns and the causes that determined them.

Figure 1 NUTS2 classification Eurostat 2021



3.2.2. Variables from the databases

The merger between the three databases provide a set of variables that will be briefly described in Table 1. Data merged from the three databases results in a total of 30 States, namely 28 EU States and 2 EFTA Countries (Switzerland and Norway) splitted in 300 regions according to NUTS2 classification.

In order to assess the research question, the focus is on two variables: collaborative patents, grouped according to Extra-European countries with which the NUTS2 regions collaborate, and foreign direct investments. In particular, FDI direction is twofold: inward FDIs refer to the flow of investments toward Europe from extra-EU countries, whilst outward FDIs relate to investments that EU regions make abroad. Other relevant variables are included in the dataset in order to subsequently analyze, in the quantitative research, their causal relationships and to be able to separate their effects from those of the explanatory variables on the dependent variables in the models.

Table 1 Summary of the variables in the database

VARIABLES	LABEL	DESCRIPTION	DATABASE OF ORIGIN
Nuts2	NUTS2 classification of European regions	Classification of European Regions with NUTS2 2021 Eurostat classification	Eurostat
Patents	Number of patents	Total number of patents filed in Europe at European Patent Office (EPO)	RegPat
Copat	Total number of co-patents weighted	Total number of collaborative patents both with European regions and extra EU States filed at EPO	RegPat
Extraeu,copat	Number of collaborative patents between EU countries and extra EU States	Amount of collaborative patents with Extra EU Inventors	RegPat
Copat,china	Collaborative patents China	Number of collaborative patents with Chinese organizations or individuals	RegPat
Copat,us	Collaborative patents USA	Number of collaborative patents with US organizations or individuals	RegPat

Copat,jp	Collaborative patents Japan	Number of collaborative patents with Japanese organizations or individuals	RegPat
Copat,dev	Collaborative patents Developed countries	Number of collaborative patents with organizations or individuals in Developed countries	RegPat
Copat,brics	Collaborative patents BRICS countries	Number of collaborative patents with organizations or individuals in BRICS countries	RegPat
employ,ind	employment in industry	Total number of employees in the industry of the region	Eurostat
hum,cap	Tertiary educational attainment	% of the population aged 25-64 who have successfully completed tertiary studies	Eurostat
gdp,pop	Gross Domestic Product pro-capite	GDP pro capite	Eurostat
pop,den	Population density	population per km2	Eurostat
emp,rate	employment rate	% of employees on population	Eurostat
univ	Number of universities	Number of Universities in the region	Eurostat
fdi,out,china	Number of FDI establishments in China	Number of FDI from EU to China	fDi Markets
fdi,in,china	Number of FDI establishments arriving from China	Number of FDI form China to EU regions	fDi Markets
fdi,out,us	Number of FDI establishments in US	Number of FDI from EU to USA	fDi Markets
fdi,in,us	Number of FDI establishments arriving from US	Number of FDI form USA to EU regions	fDi Markets
fdi,out,jp	Number of FDI establishments in JAPAN	Number of FDI from EU to JAPAN	fDi Markets
fdi,in,jp	Number of FDI establishments arriving from JAPAN	Number of FDI form JAPAN to EU regions	fDi Markets
fdi,out,dev	Number of FDI establishments in Developed countries	Number of FDI from EU to Developer countries	fDi Markets
fdi,in,dev	Number of FDI establishments arriving from Developed countries	Number of FDI form Developed countries to EU regions	fDi Markets
fdi,out,brics	Number of FDI establishments in BRICS countries	Number of FDI from EU to BRICS countries	fDi Markets
fdi,in,brics	Number of FDI establishments arriving from BRICS countries	Number of FDI form BRICS countries to EU regions	fDi Markets

3.2.3. Criticalities and limitations in the data

The sample of data examined includes European and EFTA Regions codified according to NUTS2 classification by Eurostat. The matching between the three databases was not easy, but necessary to enable the calculation of the aggregated data by regions and make them comparable with the other datasets. The procedure was undertaken in order to provide an accurate and reliable set of information. The matching variable is represented by NUTS2 codes, a classification provided by Eurostat, already available in OECD RegPat database but not in the FDI markets database, being a global database. The needed codification required two main adjustments: the update of NUTS2 in RegPat database and the codification from scratch for FDI markets database. Concerning the former issue, the RegPat database has not assigned the most recent version of the codes but instead, has a mix of two codes versions (2013 and 2016), therefore an update to the most recent version NUTS2021 was necessary in order to have homogeneous data to allow comparisons. The second point is the assignment of nomenclature codes to the records in the FDI markets database[7]. For each investment it is indicated the city, the region, the administrative region and the country of residence of the investors. For each record, the database includes information about the location of foreign direct investments, the amount of money invested, the industry of provenience and the city location of both the parent company and the local investing company. During the coding of regions by assigning NUTS2, a data cleaning was necessary, as the focus is on the innovative performance and knowledge flow across European regions, only patents filed by EU or EFTA countries (e.g. Liechtenstein, Norway, Switzerland) or possible EU candidates are considered.

In addition, FDI markets requires some data needed adjustments, as they were not precisely defined. In specific:

- In some cases, the available data on projects was defined only by NUTS1 classification: these projects were not considered as it was not possible to attribute them to the right region according to NUTS2;
- Data where there was no classification into regions and labeled as “not specified” were deleted from the dataset;
- Regions not classified by Eurostat were also deleted (e.g. Faroe Island, Belarus, Andorra, Bosnia);

[7] For more information about the assignment see the appendix 1

- For records in which only a municipality or city was mentioned, the regions in which they were located were manually identified and then the correct NUTS code was assigned;
- Typos and mistakes have been fixed and taken into account in the classification in order not to lose information (e.g. Madiera, corrected in Madeira);
- For some records, there were the same city attributed to different regions, thus the right region has been assigned.

In addition, it is worth to highlight that if the city involved is a European region, it is assigned to the NUTS2 classification, whereas, if the city is a foreign one it is allocated to the State. For sake of example, if the city is Milan, then it is assigned to the corresponding NUTS2, while if the city is New York the FDI is assigned to United States). This process is done both for city of origin and for provenience of investments.

Furthermore, as far as patents are concerned, the place where the patents are filed might not reflect the place in which the inventions were created. Many large companies that file patents have several establishments around the world located in different markets: as a result, they tend to file the invention project in the patent office of the incorporation State, rather than in the real-seat or effective country where the invention has been carried out (UNCTAD, 2020). Finally, the residence address of inventors may be in a different region from their workplace. It is fair to conclude that the interpretation of data might be, in some cases, misleading.

The research considers only greenfields as foreign direct investments, it does not take into account acquisitions (or brownfields) or other strategies of internationalizations to expand and collaborate with foreign partners. Other strategies can be adopted in order to innovate with foreign firms such as joint ventures, partnerships and strategic alliances, but these are beyond the scope of this work. Finally, the study takes collaborative patents as a proxy for collaborative innovations. However, patents do not exhaustively explain innovation. Other measures can be used to quantify innovation such as R&D expenditures, investments in high-technologies or number of new products launches. Collaborative innovation could also arise regardless of whether the idea is patented or not: some companies could decide to not protect their innovation preferring to create network around the new idea. Other companies tend to develop strong relationships without specific agreements and finally, others may decide for some other forms of protection. Moreover, the tendency to patent innovations might not be equal across industries and across different types of organizations.

3.3. Data analysis methodology

In this research a quantitative approach is chosen to analyse the phenomenon.

At first, a descriptive analysis of the data is performed to give an overview of the distribution of the data and to establish an order of magnitude of the variables considered. As a second step, the correlation between the two main variables in the model will be analysed: collaborative innovations and foreign direct investments. This is done computing the Pearson correlation between the total number of weighted collaborative patents and the total number of foreign direct investment, measured in terms of greenfields investments.

Thereafter, the effect of time is considered using a panel analysis in order to investigate the evolution of correlations for the variables of interest (Co-patents, FDI-IN and FDI-OUT) over the period between 2003 and 2015, i.e.. For the sake of a general understanding, a distinction is made between collaborations with developed and emerging Countries (BRICS). The analysis is then replicated for USA, Japan and China, as it is fair to expect a trend of increasing correlation over the years, as they are the Countries more engaged in FDI.

The next step aims at performing a multivariate panel regressions each Country to check whether the results from the correlations can be confirmed by adding control variables to the models to test the significance of the variables of interest (FDI inward - FDI outward).

Finally, to investigate the concentration of collaborative activities in innovations, a more detailed analysis based on a subset of data for the most interesting regions is conducted. The ranking studies enables to examine the distribution of collaborative patent in Europe.

4. DATA ANALYSIS

This chapter is divided in four main sections. The first one deals with a descriptive analysis and preliminary considerations. Then an initial analysis of the correlations between the two variables under consideration is performed: foreign direct investment and collaborative patenting. The third section presents the panel regression analysis to explore the relationship in question and determines whether or not to confirm our research hypotheses. The last section takes into consideration the detail of European regions to identify the distribution of collaborative innovations and analyse regional performance.

4.1. Descriptive analysis

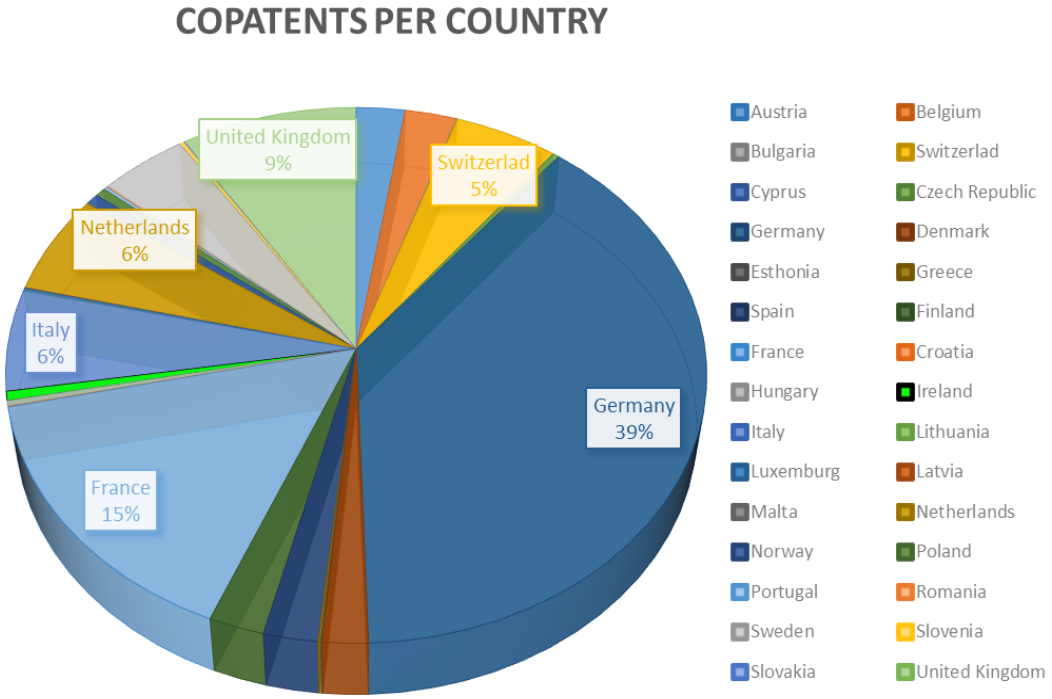
From a descriptive analysis of data summarized in *Table 2*, it can be noticed the wide dispersion of totality of co-patents in European area, ranging from zero to 2478,54 with a mean of 135,57.

Table 2 Descriptive statistics (on the whole dataset)

VARIABLE	MEAN	STD. DEV.	COEF.VAR.	MIN	MAX
Patents	206,94	380,61	1,84	0,000	3.335,33
Copat	135,57	261,51	1,93	0,000	2.478,54
Extraeu,copat	7,21	13,55	1,88	0,000	110,14
Knowledge intensity	0,10	0,12	1,24	0,000	0,79
Collaboration propensity	0,61	0,18	0,29	0,000	1,00
Extra-EU collaboration propensity	0,07	0,11	1,56	0,000	1,00
GDP pro capita	0,02	0,01	0,53	0,002	0,10
Population density	0,37	0,94	2,52	0,002	10,55
Human capital (%)	24,73	8,93	0,36	6,10	62,40
Universities	6,07	6,65	1,10	0	44
Employment rate	0,45	0,07	0,16	0,21	0,76
Employment industry share	0,17	0,07	0,43	0,02	0,39
Copat,china	0,50	1,47	2,93	0,00	19,17
Copat,us	4,98	9,25	1,86	0,00	77,62
Copat,jp	0,49	1,63	3,34	0,00	26,50
Copat,dev	5,77	10,91	1,89	0,00	89,85
Copat,brics	0,99	2,32	2,35	0	23
fdi,out,china	1,30	4,25	3,26	0	66
fdi,in,china	0,31	1,59	5,16	0	30
fdi,out,us	2,23	8,25	3,70	0	161
fdi,in,us	3,50	10,77	3,08	0	188
fdi,out,jp	0,23	0,93	4,02	0	13
fdi,in,jp	0,53	1,34	2,54	0	20
fdi,out,dev	9,38	32,42	3,46	0	552
fdi,in,dev	5,52	15,49	2,81	0	282
fdi,out,brics	3,67	11,52	3,13	0	181
fdi,in,brics	0,71	2,51	3,56	0	50

This is an initial insight on the dis-homogeneous distribution of collaborative innovations across Europe. At first analysis, examining the average number of collaborative innovations (co-patents) calculated over the years for each country with aggregate regions, the countries most involved are those belonging to the so-called "Blue Banana" area: a cluster of highly urbanized regions that grew rapidly and attract investments from outside. Collaborative innovations are mainly developed in the aforementioned corridor which begins from South England, southern Germany, the German Rhineland, Alsace-France, Switzerland and ends in northern Italy regions. In our data, we observe an average of 39% of co-patenting activities developed with German organizations, followed by the 15% of France, 9% United Kingdom, 6% Netherlands and 6% Italy. The regions were grouped in order to figure out the most collaborative regions as aggregates to represent the State. In the following parts of the chapter a more detailed analysis will be performed. Moreover, according to the data available considering each year of the dataset, there are some East-European regions such as some of Bulgaria, Romania and Poland ones in which the number of co-patents corresponds to the number of patents, meaning that the innovations come mainly from collaboration with local (collaboration propensity) or foreign companies (Extra-EU collaboration) and not from individual patenting activity.

Figure 2 Average co-patents (years 2003-2015) per Country



Source: own elaboration

4.2. Correlation analysis

As a first step, the correlations between the main variables are calculated. For the calculation, it has not been considered the time period but a mean of the whole available period (2003-2015). The correlation index is the Pearson correlation for the sample of data that is analysed:

$$\rho_{AB} = \frac{\operatorname{cov}(A, B)}{\sigma_A \cdot \sigma_B}$$

The Pearson correlation coefficient measures the strength of a linear relationship between two variables. Ranging from -1 to 1 value, it determines not only the representativeness of the data, but it also defines the sign of the relationship. In our research, we denote the positive relationship between the variables. The correlation matrix (Table 3) shows that the linear correlation between the total collaborative patents and all the types of foreign direct investments in different locations are positive and above 35%. More in detail, the foreign direct investments are associated with the total collaborative patents as linear relationships with a factor ranging from 0,354 to 0,599. Moreover, if we enter into the detail of the States considered, we can notice that the correlation of the relationship referring to US is above 44% and more generally, in developed countries is around 47% if we observe the FDI inward, while, the outward is even more correlated with a factor of 0,52. In sum from this table it results a positive relationship between the variables thus, it is fair to expect that an increase in foreign direct investments translates into an increase of collaborative innovations with different strengths. It means that a great portion of collaborative innovations is explained by the presence of FDI, without considering other variables.

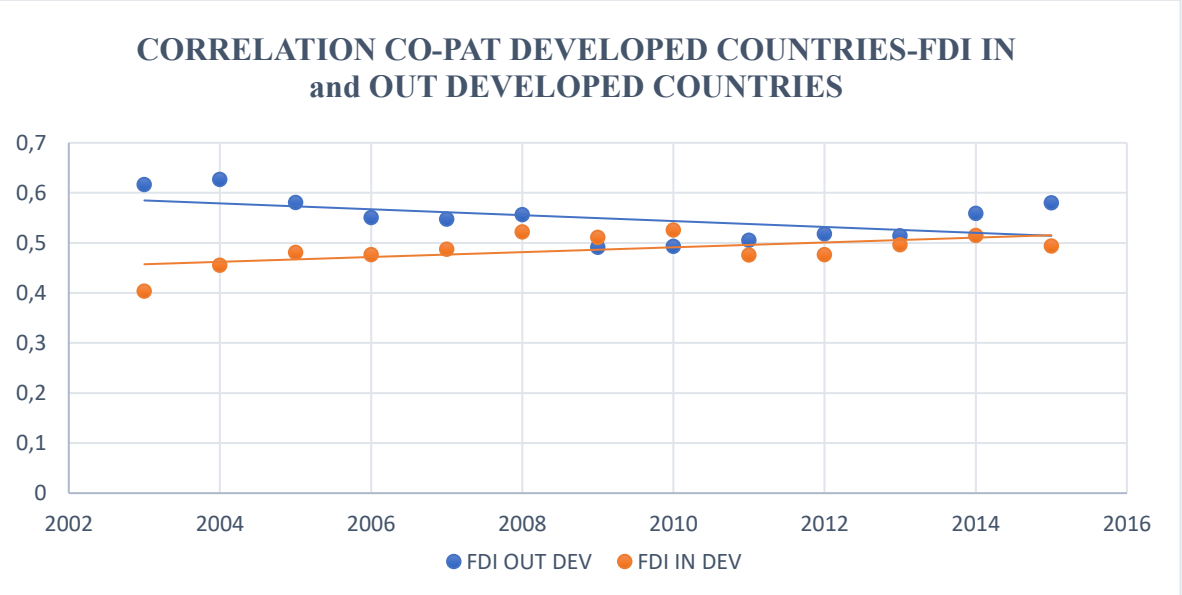
Table 3 Total correlations between the main variables of the model

VARIABLES	Patents	Copat	Extraeu,copat	Copat,china	Copat,us	Copat,jp	Copat,dev	Copat,brics	fdi,out,china	fdi,in,china	fdi,out,us	fdi,in,us	fdi,out,jp	fdi,in,jp	fdi,out,dev	fdi,in,dev	fdi,out,brics	fdi,in,brics
Patents	1,000	0,994	0,843	0,613	0,829	0,579	0,830	0,724	0,597	0,356	0,436	0,343	0,466	0,459	0,499	0,386	0,568	0,372
Copat		1,000	0,863	0,635	0,848	0,600	0,851	0,745	0,599	0,378	0,447	0,354	0,464	0,472	0,507	0,400	0,571	0,393
Extraeu,copat			1,000	0,735	0,984	0,715	0,991	0,833	0,597	0,399	0,483	0,433	0,456	0,472	0,525	0,469	0,573	0,435
Copat,china				1,000	0,666	0,446	0,672	0,924	0,398	0,301	0,334	0,224	0,279	0,305	0,343	0,266	0,392	0,318
Copat,us					1,000	0,659	0,992	0,767	0,591	0,381	0,478	0,441	0,458	0,473	0,521	0,472	0,565	0,418
Copat,jp						1,000	0,733	0,523	0,364	0,411	0,276	0,281	0,285	0,367	0,307	0,329	0,343	0,400
Copat,dev							1,000	0,771	0,591	0,398	0,477	0,442	0,459	0,481	0,522	0,476	0,565	0,432
Copat,brics								1,000	0,483	0,332	0,401	0,293	0,339	0,354	0,418	0,334	0,471	0,361
fdi,out,china									1,000	0,394	0,793	0,727	0,680	0,560	0,888	0,744	0,955	0,579
fdi,in,china										1,000	0,449	0,436	0,378	0,503	0,442	0,569	0,399	0,883
fdi,out,us											1,000	0,873	0,717	0,521	0,952	0,879	0,841	0,665
fdi,in,us												1,000	0,625	0,568	0,854	0,980	0,769	0,663
fdi,out,jp													1,000	0,462	0,769	0,643	0,716	0,516
fdi,in,jp														1,000	0,571	0,659	0,569	0,569
fdi,out,dev															1,000	0,865	0,939	0,657
fdi,in,dev																1,000	0,783	0,772
fdi,out,brics																	1,000	0,605
fdi,in,brics																		1,000

The positive relationships found above allow us to find evidence of its strength by analysing the effects more deeply to understand the dynamics of these two variables.

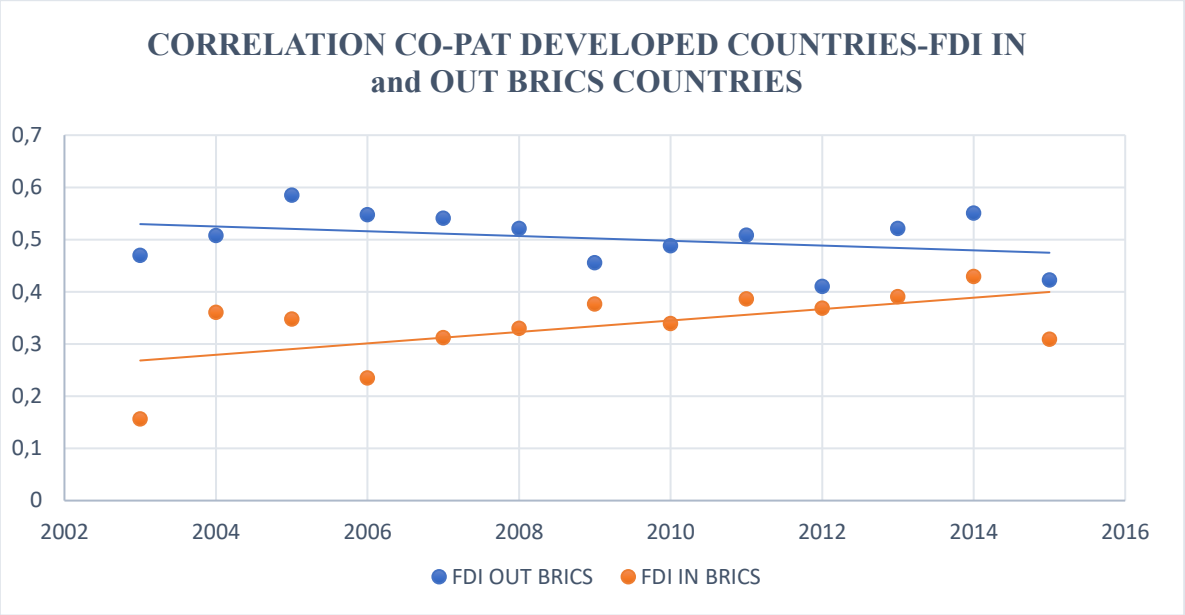
Firstly, the time factor is taken into consideration since the effect of time might affect the association between the two variables. The time factor influences the development of collaborative innovations over the years, as the importance of international innovative collaborations has flourish over time (WIPO, 2019). In the first analysis, the trend of correlation over the years is investigated using the macro distinction: developed and BRICS Countries. In the former case, *Figure 3* shows a quite stable correlation over the years, thus confirming a constant strength of a linear relationship. However, if we consider *Figure 4*, the correlation over the years tend to increase for FDI-IN, meaning that the greenfields established in Europe from BRICS countries are a strong determinant of the development of collaborative patents with European regions going from a strength of relationship of 0,15 to a 0,30 in 2015. On the other hand, the outward FDIs influence on collaborative patents seems to maintain their constant trend on the collaborative patents.

Figure 3 Trend of correlation between Co-patents and FDI IN and OUT of Developed Countries



From *Figure 4* it is evident that the strongest relationship results from the BRICS Countries, in particular, the correlation between FDI inflows and the development of collaborative innovations increases over the years, indicating almost similar growth.

Figure 4 Trend of correlation between Co-patents and FDI IN and OUT BRICS Countries



In order to gain a better understanding of the different strength of relationships, the three foreign Countries involved in the highest number of FDI are examined: China, US and Japan (UNCTAD, 2020). United States and Japan represent the developed countries whereas, for BRICS the considered country is China. The trend of correlation for US (*Figure 5*) is stable overtime and it appears to confirm the relationship between co-patent and FDI highlighted as well in developed countries (*Figure 2*). The investments in both directions seem to have a constant importance on collaborative innovations.

The relationship between the two variables does not appear to follow a trend for Japan (*Figure 6*); the data are too scattered to suggest what kind of relationship might exist. Values are not fluctuating on a trend; however, the regression might be able to clarify the relationship.

Figure 5 Trend of correlation between Co-patents US and FDI IN and OUT US

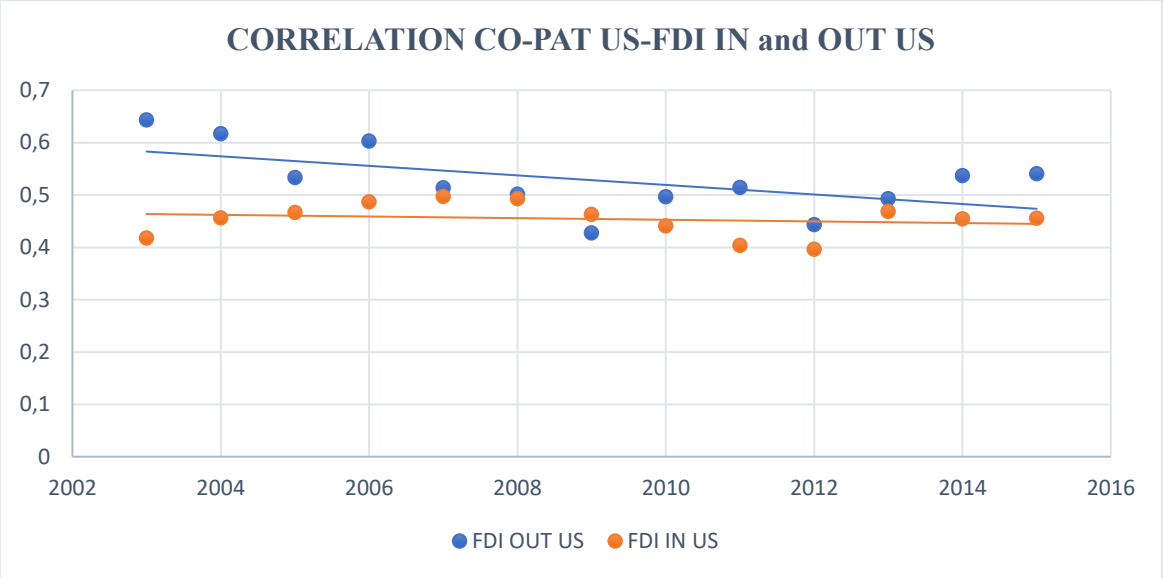
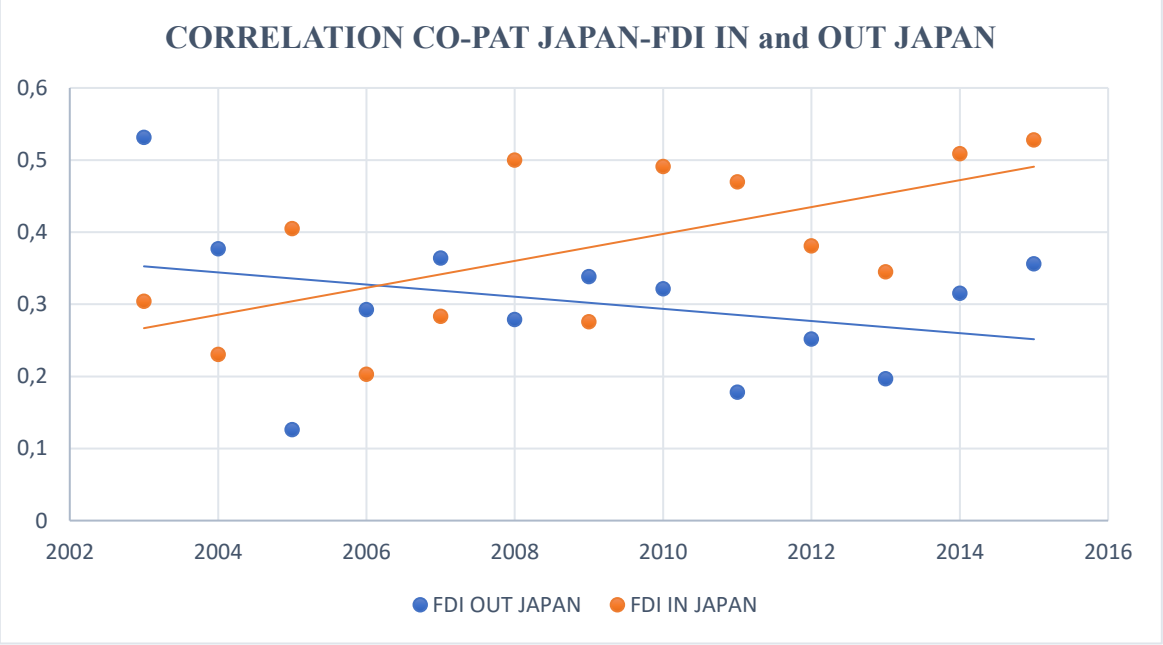


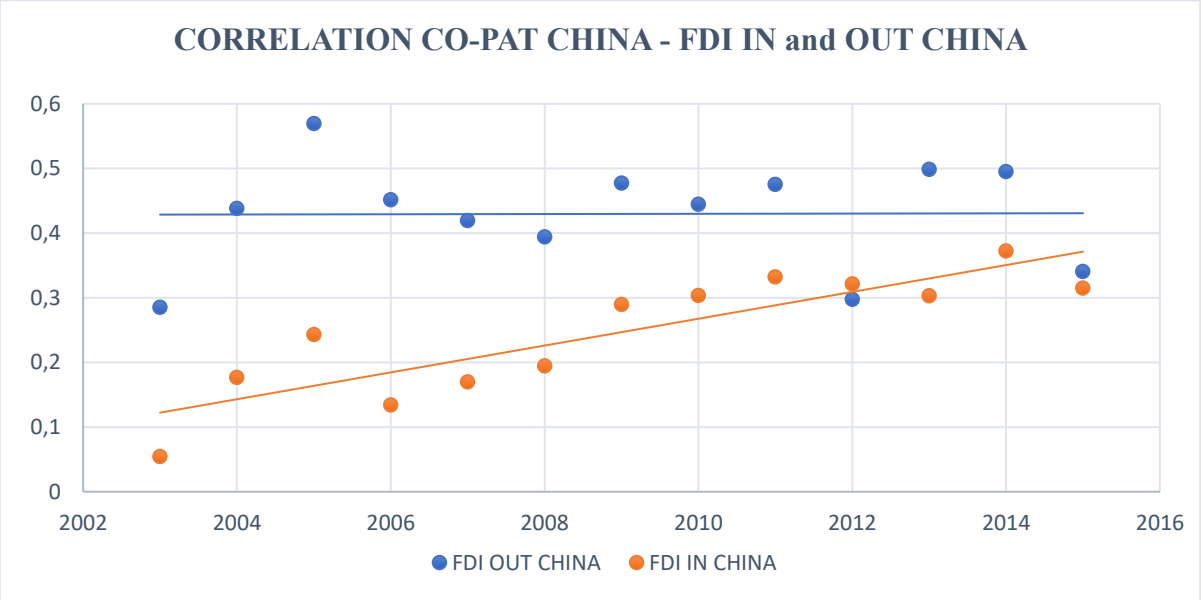
Figure 6 Trend of correlation between Co-patents Japan and FDI IN and OUT Japan



More interesting results are observed in the case of China. The importance of greenfields FDI for collaborative innovations is clear and strong for this Country. In particular, the evidence shows an increase on the strength of the linear relationships between the inflow FDI and innovative collaborations. From *Figure 7* we infer that the strength of relationship between collaborative patents and inward FDI has increased over the years, from a weak linear

relationship of 0,05 to a greater association of 0,32. Investments in terms of greenfields of Chinese firms in Europe has grown over the years in the importance for collaborative innovations.

Figure 7 Trend of correlation between Co-patents China and FDI IN and OUT China



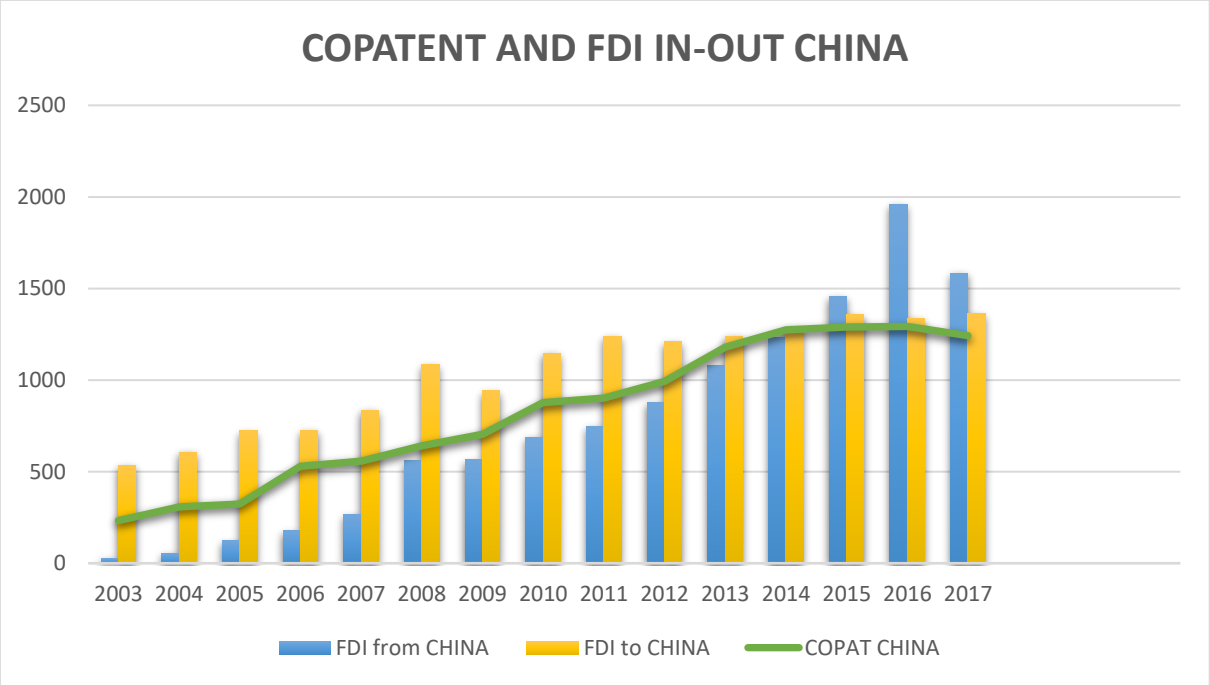
The graph of correlation over the years for US and Japan did not tell a lot about the strength of a clear relationship between the two variables, whereas the one for China highlights a possible trend in inward investments. Additional data at country level coming from different sources confirms this synergic relationship. More specifically, an analysis is performed by obtaining FDI data from UNCTAD[8] referring to the foreign direct investments to and from China in terms of annual FDI inflows expressed in millions (for visual convenience in the graph, both have been divided by 100). Moreover, data on co-patenting activity of China is retrieved from OECD statistics (available up to 2017)[9] and represents the number of collaborative patents that Chinese organizations have developed with at least one foreign co-inventor residing in a different country in the world. Only co-patents filed in the European Patent Office (EPO) are considered (to have a consistent perspective with our database). In the graph obtained from the two sources (*Figure 8*), it is depicted the trend of co-patents as well as FDI to and from China with the rest

[8] UNCTAD, Division on Investment and Enterprise, World Investment Report, Statistical Annex retrieved in http://unctad.org/en/Pages/DIAE/World%20Investment%20Report/World_Investment_Report.aspx (Annex table 01. FDI inflows, by region and economy, 1990-2019)
[9] https://stats.oecd.org/Index.aspx?DataSetCode=PATS_COOP# (Table: International co-operations in patents: Patents with foreign co-inventors)

of the world. It can be noticed that they are increasing overtime. It seems that the three variables are connected as they follow the same trend over the years considered.

The evidence at the national level is likewise confirmed at the regional level, stressing the synchronic trend of the close relationship between the variables. The union of these important results seems to confirm the LLL theory (Mathews, 2006) in which the emerging Countries internationalise to find resources and establish relationships in order to keep up with the technology improvements and consequently to innovate.

Figure 8 Collaborative Patents of Chinese organizations and FDI flow to and from China, to the rest of the world



Source: own elaboration from UNCTAD and OECD

The first analysis on correlations highlighted a constant strength of the relationship in US but an increasing strength of the considered relationship for BRICS countries (for what concerns FDI-inflows). In particular, the case of China was further investigated in order to provide evidence even at a national level of the possible presence of an important tie between co-patent and FDI as it was interesting to do further analysis since it was the only graph in our data that outlines relevant growth in the strength of the relationship. In the next section this preliminary information will be tested with the regression analysis to identify a pattern that explains the relationship.

4.3. Panel regression analysis

In this section the influence of foreign direct investments on collaborative innovations are measured with a regression analysis using a thirteen-year (2003-2015) panel database involving only European, EFTA countries and candidates countries to EU. For each foreign country with which European countries develop a copatent, a multiple regression is undertaken to test the effect of FDI net of other factors considered relevant to the development of innovative collaborations. From the merged database we take the dependent and independent variables as they are, while for the control variables some adjustments were made to handle the collinearity problem between patents, GDP, and population, since the correlation between them was high. The control variables are useful to control their causal effect on the dependent variable. They allow to measure the net effect of the explanatory variables on the dependent variable, considering that other variables could have a strong relationship with the dependent one. In addition to the control variables explained below, it is also included temporal and regional fixed effects in the panel regression model to neutralize external bias (e.g. global crisis) from considering different years and analyze all regions on an equal footing in terms of innovative performance to reduce the discrepancy between regions.

The general regression equation can be specified as follows:

$$Y_{co\text{-}pat(i)} = X_{1\ FDI\text{-}in(i)} + X_{2\ FDI\text{-}out(i)} + X_{3\ (knowledge\ int.)} + X_{4\ (collab\ prop.)} + X_{5\ (Extra\text{-}EU\ co\text{-}pat\ prop.)} + X_{6\ (GDP\ pro\ capita)} + X_{7\ (pop.den.)} + X_{8\ (hum.cap.)} + X_{9\ (univ.)} + X_{10\ (emp.\ rate)} + X_{11\ (share\ manuf.\ emp.)} + \varepsilon$$

$$i = US,\ China,\ Japan,\ Developed\ Countries\ and\ BRICS$$

Five models are developed in order to analyse not only the collaborative innovation between specific countries but also distinguishing developed and BRICS countries. After an explanation of the variables used in the model, two different approaches will be analyzed, the one considering simultaneous effects and the one considering the effects of FDI with the three-year lag on co-patents.

DEPENDENT VARIABLE

- *Copatents*

Collaborative patents, retrieved by RegPat database, represent the dependent variable in our models to measure the innovative collaborations between countries. Patents can be considered a measure of innovation as it is a legal protection of inventions developed by different actors such as firms, individuals, research organizations. This tool ensures exclusivity as no one can make any use of the inventions without the permission of the legal owner. It plays an important role in the creation, spread and use of new knowledge for future innovations[10]. Many studies in the literature found positive relationships between patents and other indicators of innovative performance (e.g. productivity, market share). Patent documents disclose information about the technological content and geographical location of invention, indicating the address of inventors and owners. Patents allow tracking the diffusion of innovative knowledge, localising from which region the innovation comes from (Maraut et al., 2008). In this research only the patents involving multiple inventors are considered: the collaborative patents. Co-patents refers to inventions deposited by two or more inventors from different regions. Collaboration is measured by dividing the effort in the innovative project and attributing it proportionally to the regions to which the inventors belong. This decision is validated in the literature as patents are often used as a proxy to measure the degree of innovation (Kim & Lee, 2015) and are found to be reliable (Acs et al., 2002). A regression is developed for each extra-European country examined and two other regression models are analyzed, taking into account the distinction between developed and BRICS countries.

EXPLORATORY VARIABLES

- *Foreign direct investments*

Foreign direct investment is recognized as the vehicle through which firms enter a foreign market to gain proximity to foreign firms. For this reason, it is considered a way to measure the closeness of partners that want to collaborate in innovation projects (measured by collaborative patents). These variables can be a proxy indicating the reduction of distance

[10] Organisation for Economic Co-operation and Development (OECD): http://www.oecd.org/

between partners. They are measured in terms of number of "investment in a new physical project or expansion of an existing investment which creates new jobs and capital investment"[11]. The flow of investments is considered in both directions: inward and outward. For the purpose of linearizing the variable, a logarithmic transformation was applied. More specifically they are taken as two distinct variables in order to measure the different effects:

➔ *FDI-OUT*

They indicate the number of FDI, considering only greenfields investments, that investors that reside in a country make on a foreign location. In the specific case, the outward FDI considered are the number of establishments made by firms in EU, EFTA Regions or candidate EU countries to Foreign Countries. Outward investments are reported as number of investments.

➔ *FDI-IN*

They indicate the number of FDI, in particular greenfield investments, done in specific countries as inflows of investments by non-residents investors. These investments regard the number of establishments made by foreign countries in the European, EFTA regions or candidate countries to EU. It measures inflows of foreign investments as a stable presence of international companies into the European area. Investments inflows are taken as the number of investments without considering their value.

CONTROL VARIABLES

- *Knowledge intensity*

Patents could not be included in the model like a pure variable as they cause a collinearity problem with other variables, therefore, to measure knowledge intensity, the number of patents divided by the population of the region is used to measure it. This ratio indicates the propensity to patent new ideas weighted for the population of the region (per capita). The variable is expected to have a positive effect on collaborative innovation assuming that the greater the number of patents per inhabitant, the higher the propensity to create patents in

[11] Retrieved in https://www.FDImarkets.com/faqs/

collaboration with other inventors. Moreover, a logarithmic transformation is adopted in order to linearize the variable and reduce its skewness.

- *Collaboration propensity*

Collaboration propensity is measured through the ratio between collaborative patents and the total number of patents for each region. This is an indicator of collaborative innovations in the region with respect to the innovation ability of the region. Collaboration propensity can increase innovative collaborations between companies by promoting the sharing of valuable resources, strategic assets and know-how to create innovations.

- *Extra-EU collaboration propensity*

Extra-European collaborations are indicated as a percentage of Extra-European co-patents with respect to the number of collaborative patents. The propensity to collaborate internationally is a sign of a global expansion capable of reaching distant partners with whom to collaborate rather than a collaboration limited to the country of origin or neighbours. The ability to share assets within heterogeneous collaboration is expected to have a positive impact on the innovative collaborations.

- *GDP pro-capita*

Gross domestic product is an indicator of economic performance of a country or a region. It is the final value of all goods and services produced within a specific national or regional geographical boundary in a year. It represents the wealth of each region in terms of financial resources available for the regional economic development including R&D investments. For the purposes of this research, the distribution of income in the region is not relevant thus, taking this index to describe average living standards and wealth enables inter-regional comparisons, regardless of the size of the region. To linearise the variable a logarithmic transformation is adopted.

- *Population density*

The population density is measured as population per square kilometre for each region. It represents the dimension of urbanization of the region. In specific, it is a proxy indicating the externalities deriving from urbanization such as the presence of laboratories for research, innovation sites and infrastructures that allow diffusion of knowledge. It is expected to positively strengthen the collaborative innovations thanks to the developed infrastructures available in the region. Here as well it is adopted a logarithmic transformation.

- *Human capital*

The variable indicates the tertiary educational attainment in the region thus, the percentage of people aged 25-64 who have successfully completed tertiary studies. Human capital is a determinant of knowledge production at a regional level (Paci et al., 2014). As seen in the literature (e.g. Teece, Pisano, & Shuen, 1997), the ability to integrate external knowledge and internal resources is crucial for the creation of innovation, therefore, well-educated labour force could facilitate these processes. It is expected that the higher the educational level in the region, the higher the level of innovation.

- *Universities*

The variable indicates the number of universities in the region. Universities are considered one of the main sources where competences are acquired and developed. The presence of multiple universities within a region is an indication of the level of incentive for tertiary education due to the availability of a range of educational structures and options in terms of educational offerings.

- *Employment rate*

The employment rate represents the percentage of employment in the region and is calculated on the population of the region. The variable takes into account the total employment in the region without considering the different sectors to which the employees belong.

- *Share manufacturing employees*

Different sectors are known to have different rates of innovation, as they can range from agriculture to high-tech services. From the total number of employees per region, only those employed in the manufacturing sector are considered as a percentage on population. Manufacturing is considered the field in which innovation take place most of the times as product or process innovations.

In order to understand the relationship between foreign direct investments and collaborative innovations, two different regression models are performed. In the first model (Table 4), a panel regression analysis with a fixed effect for time and regions is performed for the five dependent variables, while for the second model (Table 5), the same relationship is studied but lagged

three years[12] on the FDI to find out whether time has an impact on the relationship under investigation.

The five regression models in both *Table 4* and *Table 5* show some interesting results. The good overall fit of the models is confirmed by a high R-square for both models. However, it can be noticed the higher goodness of fit of the lagged models in Table 5, this is a first confirmation that the effect on the dependent variable is reasonably expected to be delayed in time.

As expected, knowledge intensity is highly significant for all models, meaning that the more a region patents innovative ideas, the more likely it is to collaborate with other partners and, as a result, patent the idea by filing collaborative patents. Moreover, another important condition for innovative collaboration seems to be collaboration propensity that positively impact on innovative collaboration only when dealing with developed countries, in particular with US (Table 4). However, in the lagged model it results not to be a determinant of collaborative innovations. Probably the rate of collaborative innovations of a region measured as copatent on patents is not influencing the trend of collaborative innovations as the individual patenting activity does.

Furthermore, the variable Extra-EU co-patenting propensity is also introduced in the model. It affects in a considerable manner both developed and BRICS countries. The results emerged from Table 4, suggest that innovative collaboration, our dependent variable, is positively influenced by the Extra-EU collaborations. It seems that collaborating with partners from abroad will increase the probability of engaging in collaborative innovations. A first insight is originated from the first model (Table 4) in which collaborative efforts are different according to the country. In particular, in developed countries, both non-EU collaboration and collaborations with other European companies influence innovative collaborations, while for the BRICS and China in particular, innovative collaborations are only related to non-European collaborations. This result confirms that innovation for China, and for emerging countries in general, originates outside the home-country with collaborations with external partners. Collaborations within Chinese or emerging countries do not seem to affect innovative collaborations with European regions. However, in the lagged model it can be noticed the it does not have a significant effect of the variables for all the models.

The wealth of EU regions impacts positively on the collaborations with US and developed countries ($p<0,01$ in both models), this lead to the creation of a favourable condition to implement collaborative innovations with regions having a high GDP pro capita.

[12] Normally, it is the most used lag. Other time lags were tested and they gave similar results

To check for the educational effect the variable human capital and number of universities in the region are introduced in the model. The human capital (representing the % of people involved in tertiary education) does not have a clear relationship with the dependent variable in both models, whereas the number of universities seems to positively affects the dependent variable when considering the collaboration with Chinese organizations or firms from BRICS countries (Table 4). In addition, the variable results significant also in developed countries, in specific US when considering the lagged model.

Moreover, the effect of urbanization is observed in the population density variable that is highly significant and positive ($p<0,001$ in the majority of regressions of the two models) for both developed and emerging countries with the exception of Japan. For these countries, the systems of well-developed infrastructures and facilities in a specific region support innovative collaborations. In addition, whether a region has a more manufacturing-based industrial structure does not significantly influence innovative collaboration as we might be led to expect given that much of the innovation comes from the secondary sector. However, employment rate in the region appears to be significant ($p<0.05$) for China, BRICS and developed countries in the first model (Table 4). This may be related to employment in other sectors such as services, agriculture, etc. that are likely to drive more collaborative innovation. However, in the lagged model this seems to not represent a significant factor influencing collaborative innovations. In general, the results emerging from the control variables are in line with the main expectations.

The flow of FDI are analysed in both directions for all the models considered. In model (5) of Table 4 emerges the positive linear relationship between the inflow of investments from China to Europe and collaborative innovations, therefore confirming the increasing trend in correlation over the years as shown above in the chapter. The high significance ($p<0.01$) of the variable implies its relevance in determining collaborative innovation between Chinese and European firms. This is an evidence that Chinese foreign direct investment flows into EU regions to acquire valuable resources and know-how otherwise absent in the Chinese organizations. The same is said for BRICS countries which tap into developed markets in order to learn from external firms and collaborate to gain competitive advantages. This is a phenomenon confirmed by LLL theory (Mathews, 2006) in which firms from emerging countries overcome internal weaknesses by expanding abroad searching strategic assets reaching foreign market by means of acquisitions or greenfields. The resources of other players in the market represent the bridge for firms operating in emerging countries to create connections with local companies in developed countries. In this way, they can create innovative collaborations through alliances, partnerships and strategic agreements. The strength

of the relationships between the inflows of FDI and the creation on innovative collaboration with Chinese organizations is even higher considering the lagged model ($p<0,001$).
In contrast, according to the regression models, the relationship between innovative collaboration and direct investment from Europe to China or to BRICS countries is not clear. These investments seems to not relate to the creation of innovative collaborations. The model suggests that preference of greenfields to expand in emerging countries is not related to innovations, rather it may be related to the expansion strategy of companies with the goal of reaching more countries and preferring to establish abroad for commercial purposes. The Uppsala model (Johanson & Vahlne, 1977) describes the process of internationalisation starting from less committing modes of entry such as export, agents or partnerships to more expensive modes such as acquisitions and greenfields. Moreover, the European companies might also aim at expanding into China or emerging countries to take advantage of low labour costs, lower taxes required and cheap raw materials. Another reason that is likely to drive those EU companies to expand is the willingness to build economies of scale in order to be able to produce at a lower costs. Often, European companies commit more resources and capital to invest in an overseas establishment when exporting and long-distance partnerships don't work as well as they hoped, therefore they attempt to further invest in order to better understand a completely different environment, but with the goal of selling more, not with an innovation perspective. Hence, this trend is confirmed not only with Chinese companies, but also at the aggregate level of BRICS companies: when investments are made in Europe, they are significantly correlated with collaborative innovation, while when FDI is implemented in emerging countries, collaborative innovation is not affected by them. This impostant result is confirmed in both models (Table 4 and Table 5).

Furthermore, it is worth noting that foreign direct investment and collaborative innovations are not linked with a clear relationship in Japan. This seems to confirm the absence of a clear trend in the correlations between the two variables over the years analyzed previously in the chapter. Probably the collaborative innovations do not rise as a consequence of FDI because the high investments required to establish in the partner's country is not balanced with benefits of being close to the collaborating firm. The two collaborating firms can develop innovation using other collaborating tools such as partnerships and joint ventures. Japan and Europe are developed countries therefore, the growing trend in economic development and technological progresses might made less convenient to engage in FDI in similar growing countries. The low engagement in fdi for Japan is also evident in the descriptive analysis (Table 2), which shows the relatively low number of FDI made in and out of Japan compared to the other countries. Neither in the

lagged model (Table 5) the relationship between dependent and independent variable is significant, meaning that inward FDI in Europe from Japanese firms and FDI outward made by European companies in Japan do not have a clear relationship with collaborative innovations. This model confirms the absence of the relationship in determining collaborative innovation even three years after the establishment of foreign direct investments. Furthermore, it is reasonable to think that Japan may build collaborative relationships with other companies than European ones, for instance US companies, in order to trigger the process of innovation. Otherwise, it may be that innovations are not deposited at European Patent Office but instead at other international organizations such as WIPO (World Intellectual Property Office).

Foreign direct investments in the first regression model (Table 4) are not significant for the US in both inward and outward directions with European companies. There is not a clear relationship between FDI and collaborative patents for the same time period. On the contrary, in the regression model considering the time lag of three years (Table 5), a significant linear relationship is found between collaborative patents and foreign direct investment made by European firms in the United States. It is observed that foreign direct investments to the United States are effective in creating innovations with US partners. Collaboration between EU and US firms seems to materialize after a period of time. Innovative collaborations are initiated once the company well establishes itself in the foreign territory, after a few years. The effects of establishments in the US by European companies determine the development of innovative collaborations enabled by the exchange of the valuable know-how and the critical resources shared. According to the OLI theory, FDI is usually made to leverage a competitive advantage already held by the firm in the foreign market and, this pattern allows firms to successfully collaborate with other firms abroad. It is reasonalbe to think that in the beginning, European multinationals and small-to-medium-sized companies expand abroad to broaden their selling markets, but once they have established and succeed in the market, they begin to collaborate with American companies and innovate successfully due to a mutual understanding of high technologies and skilled know-how. In contrast, the reverse is not true. The foreign direct investments of American companies in Europe are not a determinant for engaging in innovative collaborations neither in the same period of establishments, not after few years. FDI inward from US to Europe are implemented for the purpose of manufacturing directly abroad or having warehouses located within foreign countries to have a foothold for sales, since export involves high costs to serve foreign markets (e.g., Europe) due to transportation and other related costs (Hanson, Mataloni & Slaughter, 2001).

For what conserns developed countries, there is not a clear relationships between the dependent variable and the exploratory variables. The innovative collaborations seems to be not related to FDI in both directions. In this case, it can be reasonably assumed that taking developed countries as an aggregate fails to explain the relationship under consideration. This is likely due to the different innovation strategies that characterize the countries included in this aggregate. The possible reasons for the non-significance of the fdi variables on this aggregate may be several. The first can be found in existing collaborations built over the years (prior to the time period considered). Then, probably, the new implementation of FDI are determined by other reasons such as the creation of a new distribution network through the setting up of new sales centers, the reaching of clients with direct contacts through the implementation of commercial structure and the bypassing of some costs that would be generated with other ways of entering the foreign market. They would not, therefore, serve to create innovation. The same is also said when considering the relationship between the establishment of foreign investment made three years earlier and current innovative collaborations. The effect of time on collaboration does not seem to have an impact on relationships. However, in the two regression models, it is clear that there is not a defined relationship considering developed countries whereas taking the aggregate of BRICS, that is more specific with respect of undeveloped or emerging countries, gives some results.

To sum up, the evidence from the models stresses the positive relationships between inward investments in Europe by Chinese and BRICS firms and co-patenting activity, while the commitment in outward investments by European firms to US for the creation of greenfields is relevant for innovative cooperation.

Table 4 Results of fixed effect regression model (not considering temporal lag)

	Regression models				
	Dependent variable:				
	Collaborative patents with dev. countries	Collaborative patents with US	Collaborative patents with JP	Collaborative patents with BRICS	Collaborative patents with China
	(1)	(2)	(3)	(4)	(5)
Constant	41.141***	34.119***	-2.463	19.414***	10.423**
	(10.436)	(9.470)	(3.092)	(4.520)	(3.259)
Knowledge intensity	39.857***	31.218***	4.163***	7.478***	4.076***
	(2.985)	(2.706)	(0.885)	(1.295)	(0.936)
Collaboration propensity	0.867*	0.779*	0.019	0.259	0.165
	(0.412)	(0.374)	(0.122)	(0.179)	(0.129)
Extra-EU collaboration propensity	6.256***	5.590***	0.372*	0.976***	0.524**
	(0.592)	(0.537)	(0.175)	(0.257)	(0.185)
GDP pro capita	3.280**	3.227**	-0.377	0.670	0.237
	(1.216)	(1.103)	(0.361)	(0.527)	(0.380)
Population density	10.777***	8.322***	-0.297	7.190***	4.165***
	(2.637)	(2.394)	(0.777)	(1.138)	(0.820)
Human capital	0.019	-0.009	0.010	-0.017	-0.009
	(0.033)	(0.030)	(0.010)	(0.014)	(0.010)
Universities	-0.078	-0.030	-0.021	0.047*	0.046**
	(0.053)	(0.048)	(0.016)	(0.023)	(0.016)
Employment rate	-8.017*	-6.279	-0.227	3.212*	2.451*
	(3.739)	(3.389)	(1.107)	(1.619)	(1.169)
Share manufacturing employees	-2.601	1.352	-1.036	0.378	-0.040
	(6.286)	(5.705)	(1.862)	(2.730)	(1.970)
FDI to dev. Countries	0.031				
	(0.110)				
FDI from dev. Countries	-0.128				
	(0.104)				
FDI to US		0.101			
		(0.110)			
FDI from US		-0.164			
		(0.102)			
FDI to JP			0.102		
			(0.060)		
FDI from JP			0.020		
			(0.041)		
FDI to BRICS				0.058	
				(0.050)	
FDI from BRICS				0.181**	
				(0.057)	
FDI to China					-0.019
					(0.043)
FDI from China					0.156**
					(0.053)
Regions FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
R^2	0.950	0.941	0.813	0.774	0.711
Adjusted R^2	0.944	0.935	0.793	0.751	0.682
F Statistic (df = 280; 2711)	182.753***	155.242***	41.974***	33.239***	23.876***

Notes: *p<0.05; **p<0.01; ***p<0.001

Table 5 Regression models (with three years temporal lag)

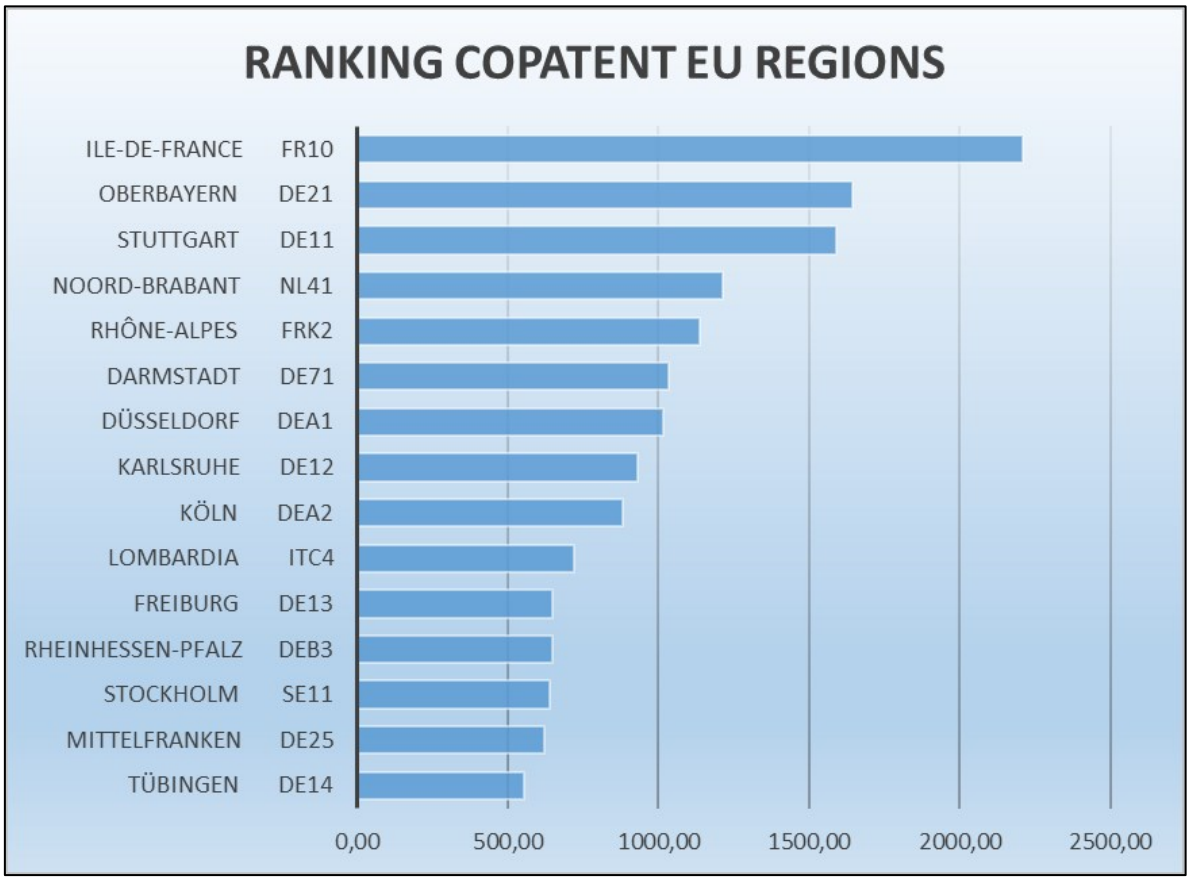
	Regression models				
	Dependent variable:				
	Collaborative patents with dev. countries	Collaborative patents with US	Collaborative patents with JP	Collaborative patents with BRICS	Collaborative patents with China
	(1)	(2)	(3)	(4)	(5)
Constant	49.349***	43.378***	1.076	13.543**	8.165*
	(12.870)	(11.517)	(3.379)	(5.182)	(3.646)
Knowledge intensity	14.164***	9.769**	1.577	4.759***	3.836***
	(3.527)	(3.153)	(0.927)	(1.423)	(1.003)
Collaboration propensity	0.104	0.019	0.0005	0.117	0.102
	(0.467)	(0.418)	(0.123)	(0.188)	(0.133)
Extra-EU collaboration prop	-0.222	-0.228	-0.034	0.247	0.143
	(0.641)	(0.573)	(0.169)	(0.258)	(0.182)
GDP pro capita	4.284**	4.319**	-0.120	0.300	0.215
	(1.481)	(1.324)	(0.389)	(0.597)	(0.420)
Population density	11.982***	9.985***	0.431	4.957***	2.987**
	(3.358)	(3.008)	(0.878)	(1.349)	(0.947)
Human capital	0.037	0.027	0.007	-0.004	-0.003
	(0.044)	(0.039)	(0.011)	(0.018)	(0.012)
Universities	-0.158*	-0.117*	-0.029	0.047	0.043*
	(0.065)	(0.058)	(0.017)	(0.026)	(0.019)
Employment rate	-4.115	-2.420	-0.729	0.882	0.341
	(4.625)	(4.132)	(1.215)	(1.865)	(1.314)
Share manufacturing employees	1.652	4.727	-1.588	-0.902	0.290
	(7.366)	(6.589)	(1.936)	(2.973)	(2.095)
FDI to dev. Countries	0.122				
	(0.125)				
FDI from dev. Countries	-0.197				
	(0.118)				
FDI to US		0.350**			
		(0.125)			
FDI from US		-0.144			
		(0.114)			
FDI to JP			-0.110		
			(0.062)		
FDI from JP			-0.036		
			(0.042)		
FDI to BRICS				-0.029	
				(0.053)	
FDI from BRICS				0.144*	
				(0.062)	
FDI to China					-0.005
					(0.044)
FDI from China					0.275***
					(0.056)
Regions FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
R^2	0.950	0.944	0.836	0.834	0.805
Adjusted R^2	0.944	0.937	0.816	0.813	0.781
F Statistic (df = 277; 2204)	152.003***	134.825***	40.594***	39.924***	32.897***

Notes: *p<0.05; **p<0.01; ***p<0.001

4.4. In-depth analysis of regional performance

The regeression analysis allows to figure out a relationship between co-patenting activity and foreign direct investments for the countries considered. The relationships between them changes accordingly to which country we are considering. Nevertheless, it is necessary to be aware of possible differences when considering regions using a more analytic and descriptive approach. The database under investigation provides data for each NUTS2 region from which it is worth conducting a more detailed analysis in order to find out the most collaborative European regions. It allows to identify the distribution of collaborative innovations across Europe and next, examine the fdi inward and outward strategies.

Figure 9 Ranking of collaborative patents European Regions using NUTS2 codes



Source: own elaboration

At the national level according to the World Intellectual Property Report (2019) the innovation is concentrated in a limited number of areas in the world. In this section the analysis is devoted to understanding whether the phenomenon is reflected also in Europe among the 300 regions identified at NUTS2 level. To provide a more comprehensive understanding of the data, the

average of years with respect to copatent, fdi in and out was computed for each region to provide the starting point from which to perform the analysis. The bar chart in *Figure 9* shows the top fifteen most collaborative regions in Europe. It can be noticed that ten of the fifteen regions in the ranking are regions belonging to Southwest Germany.

The positions regarding outward investment and investment from other countries are also analyzed. *Figure 10* shows the ranking of foreign direct investment in both directions with respect to China, United States, Japan, developed countries and BRICS for the top 15 EU regions involved in the co-patenting activity.

The first place in the co-patenting ranking is occupied by ***Ile-de-France (FR10)*** region. Over thirteen years (2003-2015) it performs on average 2209 collaborative patents per year and mainly it collaborates with US, Japan and developed countries in primis but it is classified at fourth position considering only co-patents with BRICS countries and seventh with China. The region makes greenfields investments in the same countries they collaborate and interestingly, either US, Japan and in general developed countries are usually making investments in foreign plants within the French region. In addition, the region also ranks second in the BRICS countries and more specifically in China in terms of investment in FDI made in these countries. It seems that this region invest not only in developed countries but also in emerging countries. The region is able to integrate knowledge flows from different sources, both investing firstly in similar countries in order to collaborate to develop innovations and in emerging countries to exploit different knowledge from the one already possessed.
In addition, the ranking in the first positions also in terms of the inward FDI in the region foster the creation of spillovers and network of knowledge integrating heterogeneous resources and know-how.

The first German region is ***Oberbayern (DE21)***, located in southern Germany, which is behind the top ranked region by 26 percentage points with an average of 1644 co-patents. It is placed in the second position of collaboration with every country but it invests with foreign direct investments both in developed and BRICS countries, thus accessing different streams knowledge. However, it is interesting to note that it is not on the first positions in the Japan FDI outward ranking. The flow of knowledge inward is quite different. This region is not positioned in the podium, even if it is in the first 20^{th} positions. It seems that the region is more prone to invest abroad in order to reach different knowledge and integrate them rather than receiving greenfields from abroad.

Table 6 Rankings of foreign direct investments for the top 15 co-patenting regions

RANKING	EU REGIONS	NUTS2	FDI OUT DEV COUNTRIES	FDI OUT US	FDI OUT JAPAN	FDI OUT BRICS	FDI OUT CHINA	FDI IN DEV COUNTRIES	FDI IN US	FDI IN JAPAN	FDI IN BRICS	FDI IN CHINA
1st	Ile-de-France	FR10	2nd	2nd	1st	2nd	2nd	2nd	3rd	1st	4th	5th
2nd	Oberbayern	DE21	3rd	4th	12th	3rd	3rd	6th	5th	6th	6th	6th
3rd	Stuttgart	DE11	9th	5th	8th	7th	5th	*More than 20th*	*More than 20th*	9th	12th	11th
4th	Noord-Brabant	NL41	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*
5th	Rhône-Alpes	FRK2	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	18th	*More than 20th*	*More than 20th*
6th	Darmstadt	DE71	*More than 20th*	*More than 20th*	18th	*More than 20th*	14th	4th	6th	5th	3rd	2nd
7th	Düsseldorf	DEA1	12th	12th	14th	6th	8th	5th	20th	2nd	2nd	1st
8th	Karlsruhe	DE12	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*
9th	Köln	DEA2	6th	6th	15th	8th	6th	13th	*More than 20th*	*More than 20th*	5th	4th
10th	Lombardia	ITC4	13th	14th	3rd	12th	17th	12th	10th	16th	14th	8th
11th	Freiburg	DE13	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*
12th	Rheinhessen-Pfalz	DEB3	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	13th	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*
13th	Stockholm	SE11	9th	7th	9th	10th	11th	*More than 20th*	18th	*More than 20th*	*More than 20th*	*More than 20th*
14th	Mittelfranken	DE25	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*
15th	Tübingen	DE14	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*	*More than 20th*

Source: own elaboration

Another German region is ***Stuttgart (DE11)***, positioned at the third place, it is involved in co-patenting activity mainly with BRICS countries, China and Japan. It is classified in the 5th position for foreign direct investments made in US and China. However, the investments greenfields to developed countries, Japan and BRICS appears to be significant as well. Instead, the majority of inbound investment comes from Japan, BRICS and China. It is reasonable to think that greenfields established in the region from US are not connected to innovation.

The fourth region: ***Noord-Brabant (NL41)*** in Netherlands in highly involved in co-patenting activity but it seems to not invest in neither of the two directions for what concerns greenfields. As there are a lot of companies that incorporate in Netherlands for the favourable company law, probably this is one of the case in which the patent is registered in the region of the registered office and not in the real seat of the firm. In this way, the connection with FDI and collaborative innovation is lost. Moreover, it seems that collaborative innovations of the region are not linked

or fostered by the close presence of the partners, neither Netherlands companies need a proximity with foreign firms to collaborate.

The ***Rhône-Alpes (FRK2)*** region develop collaborations mainly with developed countries including Japan and US. The co-patenting activity is well-developed but it is not followed by a corresponding to a high investment in FDI, with the exception of Japan. From the fdi rankings it is not classified on the relevant positions neither inward nor outward. This could be due to the different forms of entering international markets (e.g. through joint venture, contracting, acquisitions etc.) that still seems to foster collaborations. Spatial proximity appears to be a relevant factor for this region with Japanese firms as it falls into the top 20 positions for Japanese investment in the French region.

The ***Darmstadt region (DE71)*** predominantly cooperates with developed countries and ranks in the top three with the United States and Japan and minor collaborations with Chinese firms. In contrast, there is a significant relevance on the investments received from BRICS and Chinese organizations that commit to establish in the region. The region is second in number of FDI inward from China. As it is in the top 10 of Japan inward investments, it seems that there could be policies to attract foreign investments from Asian countries in the region. The German region is not investing much abroad with FDI compared to the others, as it is not in the top 20 FDI outbound ranking, except for Japan.

On the contrary, the region of ***Düsseldorf (DEA1)***, that appears in the collaboration with all the analysed countries, receives high foreign direct investments from BRICS, Chinese and Japanese organizations in terms of greenfields. It attracts them, probably encouraged by specific policies encouraging the establishments of greenfields. The organizations in the region are expanging abroad with high FDI above all in BRICS countries and China. In sum, both directions of investments can create collaborative innovations.

The ***Karlsruhe region (DE12)*** is involved in the creation of co-patents with developed countries but it does not commit resources on foreign direct investments. It is the first German region in the ranking in which there are not significant investments abroad neither inward nor outward.

Instead, the ***Köln region (DEA2)*** that collaborates mainly with Asian and BRICS countries invests in greenfields both in BRICS and in developed countries. Specifically, it is also in the top positions for outbound investments in the individual countries considered. As in most of the German regions analyzed so far, this region also attracts investment from the BRICS and China.

In the tenth position Italy enters the ranking as the region with the highest number of copatent in Italy. ***Lombardia region (ITC4)*** develops on average 719 co-patents each year mainly with developed countries, in particular with US. In terms of investments it attracts both Chinese and US investments ranking on the first tenth with greenfields but in terms of outward investments the main receipient is Japan ranking at the third position.

The following two German regions: ***Freiburg and Rheinhessen-Pfalz (DE13-DEB3)*** develop co-patents with a wide range of countries but are not engaged in a great amount of FDI to rank in the first twentieth positions of any FDI classification (except outward FDI to China for Rheinhessen-Pfalz region). Probably the region is not attracting foreign direct investments or it has too restrictions to follow but it requires a further analysis.

The ranking of major copatenting regions now reveals a country that has developed in terms of innovation in recent times: Sweden (De Noni et al., 2018). In particular, the region that includes the capital City: ***Stockholm (SE11)*** is the first region in the ranking of co-patenting with BRICS and China. A minor impact on collaboration is represented by connections with developed and US countries. The region appears mainly in the rankings of outward FDI, underlying the importance of outbound investments in greenfields in order to reach different knowledge in the market. Heterogeneous knowledge acquired with establishments abroad seems to encourage collaborations with local firms and to consequently foster innovation of different types. In inward investments, US represents the country that invests in the region with greenfield.

The last two German regions: ***Mittelfranken and Tübingen (DE25-DE14)*** in the ranking are neither investing in FDI nor attracting them in the same measure of the classified regions.

Finally, it should be pointed out that there is one region that does not appear in the top fifteen regions co-patents ranking but it has a prominent position in terms of foreign direct investments both inward and outward. This is the ***London region***. It seems that foreign direct investments are not facilitating collaboration to create innovations by means of co-patents.

As we can see, there is a general rule deriving from the regressions for which the higher the foreign investments the higher the likelihood to engage in collaborative innovations with some differences linked with the direction of investments (inward and outward). At the same time, there are some exceptions considering the level of detail of regions. In this section it is demonstrate how regions can have develop strategies in terms of FDI and collaborative innovations.

5. DISCUSSION AND FURTHER RESEARCH

5.1. Discussion and concluding remarks

The objective of this thesis is to understand the impact of foreign direct investments on collaborative innovations. The importance of innovation and collaboration in a globalised context prompted a study of the phenomenon given the growing relevance of network creation. Collaborative innovations are analysed at a regional level taking EU regions classified according to NUTS2 codification and foreign partners of developed countries such as the US and Japan and BRICS countries including China. The internationalization process to reach Extra-EU partners is analysed choosing as entry mode the Foreign Direct Investments, in particular, greenfields investments. The main hypothesis of the research is that foreign direct investments can sustain the collaborations for the creation of innovations. The literature underlines the importance of spatial distance to engage in innovations with foreign partners, but at the same time, other scholars argue that geographical proximity can be overcome by other types of proximities such as organizational, cognitive, technological, institutional etc. From the regression analysis it is revealed that the two perspectives are valid but there are some considerations to make.

Collaborative innovations can be driven by foreign direct investments in two directions: inward and outward. The former refers to the inflows of investments from foreign firms to EU regions while the latter relates to the outgoing investments in greenfields to the foreign countries. Furthermore, it is necessary to distinguish developed countries from emerging countries to figure out the strategies of internationalization. These two distinctions (inflows-outflows FDI and developed-emerging countries) referring to the direction of investments and development of a country, helps in understanding the importance of FDI strategies. The regressions show important relevance in this respect. Investments in greenfields impact positively on collaborative innovations depending on the countries in which they are done. If we refer to a developed country, in this case US, the investments are relevant in the outgoing direction whereas, referring to an emerging country such as China, the opposite direction is significant, i.e. the inflows investments in Europe. These results are confirmed by the main theories of internationalisation.

The OLI theory (Dunning, 1977; 2000) emphasises how the presence of a competitive advantage is important for expansion in international environment. The concomitant presence

of ownership, localisation and internalisation advantages gives the opportunity to consider committing resources and increase efforts in order to engage in foreign direct investments. From this research it is shown how foreign direct investments impact on innovations in outward directions from EU regions to the US country. The internationalization through FDI, allows EU companies to reach a foreign market that is similar in terms of technological advancement and economic development to collaborate and develop innovations (the higher the FDI-outflows, the higher the number of co-patents).

In contrast, the LLL framework (Mathews, 2006) and the Springboard theory (Luo &Tung, 2007) stress the position of Asian companies in the internationalization processes. The expansion is finalized at seeking the strategic assets and the valuable resources to overcome the internal weaknesses and companies' constraints. They successfully internationalise by being active listener in the host-country and developing interactive relationships. The enacted process of learning aims at exploiting the foreign resources and gaining more sophisticated knowledge. These companies consider the market as a reservoir of resources in which to tap into in order to accelerate their internationalization process. These latecomers transform their disadvantages into advantages using a reverse perspective: they pull from abroad to adapt and keep up with new technologies. In our model, China is willing to invest in greenfields in EU regions, as it draws on the European market looking for strategic assets that are absent or limited in the domestic market. The strength of the relationships between FDI-inflows and co-patents in the model considering China (*model (5)-Table 4-Table5*) reinforce the ambition of Chinese companies to invest in Europe to find the resources and build relationships to create collaborative networks thus, fostering innovation.

The Uppsala model (Johanson & Vahlne, 1977; 2009) depicts the steps to enter foreign markets, contemplating FDI as one of the final steps used by companies when they decide to internationalise. The gradual process of accessing foreign markets is enacted because of the incremental learning process of the foreign market. Once the company entered in a new context it experiences different challenges and opportunities that will constitute the knowledge of the market. The experiences gained allow then the investing firm to take future decisions on the level of commitment in that foreign market. As a result, at the end of the incremental learning process, the companies can effectively establish in the foreign market and grasp the opportunities that are offered. Therefore, the strategies to invest in greenfields can be dictated by multiple reasons but, if a learning process is implemented, there is major likelihood that the company might develop collaborative innovations with at least one foreign inventor.

In our model, foreign direct investment is not significant for collaborative innovation when developed and BRICS countries have been accounted. In these cases it can be reasonable to think that countries taken as aggregate do not give some interesting insights on the relationships, probably because each developed or BRICS country differs in strategies of internationalization. In confirmation of this, for the developed countries the relationship is positive and significant for the US but not significant for Japan. Distance being equal, cultural distance could affect the country's potential for cooperation with Europe. Similarly, for the BRICS countries the differences are probably more smoothed out as China shows a very strong relationship between FDI inflows and co-patents, while for the BRICS the relationship is still significant although to a lesser extent.

The findings of the regressions confirmed the general rule according to which developed countries are engaged in collaborative innovations using FDI in other developed countries, while emerging countries commit in collaborative regions with FDI in developed countries. They are fuelled by different reasons, as above explained.

From the considerations above, it is necessary to recognise that there are some exceptions, which are discovered in the more detailed analysis at regional level. There are some regions in the EU that are involved in innovative collaboration, but which handle FDI strategies differently and others that are strongly collaborative with foreign countries but invest less in greenfields. The empirical results in the co-patents ranking show this phenomenon. In particular, it can be noticed that the regions in the podium, the highly collaborative regions of Ile-de-France (FR10), Oberbayern (DE21) and Stuttgart (DE11), are also in the ranking of foreign direct investments in both directions. As you move down the ranking, other than Düsseldorf and Lombardia that respect the general rule, there are some exceptions such as Noord-Brabant (NL41) and Rhône-Alpes (FRK2) that are high ranked in terms of collaborative innovations but the trend is not replicated for FDI. There are some German regions (e.g Darmstadt, DE71) engaging in collaborative innovations while attracting foreign direct investments, and some others (e.g. Köln, DEA2) that make foreign investments to collaborate. Interesting the case of Stockholm (SE11) which enters the ranking of co-patents in the 13th position and it is ranked in the first positions both in FDI outward of developed countries and BRICS countries, highlighting the heterogeneous strategies of interantionalizations. Finally, another exceptions is London area, which results in having high investments in greenfields but that are not linked with collaborative innovations.

Furthermore, another point to consider is the distribution of innovative activities across Europe. From the descriptive analysis it is confirmed the unequal distribution of innovation for

European regions, which is primarily shown in Table 2 where the discrepancy in terms of number of co-patents is visible. With a minimum of zero and a maximum value of 2478,54, the mean calculated is 135,57. Another evidence comes from the percentage of collaborative patents done by Germany and France that constitute more than 50% of the total amount of collaborative patents per year on average.

Moreover, an additional confirmation of the regional concentration of innovations is displayed in the in-depth analysis on regional performance. It is clear that the innovative collaborations mainly come from regions pertaining to 5 States: France, Germany, Netherlands, Italy and Sweden. More in detail, in each of these States, regions classified with NUTS2 codes are not equally innovative as well (e.g. in France the innovative regions are mainly just Ile-de-France and Rhône-Alpes).

Finally, the effect of foreign direct investments is most likely to be delayed in time. It is confirmed by the regression models and it can be noticed in the higher R-squared for the lagged regressions (*Table 5*), indicating the higher goodness of fit of the model. The lagged effect of creating collaborations hints at how European policies should not only support the establishment of foreign firms, but also create favourable conditions for the promotion of networking once the foreign firm is embedded in the regional set of infrastructure. This would facilitate the collaborative innovation of the region.

5.2. Further research

The research in this thesis highlights the important results described above in the 5.1 section. Furthermore, it will be worth analysing in future research three main topics, understanding other aspects related to the relationships investigated in this research. An interesting discrimination could be done in order to understand the impact of policies to attract foreign direct investments on collaborative innovation. It can be studied the regional policy in terms of support to FDI in both inward and outward directions. In addition, it could be interesting to examine the relationship between FDI and collaborative innovation at a firm level to see whether there is differences due to the different size of the firms (e.g SMEs, MNEs, corporations etc). Finally, Japan's innovative collaboration is not captured by the model studied in this thesis. It would be worthwhile to identify the countries with which Japan collaborates to understand whether FDI is significant in innovative collaborations. Also, given that Japan is one of the most innovative countries, it would be interesting to understand Europe's difficulty in collaborating with Japan, if this is only a cultural problem or there are other determining factors.

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APPENDIX

APPENDIX 1: Assignment of NUTS2 codes to records from fDi Markets database

The allocation was carried out for all records in the database by matching regions and NUTS2 2021 codes. If the codes could not be found, the cities were searched for using a variety of techniques such as substituting special characters, searching for municipalities in NUTS3, taking the administrative region into account and matching it to the nuts2 region. Here is an extraction of the extensive allocation process (program used: VBA excel) including the example of Germany.

ASSIGNMENT OF NUTS2 2021 CODES

```
Dim DtbA(1 To 12500, 10) As Variant
Dim dtbNUTS(1 To 12500, 3) As String
Dim i, j As Single
Dim lastA, LastN As Single

'activate worksheet LAVORO

Worksheets("LAVORO").Activate


'UPLOAD DATA IN THE DATABASE DTBA
For i = 1 To 12500
   For j = 1 To 6
      DtbA(i, j) = Cells(i, j).Value
   Next j
   'IF I FIND AN EMPTY ROW, I RUN OUT THE CICLE FOR
      If DtbA(i, 1) = "" Then
         lastA = i - 1
         Exit For
      End If

Next i

Worksheets("NUTS").Activate

'UPLOAD DATA IN DATABASE NUTS

For i = 1 To 12500
   'Code 2021
   dtbNUTS(i, 1) = Cells(i, 1).Value
   'Nuts Level
   dtbNUTS(i, 3) = Cells(i, 6).Value
Next i
```

```
‘ASSIGNMENT OF NUTS 2 TO ALL RECORDS

Dim ARegion As String
Dim REGION As Boolean

Worksheets("NEWL").Activate

For i = 1 To lastA
   For j = 1 To 6
      Cells(i, j).Value = DtbA(i, j)
   Next j
   If DtbA(i, 6) = "NA" Then
           ARegion = Left(DtbA(i, 4), 5)

     REGION = False

      If ARegion <> "NA" Then
         For j = 2 To LastN

            'IMPOSING CONTROL ONLY WITHIN THE COUNTRY
             If DtbA(i, 7) = Left(dtbNUTS(j, 1), 2) Then
               If dtbNUTS(j, 3) > 0 Then
                  If ARegion = Left(dtbNUTS(j, 2), 5) Then
                     DtbA(i, 8) = dtbNUTS(j, 1)
                     DtbA(i, 9) = dtbNUTS(j, 2)
                     REGION = True
                     Exit For
                  End If
               End If
            End If
         Next j
      End If

      If REGION = False Then
         ARegion = Left(DtbA(i, 2), 5)
        If ARegion <> "NA" Then
         For j = 2 To LastN
            'IMPOSING CONTROL ONLY WITHIN THE COUNTRY
            If DtbA(i, 7) = Left(dtbNUTS(j, 1), 2) Then
               If dtbNUTS(j, 3) > 0 Then
                  If ARegion = Left(dtbNUTS(j, 2), 5) Then
                        DtbA(i, 8) = dtbNUTS(j, 1)
                        DtbA(i, 9) = dtbNUTS(j, 2)
                        REGION = True
                        Exit For
                  End If
               End If
```

```
            End If
          Next j
          End If
        End If

        If REGION = False Then
          ARegion = Left(DtbA(i, 3), 5)
          If ARegion <> "NA" Then
          For j = 2 To LastN
              If DtbA(i, 7) = Left(dtbNUTS(j, 1), 2) Then
                If dtbNUTS(j, 3) > 0 Then
                  If ARegion = Left(dtbNUTS(j, 2), 5) Then
                    DtbA(i, 8) = dtbNUTS(j, 1)
                    DtbA(i, 9) = dtbNUTS(j, 2)
                    REGION = True
                    Exit For
                  End If
                End If
              End If
          Next j
          End If
        End If

Next i

'Worksheets("ASSIGNMENTS").Activate

For i = 1 To lastA
   For j = 8 To 9
      Cells(i, j).Value = DtbA(i, j)
   Next j
Next i
```

GERMANY RECORDS ASSIGNMENTS

```
Sub Germany()
Dim i, j, k As Single
Dim Germany(1 To 125000, 2) As Variant
Dim LastR As Single
Dim LastN As Single
Dim conta As Single
Dim ooo As String
Dim aaa As String
Dim uuu As String
Dim Saarland As String

Worksheets("NUTS").Activate
```

```
For i = 1 To 125000
   If Cells(i, 11).Value = "" Then
      LastR = i - 1
      Exit For
   End If
Next i

k = 1
For i = 1 To LastR

If Cells(i, 7).Value = "5" And Cells(i, 6).Value = "2" Then
   Germany(k, 1) = Cells(i, 11).Text
   Germany(k, 2) = Cells(i, 12).Value
   k = k +1
   Else
      If Cells(i, 7).Value = "5" And Cells(i, 6).Value = "3" Then
         Germany(k, 1) = Cells(i, 11).Text
         Germany(k, 2) = Cells(i, 12).Value
         k = k + 1
      End If
End If

Next i

Worksheets("NUTS GERMANY").Activate

For i = 1 To k
   'Cells(i, 1).Value = GERMANY(i, 1)
   'Cells(i, 2).Value = GERMANY(i, 2)
next i

ooo = Cells(1, 3).Value
aaa = Cells(2, 3).Value
uuu = Cells(3, 3).Value

For i = 1 To k
   Germany(i, 2) = Replace(Germany(i, 2), ooo, "o")
   Germany(i, 2) = Replace(Germany(i, 2), aaa, "a")
   Germany(i, 2) = Replace(Germany(i, 2), uuu, "u")

Next i

For i = 1 To k
   Cells(i, 1).Value = Germany(i, 1)
   Cells(i, 2).Value = Germany(i, 2)
Next i
```