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THE ANALYSIS OF LOCATION IN A SCIENCE AND TECHNOLOGY PARK ON SUSTAINABILITY PERFORMANCE THROUGH KNOWLEDGE SPILLOVERS AND ABSORPTIVE CAPACITY

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Memoria presentada por José María Fernández Yáñez para optar al grado de doctor por la Universitat Jaume I

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The secret, Alice, is to surround yourself with people who make your heart smile.
It’s then, only then, that you’ll find Wonderland.

Lewis Carroll, Alice in Wonderland

To my family

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ABSTRACT

Since the beginning of the Industrial Revolution, climate change and the depletion of natural resources resulting from human activities have been strongly intensified to become issues whose resolution is urgent for society (Wadanambi et al., 2020; Abbas & Sagsan, 2019; Morrar et al., 2017; Robbins, 2016). Certainly, the Industrial Revolution initiated in the 18th century in England had important repercussions on economic growth, increased productivity of companies and, on the advancement of the welfare of societies in general (Camisón et al., 2020; Morrar et al., 2017; Feliu & Suidrà, 2013; Allen, 2009). However, it is no less true that the distribution of wealth has not been equal either between the different social strata of the same nation or between different nations, in addition to the aforementioned problem of the depletion of natural resources and climate change (Wadanambi et al., 2020; Morrar et al., 2017).

The production and consumption model that has prevailed in society since the industrial revolution is based on a linear scheme in which natural resources are extracted, subjected to manufacturing processes for subsequent sale, and after their use and enjoyment by consumers, are usually discarded (Sharma et al., 2020; Korhonen et al., 2018; Geissdoerfer et al., 2017). This logic imposes a cycle of exploitation of natural resources that together with the higher energy consumption required for production (which in turn implies higher emissions of polluting gases), coupled with sometimes irresponsible disposal of products, have contributed greatly to exacerbating the environmental problems that afflict us as a society (Sharma et al., 2020; Geissdoerfer et al., 2017). Climate change is probably the most pressing issue to resolve by our society, as it seriously threatens biodiversity and the survival of ecosystems (Michel et al., 2021; Weiskopf et al., 2020).

Climate change implies that small variations in global temperature will have more severe consequences by altering the patterns of climatic phenomena, becoming more irregular and extreme, and causing other collateral effects such as the melting of the polar ice caps, consequently increasing sea water levels or periods of extreme drought (Michel et al., 2021; Murshed & Dao, 2020). Nor can we ignore the impacts that climate change can have on people's health (Meierrieks, 2021; Aron & Patz, 2001), helping in the spread of viruses, pathogens, and other diseases such as malaria, cholera, Venezuelan haemorrhagic fever, dengue fever, or red tide.

On multiple occasions, modifications of the natural environment such as ocean warming, deforestation, or extensive agriculture and animal husbandry have spurred the rapid spread of these and other diseases (Aron & Patz, 2001), such as the recent coronavirus (Niewiadomski, 2020).

In addition to the above implications in the health sphere, the prevailing production and consumption model has brought with it other pernicious effects in the social sphere. Thus, as underscored by current international frameworks such as the Sustainable Development Goals (SDGs) of the United Nations (UN, 2015), in addition to the resolution of the above problems in the environmental sphere, there is an urgent need for coordinated action by all stakeholders in the health sector, and also desires the joint action of all the agents that compose the economies to solve some of the major objectives of societies such as providing stable jobs to the people who compose them, improving the working conditions of workers, ensuring full equality between people, contributing to the social development of communities, or the eradication of all forms of poverty thus guaranteeing social justice (Fleetwood, 2020; Salvia et al., 2019; Qu et al., 2015; UN, 2015).

Alleviating the above negative externalities in social and environmental terms that the economic progress of the last three centuries has brought with it is a global challenge with influences in ecological-environmental, technological, health, socio-political and socio-economic disciplines, to name just a few of the most fundamental (Feliciano et al., 2022; Leal-Filho et al., 2021). Therefore, in recent decades, the concept of sustainability has dominated the main agendas of governmental and non-governmental entities, academic institutions and, more recently, also the business sector, facilitating the development and large-scale dissemination of the concept (Hall, 2019; UN, 2015; Caradona, 2014; De Marchi & Grandinetti, 2013; WBCSD, 2010). Sustainability, referred to as nature's capacity for the regeneration of its ecosystems (WCED, 1987), stands as a paradigm capable of addressing social, economic, and environmental dimensions under the same construct to contribute to the resolution of the above issues (Zijp et al., 2015; Elkington, 1994; WCED, 1987).

If at the beginning the concern for sustainable development was a matter whose debate and management was mainly undertaken by governments and other non-governmental organizations (WCED, 1987), the 2030 Agenda containing the Sustainable Development Goals (SDGs) has brought about a paradigm shift in this aspect by pointing to companies as essential actors in the management of sustainability (Salvia et al., 2019; UN, 2015). The vision of the company as a supplier of goods and services, provider of labour, and whose main accountability is to its owners is a thing of the past (Camisón et al., 2021). Thus, internal and external factors induce companies to voluntarily adopt broader roles and responsibilities, managing the company holistically to balance economic, social, and environmental performance for the benefit of current and future generations (Aragón-Correa et al., 2020; Ozbekler & Ozturkoglu, 2019; Lozano, 2015; Lozano et al., 2014), are on the rise.

Previous research points to the importance of government policies, incentives, and regulations as an external driver for the business sector to adopt certain measures aimed at improving sustainability (e.g., Guisado-González et al., 2021; Costantini et al., 2017; Camisón, 2010). However, in addition to government regulations and measures, there are powerful market reasons for companies to seek to improve their performance from the triple bottom line of sustainability beyond avoiding potential economic penalties or obtaining tax benefits (Aragón-Correa et al., 2020; Ozbekler & Ozturkoglu, 2019). Thus, increased awareness and scrutiny by consumers when selecting their consumption options is one of the external variables with the capacity to influence the company's strategic decision-making (Harrison et al., 2005). On the other hand, potential reputational risks due to action away from sustainability principles may convince the company of the need to incorporate these principles into its strategy and daily operations to preserve intangible assets such valuable nowadays as reputation or good corporate brand image (Ioannou & Serafeim, 2015; De Marchi, 2012).

Sustainable development requires rethinking the currently prevailing economic and business model towards one that can be restorative and regenerative, able to reconcile equitably and without biases higher economic returns, with better environmental performance and ensuring social welfare (Shrivastava & Paquin, 2011). The "business as usual" model is no longer valid to meet the requirements of sustainable development (Niewiadomski, 2020; Maibach & Hornig Priest, 2009). In the current competitive landscape, afflicted by the social and environmental issues already mentioned, there is no room for old debates and dilemmas that address the dichotomy between better performance or being more socially and environmentally responsible as irreconcilable positions (Guisado-González et al., 2021). Thus, corporate performance and long-term competitiveness increasingly rest on the reconciliation of economic, environmental, and social expectations (Forés, 2019; De Marchi & Grandinetti, 2013; Hart & Dowell, 2011; Esty & Winston, 2006; Porter & Kramer, 2006; Porter & Van der Linde, 1995).

To contribute to this improvement of business performance and competitiveness in the field of sustainability, there is a general consensus that science and technology (ultimately, knowledge), will play a leading role in the achievement of sustainability frameworks such as the SDGs (e.g., Walsh et al., 2020; Forés, 2019; Imaz & Sheinbaum, 2017; Mol & Birkinshaw, 2014; De Marchi & Grandinetti, 2013; Grant, 1996; Nonaka & Takeuchi, 1995). The application of sustainability principles within the firm requires a transformation toward what has come to be called knowledge-based companies (Demir et al., 2021; Paillé & Halilem, 2019; Simao & Franco, 2018; Nonaka & Teece, 2001; Kogut & Zander, 1992). In such companies, knowledge becomes a strategic intangible asset that is proactively managed (Lim et al., 2017; Grant, 2013; Foss, 2005). These companies, through processes of learning and the creation of new knowledge, can respond to the needs that the environment imposes on them (Del Giudice & Maggioni, 2014). However, having all the knowledge necessary to improve performance under the triple bottom line of sustainability within the company is little less than utopian (Chesbrough, 2003, 2006).

Knowledge is becoming increasingly complex, specific, and is distributed among a wide range of economic agents (Scuotto et al., 2017; Chesbrough, 2003, 2006). Accessing external knowledge sources represents an opportunity to diversify on the traditional knowledge base of the industry, and also facilitates the development of ecological or social innovations in a faster, better, and more effective way (Kennedy et al., 2017; Meoli et al., 2013; Laursen & Salter, 2006). The above fact is more pressing if one considers that to develop innovation with a high degree of novelty, the firm requires data and information beyond what it will be able to find within its own boundaries; that is, it will need to make use of inter-organizational knowledge flows (e.g., Ferraris et al., 2017; Wang et al., 2017). From the aforementioned, it is deduced the importance for the company sustainability performance to be inserted in environments with a wide variety of organizations with the capacity to establish inter-organizational knowledge networks in which knowledge spillovers exist and flow.

Science and technology parks are infrastructures designed to host organizations of very different nature, such as companies, start-ups, research institutes, and spin-offs of university research groups, or technological institutes, among others (Díez-Vial & Montoro-Sánchez, 2016; Guadix et al., 2016; Squicciarini, 2008). In science and technology parks, physical proximity, complementarity, and enjoyment of shared services can stimulate interaction between the hosting organizations and generate new knowledge (Díez-Vial & Montoro-Sánchez, 2014; Giuliani & Bell, 2005). Companies hosted in a science and technology park can establish formal or informal relationships with researchers and workforce from universities or other R&D centers more easily, thus being able to access the most novel knowledge on the technological frontier (Claver-Cortés et al., 2018; Pan et al., 2018; Giaretta, 2014; Squicciarini, 2008). On the other hand, STPs have a management team in charge precisely of strengthening the links between organizations and the weaving of knowledge networks (Hansson, 2007).

Companies hosted in a science and technology park benefit from being integrated into an environment where knowledge spillovers flow abundantly from research, ideas, and projects that both universities and scientific or technological research centers develop in the surrounding areas (Díez-Vial & Montoro-Sánchez, 2016). Companies that decide to locate in science and technology parks are also exposed to knowledge spillovers from other installed companies, which can even act as agents of their value chain (Bakouros et al., 2002; Colombo & Delmastro, 2002). Considering that the most valuable knowledge is usually tacit and sticky, interaction and proximity between agents are key characteristics to stimulate its transmission (Maskell & Malmberg, 1999; Spender, 1996). Thus, integration in a territorial agglomeration of companies is an antecedent factor capable of explaining the sustainability performance of a company (González-Masip et al., 2019)[1] encouraged by the knowledge spillovers that emerge in these spaces.

Numerous studies (e.g., Lamperti et al., 2017; Díez-Vial & Montoro-Sánchez, 2017; Vásquez-Urriago et al., 2016); have tried to elucidate empirically whether the fact that a firm chooses to locate in a science and technology park influences variables such as its economic performance, its innovation performance, or its growth, among other variables. Yet, on many occasions, research has found that the relationship between physical proximity and better firm performance on some of the above variables is far from conclusive (e.g., Patton, 2014; Bakouros et al., 2014). Colocating firms with common knowledge bases facilitates mutual understanding between these firms so that they can benefit more from knowledge spillovers thanks to the cognitive community they develop (Ter Wall & Boschma, 2009; Boschma, 2005). Moreover, considering that diversity of knowledge sources can be key to business success (e.g., Leiponen & Helfat, 2010; Laursen & Salter, 2006) in today's environment, locating in a science and technology park seems a crucial strategic decision. However, to resolve this paradox it is necessary to consider that there is heterogeneity in firms located in a science and technology park when it comes to taking advantage of the knowledge spillovers that converge in these environments, and that not all firms benefit in the same way (e.g., Claver-Cortés et al., 2018; Camisón & Forés, 2011).

In this research, we will take into account that the benefits of a company's location in a science and technology park do not depend exclusively on the access to a greater number of knowledge spillovers, but also on the strategies and efforts at the internal level that each company makes to be able to make effective use of these localized endowments of knowledge (Camisón et al., 2018; Claver-Cortés et al., 2018; Munari et al., 2012; Camisón & Forés, 2011; Morrison & Rabelloti, 2009; Giuliani & Bell, 2005). And this will be the case for firms located in a park as long as they

[1] However, if the literature referring to eco industrial parks (e.g., Qu et al., 2015; Heeres et al., 2004) is excluded, the influence of geographic and location factors for the improvement of firms' sustainability performance has not gained sufficient momentum from academic research in the field of management until very recently (e.g., Zubeltzu-Jaka et al., 2018; Leoncini et al., 2016).

are able to identify the knowledge flows (and the people involved in their creation) and become part of them by rooting themselves in the networks, processes and social activities that make up the park (Camisón, 2004; Granovetter, 1985). Thus, a company will be able to take the major advantage of knowledge spillovers to improve its sustainability performance to the extent that it can identify and integrate them with its current knowledge base and later apply them for that purpose (Marrucci et al., 2021; Claver-Cortés et al., 2018; Tzabbar et al., 2013; Camisón & Forés, 2011; De Marchi, 2012). In addition, depending on the degree of similarity of knowledge spillovers from the environment with the company's current cognitive bases, some can be easily integrated and combined with the company's knowledge endowments (Camisón et al., 2017, 2018; March, 1991). This combination will facilitate more efficient exploitation of the company's existing functional capabilities to improve its sustainability performance. In contrast, other, more tacit, complex, knowledge spillovers at the knowledge frontier require the firm to develop an absorptive capacity capable of multiplying the effect of these localised knowledge endowments on its sustainability performance (Camisón et al., 2018; Camisón & Forés, 2011).

Consequently, this research will advance the literature by providing empirical evidence of the effects of location on the sustainability performance of Spanish firms through the mediating effects of knowledge spillovers and individual firm absorptive capacity. For this purpose, we will resort to a longitudinal empirical analysis of data extracted from the Panel on Technological Innovation in Spanish Companies (PITEC) distributed annually by the Spanish National Statistics Institute (INE). From the results of this analysis, we will draw conclusions and practical implications for both academia and management practitioners. The study will also serve as a reference point for future lines of research.

Therefore, in light of the above arguments, the following main research questions have been formulated:

1. Does the location matter for sustainability performance? Is there and direct or indirect effect between both constructs?
2. What is the role of science and technology parks in the development on knowledge and innovation?
3. What is the effect of knowledge spillovers and absorptive capacity in improving corporate sustainability performance?

RESEARCH AIMS AND CONTRIBUTIONS

To answer the above research questions, it is necessary to first carry out a theoretical review of the main concepts to be analysed. Sustainability performance consists of evaluating the company's results not only in economic-financial terms but also taking into account the social and environmental repercussions. This approach to the company's triple sustainability performance denotes the company as an agent capable of contributing to the improvement of society and moves away from the traditional economic view, according to which the company's sole responsibility is to use its resources in activities aimed at increasing shareholders' profits (Friedman, 1970).

Sustainable performance invokes the management of the concerns and demands of all stakeholders that are affected by the company (Freeman, 1984). The purpose of the organisation must be to deploy policies and practices capable of reconciling increased economic performance with the protection of natural ecosystems and the resolution of social problems (Porter & Kramer, 2011). The long-term competitiveness of organisations will lie in successfully reconciling this triad. However, achieving performance under the triple bottom line of sustainability, in a highly globalised environment, where the pace of technological evolution is fast-paced, requires high doses of knowledge resources, probably the most fundamental intangible asset guaranteeing sustainable competitive advantages.

Accessing certain cutting-edge knowledge can be easier when the organisation is integrated into a space where there are other competing companies, complementary organisations, universities, suppliers, or research centres. Science parks are an instrument of innovation and industrial policies that were created precisely to provide cutting-edge knowledge to companies. Science and technology parks have their origins in the Stanford Research Park in California, the predecessor of Silicon Valley, in the middle of the last century. Given the resounding success of this technology complex in hosting and nurturing new knowledge-based companies, there have been numerous policy initiatives to develop similar initiatives in other territories. However, it must be said that, like other initiatives such as clusters, its clearest ancestor is the industrial districts of England at the birth of the Industrial Revolution (Amoroso et al., 2019).

Therefore, one of the main objectives of this dissertation is to delve into the origins of agglomeration theory. To this end, we will review the most classical postulates of economic thought, the most relevant contributions from the theory of organisation and strategic management of the company, and the latest academic studies that emphasise the role that territorial agglomerations of companies can play in promoting the sustainable development of the territory in which they are located. This will facilitate the recognition and study of the main typologies of territorial agglomeration of companies that abound today. Once the different models of territorial agglomeration of companies have been differentiated, the focus will be on science and technology parks as learning centres where organisations can take advantage of knowledge spillovers from multiple agents to improve their performance.

Academic literature points out that, to have any impact on corporate performance, science and technology parks must be munificent environments where there is an abundance of knowledge spillovers as well as offering companies an idyllic location in which to enhance their image or reputation. Recent empirical studies have addressed the impact that such knowledge spillovers can have on improving the innovative performance of firms integrated into science and technology parks (e.g., Claver-Cortés et al., 2018). These investigations, adopting the postulates of strategic management, have focused not only on the endowment of knowledge resources available in the science park environment but also on the individual capabilities of host firms to recognise and take advantage of them.

This doctoral thesis holds the same position; that is, it will not be enough for a firm to locate itself in an environment rich in knowledge spillovers to improve its sustainability performance. On the contrary, the firm will have to make an active effort to take advantage of such knowledge either directly by the degree of similarity with its current knowledge base, or by making use of the absorptive capacity for more disruptive, novel, technological knowledge, and innovation. The objective here is to understand the magnitude and relationship of both effects. That is, how they affect both individually and jointly the improvement of the company's sustainability performance.

In this vein, the main contribution of this PhD dissertation hopes to make is to gather, in one theoretical model, some of the main antecedent variables that explain a better company's sustainability performance, the key to its long-term competitiveness. We will consider the effect of the external environment reflected in the location of the company in a science and technology park and the knowledge spillovers that can arise there. The heterogeneity of companies, widely recognized in the literature on strategic management, will also be taken into account through the mediating effect of absorptive capacity. Using a large panel dataset and several statistical procedures, we hope that our objectives will contribute to the field of strategy, in several areas whose confluence has only recently begun to be explored.

In light of the above, the research objectives of this study are as follows:

1. To explain why sustainability performance is the new measure of business competitiveness.
2. To review and integrate the main theories of territorial agglomeration of companies and why these enclaves can be beneficial both for companies and the territories in which they are located.
3. To define and recognise the different typologies of territorial agglomeration of companies identified in academic literature and institutional sources, with special emphasis on the typology of science and technology parks.

4. To diagnose the state of the art in the literature on science and technology parks.
5. To identify and contextualise the phenomenon of science and technology parks in Spain at present.
6. To review the theoretical background of the microeconomic theory of business competitiveness, using the resource-based view and its more dynamic extensions, delving into the study of absorptive capacity.
7. To develop the hypotheses of a theoretical model capable of explaining the sustainability performance of companies located in a science and technology park. Taking into account the mediating effects of knowledge spillovers and the absorptive capacity of organisations.
8. To empirically validate the above hypotheses using a panel database and several advanced statistical procedures.
9. To draw conclusions, implications, and recommendations for research and practitioners in a way that stimulates progress in the field.

OVERVIEW OF THE PHD RESEARCH

This doctoral thesis is divided into seven chapters which are accompanied by this introductory section on the research framework, as well as an appendix with additional statistical evidence.

The first four chapters are intended to comprehensively lay the fundamental theoretical foundations of the concepts around which the thesis revolves: sustainability performance, territorial agglomerations of firms (with emphasis on the typology of science and technology parks), and the microeconomic sources of business competitiveness. Due to their theoretical review nature, these first four chapters will be followed by a final section summarising the main ideas obtained from these literature reviews.

The fifth chapter then sets out the main working hypotheses derived from the previous research questions and objectives. The sixth chapter is devoted entirely to the statistical methodology applied on a panel database of Spanish firms, as well as to present the results obtained. Finally, the seventh chapter is devoted to a more extensive discussion of the previous results, making explicit academic implications in the form of future lines of research, and outlining recommendations for the professional practice of management.

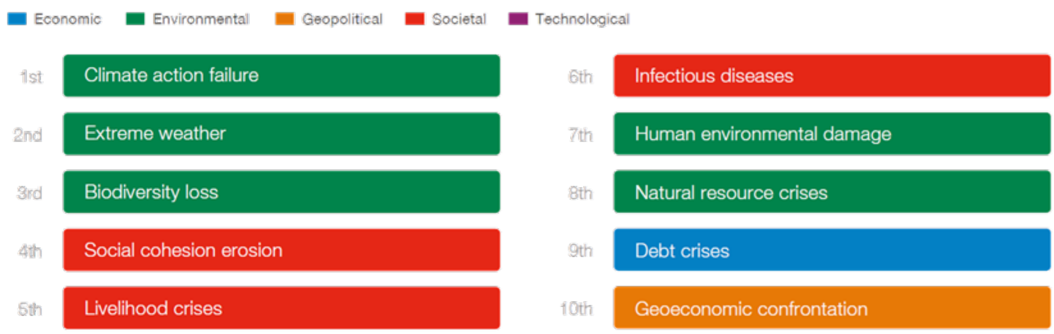
1. PERFORMANCE IN SUSTAINABILITY AS A NEW FORM OF BUSINESS COMPETITIVENESS

1.1. INTRODUCTION

Traditionally, there was a vision that considered the company as a supplier of goods and services, a contractor that offered work, and a potential destination to which families could channel their savings (Camisón et al., 2021). Today, the range of expectations and demands on the company has expanded, especially concerning its responsibility to society and the protection of the environment. If in the past the legitimacy of the company to operate in the market rested on the fulfilment of its financial and legal obligations to its shareholders (Quazi & O'Brien, 2000; Friedman, 1962), now it depends on the approval of a larger group of stakeholders. stakeholders interested in their actions beyond economic-financial performance (El-Kassar & Singh, 2019; Ambec & Lanoie, 2008; O'Rourke, 2003; Freeman, 1984). In this situation, calls for a greater social role of the company are progressing upwards, not only to continue being competitive in the markets, but also to actively and effectively contribute to the challenges present in the current environment, and thus meet the expectations that stakeholders place on the company (Camisón et al., 2021).

The proactive management of sustainability in organizations becomes more pressing if some considerations such as those presented below are considered. According to the Global Risk Landscape 2022 edition prepared by the World Economic Forum to assess the risks faced by societies globally, the first five of these risks responded to aspects related to environmental sustainability (climate action failure, extreme weather, biodiversity loss) and social sustainability (social cohesion erosion, livelihood crises, infectious diseases) (see Figure 1). International summits such as the United Nations Climate Change Conference (COP26) have tried precisely to address some of the previous concerns pointed out by the World Economic Forum, especially those related to the climate crisis and the economic effects that the health crisis derived from the spread of the coronavirus has brought along. Governments at different scales are approving a growing number of regulatory measures and incentives to promote an increase in the contribution of companies to the improvement of sustainability[2].

Figure 1. Risks faced by societies



Source: World Economic Forum (2022)

According to several recent investigations (e.g., Ioannou & Hawn, 2019; Forés, 2019; Wijethilake, 2017), sustainability is becoming a crucial aspect of the strategic management of companies globally. A growing range of companies are voluntarily carrying out a set of sustainability actions to address the expectations of their stakeholders in the environmental and social domains to build competitive advantages in differentiation, thus integrating sustainability into their strategy, organizational processes, management structures, and corporate governance (Shang et al., 2020; Khan, Serafeim & Yoon, 2016; Eccles et al., 2014). The benefits of adopting more sustainable strategies and practices have a clear impact on business performance and success in competitive markets.

However, this belief, which seems to be gradually becoming part of the core business, has not always been the case (Rezende et al., 2019; Cai & Li, 2018; Hussain et al., 2018). For a long time, improving organizational performance taking into account sustainability criteria has been considered a source of cost (Dey et al., 2019). Rennings (2000) explains that, at least about actions

[2] At the national level, the implementation of an ambitious plan called the Spanish Circular Economy Strategy stands out, which has been accompanied by a Climate Change Bill (April 8, 2021). An adaptation of the Codes of Good Governance of Listed Companies has also been made in the 2020 financial year by the National Securities Market Commission to delve into aspects of sustainability. All this has been accompanied by a change in the Spanish regulations for the reporting of non-financial information that will be mentioned later in this doctoral thesis. Finally, in the Valencian Community, among other initiatives, Law 18/2018 of July for the promotion of social responsibility, creation of the Register of Socially Responsible Valencian Entities and the Valencian Council of Social Responsibility stand out. In Camison et al. (2021) a detailed explanation of this regulatory trend can be found, as well as the economic and non-economic incentives that public authorities make available to companies to improve their environmental and social performance.

related to improving environmental performance, there is a double externality problem that makes business action difficult. According to the author, these types of actions benefit society, but they increase the costs for the companies without significantly altering their income, therefore the rival companies are more cost-efficient and, in addition, they can benefit from spillovers of knowledge derived from the proactive company in these aspects (Cai & Li, 2018; De Marchi, 2012; Rennings, 2000). Other authors such as Walley and Whitehead (1994) affirm that the implementation of corporate measures that improve sustainability performance that can create a win-win situation between company and society is nothing short of utopian, or that it will hamper the competitiveness of the company in the long run (e.g., García-Sánchez et al., 2019).

The seminal article by Porter and Van der Linde (1995) represents a paradigm shift concerning the previous thesis and establishes a more favorable relationship between the improvement of sustainability (in this case, focused solely on environmental aspects) and the improvement of economic performance. This improvement in the economic performance of the company, according to Porter and Van der Linde, is obtained thanks to internal innovation, the improvements obtained in efficiency, and the differentiation obtained in the market by pursuing environmental performance. More recent studies in the literature suggest that there is a positive relationship between improving the sustainability of the company and its competitiveness, through improving its efficiency and profitability, giving the company important competitive advantages (e.g., Bacinello, 2019; Suat and San, 2019; Qiu et al., 2019; Gürlek & Tuna, 2018). A recent Oxford University study reviewed a total of 190 academic studies dealing with sustainability performance and found evidence that good environmental and social performance also contributed to better economic performance (Clark et al., 2015).

The most obvious benefit of organizations voluntarily adopting more sustainable practices is less likelihood of sanction and regulatory intervention by public entities. Voluntary large-scale business adoption of more sustainable practices can have such an impact that the new policies in the field have an incentive character instead of a sanction (Aragón-Correa et al., 2020; Forés, 2019; Camisón, 2010; Baron, 2001). The adoption of sustainability as a guide for strategic and operational activities in companies allows for mitigating reputational risks, acting as an insurance to protect intangible assets such as image and prestige (Camisón et al., 2021; Ioannou & Serafeim, 2015) under the greatest scrutiny by society (Luo, Zhang & Marquis, 2016). Therefore, being sustainable is a way to increase the company's reputation and prestige in the markets (Yao et al., 2019; Du et al., 2011).

In addition, in financial terms, it can be a great opportunity so that, while improving the impact on ecosystems and helping to solve social dilemmas, the economic benefits of the company are increased. In this sense, according to various academic sources (e.g., Schroders, 2020) and expert sources in corporate financing (e.g., BlackRock, 2020), companies that focus on sustainable practices and fair management of all their stakeholders seem to have outperformed peers that lack this approach in economic performance. This fact, moreover, has permeated the valuation of these more sustainable companies in the capital markets, seeing their capitalization increase concerning counterparts considered less sustainable by investors. In this sense, a more sustainable company has better access to external financing (Cheng et al., 2014). According to the Bloomberg portal[3], bank financing dedicated to business projects in the field of sustainability has exceeded the amount of 1.6 trillion dollars in 2021, representing an increase of three figures compared to 2019.

A more sustainable company is capable of attracting more qualified human capital, probably more aware of the importance of contributing from the business sphere to the challenges of sustainable development (e.g., Flammer & Luo, 2017). Having a qualified human capital, as well as the search for innovative solutions to reduce environmental problems or contribute to social causes, mean that these companies concerned about integrating sustainability into their strategic and operational management also obtain greater innovative performance (e.g., Flammer & Kacperczyk, 2016).

Effects at the supply chain level cannot be ignored either. Suppliers or partners in strategic alliances are exerting increasing pressure on their partners to deploy more actions in sustainability (Camisón et al., 2021; Durand et al., 2019). For their part, consumers are increasingly aware of the care and protection of the environment or aspects such as social justice (García-Sánchez et al., 2019). Therefore, a company that can reconcile economic performance with social and environmental performance will have a greater facility to satisfy its customers (Delmas & Pekovic, 2013; Hart, 1995). Likewise, and given the growing regulation on the issue of sustainability in international markets, being more of a more sustainable company can also be an incentive to guarantee access to certain markets that have stricter operating regulations (Hawn, 2020).

As the Boston Consulting Group underlines, the company's management, now more than ever, must understand the importance of timely interpreting changes in consumer tastes, new green technologies, the capacity and resilience of supply chains, the impacts of climate change, and how all these factors affect the company's strategy and performance (Young & Beck, 2022). In the same way, recent calls in the academic literature encourage researchers to delve into the factors internal and external to the company that induces it to develop new capacities capable of impacting the triple economic, social and environmental performance of the company (Forés et

[3] https://www.bloomberg.com/news/articles/2022-02-03/esg-by-the-numbers-sustainable-investing-set-records-in-2021

al., 2022; Camisón et al., 2021; García-Sánchez et al., 2019; Pislaru et al., 2019; Rezende et al., 2019).

1.2. THE PARADIGM OF SUSTAINABILITY

The sustainability paradigm is the result of a long history in which the foundations of the concept have been nurtured by different movements and social, political, scientific, and academic influences (Abbas & Sagsan, 2019; Morrar et al., 2017; Caradonna, 2014; Kidd, 1992). As has been indicated, this new paradigm does not only seek to comply with the legal obligations and the satisfaction of the owners or shareholders in their search for profit maximisation, but instead tries to impose what they call stakeholder capitalism (World Economic Forum, 2022; Shang et al., 2020), which seeks to achieve more ambitious goals for all these agents in economic, social and environmental terms. From this perspective, the company is seen as a social institution based on relationships of trust and commitment (Camisón et al., 2021).

Sustainability as a platform to achieve a balance between the carrying capacity of natural ecosystems and social and economic systems gained strong momentum after the Brundtland Commission (1987). In this commission, sustainable development was defined as "that which is capable of guaranteeing the needs of the present without compromising the possibilities of future generations to satisfy their own needs" (WCED, 1987: 43). Unfortunately, the vagueness of this incipient definition to cover an aspect of such complexity has favoured a multitude of meanings and a long debate about which of all of them is the most adjusted to encompass all the nuances that sustainability addresses (Johnston et al., 2007; Hopwood et al., 2005). The following Table 1 lists the most used definitions in the literature.

Table 1. Definitions of sustainability

Definition	Source
Sustainable development is one that is capable of guaranteeing the needs of the present without compromising the possibilities of future generations to satisfy their own needs.	Brundtland Commission (WCED, 1987)

Sustainability is the ability of a human, natural or mixed system to resist or adapt to endogenous or exogenous changes indefinitely.	Dovers and Handmer (1992)
Sustainability is the relationship between dynamic human economic systems and even more dynamic, but typically slower-changing, ecological systems in which (I) a human life can continue indefinitely; (II) human individuals can flourish; and, (III) human cultures can develop.	Constanza (1992)
Sustainability involves improving the quality of human life while living within the carrying capacity of supporting ecosystems.	Munro and Holdgate (1991)
Sustainable development implies the simultaneous search for economic prosperity, environmental quality and social equity.	Elkington (1997)
Sustainability is an economic state in which the demands that people and commerce place on the environment can be met without reducing the environment's ability to provide for future generations.	Hawken (1993)

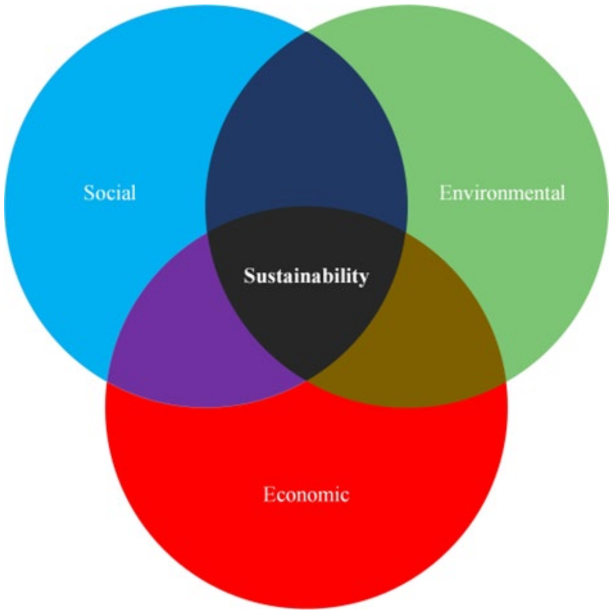
Source: Own elaboration based on Cheng et al. (2017)

In the corporate sphere, sustainability is defined as "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities, etc.) without compromising its ability to meet the needs of future stakeholders as well” (Dyllick & Hockerts, 2002: 131). This satisfaction of the needs of all the company's stakeholders must rest on a strategic action that, as has been introduced earlier in this thesis, allows the company to meet social and environmental expectations, maintaining profitable economic performance both in the short and long term (Artiach et al., 2010).

What lies behind this paradigm of sustainability is a new management style capable of seeking solutions to existing production systems, establishing an organizational model that is capable of making more efficient use of resources, reducing the impact on ecosystems, and more actively and efficiently managing the concerns of its stakeholders (Camisón et al., 2021; Shang et al., 2020; Engert et al., 2016). Therefore, "sustainability is a managerial trend that plays an important role in contemporary organizational strategy management" (Shang et al., 2020: 595).

Based on the above definitions, the pre-eminence that the economic, social, and environmental dimensions have in the conceptualization of sustainability can be verified (Svensson & Wagner, 2015). Even though other authors consider additional dimensions such as the institutional (Turcu, 2012), the cultural (Soini & Bikerland, 2014), or the technical (Hill & Bowen, 1997), the reality is that there is a fairly consensus on academia and in practice regarding the limitation of the concept of sustainability to the three traditional dimensions (e.g., Engert et al., 2016; Zijp et al., 2015; Mori & Christodoulou, 2012 Dyllick & Hockerts, 2002; Elkington, 1997). The representation of this relationship between the dimensions of sustainability is usually reproduced through three intersecting circles, in which sustainability lies in the center of said intersection (see the following Figure 2).

Figure 2. Sustainability dimensions



Source: adapted from Camisón et al. (2021)

The characteristics of each of these three dimensions that make up the sustainability construct are detailed below, as well as how the company can take action to improve its performance in each of them (Piccarozzi, 2017; Khan et al., 2016; Svensson & Wagner, 2015):

● **Economic dimension**. This first dimension, traditionally linked to economic development, focuses on the "maintenance of capital" (Goodland, 1995). Thus, it encompasses the management of the resource base that generates new employment opportunities, allows the development of more environmentally sound production models, or stimulates the creation of new companies (Svensson & Wagner, 2015; Leff, 2004). The company can improve its performance in this dimension by opting for the introduction of a wider range of goods and products, expanding its market share, improving the quality of current goods and services, or making its production processes more flexible (Camisón et al., 2021).

● **Environmental dimension**. In the notion of sustainability, this dimension contains all life support systems that are essential for the existence of humanity (Goodland, 1995). The environmental dimension includes the following factors: land use, waste management, water, and energy consumption, or the use of renewable energy sources (Khan et al., 2016; Daly, 1990). Thus, improving environmental performance involves new ideas, behaviours, products, and processes that reduce the environmental impact (Rennings, 2000: 32). This improvement in environmental performance implies the reduction of materials per unit produced, dropping energy consumption per unit produced, or decreasing the environmental impact of companies (Camisón et al. 2021).

● **Social dimension**. It refers to the maintenance of common social capital, including community values and morals. A civil society in which there is significant community participation will help achieve sustainability (Goodland & Daly, 1996). Strengthening social sustainability requires investing in areas such as education, health, security, or the creation of structures that allow the effective participation of citizens in decision-making and power structures (Khan et al., 2016; Goodland, 1995). Improving the social performance of a company always entails "contributing to important public values (e.g., health, education, safety, and life quality") (Piccarozzi, 2017: 6). The company's most urgent measures in this area are to refine its processes and protocols in such a way that it can guarantee the improvement of the health and safety of its employees, maintain employment and even increase it, and that this employment is the most qualified possible. Actions aimed at improving the quality of life of the community in which the company is inserted through actions of sponsorship, patronage, or collaboration in social projects would also fit in improving this performance (Camisón et al., 2021).

In the literature many studies treat sustainability as a holistic concept; that is, considering the three dimensions explained above (e.g., Camisón et al., 2021; Hashemi et al., 2019; Hussain et al., 2018; Engert et al., 2016; Marshall et al., 2015; Zijp et al., 2015; Pagell and Wu, 2009; Pullman et al., 2009). However, it is also common to find research focused solely on one of the dimensions of the construct, especially the environmental one (e.g., Forés, 2019; Klewitz & Hansen, 2014). The primacy of environmental sustainability over social sustainability is because the latter always involves greater difficulty in measuring the organizational practices that contribute to its improvement (Mani et al., 2018; Huqand Stevenson, 2018; Ashby et al., 2012). For this reason, there are not a few calls in the literature to delve into the concept of sustainability in the business field from the triple perspective originally proposed by Elkington (1997), that is, from a more holistic approach (e.g., Ben Arfi et al., 2018; Adams et al., 2016; Engert et al., 2016).

Therefore, this doctoral thesis will follow the classic doctrine of Elkington (1997) in which, to speak of sustainability, it is necessary to achieve an adequate balance between the three dimensions and evaluate the relationships between them. The justification for the compelling need to reconcile the three dimensions of sustainability can be illustrated with an example. Agricultural and industrial development is a form of economic growth that requires the intense use of the biosphere and its resources and, therefore, it is necessary to evaluate the impacts of such activities on the environmental dimension (Kammerbauer, 2001). On the other hand, the consequences of natural disasters, such as hurricanes or earthquakes, are so devastating for human beings that they illustrate how difficult it is to treat the social and environmental dimensions in isolation (Newton, 2007; Mittman, 2006).

From the previous statement, it can be deduced the existing difficulty is to balance the different compensations and tensions that occur between dimensions whose objectives must be equally desirable (Purvis et al., 2019). In other words, it cannot be considered a sustainable solution, for example, an industrial policy that promotes the sustained growth of aggregate income and environmental protection but increases social inequalities.

The study of performance from the triple perspective of sustainability is necessary not only to continue the progress of academic knowledge on the subject. It is also crucial for providing new insights that help company management to implement measures that will improve their sustainability performance. Recent academic publications (e.g., Camisón et al., 2021; Severo et al., 2017; Schaltegger et al., 2012) and others from a more professionalized field (e.g., Young & Beck, 2022) point out that it is necessary to incorporate the precepts of sustainability in business strategy and operations, as it will be crucial for its competitiveness and future survival in a society that is increasingly aware of these aspects.

1.3. INTERNATIONAL FRAMEWORKS FOR THE ADOPTION OF MORE SUSTAINABLE PRACTICES AND THEIR REPORTING

Traditionally, it was considered that sustainable performance, from the triple economic, social and environmental perspective, was only feasible for large companies (Graafland & Smid, 2016). However, the reality is that environmental concerns such as climate change, the growing cost of non-renewable energy sources, or the increased awareness of societies to promote a more sustainable development model, force small and medium-sized companies to gradually adopt new organizational practices that actively contribute to the sustainability of their environment (Eikelenboom & de Jong, 2019; Graafland & Smid, 2016), especially with the call of the 2030 Agenda and its 17 Sustainable Development Goals.

Thus, the sustainability paradigm represents an opportunity for the CEOs of any company, regardless of its size, to make decisions capable of capturing competitive advantages, modifying their practices and organizational structures, and contributing to leaving behind a more prosperous and sustainable society for future generations (Young & Beck, 2022; Berrone et al., 2010). The awareness of company management is important because, without the support of business organizations, achieving the 17 SDGs will be much more complex to achieve (Eikelenboom & de Jong, 2019; Nawaz & Koç, 2018).

In the process of creating value from the perspective of sustainability, company executives will have to deal with renewing, transforming, reconfiguring, and sometimes discarding many of the resources that had been the basis of their competitive advantage until now (Teece, 2007). Well, as various academic studies point out (Camisón et al., 2021; Eikelenboom & de Jong, 2019) but also from the professional side of strategic consulting (Young & Beck, 2022), dealing successfully in the race for sustainability may likely require new resources and organizational capabilities, and also new business models. For this process to be successful, it is necessary that the strategy, the structure, and the management systems are aligned and coordinated, as well as that the workforce is committed and motivated (Epstein & Roy, 2001).

In addition, companies must not only introduce green technologies or develop capacities to obtain a higher sustainability performance; on the contrary, they will also have to provide reliable information to society on their performance in the triple bottom line (Pislaru et al., 2019). The reporting of non-financial information is an unavoidable issue for companies both due to the demands of interest groups and the growing regulation on the matter (Camisón et al., 2021). Thus, according to the consulting firm KPMG, in 2017, 93% of the 250 largest companies in the world had a sustainability report or non-financial information report or included it together with their annual accounts. This implies that financial and non-financial information are two sides of the same strategic coin (Camisón et al., 2021; Stolowy & Paugam, 2018).

However, although there are numerous reference frameworks for measuring the sustainability performance of companies and their disclosure to stakeholders (Qorri et al., 2018; Beske-Janssen et al., 2015; Ness et al., 2007) only a few integrate the perspective of analysis under the triple bottom line (Taticchi et al., 2013). Many of the traditional instruments have focused fundamentally, as previously mentioned, on the metrics of the company's environmental performance. As was the case previously when we spoke of a positive bias in the academy towards the environmental dimension of sustainability, this is also replicated when it refers to both the disclosure of non-financial information and the increase in investments in the field of ESG (environmental, social and governance aspects). According to a study by the consulting firm McKinsey & Company, the environmental dimension continues to guide the growth of these financial products in the face of climate change concerns (Pérez et al., 2022)[4]. However, the same study also points out that the social and corporate governance dimensions are gaining prominence.

However, despite the multiple instruments available on the market (e.g., Global Reporting Initiative) and developed by the academy in the form of validated scales (e.g., Ahi & Searcy, 2015) that integrate in a weighted way the three classic dimensions of the construct of sustainability, there is no absolute consensus on the best indicators to adequately measure corporate performance in the field of sustainability (Antolín-López et al., 2016). The following Table 2 includes some of the main instruments that can serve as a guide for companies to implement management practices and models with an impact on their sustainable performance, as well as reporting frameworks for this improvement in their performance to society. The table lists the instruments in an aggregate and integrated manner according to whether they are intended for macro-level units (regions, countries, or units of higher political aggregation), meso-level (cluster or business park), and micro-level (business level).

[4] Similar conclusions about the preponderance of environmental factors over social and government factors are obtained by BlackRock in a study carried out in 2020 on more than 425 investors in 27 countries. Accessible at: https://img.lalr.co/cms/2021/05/28202727/blackrock-sustainability-survey.pdf

Table 2. Main instruments and guides for companies to implement sustainable management practices

Level	Instrument	Brief description
MACROLEVEL (Region, country, or higher political aggregation units)	Millenium Development Goals (2000)	They were created as a roadmap to implement the Millennium Declaration. The Millennium Goals (MDGs) are structured into 8 clear goals with 21 targets to try to end hunger and poverty, but also to introduce improvements in health, environmental sustainability, and gender equality. They were the predecessors of the Sustainable Development Goals (SDGs).
	Sustainable Development Goals (2015)	Adopted by the 193 countries that make up the United Nations on September 25, 2015, the 17 Sustainable Development Goals contained in the 2030 Agenda contain a total of 169 goals to solve problems related to sustainability. It emphasizes the participation of all the agents that make up the economies.
	Paris Agreement (2015)	An international legally binding treaty on climate change was adopted at COP 21 in Paris. Its fundamental objective is to limit global warming to well below 2ºC, preferably 1.5ºC. There is no global framework of indicators to monitor the agreement.
	Sendai (2015)	Also known as the Framework for Disaster Reduction (2015-2030), it offers States a series of concrete actions that can be taken to protect the benefits of development against the risk of disasters. It emphasizes alliances despite recognizing that the fundamental role falls on the State. It has specific measures and indicators,

		especially in terms of risks and progress of companies.
	New Urban Agenda (2016)	Approved at the III Habitat Conference on Housing and Sustainable Urban Development. There is no global framework of indicators to monitor the agreement. The New Urban Agenda is based on SDG number 11 "make cities and human settlements inclusive, safe, resilient and sustainable".
	Tripartite declaration of principles concerning multinational enterprises and social policy (2017)	Promoted by the International Labor Organization. It is an instrument that provides targeted guidance on social policy and inclusive, responsible, and sustainable practices in the workplace. It is the only global instrument on social sustainability adopted by governments, employers, and workers around the world.
MESOLEVEL (Business parks)	An International Framework for Eco-Industrial Parks (2019, 2021)	Created by the World Bank in collaboration with the United Nations Industrial Development Organization (UNIDO) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. This framework defines the basic requirements and sustainability performance criteria to qualify a territorial agglomeration of companies as an eco-industrial park. Its objective is threefold: (I) help the stakeholders of a business area to develop and move towards the eco-industrial park stage; (II) encourage the promotion and recognition of these territorial agglomerations of sustainable companies; and, (III) increase the sustainability performance of industrial companies.

MICROLEVEL (Firms and other organizations)	AA1000 and subsequent revisions (1999)	Standard that includes the identification, understanding, and responses to issues and aspects related to sustainability. It also deals with reporting to the company's stakeholders about the actions and performance achieved.
	Dow Jones Sustainability Index (1999, 2010)	Global indexes that evaluate the financial performance of leading companies in sustainability criteria. To access this index, specific economic, social and environmental criteria must be met. This index was merged with the S&P Index in 2012.
	Global Reporting Initiative -GRI- (2000)	Independent institution that created the first worldwide standardized model for the preparation and presentation of corporate sustainability reports, evaluating business performance in the economic, social, and environmental spheres.
	Directive 2014/95/EU	Amending Directive 2013/34/EU, Directive 2014/95/EU requires certain large companies to disclose relevant non-financial information to provide investors and other interested parties with a fuller picture of their performance, results, and condition, as well as their impact on ecosystems and societies. In Spain, its transposition has been carried out through Law 11/2018, which obliges capital companies and public interest entities with more than 500 workers to present a non-financial information statement. Companies that for two consecutive years meet two of the following circumstances are also obliged: 1. Total asset items > €20M 2. Net turnover amount > €40M

		3. Average number of workers > 250
	The green book of the European Union (2001)	The objective of this green book is to promote a framework to achieve sustainable development and greater social cohesion among European partners. It shapes the lines of the EU in terms of sustainability and Corporate Social Responsibility (CSR), pointing out the nuclear role that companies play in achieving the proposed objectives.
	International Standard on Assurance Engagements, ISAE (2000, last revision ISAE 3000 in 2013)	Standard that provides the basic framework for non-financial audits. It consists of a set of guidelines for ethical behavior, quality management, and compliance with laws and regulations on sustainability.
	Guidelines for Multinational Enterprises (OCDE, 1976, revised in 1979, 1982, 1984, 1991, 2000, 2011, and 2013)	They are a compendium of recommendations on employment, industrial relations, human rights, transparency, and the environment, among others, made by governments to multinational companies operating in OECD countries. They are voluntary and non-binding.
	Regulations International Standard Organization (ISO)	They are a set of internationally recognized standards created to help organizations to establish levels of homogeneity in various parameters related to management, development of industrial products, and provision of services. The ISO standards most linked to sustainable management are ISO 9001 (quality management), ISO 14001 (environmental management), and 45001 (occupational health and safety management), among others.

	Eco-Management and Audit Scheme (EMAS)	EMAS is the Community Eco-management and Eco-audit Regulation that recognizes those organizations that have implemented an environmental management system and acquired a commitment to continuous improvement. It is verified and renewed through independent audits.
	BS 8001 standard on circular economy (2017)	Developed by British Standards, it seeks to serve as a guide for organizations to advance in the implementation of circular economy initiatives. It is based on six principles: innovation, management, collaboration, optimization of values, transparency, and systemic thinking.
	Circularity Indicators (2017)	As responsible for modelling the circular economy agenda at a global level, the Ellen MacArthur Foundation, among other initiatives, has developed the Circularity Indicators. This tool offers a methodology to measure an organization's progress in moving from a linear to a circular economy.
	UL 3600 (2018)	The framework developed by the UL organisation is the first certification that evaluates the degree of circularity of the material flows of companies and the efforts of companies to move to a more circular business model. UL 3600 also allows reporting on different aspects of sustainability such as recycled content, product recyclability, and waste minimization.
	International Reporting (IR) Framework	The International Integrated Reporting Council (IIRC) promotes the guidelines for the preparation of an integrated report in which aspects such as the strategic approach and future orientation, information connectivity, relations with interest

		groups, or materiality are made explicit. Emphasizes corporate governance content and social relations.
	Sustainability Accounting Standards Board (SASB)	The SASB currently has a set of standards to help companies disclose environmental, social, and governance issues to their stakeholders. Currently, their standards packages cover 77 different industries.

Source: own elaboration

1.4. CONCLUSIONS OF THE CHAPTER

The business world is changing. If in the past the legitimacy of the company rested on the fulfilment of its legal and corporate governance obligations, now it depends, increasingly, on the approval of a greater number of stakeholders with varied expectations about how the company should contribute to an issue of such importance. such as sustainable development. International frameworks in the field of sustainability such as the Sustainable Development Goals contained in the 2030 Agenda of the United Nations, point out that companies cannot delay their contribution to goals of such magnitude as those included in said reference framework. According to this new vision, the company has the duty and, much more importantly, the capabilities to contribute to sustainable development. For this, it is unavoidable that the management of the companies understand that their performance must be considered from a triple perspective of sustainability; that is, considering economic, social and environmental aspects. The long-term competitiveness of companies depends on it.

The business paradigm has been modified by increasing the power of interest groups (stakeholders) to condition business strategy. Companies, therefore, must respond to these calls from their stakeholders towards a greater social role of the entity while developing innovative competitive strategies that open up a differentiated and defensible position in the markets. This objective of competitiveness is going to be increasingly difficult to achieve with strategies focused exclusively on efficiently managing intangible or financial assets. The long-term success of the company will depend on its ability to reconcile economic, social, and environmental performance based on practices aimed at reducing its environmental impact, the correct and fair management of its human resources, and the creation of value for its shareholders and society as a whole. Therefore, in the current competitive arena, guided by concern for sustainability, but also by other aspects such as the globalization of markets or the hectic pace of innovation, the focus of managerial work must turn, increasingly, on a correct orchestration of its practices and capabilities so that it can obtain a performance that meets the expectations of its stakeholders.

In addition, as Camisón et al. (2021), to strategically manage sustainability, it is not enough to develop adequate practices and capacities, information on its performance must be transferred to society so that it is aware of the efforts that the company makes. This will have repercussions on reputational improvements that are a strategic asset of high value in the current competitive arena. What is clear from the presentation made in this first chapter is that companies, regardless of their size, cannot delay their contribution to sustainable development to the best of their ability and possibilities. This fact is justified both by the influence that sustainability has on the conservation of ecosystems and our societies as we know them; but also, in the business sphere, due to the important repercussions it has on long-term competitiveness. Therefore, its study in this doctoral thesis is more than justified following the above.

2. ECONOMIC AND BUSINESS THEORIES TO THE STUDY OF TERRITORIAL BUSINESS AGGLOMERATIONS

2.1. INTRODUCTION TO THE STUDY OF TERRITORIAL AGGLOMERATION OF BUSINESS

The impact that agglomeration economies have on the location decisions of firms is possibly one of the questions that most quickly aroused the interest of economic science (Camisón et al., 2020). Thus, Adam Smith (1776) in his magnum opus already highlights the fact that certain economic activities can only be carried out profitably in certain spatial locations as a consequence of the markets they generate and the attraction that this market endowment generates in the decision of an external company[5]. Even beforehand, Cantillón (1755) asserted that social and territorial organisation depended entirely on the fertilising capacities of the land and the human labour force dedicated to it. His postulates state that the economic costs of time and transport are antecedent factors for the agglomeration of economic agents and thus favour the birth of cities.

Later eminent economists such as Ricardo (1817) extended the foundations to the study of agglomeration economies and trade. Specifically, his studies made an aggregate analysis of transport costs, considering them as part of the production costs or total cost. However, perhaps the most relevant contribution made so far in this field of knowledge and which continues to be an inspiration in studies on the dynamics of territorial agglomeration is that of the British economist Alfred Marshall. In his Principles of Economics (1890), he recognises that the industrial district is a pool of external economies for its member firms in the form of specialised suppliers, a trained workforce, and, especially, knowledge. In Industry and Trade (1919) Marshall adds to his earlier contribution the notion of "industrial atmosphere" by emphasising how knowledge flows in the district environment thanks to the existence of mutual trust between the agents within it.

During the first half of the 20th century, researchers such as Ohlin (1933), Hoover (1948), and Isard (1956) contributed to the consolidation of the study of external economies identified by

[5] Adam Smith points to places such as Lisbon, London or Copenhagen as examples of places with a high power of attraction and agglomeration of companies capable of meeting the internal consumption needs of these locations, but also of supplying other external ones.

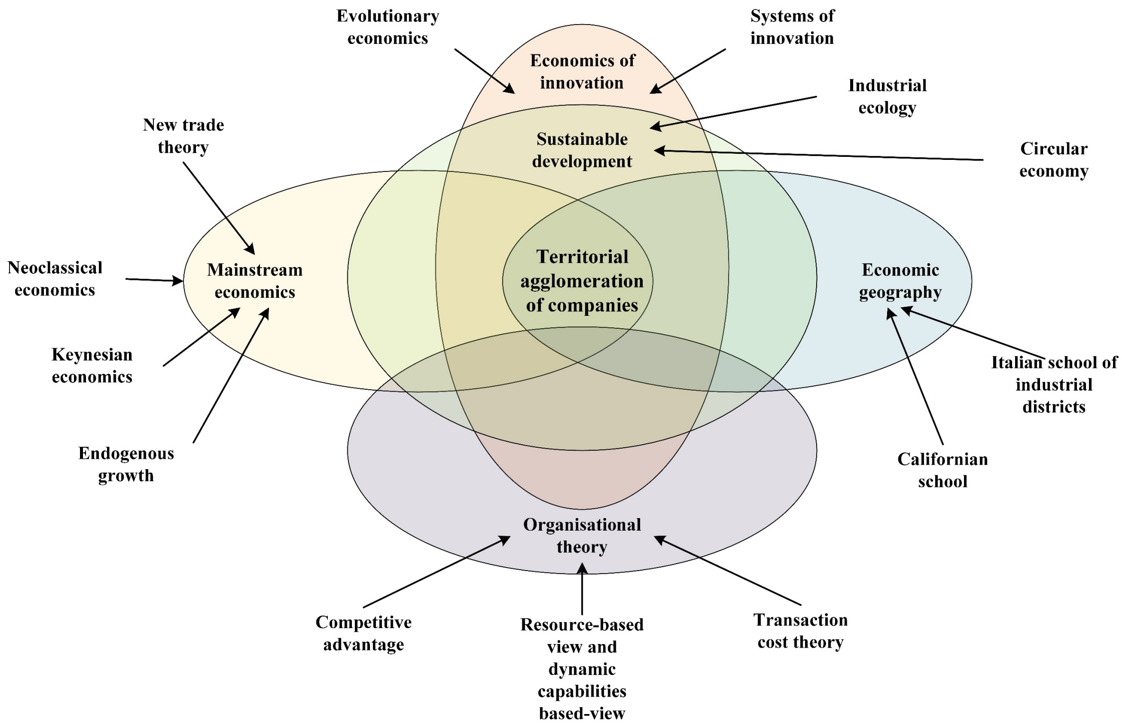
Marshall. At the same time, Keynesian economics also made interesting contributions to the study of the dynamics of the territorial agglomeration of firms through state intervention to alleviate market failures. It should be noted that these more classical theories fall within the scope of economic science, and were therefore considered by these economists as a means to a greater end, economic growth. The study of growth has occupied economists since the beginning of economics itself as a science to help reduce economic inequalities precisely through the sustained growth of income (Pike et al., 2006). Other theories that will be discussed in the chapter, such as Marxist theory, will be seen to present complementary axioms to those of Keynesian theory.

The rediscovery of Marshallian economies by the Italian School of industrial districts reopens the debate on the advantages of industrial districts for the company and the community of people in a territory (Brusco, 1982; Becattini, 1979). Italian scholars popularised the term industrial district. Gradually, new theories such as that of international trade (e.g., Krugman, 1991) appear, which continue to explore the dynamics of territorial agglomeration and the advantages that it presents for companies and for the economies in which they are located. Specific contributions such as the theory of the competitive advantage of nations (e.g., Porter, 1990) establish this paradigm within the field of study of the firm.

Finally, the concern for sustainability has permeated the study of the dynamics of territorial agglomerations of companies and how they can actively contribute to the objectives pursued by sustainable development. To this end, the theories of industrial ecology (Frosch & Gallopoulos, 1989) and the circular economy (Korhonen et al., 2018) will be presented as the culmination of this exploration of the foundations of territorial agglomerations of firms, which is presented more visually in Figure 3 below.

The aim of this chapter is therefore to carry out a comprehensive review of these theories that have served to consolidate the phenomenon of business agglomeration. This should help us to understand the theoretical foundations of these territorial agglomerations of companies and why they continue to be a phenomenon that is still very much alive today. Some of these theories have given rise to specific models of territorial agglomeration (such as science and technology parks or industrial districts), which will be expanded upon in the third chapter of this doctoral thesis.

Figure 3. Sustainability paradigm in the study of territorial agglomerations



Source: own elaboration based on Dahl (2001)

2.2. NEOCLASSICAL THEORY OF REGIONAL CONVERGENCE

The neoclassical theory represents the point of continuation of the classic economic postulates of Adam Smith, David Ricardo, and Jean-Baptiste Say. Neoclassical economics is characterized by the adoption of a microeconomic approach concerned with the study of regional growth and the economic disparities that occur between different regions (Williamson, 1965; Borts & Stein, 1964). This theory conducts a study of economic systems by statically examining their equilibrium based on the classical production function (Solow, 1956) in which the productive capacity of a country can be summarized in the additive effect of the capital stock, the labour force growth, and technological progress, as listed in the following Cobb-Douglas equation:

$$Y_t = A_t F\ (K_t,\ L_t)$$

In the above equation of the most simplified neoclassical model, Y is the Gross Domestic Product (GDP); K and L are the amount of capital and workers, respectively, available for the production of goods and services, with F being the production function in charge of transforming the productive factors into goods and services. A is a parameter of total factor productivity. Finally, the subscript t indicates the time. Technological progress is treated as an exogenous variable in this economic model (Vázquez-Barquero, 2002a) along with other variables such as human capital, savings in the economy, or population growth. It is for this reason that the neoclassical growth model is known as the exogenous growth model.

Under this school of economic thought, regional growth consists of the reduction of disparities between regions in the long term, measured in terms of per capita income and production (Armstrong & Taylor, 2000). According to Martin and Sunley (1998), neoclassical theory predicts a reduction in spatial disparities between regions that will allow for optimal balance and convergence in economic terms in the long run. The model is based on a series of premises to guarantee the previous assertion.

Thus, the model assumes premises such as perfect mobility of factors of production between regions, diminishing returns in the use of factors in the long run, perfect knowledge of the price of factors, and the economically rational options that consumers make in response to the signals provided by the market (Barro & Sala-i-Martin, 1995). The perfect mobility of factors is one of the premises that must be taken into account since it contributes to favouring the movement of companies and workers between regions, which contributes to stimulating the process of convergence between regions, generating numerous territorial agglomerations of companies that can be beneficial for their territories in question. Thus, as Barro and Sala-i-Martin (1995) point out, companies will tend to locate and invest in those regions with lower wages and the labour force, on the contrary, will tend to move towards regions in which wage figures are higher.

The approach proposed by neoclassical theory has had a high influence on the development of industrial policies to stimulate industrial enterprise and regional development (Pike et al., 2006). Specifically, it has nurtured the field of regional policies made under the principles of the free market and aimed at correcting market failures (Armstrong & Taylor, 2000). Despite the clear explanatory utility of the model, empirical evidence suggests that convergence between regions is a slow process (e.g., Scott & Storper, 2003; Armstrong & Taylor, 2000; Barro et al., 1991). On the other hand, the model has also been criticized for the lack of realism in certain of its postulates referring to the perfect mobility of the labour force, as well as for the inequality in capital endowments between regions that can make the process of expansion very difficult. predicted convergence (Armstrong & Taylor, 2000; Mason & Harrison, 1999; Martin & Sunley, 1998).

2.3. KEYNESIAN THEORIES OF REGIONAL DIVERGENCE

This current of studies takes its name from the pre-eminent British economist John Maynard Keynes who revolutionized the economic paradigm with the publication of his work "General Theory of Employment, Interest, and Money" in 1936[6]. Therefore, Keynesianism includes the set of later studies that try to elucidate the ideas put forward by this author (e.g., Domar, 1946; Harrod, 1939). Among other topics, these Keynesian theories have also had an interest in the study of the dynamics of regional growth. However, in contrast to the neoclassical approach, Keynesian theories always foresee a divergence in regional growth patterns that persists over time (Pike et al., 2006).

Thus, the differences in the growth of the regions may be the direct consequence of the external demand for certain products produced in the region (North, 1955) which, lasting over time, are an explanatory factor of regional specialization in certain industries. Growth spurred by external demand is cumulative, and according to Armstrong and Taylor (2000), it produces a positive multiplier effect on regional income, inducing greater business investment, a greater influx of labour to regional industries, and the growth of new subsidiaries and complementary industries.

This would create patterns of territorial agglomeration of specific companies that are difficult to replicate in the short term in other territories. In this way, in contrast to the neoclassical theses, the greater degree of regional specialization pointed out by the arguments of the previous Keynesian theory only reinforces the idea of the heterogeneity of each territory, its markets, and the companies that operate in it. Therefore, productive specialization will tend to increase inequality between territories.

The previous proposition referring to productive specialization can be explained by the proposal of Verdoorm (1949) who postulates that the increase in industrial production necessarily involves new learning processes derived from the division of labour, the expansion of markets, or the incorporation of new technological advances; therefore, it is expected that labour productivity will increase within the same sector. This fact would reinforce the cyclical effects of spatial concentration of the industry, increasing regional differences.

About the specialization of the industrial companies of certain territories and their importance in regional growth, the author Kaldor (1970, 1981), after analyzing a wide range of developed

[6] The distinctive approach of the author in this work focused on the underemployment of resources and, contrary to neoclassical theses, the demand side of the economy and the role of the State in its management.

countries to explain the differences in their growth rates, observed the pre-eminence of the industrial sector in the increase of this economic variable through its multiplier effects on the rest of business activities. The explanation for this effect, according to the author, is due to the high elasticities of demand for manufactured goods, and the linkages that occur in production chains, stimulating economies of learning and specialization. The derived increases in productivity are cumulative and, in this way, the regions that, thanks to their industrial sector, grow more rapidly, further reinforce their specialization and prevent the convergence process of the less developed regions (Armstrong & Taylor, 2000). This relationship between industry and the rest of the economic activities proposed by Kaldor is reflected in the following mathematical relationship:

$$q_T = a_0 + a_1 q_M$$

$$q_{NM} = a_0 + a_1 q_M$$

In the above mathematical expression, q_T represents the growth rate of the aggregate product of the economy of the territory as a whole; q_M corresponds to the growth rate of the manufacturing product; and, finally, q_{NM} is the growth rate of those products derived from non-manufacturing activities. With this simple formula, it is possible to empirically test whether the expansion of the manufacturing or industrial product causes a drag effect on the rest of the economic activities. For this reason, according to the author Kaldor (1970), those regions that have broad industrialization of their business fabric enjoy advantages in international trade.

Regarding the cumulative economic growth of those regions that have an industrial specialization, the growth pole theory of Perroux (1950) is also framed within this Keynesian vision. According to Perroux (1950, 1955), the inter-industrial links that occur through certain supply chains located in a certain territorial environment are capable of driving economic growth in that region. Perroux's contributions go further and even make a distinction of the contribution that each industry makes to the aggregate of economic growth with the concept of driving industry. According to the author, "these industries, during certain periods, have higher rates of increase in their product than the average rate of increase in the industrial product and the product of the national economy" (Perroux, 1961: 157). Perroux's contributions, as will be seen later in this thesis[7], have had a strong influence on the promotion of business areas whose main promoter has been the state or regional governments.

In short, the set of these theories has greatly influenced industrial and regional development policies. As Pike et al. (2006) suggest, unlike the neoclassical theory that postulates the free market as the most valid option to stimulate convergence between territories, the sum of the

[7] See chapter 3 of this doctoral thesis.

previous Keynesian theories advocates State intervention to correct market failures and the stimulation of demand. Specific examples of the political application of the Keynesian approach are, for example, the American New Deal (Pike et al., 2006), and the Spanish policy of promoting regional industrial poles (Camisón et al., 2020). However, as was the case with the neoclassical approach, the Keynesian approach has been criticized for being considered too simplistic and ignoring key factors (e.g., entrepreneurship) that can determine regional growth, and for not providing a systematic explanation of the determinants of regional growth (Armstrong & Tailor, 2000). Other authors have questioned the results of public intervention in promoting regional development (Cole & Ohanian, 2004). Lastly, and in contrast to the divergence between the growth rates between advanced and lagging regions predicted by the different Keynesian models, there are studies (e.g., Townroe & Kee, 1984; Hirschman, 1958) that suggest that there could be a transfer from the most advanced region to other less developed areas, preventing them from falling behind.

2.4. MARXIST THEORY OF REGIONAL GROWTH

This theory is based on the prolific work of Karl Marx (especially, "The Communist Manifesto" and "The Capital")[8]. The changes that occurred in world society during the 1960s, 1970s, and 1980s, which coincided with the end of the golden age of capitalism, the economic crisis spurred by the restriction of the supply of raw materials, until reaching an economy increasingly globalized, arouse again interest in Marxist postulates also called radicals (Pike et al., 2006; Zamagni, 2001; Goldsmith, 1978).

The Marxist theory seeks to understand how deindustrialization, the progression to a service-based economy, globalization, or international factor mobility, entails and explains the restructuring of business activities across different regions and the spatial division of labour (Lovering, 1989; Massey, 1984, 1995). These spatial structures, as pointed out by Sunley (2000), present a hierarchy that has implications for employment and development in the region.

From the restructuring of business activities as a result of the social, political, and economic changes mentioned above, the regions specialize in certain organizational functions: production and assembly, research and development, and administration (Pike et al., 2006). Under Marxist analysis, the traditional regional specialization in the production of a type of goods breaks down into multiple territorial units through which a hierarchical relationship between territories is

[8] For a recent analysis of the conception of the Marxist doctrine, its epistemology and its methodological contributions to studies on development and world economy, the work of Enríquez Pérez (2017) can be consulted.

established. This hierarchy is transferred to jobs and occupations between regions (Massey, 1995).

In a critique of neoclassical economics, Marxist postulates specify that the crises of accumulation inherent in capitalist development have generated social, economic, and technological fragmentation that have created an optimal breeding ground for the appearance of periods of growth and decline at the regional level (Storper & Walker, 1989). Therefore, the theory predicts that regional growth will be characterized by a successive chain of periods of convergence and divergence (Pike et al., 2006; Martin & Sunley, 1998).

As was the case with Keynesian approaches, the political implications of Marxist theory advocate greater State intervention through regional policies that contribute to the reduction of territorial inequalities in a responsible manner (Pike et al., 2006).

2.5. ENDOGENOUS GROWTH THEORY

As mentioned above, in the fifties and sixties of the last century, theories of economic growth occupied the time and efforts of neoclassical and Keynesian economists. However, the hypothesis of diminishing returns led them to recognize that capital accumulation tended to weaken in the long run and that technological progress was ultimately the true engine of progress. Since they considered this technological growth exogenously, the increases it generated in productivity were also exogenous (Vázquez-Barquero, 2002). Since the above statement did not fit with the empirical evidence of the growth of the most advanced economies, neoclassical development theories suffered stagnation for decades (Pike et al., 2006). It is not until the appearance of the seminal works of Arrow (1962) and Romer (1986) that interest in growth theories is recovered from the contributions that the author makes correcting assumptions of traditional neoclassical models.

The new models of endogenous growth focus the study on the explanation of the causes of this technological progress given the impact that it can have on regional growth (Vázquez-Barquero, 2002). Regional growth is conceived as a reduction of regional inequalities. For their study, these models retain part of the heritage of traditional neoclassical models and use the same language to explain the causes of convergence or not between regions.

Romer (1994) points out that technological progress occurs as a consequence of economic actors deciding to do things, to innovate, and not because of the mere passage of time (Blomstrom et al., 1996). Therefore, although it might seem that scientific and technological discoveries are driven by forces external to the individual, the aggregate rate of discoveries is endogenous and is therefore determined by the decisions made by these economic agents. Likewise, companies and individuals have power in the markets and, therefore, obtain monopoly rents as a consequence of the benefits of capitalizing on their scientific and/or technological discoveries. Thus, and following the Schumpeterian vision of rents, companies and individuals can capitalize and appropriate, at least for some time, their innovations through market power granted by the differentiation that this innovation provides to its owner (Armstrong & Taylor, 2000).

However, variables such as the quality of work, investments in education, and, especially, investments in R&D and technologies made by individual companies are introduced in the production function that, in equilibrium, will present increasing returns to scale in the said function that will be constant for each company individually. This assumption implies the recognition by this new theory of the existence of externalities of aggregate production. This acceptance of introducing increasing returns to scale in production was taken from the previous propositions of Alfred Marshall (1890) who, contrary to visions such as that of Maltus or Ricardo (Vázquez Barquero, 2002), recognizes the existence of a series of economies external to individual companies but internal to the district or region in which they are located.

As Becattini (2002) pointed out, this resurgence of the Marshallian approach shifts the focus of attention from the endogenous models of the analysis of exosomatic instruments of production (e.g., machines, installations, etc.) that can be appropriated and accumulated, to the endosomatic instruments of production (such as individual human capacities, business capacities or social capital), which cannot be assigned or appropriated, but whose study is unavoidable to explain the dynamics of regional development and economic growth. This new trend of studies represents, therefore, a substantial change concerning the previous contributions from the tradition of the most classical economic theories.

Marshallian externalities highlight the importance of the territorial environment in the agglomeration of people and companies, and the generation and development of human capital and technical improvements. For this reason, in important models of endogenous growth (e.g., Lucas, 1988) cities appear as the main engine of economic growth. This new paradigm for the study of localization factors makes us go from talking about endogenous growth models to endogenous development models (Muñiz, 2002; Glaeser et al., 1992). In them, as will be seen in the following chapters of this doctoral thesis, the territory goes from being a passive recipient of the strategies of large companies to a more active role that allows it to influence its own dynamics (Vázquez Barquero et al., 1997).

2.6. NEW INTERNATIONAL TRADE THEORY

Economic geography is concerned with analysing national economic prosperity through trade and the implications this presents for whether or not business growth and development are uneven across regions (Pike et al., 2006; Brakman & Garretsen, 2003). These models interpret development as an increase in income and prosperity thanks to gains in regional and national competitiveness of the industries of particular regions or nations (Kitson et al., 2004).

Traditionally, economic geography theory was built on the assumptions of previously seen neoclassical models such as methodological individualism, economic rationality, perfect information, firm profit maximization, and perfect competition (Dymski, 1996) despite its criticism of them.

Thus, the models of classical theory, such as the Ricardinan or the Heckscher-Ohlin model, were characterized by being static and presenting some starting assumptions, such as constant returns to scale, homogeneous products, perfect competition, and non-existence of transport costs, etc., far from reality (Armstrong & Taylor, 2000). These models predicted a national specialization in goods whose factors of production were abundant in the country and an inter-industry trade, that is, of goods belonging to different industries.

However, since the sixties of the last century, the literature (e.g., Tugores, 2002; Grubel & Lloyd, 1975) has been demonstrating that most of the international trade that occurs between industrialized countries is intra-industry (Helpman, 1999); that is, the exchange of differentiated products that belong to the same industry predominates. Consequently, new theories have emerged that seek to find more rational explanations for international trade. These new approaches have introduced assumptions such as economies of scale, product differentiation, and imperfect competition, the classic references being Krugman (1979) and Helpman and Krugman (1985).

The new theory of international trade emphasizes how regional industrial specialization and concentration are influenced by the company's commercial activity in a context of imperfect competition and increasing returns to scale (Krugman, 1990). Economies of scale can be internal when the unit cost depends exclusively on the size of the company, and external when the unit cost depends on the size of the industry. Therefore, in the presence of internal economies of scale we find ourselves in a model of imperfect competition while, in the presence of external economies of scale, the market structure responds to the model of perfect competition.

According to Krugman and Obstfeld (2001), it is possible to distinguish three models of international trade. Of the three trade models proposed by the authors, two of them consider economies of scale and imperfect competition as a fundamental premise, the monopolistic competition model and the reciprocal dumping model. In contrast, the third model contemplates the presence of economies of scale in a perfect competition regime, the theory of external economies, which is the one that arouses analytical interest in this research.

The theory of external economies assumes that economies of scale external to the companies, but internal to the industry (Marshall, 1890), will significantly influence the competitiveness of the companies and their location patterns (Krugman, 1993). The model proposes that the greater the industrial production, the more important external economies will be, reducing costs and sales prices. Therefore, these externalities will underlie the growth and development of industries in specific locations (Krugman, 1991).

However, external economies can also have undesirable patterns of regional specialization and welfare losses from trade. As an example, a country that, due to its factor endowment, could potentially produce the same goods as a country that currently, thanks to strong external economies, enjoys an advantageous position, will not be able to develop a competitive industry due to high production and entry costs compared to those existing in the already established industry. On the other hand, established specialization patterns may imply “lock-in” effects on known competitions between industries in a region due to their trajectory and cumulative gains from trade (Krugman, 1990). This pattern of closure can prevent companies from making a dynamic adaptation to their environment and their consumers, hindering their competitiveness in the long term (Boschma, 2005).

However, despite its contribution to explaining regional development patterns, the New Trade Theory has been criticized for its partial explanatory vision of these patterns, in which the social, cultural, and historical characteristics that make up the regions have a supporting role (Martin, 1999). On the other hand, in this model, the territory is reduced to the mere container of industrial activity instead of being a potential engine for economic activity (Scott, 2004).

In the political sphere, the New Trade Theory is used to carry out an analysis of the potential of national and regional industries and apply the necessary policies to enhance them if necessary. Thus, taking the previous example of an industry that could potentially compete and acquire the advantage of another international industry in the production of a good, justifies the application of policies to support the creation of this new industry through tools such as subsidies for exports, tax incentives for R&D, or the application of protectionist measures to international trade.

2.7. THEORY OF THE COMPETITIVE ADVANTAGE OF NATIONS

The theory of competitive advantage, unlike previous economic theories, places special emphasis on the dynamic role offered by the geographical clustering of national industries and its potential contribution to the growth of productivity, innovation, and competitiveness of companies of a certain region (Tallman et al., 2004; Porter, 1990, 1998). Development under this theory is understood as improving the competitive advantage of companies, clusters, and the national economy within international markets.

Although in Chapter 3 of this doctoral thesis the concept of industrial cluster/district will be described in greater depth to know its idiosyncratic characteristics, a seminal description of the concept is included here to better understand the proposal of the competitive advantage of nations. Thus, the concept of a cluster is defined as “geographical concentrations of interconnected companies, suppliers and providers of specialized services, companies in related sectors and associated institutions (for example, universities, standardization agencies and trade associations) belonging to a specific economic activity in which they compete, but also cooperate” (Porter, 2000: 253).

The author, like his contemporaries from the Italian districts school, expands the limits of the cluster by including other agents within the infrastructure, such as universities, R&D institutions, public bodies, or capital agencies. Firms typically share resources and draw on a dense community of skilled labour that flows between firms with relative flexibility. It also emphasizes, like the school of industrial districts, the importance of the network of relationships that are established in the cluster through the repeated interaction of the companies that coexist in a circumscribed geographic area (Porter, 2000). Due to this sharing of common characteristics, both terms have sometimes been used interchangeably in the literature (e.g., Lazeretti, 2006; Camisón, 2004) to designate the same reality.

However, the terms cluster and industrial districts are not completely interchangeable. Professor Porter's ideas are inscribed within the tradition of strategic management and involve increasing the scope of the use of competitive advantages as determinants of a nation's competitiveness through the optimization of the value systems of its industries. Likewise, it almost completely dispenses with the social element that configures the hypothesis of the Italian districts and that is a factor of categorical relevance of them (Sforzi, 2015). Fundamentally, their differences are delimited by the following factors (Sforzi, 2015; Porter & Ketels, 2009; Catalán et al., 2008):

- Company size: the Italian canonical approach establishes that industrial districts are mostly made up of small and medium-sized companies. Porter's cluster concept does not necessarily imply any specificity or business size restrictions. The Harvard professor mentions clusters such as Detroit (Ford, GM, Chrysler) or Seattle aeronautics (Boeing) where some of the largest business groups in the United States are located. Therefore, the agglomeration of a set of vertically interconnected small and medium-sized companies, such as that presented in the district approach, under Porter's prism, is only one of the different structural options that can appear in clusters (Porter & Ketels, 2009).
- Sectoral Composition: Italian districts are usually limited to industrial or strictly manufacturing sectors (textiles, tiles, etc.) while the cluster can incorporate activities from the primary or tertiary sector (Porter gives the example of the Leverkusen chemical and pharmaceutical products cluster, the casinos of Las Vegas, or the Portuguese horticultural one).
- Competitive Advantage of the industry: the cluster approach places greater emphasis on how the externalities produced by the agglomeration or geographic concentration of the industry can play a differential role in the competitiveness of the industry or territories. The consideration of the location in a cluster falls within the strategic decisions based on the conditions presented by the environment, while the industrial district, for its part, is a product of the environment, and not a previously deliberate strategic decision (Becattini et al., 2009; Becattini, 2002).

Focused on the explanation of international competitiveness, Professor Porter identifies the conditions under which co-located companies carry out high-productivity economic activities that allow them to be internationally competitive. The keys to this productivity are innovation and continuous improvement. Thus “the nation's competitive advantage depends on the industry's ability to continuously innovate and improve” within a process “that is created and sustained through localization” (Porter, 1990: 73). Porter's Diamond is the graphic representation of the determinants of competitiveness, innovation, and spatial growth. Its nature promotes the clustering of competitive industries structured in relationships of a vertical nature (supplier/buyer) and a horizontal nature (channels, technologies, grouping of clients) (Porter, 1990: 148). The four elements that compose the diamond are:

- Factor conditions: included in this category are the availability of, among others, a workforce trained in the needs of the industry, sources of financing, and specialized access to sources of knowledge and information.
- Conditions of demand: refers to the size and degree of sophistication of the clients, especially those belonging to the company's national market. When a national market

meets the aforementioned characteristics, it is capable of providing means for the creation of competitive advantages through faster identification of customer needs, increased pressure to innovate, or detecting the clearest signs or trends of buyers.

- Related and support industries: these groups of companies operate in industries attached to or related to the reference sector. Highly competitive supporting industries provide innovations and motivation to improve components, inputs, and processes.
- Strategy, structure, and rivalry of the companies: the conditions and the national context influence how the companies organize themselves, formulate their strategy and contribute to the definition of the degree of domestic rivalry. Porter (1990) indicates that intense domestic rivalry is essential since it exerts pressure to increase the innovative capacities of companies, so that they reduce their costs or improve quality, thus increasing regional competitiveness.

Professor Michael Porter's theories have enjoyed great recognition and influence in the field of regional policy (Konstantynova & Wilson, 2014; Lagendijk & Cornford, 2000) and have been used to recreate the necessary conditions to develop competitive advantages and, thus, promote the growth of other industrial clusters in other geographical locations. The OECD itself has promoted the creation of clusters for decades as a means of contributing to the creation of more competitive and innovative regions (Sölvell et al., 2003; Bergman et al., 2001). In Spain, this process had its impact on the regional policies that the Minister of Industry and Commerce of the Catalan regional government, Antoni Subirá, began to consider, having the creation of clusters as their central axis. These ideas also permeated the Basque Country region in the 1990s through the orchestration of the Competitiveness Plan for this autonomous community, advised by Michael Porter himself (see chapter 3).

The recognition and popularity of Porter's ideas on the cluster have also resulted in the rise of a series of criticisms of the model. Martin and Sunley (2003) have described the cluster concept as chaotic concerning the rest of the theoretical approaches that address the reality of territorial agglomerations. In particular, due to the limited attention that the model pays to the social dimensions in its formation and the dynamics of the territory. On the other hand, O'Donnell (1997) mentions the lack of clarity in the approach as to how competitiveness can be defined in terms of localities, regions, or nations. Finally, although the model has been well received in the field of public development policies, no critical evaluations have been made of the impact it has had on said regional development.

2.8. THEORIES OF INNOVATIVE MEANS AND INNOVATION NETWORKS

2.8.1. Institutionalism and socioeconomic approach

As has been pointed out in the previous sections, the territorial agglomerations of companies are characterized by the confluence of multiple agents, public institutions, resources, initiatives, and information (Benko, 1991), there is a current in the literature that explains how regional growth is the direct consequence of the relationships that this confluence of factors establishes (Granovetter, 1985). Networks are an institutionalized form of social capital based on mutual benefit to network participants (Cooke & Morgan, 1998).

To know the importance of the analysis of social networks to the study of the territorial agglomerations of companies, it is necessary to make a first approximation to the concept of social capital. In this sense, social capital is understood as the set of resources, real or virtual, that an individual or group of individuals accumulates by having a lasting network of more or less institutionalized relationships endowed with familiarity and recognition (Gargiulo & Benassi, 2000; Nahapiet & Ghoshal, 1998; Bourdieu & Wacquant, 1992).

The concept of social capital appears initially linked to studies on communities, pointing out the importance of strong personal networks in the long term, since these are the basis of trust, cooperation, and collective actions (Jacobs, 1961). However, it is currently one of the most popular exports of sociological theory (Molina, 2001) applicable to multiple fields of social study such as business management (Coleman, 1988), the development of geographic regions (Fukuyama, 1995; Putnam, 1995), or social causes of such depth as the eradication of poverty (Naranyan, 2002) or education (Healy & Cotê, 2001).

In the context purely associated with regional development, trust acts as a governing element in relations between regional agents, reducing the risks of opportunistic behaviour between the parties in environments of risk and uncertainty (Bhattacharya et al., 1998). Strong links provide two advantages: first, they favour the exchange of quality information and tacit knowledge (Uzzi, 1997; Coleman, 1990); and, secondly, they serve as a social control mechanism, as mentioned above, due to trust between parties (Kale et al., 2000; Uzzi, 1996).

The regions that present this type of relationship of trust between the agents that compose them are capable of developing a regional advantage based on adaptation and innovation capacities that are likely to have an impact on regional development and the competitiveness of companies (Saxenian, 1994).

Note that the accumulation of local social capital may be insufficient for the development of the region (Boschma, 2005) and that an excessive degree of isolation of the local network from other external agents may lead to a loss of effectiveness in the objectives of the same (Szreter, 2002). Therefore, when the objective is to promote regional development, the establishment of ties between agents located in the region, but also with other agents outside the local network, should be encouraged. The excess or lack of any of the two dimensions would be fatal for the region and for the competitiveness of the companies that settle in it (Woolcock, 1998).

The core of institutional and socioeconomic theory for regional development sees regional development as a consequence of the historical evolutionary trajectory of the region (Nelson & Winter, 1985). Therefore, according to this principle, future regional evolution is conditioned by its past trajectory (Arthur, 1996). However, the trajectory of regional development is not linear and, although it may be influenced by its past, dynamic changes may occur that alter its foreseeable trajectory (Storper et al., 1998).

For this purpose of strengthening the networks, the active participation and collaboration of public institutions is crucial. This interweaving must translate into a strong institutional presence at the local level, high levels of interinstitutional interaction, strong social structures, and a collective awareness of common regional goals (Amin & Thrift, 1995). This participation of institutions can provide critical externalities in regional economic development (Martin & Sunley, 1998).

The institutionalist and socioeconomic approach have had a significant impact and influence on regional development policies, emphasizing the importance of institutional entities to develop assets and specific resources of a territory that result in an improvement in the competitiveness of their companies and guarantee a dynamic adjustment. (Scott, 2004; Sunley, 2000; Amin & Thrift, 1995). The promotion of social networks among regional agents has been discovered as a route to regional development both in the most prosperous regions and in industrial locations that have become obsolete over time (Cooke & Morgan, 1998; Cooke, 1995).

However, there is no lack of critical voices that question the ability of these approaches to explain regional development and politics (Wood & Valler 2001; Sunley, 2000) or the limited attention given to the balance between cooperation and competition between agents and institutions that make up the network (Glasmeier, 2000). We must not forget the effect of the closure or lock-in that can occur in the region if, as has already been mentioned, only the social ties between regional agents are reinforced (Boschma, 2005).

2.8.2. The means of technological innovation

The debate that emerged after the inability of neoclassical models of economic growth to explain the sources of regional development and business competitiveness caused changes in the study of territorial dynamics (Dunford & Perrons, 1994). These changes were further spurred on by industrial change represented by the rise of industrial specialization to the detriment of the classic Fordist system of mass production (Piore & Sabel, 1984).

Piore and Sabel described this process as an industrial transition. Flexible specialization is "a strategy that consists of permanent innovation, in adapting to incessant changes instead of trying to control them. It is based on a flexible team; in skilled workers and the creation, through politics, of an industrial community that allows only the kinds of competition that favour innovation" (Piore & Sabel, 1990: 29).

To interpret the changes that have occurred in contemporary capitalism, the new global processes, and the speed of technological change, new theories are formulated whose objective is to understand the patterns of territorial business organization by analyzing the role of territorial conditions and new technologies. The main approaches in charge of analyzing these new "innovative spaces" are the Mileu and the Technological Innovation Means.

The Mileu theory (from the French, Middle), relates economic development, organization of production units, and territorial conditions in the same model of analysis. This theory arises from the studies of Aydalot (1986), Störh (1986), Camagni (1986), and Maillat (1995), among others, and has been subsequently developed by the international research group GREMI (*Groupe de Reserche Européen pour les Milieux Innovateurs*). This group developed a series of empirical studies throughout fifteen European regions to clarify the reasons that relate the innovative capacities of companies with the dynamics of territorial development.

Following Méndez (2000), the innovative milieu can then be defined as a set of relationships that take place in a geographical area and that regroups the following parts into a coherent whole:

- A territorial substratum of local scope, which presents features of internal homogeneity and which behaves as a living and working space for the majority of residents.
- A group of actors (companies, public institutions, unions, research centers, educational institutions, etc.) with decision-making capacity in the actions identified in that space.
- A set of material resources (physical and industrial infrastructures) and immaterial resources (culture, know-how) that are specific to the territory in question.
- A logic of interaction that shows the capacity of the actors to reach beneficial agreements for all the parties in the long term.

The environment is one more element that configures or not the competitive business environment, depending on its impact on the innovation activities carried out by companies. For this reason, it is presented as an attribute of a higher order than the mere location factor, since it emphasizes its ability to create resources and manage the processes that generate innovation than in the physical setting itself where the business activity takes place and determining, therefore, different regional growth trajectories (Vázquez Barquero, 1990). The characteristics of the Mileu theory are the following (Ondategui, 2001):

- The environment is a changing element that, throughout history, has endowed a territory with a series of economic, social, and cultural characteristics whose integration configures the space -the environment-. Regional development and business performance depend largely on how it influences the economic and technological attitude and the results obtained by companies for regional development.
- For the company located in the milieu to be competitive, it must adapt to the changes that occur in it. To do this, companies must make their production models more flexible and cooperate with other units and organisations in the environment.
- In managing innovation, companies must manage a series of resources (financial, commercial, productive, etc.) whose cost and availability will be determined by the environment and, ultimately, will determine the competitive possibilities of companies.
- The potential of a territory, therefore, will be given by the environment. This potential may or may not be used by companies according to their internal resources, or according to their needs to generate innovation and, in this way, improve their competitive position.
- In the environment, a series of interpersonal relationships and practices are spontaneously developed that are higher than the formal institutional channels. This certain informality in the cooperative relationships between agents serves to develop adaptability and flexibility.
- The local production system is an integration of the industrial organization together with the institutional structure of the public system with the attention focused on generating synergies and both formal and informal internal links that favour the development of the region.

According to Ondategui (2001) of these characteristics, the Mileu theory distinguishes two types of industrial structures that are distinguished by their opposite industrial and organisational culture. The first structure is characterized by being a system dominated by large industrial units that have little or no degree of relationship between them. This space is organized according to the interests of each company and therefore lacks many of the premises defended by this theory to generate innovation. This first type of structure is very similar to the poles or concentrations of industrial companies that proliferated in Spain at the time of economic development, as previously mentioned. The second production structure, however, has significantly different peculiarities as it is built on much more diversified production systems that also work closely with the public sector. In this type of structure, there is a high degree of relationship between agents that allows generating a more dynamic environment for the development of innovative capacities in companies.

Therefore, the Mileu theory redefines the dynamics of the relationship between regional development, productive organization, and technology. The model has shown that the relationships between the territory and technological change are associated with local know-how, the importance of R&D, the networks of relationships between regional agents, and the valorization of human resources (Maillat, 1992, 1995; Camagni, 1991).

The second contribution called "Means of Technological Innovation" (MIT) is a conceptual theory developed by Castells and Hall (1994) that investigates the causal relationships that exist between the spatial organization of the industry and technological innovation through empirical analysis of the evolution suffered by international markets and information and communication technologies. This thesis is considered complementary to the GREMI del Mileu theory (Ondategui, 2001).

MITs are defined as a specific set of production and management relationships, based on a social organization that fundamentally shares a professional culture and instrumental objectives aimed at generating new knowledge, new processes, and new products.

These relationships are reflected in open business locations, which present an appropriate atmosphere for technological, economic, and social development capable of spurring the creation of a new business fabric and an innovative culture. In the impulse to establish the MIT theory, Castells and Hall (1994), based on empirical observations made on a global scale, classify and define technological spaces in five means of technological innovation collected in the following Table 3.

Table 3. Means of Technological Innovation classification

Means of Technological Innovaton	Definition
1. Industrial complexes of technological innovation	Industrial agglomerations that house scientific and technological research centers capable of generating knowledge that translates into new products or processes in the industries present in the agglomeration. The sources of innovation may or may not

	belong to the industry, although historically they are first generated externally in research centers and later incorporated into the industry. Classic examples of these spaces are Silicon Valley, Greater Boston, the Singapore Complex or the Munich Area.
2. Science Cities	Concentrations of research centers (both public and private) in the surroundings of a city to generate sufficient critical mass capable of advancing the generation of scientific knowledge, without the incorporation of the industrial element. The cities of Tsukuba or Kansai in Japan are magnificent exponents of this means of innovation.
3. Technological parks	Used as a generic name for MITs, it is applied more precisely to industrial areas planned by different public or private administrations. They are intended to house companies belonging to high-tech sectors. The determining characteristic of this type of infrastructure is the type of product manufactured, closely related to information technology. Examples of these infrastructures are found in Cambridge or Sophia Antipolis.
4. Metropolitan centers of high-tech industries	They comprise large metropolitan areas where the largest concentrations of high-tech industries in the world are located, such as Los Angeles, Paris, or Tokyo.
5. Regional technology hubs	They are concentrations of industrial infrastructure and technology centers promoted by public administrations to promote regional development. The case of the projects promoted by Ministry of Economy, Trade and Industry in Japan is an illustrative example of this MIT model.

Source: Castells and Hall (1994)

Castells and Hall (1994) suggest that national economies are submerged in a common and global market that acts as a whole. That is the reason that explains a disruptive change in the technological and industrial paradigm that is modifying industrial organizations and classic business models. In this new industrial pattern, mass production gives way to a more flexible and specialized system where, in addition, the synergy between the different agents of the industry becomes a necessary condition to raise the degree of competitiveness (Piore & Sabel, 1984). On the other hand, in terms of organizational structure, the pyramidal organization charts that prevailed in the early industrial era were modified by other flatter schemes, with a greater degree of decentralization (Piore & Sabel, 1984).

The new conditions of the markets and competition, together with the new attributes of the industries facilitate the creation of new companies with high innovative capacity and based on the use of new technologies as a form of productive specialization. These types of companies called companies with high growth potential (Camisón et al., 2013), can generate enough socioeconomic impact to move towards more innovative regional models and a knowledge-based economy.

In short, while the theoretical approaches of the GREMI underline the importance of aspects such as the regional profile and trajectory, or collective know-how as factors that configure the environment with the capacity to generate and favour innovation, the thesis of Castells and Hall (1994) highlights the importance of the development of new technologies as a transforming element of regional competitive conditions and advantages.

The approaches of Castells and Hall (1994) reiterate that countries that do not include productive sectors associated with new technologies and new production methods could fall into a spiral of decomposition of their industrial structure and plunge into an economic and social crisis of difficult reversion. The authors do not mean that this implies the end of sectors or industries with technologies or processes not related to the new technology, but they do affirm that they must make innovative efforts to raise the degree of differentiation of their products. About this last contribution, the author Benko (1989) points out that the new economy is governed by "an international configuration where new technologies have a role to play, but do not determine the model, since they are compatible with a whole range of new models of development" (Benko. 1989:19).

2.9. INNOVATION THEORIES

Innovation is a concept capable of explaining economic growth, the creation of new companies, the competitive advantage of the company, the effective management of both public and private organizations, and the social welfare of a country or a region (Damanpour & Aravind, 2012; Gopalakrishnan & Damanpour, 1997; Drucker, 1985; Schumpeter, 1911). These implications of the concept of innovation have favoured this concept to become a popular area of study in multiple fields of knowledge such as management, economics, engineering, psychology and sociology (Damanpour & Aravind, 2012).

The generalization in everyday and labour aspects of the terminology linked to innovation has created a certain degree of confusion between concepts such as innovation, creativity, change, research, and technological development (Camisón et al., 2020). It is necessary, therefore, to stop to contemplate the conceptual differences and practical applications of each of the previous constructs.

Creativity is defined as the production of new and useful ideas in any domain (Amabile et al., 1996) and is the main source or origin of the innovative process since "it can influence the processes and results that affect multiple levels of analysis and can resolve dilemmas that arise throughout the innovation process" (Ford, 1996: 1113). Creativity also has a difference from innovation, while the former requires a context of freedom and a climate where individuals are not limited in their search for solutions (Amabile, 1988), the latter requires a much more focused, organized process. systematized and focused on success (Dougherty & Hardy, 1996; Drucker, 1985). Creativity can be individual or collective, and both support innovation in organizations (West & Richter, 2008). Innovation, therefore, comprises "the successful implementation of creative ideas" (Amabile, 1988: 126).

The above is not the only definition of the term innovation in the literature. Below are some of the most used in the literature. Researchers have conceived of innovation as a discrete result and product, or as an organizational capacity (Camisón & Monfort-Mir, 2012; Forés & Camisón, 2011).

The aim of studies that present innovation as an outcome is to determine the contextual and structural conditions under which firms innovate (Gopalakrishnan & Damanpour, 1994) and how this innovation contributes to firm competitiveness and wealth production (Drucker, 1985). Therefore, from this perspective, innovation is seen as the introduction of new products and services (Damanpour & Schneider, 2006) or new processes, policies, or systems in the organization (Klein & Sorra, 1996; Damanpour, 1991). In the definition of Spanish COTEC Foundation for innovation (1998), innovation is the complex process that brings ideas to the market in the form of new or improved products or services.

On the other hand, innovation can also be approached as a process, examining how it is originated, developed, and implemented (Van de Ven et al., 2000). Under this prism, the literature (e.g., Gopalakrishnan & Damanpour, 1994) treats innovation as a sequence of events, activities, decisions, and social systems. Innovation under this approach covers all efforts and activities aimed at creating new ideas and making them work (Roberts, 1988). Therefore, innovation is a multifaceted construct with multiple typologies that make it up and which will be discussed below.

Beginning with the origins of the theory of innovation, the Austrian economist Josep Schumpeter indicated that the concept of innovation encompasses a multiplicity of phenomena that can be grouped into the following five categories (Schumpeter, 1942: 77):

- Product innovation that includes “the introduction of a new good or a new quality of a good”.
- The innovation in process or new production method must not have “been proven by the experience of the manufacturing branch in question, which does not need to be based on a discovery from the scientific point of view”.
- The opening of a new market “in which the special manufacturing branch of the country in question has not entered”.
- The appearance of new sources of materials for production, these being “raw materials or semi-manufactured goods”.
- The emergence of new organizational forms in the industry, to which Schumpeter alludes regarding the competitive structures of the market.

The Oslo Manual published by the Organisation for Economic Cooperation and Development (OCDE) clarifies the different innovation activities and also provides its definition of the concept of innovation. Thus, innovation is "the introduction of a new, or significantly improved, product (good or service), a process, a new marketing method or a new organizational method, in the internal practices of the company, the organization of the workplace or external relations” (OECD, 2006: 56). This broad definition encompasses various types of innovations that the Manual classifies as follows:

- Product innovations: which implies the introduction of a new or significantly improved good or service in terms of its characteristics or possible uses. This definition implies a significant improvement in technical specifications, components or materials, embedded software, ergonomics, ease of use, or other functional characteristics.
- Process innovations: it is the introduction of a new, or significantly improved, production or distribution process. This implies significant changes in techniques, materials, and/or computer programs.
- Marketing innovations: it is the application of a new marketing method that implies significant changes in the design or packaging of the product, in its positioning, promotion, or its pricing.
- Organizational innovation: is the introduction of a new organizational method in the practices, the organization of the workplace, or the external relations of the company.

Another important distinction when we talk about innovation is based on the technological advance associated with this association. In this case, it is possible to distinguish between radical innovations and incremental innovations. Radical innovations are those that have a significant impact on the market and on the economic activity of the companies in that market (OECD, 2006).

Its most significant characteristics are its novelty and its little predictability. The impact they generate can change the structure of the market, create new markets or render existing products obsolete (Christensen, 1997). On the other hand, incremental innovations are small successive improvements of existing goods and processes. They involve predictable technological changes with reasonable degrees of certainty. In the case of goods, it is aimed at improving their quality, reducing costs, or expanding the range of uses. When it comes to processes, it implies technical improvement, productivity increases, and process precision. Incremental innovation is considered the "natural path" of technology (Nelson & Winter, 1982) and is conceptualized as a "technological paradigm" (Dosi, 1988).

2.9.1. Linear Models

The conception of the innovation process has also evolved over the last decades. However, even though, as we will see below, the quality and applicability of innovation models have improved over the last decades, there is no lack of critical voices in the literature that affirm that there is no explanatory model of the innovation process fully generalizable (e.g., Hobday, 2005; Forrest, 1991).

Although numerous models have tried to conceptualize and explain each of the tasks that constitute the innovation process (e.g., European Commission, 2004; Escorsa & Valls, 2003), most of them are unable to capture the reality of the innovation process due, fundamentally, to the complexity of the reality to be described (Padmore et al., 1998).

Until the mid-1980s, innovation theory considered that this was a process made up of sequential activities of research institutions, exogenous to the production model and, therefore, of companies. This traditional model is called the linear model of technological change. Its conceptual basis suggests that the product or result of the process is highly related, in a linear way, to the input factor and this relationship is summarized in the production function (Forrest, 1991).

Note that this model conceptualizes R&D as an isolated activity, which is carried out in research centers in which there is no influence from the market or companies. Its defining characteristic is linearity, the progressive and sequential staggering between the scientific discovery or source of innovation, until the market launch of the novelty.

The operation of the model responds to the technological push and was widely disseminated and highly influential from the years after the Second World War until the mid-1970s (OECD, 1992). Thus, innovation is a sequential linear process carried out in isolated phases. The first phase of this process would be basic research, followed by applied research. As a result of the results of this, the next step would be technological development. If the results of the design and tests are satisfactory, the marketing tasks would be carried out, which would comprise the penultimate phase. The model ends with the dissemination of innovation in the market.

However, as the 1970s progressed and greater attention began to be paid to the role played by consumers in the innovative process, the model underwent a remodelling, contemplating the innovation process from the perspective of the pull of market demand. The growing emphasis and rise of strategic marketing processes altered the perceptions of innovation processes and a greater intensification of demand factors occurred in the model (Rothwell, 1994). In this way, the needs of the client are the starting point of the new linear model and those that trigger the innovation process (European Commission, 2004). The second phase of the model would be the development phase, which would give way to the production phase and would end with the product sales activities.

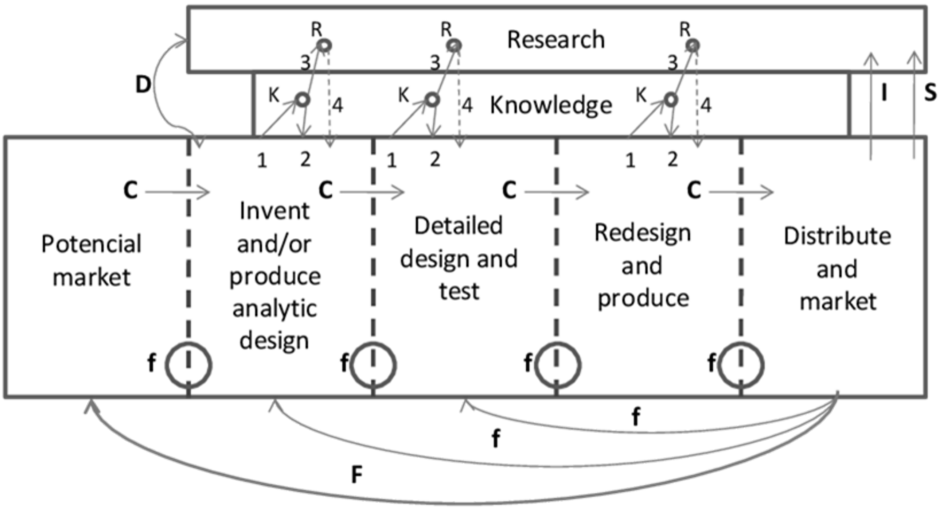
The linear model is extremely useful to understand the innovation process simply and rationally. Proof of them is later evolutions such as the model by departmental stages. However, it has several shortcomings that have led to its obsolescence. Thus, the model assumes that technology transfer and dissemination is an automatic process, free of costs or time delays. Therefore, the model denies the influence of factors such as institutions, strategies, competitive attitudes of companies, education of the workforce, or conditions of the factors in each nation or region. Therefore, policies based on the linear model are aimed at generating innovations through the creation of research centers, institutional support for R&D, or direct financing of business research activities.

2.9.2. Interactive models

Starting in the 1980s, a new model was erected capable of combining technological change with dynamic processes such as learning, or the inclusion of elements of both technological push and demand pull, being, therefore, much more representative of the innovation process (Forrest, 1991). The interactive, evolutionary or mixed model implied radical changes in the management of innovation to reduce the incidence of failures and the waste of resources. Among all the existing interactive models in the literature, the link chain model or Kline model stands out.

The link-chain model proposed by Kline, instead of having a single main course of activity in the innovation process as in the linear model, has five (Kline & Roserberg, 1986: 289). These paths or trajectories are pathways that connect the three most relevant areas in the innovation process: research, the body of scientific and technological knowledge available, and the central chain of the innovation process. It is the link between the different areas that serves as the basis for calling Kline's model the chain-link model or "chain links" (Kline & Rosenberg: 1986: 290). Figure 4 below illustrates the chain-link or Kline model.

Figure 4. Kline model of innovation



Source: Kline and Rosenberg, 1986

The first trajectory of the model is called the central chain of innovation (Kline & Rosenberg, 1986: 289). This central trajectory or central chain of innovation begins with an idea that materializes in an analytical design or invention capable of responding to a market need. The second path of the model consists of a series of feedbacks (Kline & Rosenberg, 1986). The feedback loop is represented by the arrows f (feedback links) that represent the information obtained from the needs of the market and used in the preceding phases of the technological innovation process. The feedback comes from the final market and reaches up to the potential market (represented by arrow F), and provides information on new product possibilities, new industrial applications, or new markets. Lastly, the third path of innovation is made up of the existing links between knowledge and research with the central chain of innovation. When the central chain has a problem, the body of available scientific and technological knowledge is used (arrow 1) and, if they can provide the necessary information, it is incorporated into the innovation (arrow 2). If the existing body of knowledge is not sufficient, research will be used (arrow 3) and, later, the results obtained from the research will be added to the stock of existing knowledge (arrow 4).

Additionally, the model presents two more trajectories that follow the tradition of previous linear models. The fourth trajectory that innovation can follow is the connection between research and invention (arrow D). Based on the push model of science, it recalls how new scientific discoveries can make radical innovations possible (Kline & Rosenberg, 1986: 293). However, the relationship is bidirectional: science can create opportunities for new developments, but the perception of new market needs can stimulate the development of new research (Fernández-Sánchez, 1996). Finally, the fifth trajectory represents the direct connections between the market and scientific research

(Arrow S). As Kline and Rosenberg (1986: 293) state, some innovation results (e.g., instruments, machines, tools, and technological procedures) are used to support scientific research.

In short, the Kline model represents an evolution concerning traditional linear models since it provides feedback possibilities in all the stages that make up the model and, on the other hand, relates science and technology with each of these stages, and not only at the beginning. This results in a much more applicable and realistic model with the real process of innovation. However, the model is not without criticism. Among them, the maintenance of the linear character of the process, the excessive duration of the process, the absence of guarantees of functional integration, and the delay in decision-making caused by the excess of feedback processes (Morcillo, 1997) stands out.

2.9.3. Network models

The evolution of the globalization process, the development of new technologies, and the characteristics of the environment have revealed the impossibility of carrying out innovation processes in a completely isolated manner within companies. Under these new environmental conditions, innovation becomes a "network process" (Rothwell, 1994: 22). In this situation, the System Integration and Networking Model points to the fundamental role of learning within and between companies and suggests that innovation is, generally, a process distributed in networks. collaborative (Hobday, 2005).

Increasingly, companies are striving to involve their customers, suppliers, and other third parties in their innovation processes. This phenomenon of integration and use of external knowledge sources of the company together with internal ones is called “open innovation” (Chesbrough, 2003, 2006). The author himself defines open innovation as "the use of internal and external flows of knowledge to accelerate internal innovation and expand markets for the external use of said innovation" (Chesbrough, 2006: 1). Open innovation can manifest itself in three forms: alliances between companies, static networks, and outsourcing.

Recently, a new way of applying the principles of open innovation called a collaborative community of companies is appearing (Snow et al., 2011; Miles et al., 2005). Under this new modality, a set of complementary companies are brought together (Stieglitz & Heine, 2007) in which a community of values and collaborative processes and capabilities allow these companies to work with each other on innovation projects temporarily. This modality has been named “Innovation Community” (Pisano & Verganti, 2008). Referring to the dynamic nature of the network where any member can present their problems and others can offer solutions and decide which solutions to use, acting, as will be seen in the next section, as an integrated system.

2.9.4. National and regional innovation systems

As has been seen, understanding the dynamics of innovation is far from simple. However, it is possible to draw two conclusions from the entire analysis process above. The first is the endogenous nature of innovation within production systems and it is only possible to speak of innovation after its effective implementation. The second conclusion has to do with the complexity of the innovative process and its results. The results in innovation are the fruit of complex learning processes in which, increasingly, agents external to the companies are involved, in charge of channeling and stimulating knowledge flows and correcting market failures that can limit the innovative activity of companies. This cooperation between agents can be articulated in multiple ways and constitute the phenomenon known as the national/regional innovation system.

A national innovation system (NIS) (Edquist, 2005; Lundvall, 1992; Freeman, 1987) essentially comprises the set of existing institutional and business organizations in a specific territory that interact with each other to allocate resources and stimulate activities, aimed at both the generation and dissemination of knowledge. The flexibility of the model is made clear by Lundvall's definition according to which “National Innovation Systems are open and heterogeneous systems. Innovation processes transcend national borders and are sometimes local rather than regional” (Lundvall, 1992: 4).

The SNI concept illustrates how the process of division of labour in the innovative process among numerous specialized agents in each of the areas or phases that make up this process is capable of generating synergies between regional agents and reducing the costs of the process. The regional application of this model is protected under the figure of the regional innovation system (RIS) (Hejis, 2001; Koschaatzky et al., 2000; Braczyck et al., 1996). Note that the NIS/RIS concepts imply a “geographical approach” to innovation (Cooke, 2001), implicitly giving a prominent role to the economic, political, and social characteristics of the environment. This “open and flexible” conception (Lundvall, 1992:13) of the NIS has had as its main implication its application to the different geographical, national, regional, local, and even supra-state units (Edquist, 1997).

Special interest deserves the cumulative causation processes that occurs in these environments, in which, frequently, the elements that compose and interact reinforcing each other in the promotion of innovation and learning processes and viceversa. Thus, a virtuous circle is produced that promotes continuous production of innovative results, an idiosyncratic characteristic of innovation systems (Lundvall, 1992).

In other words, the transmission of knowledge, technology transfer, and learning processes are important aspects resulting from the interactions between the agents of the system involved in the innovative processes and activities. These repeated interactions require an environment where the reciprocal exchange of ideas, experiences, and knowledge is an identifying characteristic of it (Stöhr, 1987).

Interactions between agents participating in the national/regional innovation system can take many forms and are often not symmetrical. The managers and coordinators of the system must take these asymmetries into account and channel the appropriate actions to solve said asymmetries in the sharing of information and knowledge. Its treatment and solution will affect the effectiveness in promoting innovation than in those innovative systems that avoid its management (Arocena & Sutz, 2006).

From all the characteristics described above, it is easy to infer that the concept of a NIS/RIS is the result of the fusion of various currents in the literature. On the one hand, it integrates those theoretical approaches that underline the importance of geographical proximity and the externalities produced by said location to favour the development of innovation results. Here, therefore, the theories of the Marshallian districts (Marshall, 1919), the Perrouxian poles (Perroux, 1955), and the cluster (Porter, 1990) are integrated. In addition, the concept of innovation system also invokes the postulates of growth theory that underline the importance of innovation for the economic development of geographical areas presented in the new conceptualizations of the neoclassical theories of Romer (1986) and Lucas (1988), among others.

2.10. THEORIES TO THE STIMULUS OF SUSTAINABLE REGIONAL DEVELOPMENT

In recent decades, the degradation of ecosystems, the depletion of non-renewable resources, the increase in environmental disasters and the need to urgently modify the socioeconomic system towards more sustainable and responsible options, encouraging the study of new theories on sustainable development. (OECD, 2012). The term sustainable development has thus become an element of capital influence in regional development policies in recent decades (Roberts, 2004). Therefore, numerous theories have emerged to study the promotion of regional development aligned with the principles of sustainable development. We highlight in this doctoral thesis two very specific theoretical contributions due to their impact on the development of more sustainable territorial agglomerations of companies, industrial ecology, and the circular economy.

2.10.1. Industrial Ecology

As already indicated, derived from the severe damage to the environment caused by the mass production of goods and services, the Industrial Ecology approach appeared in the 1970s (Watanabe, 1972; Hoffman, 1971; Gussow & Meyers, 1970). The theory was popularized from the studies of Frosch and Gallopoulos (1989), who reconceptualized traditional linear industrial systems into new cyclical systems that mimic the behaviour of natural ecosystems, promoting the closing of the cycle of matter and improving sustainable development.

Frosch and Gallopoulos propose that the industrial cycle must change from a model in which there is an unlimited input of energy, raw materials, and resources to one in which these same materials and resources remain as components of the system for a longer time. This would also avoid the unlimited emission of waste, residues, and pollution. Thus, as Liwarsa-Bizkojc et al. (2009) propose, this would generate an ecological flow of cyclical materials that would only need the input of energy to maintain its operation. This would reduce the inconsiderate exploitation of the natural resources of the territory and contribute to improving its sustainability.

Industrial ecology can be defined as "the means by which humanity can deliberately and rationally approach and maintain sustainability, given continuing economic, cultural, and technological evaluation. It is the vision of a system that seeks to optimize the total cycle of materials, from virgin materials, or finishing materials, to components, to products, to obsolete products, and to the final disposal. The factors to be optimized include resources, energy, and capital" (Graedel & Allenby, 2003: 18). To meet the objectives that the theoretical definition promulgates, the paradigm of industrial ecology is based on a process called industrial symbiosis (Chertow, 2000).

Industrial symbiosis is defined as "the process of optimizing resources based on the exchange of by-products and shared infrastructures between different companies located in a territorial agglomeration" (Brings-Jacobsen, 2006:240). Therefore, symbiosis comprises the exchange of materials, by-products, and waste between several systems so that what for one member of the system may be worthless waste becomes raw material for the production process of another, thus promoting a network cooperative (Chertow, 2003) of exchange between companies and industries (Gibbs & Deutz, 2007). With all this, what industrial ecology intends is that the industrial systems of a territory reduce the exploitation of the natural resources of the ecosystems to obtain raw materials (Erkman, 1997) and that, at the same time, they can reduce the levels of waste discharged into the environment (Wernick & Ausbel, 1997). The precepts of industrial ecology, as will be seen below, have had an impact on subsequent theoretical currents, such as the circular economy.

2.10.2. Circular Economy

Closely aligned with these principles of systems thinking and recirculation of by-products is the circular economy framework (Saavedra et al., 2018). The circular economy proposes that the productive sectors must formulate strategies aimed at conserving the environment through the change from linear production and consumption models (produce-use-dispose) towards more circular models, maintaining the constant flow of materials within the productive system. (Kalmykova et al., 2018; Pomponi & Moncaster, 2017). The objective of the circular economy is to reincorporate as much waste as possible back into the production process to avoid extracting new resources from the environment (Camisón et al., 2021; Rodríguez et al., 2020). This new model of production and consumption also opens up possibilities such as the use of shared products and services, or the transformation of economic sectors to promote a restorative and regenerative economic model (Camisón et al., 2021; Lieder et al., 2016).

Although numerous definitions for the term abound in the literature (Kalmykova et al., 2018; Kirchherr et al., 2017), the definition proposed by Geissdoerfer et al., (2017) is adopted here. These authors conceptualize the circular economy as “a regenerative system in which resource and waste inputs, emissions and energy leakage are minimized by slowing down, closing and tightening material and energy loops. This can be achieved through durable design, maintenance, repair, reuse, remanufacturing, reconditioning, and recycling” (Geissdoerfer et al., 2017: 759). The notions and principles of the circular economy are built on a set of well-established theories in the literature, among which the following stand out (Camisón et al., 2020):

- The economics of astronauts (Boulding, 1966). In his essay, Boulding suggests that the traditional open economic system be replaced by a cyclical system capable of continuously reproducing materials, although this cannot exist without energy inputs.
- The theory of limits to growth. It arises from a request from the Club of Rome to Massachusetts Institute of Technology (MIT) in 1972 in which, for its development, a team of 17 professionals was coordinated by Donella Meadows, a biophysicist, and environmental scientist. Through computer simulation of exponential economic and demographic growth, and starting from the premise of the existence of finite resources, the theory predicts three scenarios: two of which lead to an "overshoot and collapse" of the global system, while a third it would lead to a “stabilized world”, in which people's needs are met and natural resources are not depleted by economic growth.
- Cradle to Cradle Approach (Stahel & Reday-Mulvey, 1981). The concept represents a closed system of resource flows approached from a product life cycle perspective.

- Industrial ecology (Frosch & Gallopoulos, 1989). Already addressed above, it provides for the integration of industrial ecosystems in analogy with biological ecosystems, to reduce the exploitation of material resources and the careless dumping of waste into ecosystems where energy is the only external input used in the process (Ayres, 1996).
- The steady state economy (Daly, 1991). Built on principles of neoclassical economics (Kerschner, 2008), it proposes that production systems should be characterized by the lowest possible flows of matter and energy from the first stage of production to the last stage of consumption. This theory should not be confused with a state of economic stagnation, since the first represents the result of a set of political actions aimed at protecting fragile ecosystems and limited natural resources, and the second includes the arrest of the sudden growth of the production of a growing economy. Despite this, degrowth and the steady state economy can be considered complementary concepts (Kerschner, 2008: 15).

The transition from a linear economy to a circular one requires reaching an optimization of the stock of resources and severe prevention of waste derived from the production process. For this, the environmental strategies of the 4 Rs (Stahel, 2013) can be used: reduce, reuse, recycle, and recover. Strategies that, on the other hand, recent studies in the field of the circular economy have expanded with new typologies (Van Buren et al., 2016): reject, repair, recondition, rethink, remanufacture and readapt. With all of them, it is possible to configure a reference framework that is a kind of guide to increasing the circularity of raw materials and waste, facilitating the transition from a linear economy to a circular economy. Next, it is described what each of these practices sewed:

- I. Refuse: rejecting the use of raw materials;
- II. Rethink: thinking of new ways to make the use of the product or the raw materials more intensive;
- III. Reduce: reducing the use of raw materials;
- IV. Reuse: finding ways to use products again (e.g., second-hand, sharing of products);
- V. Repair: increasing the maintenance and repairing of products;
- VI. Refurbish: refurbishing a product and bringing it up to date;
- VII. Remanufacture: creating new products from (parts of) old products with the same function;
- VII. Repurpose: using discarded products or parts thereof in a new product with a different function;

- IX. Recycle: processing used materials to obtain materials of the same (high grade) or lower (low grade) quality;
- X. Recover: incinerating materials with the aim of recovering energy.

2.11. CONCLUSIONS OF THE CHAPTER

The study of the territorial agglomerations of companies extends back to the origins of economics as a science, as we know it today. Classical economic approaches made instrumental use of these territorial agglomerations of companies to explain how it is possible to improve economic development. Subsequently, the approaches inserted in the theories of business management point out the benefits that these spaces have to increase the competitiveness of companies. Beyond the advantages associated with cost reduction, perhaps the aspect that has been able to influence the literature on territorial agglomerations the most is the Marshallian notion that, in a territorial agglomeration of companies, knowledge flows between the agents involved in it are inserted. This knowledge is the basis for new technological and non-technological innovations that result in improving the competitiveness of integrated companies. Even more recently, certain theories anchored to the sustainability paradigm also point out that these territorial agglomerations of companies can be configured as a system capable of promoting the sustainable development of a territory. Therefore, this binomial of competitiveness and involvement for sustainable development through the knowledge and practices that the group of companies clustered in a district or industrial park can develop makes the territorial agglomerations of companies an external factor that explains performance in the sustainability of the company that requires further study and empirical verification.

3. MAIN TYPOLOGIES OF TERRITORIAL AGGLOMERATION OF COMPANIES

3.1. INTRODUCTION TO MAIN MODELS OF PROMOTION OF TERRITORIAL AGGLOMERATIONS OF BUSINESS

In recent decades, there has been a proliferation of business agglomerations promoted by different public and private agents in the hope of obtaining for the companies and the region where these business agglomerations are located some of the benefits pointed out by previous theories. This spread of business agglomerations driven by very diverse agents with objectives that may differ completely, has generated multiple terminologies to identify, classify and differentiate each typology of territorial agglomeration of companies according to their defining characteristics and functions (Camisón et al., 2020). This fact has contributed to the coexistence of a wide variety of often confusing proposals for the denomination of these business agglomerations. For this reason, it is necessary to form a typology that runs between terms whose description is more generic, as opposed to others that have a greater degree of specificity of the particularities of each type of agglomeration presented.

No typology or strategy for the creation and development of industrial sites is universal or easily transferable to any region. As Storper (1997) stated, the mere reproduction of development policies in different contexts has practically no impact on the generation of sustained regional or local development or long-term employment effects. Traditionally, policies for the creation of industrial areas have been structured along two main lines: the provision of adequate infrastructures for the development of business activity, the creation of new companies, and the attraction of large international companies to regions with little industrial tradition. These measures have had a questionable impact on numerous occasions (Camisón et al., 2020; Crescenzi & Rodríguez-Pose, 2012).

The provision of adequate infrastructure to improve access to lagging regions, articulated through traditional public spending programmes to incentivise the construction of highways, telephone lines, or sewage systems, has not always had the expected results. Empirical research (e.g., Crescenzi & Rodriguez-Pose, 2012; Vanhoudt et al., 2000; Martin, 1999) illustrates that in the European Union it has revealed a constant or negative economic return on infrastructure investment.

One possible explanation posits that changes in accessibility resulting from new roads may benefit the economic core at the expense of the periphery making the investment (Crescenzi and Rodríguez-Pose, 2016). Another plausible possibility analyses the local institutional environment in which investments are made will affect the scale and type of new infrastructure investments and, consequently, their economic returns. Poor institutions increase the opportunities for private gain at the expense of robust public goods provision (Acemoglu & Dell, 2010). Under conditions of weak government quality, new transport infrastructure investments may respond more to political and individual interests than to economic and collective interests (Henisz, 2002), leading to problems such as bid rigging, misrepresentation of costs and benefits, and misrepresentation of the time needed for implementation (World Bank, 2011; Flyvbjerg, 2009).

The second fundamental strategy implemented by public administrations has been based on the attempt to industrialise lagging areas by attracting large companies to these regions (Camisón et al., 2020). The aim of these policies was to strengthen weak industrial fabrics and, through this attraction of companies, to generate employment, technology transfer and even encourage entrepreneurship. Following Perroux's (1955) theories of poles of attraction, many regions in countries such as France, Italy and Spain have developed industrial policies with these characteristics, but they have not triggered the expected dynamic and innovative effects (Roura, 1994).

There are multiple reasons for the failure of traditional regional development policies (Pike et al., 2006). Some of them are external, such as the poor education and skills of the labour force in which development policies are applied. Similarly, the weak social and economic structures in some regions have also been identified as external causes for the poor performance of these policies (Rodriguez-Pose, 1999). In addition, there are also a series of internal causes, among which the existing imbalance in the promotion of these policies, which bypasses the support or development of other factors, such as support for local companies, the improvement of human resources training, or the dissemination and integration of new technologies, stands out.

The failures of top-down policy have led to a serious rethinking by practitioners and academics alike about the basis on which regional policies should be formulated. Thanks to the promotion and dissemination of many of the theories discussed earlier in this research, a number of innovative bottom-up regional policies have emerged (Amin, 2000). This bottom-up model has progressively gained ground as the basis for new regional development strategies (Vázquez Barquero, 2003). White and Gasser (2001) establish the four fundamental characteristics that effective development policies should fulfil: they require participation and social dialogue, they must be based on a territorial perspective, they must involve and mobilise local resources and competitive advantages, and they must be regionally managed.

Thus, according to the literature (e.g., Vázquez-Barquero, 2010; Cooke & Morgan, 1994) there are three models of concentration of industrial spaces, determined by a series of patterns or underlying logic within the different models that determine their idiosyncratic characteristics. They can be classified as the top-down model, the bottom-up model and the network model. Since the network model can have a planned or spontaneous origin, the differences between the dirigiste and spontaneous models will be pointed out. The following Table 4 illustrates the main differentiating features between the two development models.

Table 4. Development models of territorial agglomeration of business

	Traditional or top-down development policies	**Local and regional endogenous or bottom-up development**
Main strategy	-Functional view of development -Polarised development	-Territorial vision -Polycentric development
Objectives	-Quantitative growth -Large projects	-Diffusion of innovation -Institutional change -Numerous smaller projects
Mechanisms	-Capital and labour mobility -Functional redistribution of revenues	-Mobilisation of endogenous capital -Utilisation of local resources for development
Organization	-Centralised management -Public funding to companies -Public management of resources -Administrative hierarchies	-Localised management -Provision of services to companies -Intermediated management through specialised agencies -Strategic collaboration of local actors

Source: own elaboration based on Vázquez-Barquero (2010), Pike et al. (2006) and Cooke and Morgan (1994)

However, recent studies (e.g., Crescenzi & Rodríguez-Pose, 2011) advocate the integration of both frameworks in order to combine their multiple advantages, facilitate the generation of synergies between both approaches and facilitate the comparability of results across regions.

Derived from the above classification, a set of regional infrastructures emerges with idiosyncratic characteristics that need to be reviewed in order to understand the different instruments available to foster localised business growth and their influence on firm performance. The next section therefore introduces the typology of industrial infrastructures with specific examples of each infrastructure in the case of the Spanish Valencia Region whenever possible. The aim is to help to establish the knowledge of each model of territorial agglomeration of companies, although the focus of this thesis concentrates on the specific typology of science and technology parks.

3.2. INDUSTRIAL DISTRICTS AND CLUSTERS

In the literature on territorial agglomerations of firms, a cluster or industrial district[9] is a reality in which a population of firms and institutions linked to a given industry act in an interconnected manner in a combination of cooperative and competitive relationships (Becattini, 1992; Porter, 1990). This dense network of relationships allows firms and other organisations linked to the cluster to enjoy a number of advantages to which access by entities outside the cluster is much more limited (Zeitlin, 1992; Marshall, 1890). These advantages, or external economies, are related to the specialisation of the labour force in the territory where the cluster is located, the availability of other supplier or auxiliary firms to the main one that determines the cluster, and the dispersion of new knowledge among the linked agents (McEvily & Zaheer, 1999; Zeitlin, 1992; Krugman, 1991).

The above advantages have permeated not only the academic study of the phenomenon of the location of firms in a given cluster, but also industrial policy itself in order to promote the regional competitiveness of firms, and to stimulate the transition towards a knowledge-based economy in an aggregate manner (Moodysson et al., 2015). Location decisions have proven to be a crucial aspect for firms insofar as it gives them control over means of production, access to markets or the reduction of transport costs (Capó-Vicedo, 2011). Therefore, it is not surprising that classical

[9] Although, as noted above, we recognise the most significant differences between the two concepts pointed out by the more specialised literature (see, among others, Camisón et al., 2020; Sforzi, 2015; Becattini et al., 2009; Catalán et al, 2008) in this thesis, following other studies (e.g. Camisón & Forés, 2011; Lazzeretti, 2006; Camisón, 2004; Markusen 2003) both terms are used interchangeably as synonyms of the same reality as their distinction does not alter the main purpose of the doctoral thesis.

economists such as Adam Smith or David Ricardo tried to delve into the reasons or motives that lead a company to decide whether or not to locate in a certain place.

Guided by the above economic logic, the model of the large vertically integrated company was born and developed consistently with the consolidation of the capitalist production model in the 18th century (Guenzi, 2009). However, this is not the case with clusters, which do not have a clear industrial predecessor model and, therefore, their emergence cannot be associated with a specific historical period. Even so, according to certain authors[10] (Belfanti, 2009; Guenzi, 2009) it seems clear that the guild organisation characteristic of the Middle Ages in Europe represents a more than possible genesis of the concept, since they share essential characteristics such as the establishment of cooperation networks, the tacit sharing of knowledge, or the stimulus to entrepreneurship of the workforce when it possesses a high level of knowledge.

There are studies that confirm the heritage of the guild system in some clusters that are fully operational today. Thus, for example, a study by Belfanti (2009) states that the Sheffield arms district is the current evolutionary stage of the very old guild system specialising in the production of cutlery, whose activity has been recorded in written sources since at least the 16th century. According to this author, the organisation of the production process of this guild was distributed in several phases, each of which was carried out in small family workshops, under the supervision of a master craftsman and with a strong cohesion between the production units. Similar is the case of the Italian textile industrial district in the town of Prato, where the municipal authorities took over the control of the productive activity and training of the workforce which, until its abolition, had been carried out by the '*L'Arte della Lana*' guild (Belfanti, 1999; Allio, 1998).

At the end of the 19th century, cases such as the previous Sheffield district or similar ones in Anglo-Saxon localities such as Lancaster attracted the attention of a young professor at University of Cambridge called Alfred Marshall. In his Principles of Economics, he devotes an entire chapter to the study of these industrial districts, in which he explains at length this alternative form of production to the then already clearly expanding model of the large vertically integrated company. Even then, Marshall proposed the archetype of the industrial district as an alternative model for organising production: "the advantages of large-scale production can, in general, be obtained either by grouping together a large number of small producers in the same district or by building large factories" (Marshall, 1890: 226). Although authors such as Alchiam, Penrose and

[10] However, the authors point out that other forms of production organisation such as the putting-out system, the mercantile entrepreneur or the non-mechanised concentrated manufacturing more characteristic of rural areas where the guild model sometimes did not exist were also the starting point for the development of industrial districts.

Richardson continued Marshall's work, his contributions on the organisation of districts remained dormant.

Industrial districts were reintroduced into the theories of regional development and business administration by Giacomo Becattini, professor at the Università di Firenze. The Italian school observed that the north-western Italian region (particularly the regions of Emilia Romagna, Tuscany, Veneto and the Marche) had been experiencing ratios of economic growth and business activity since the end of the Second World War, which was consolidated with the so-called Oil Crisis and which broke with the traditional discourse among intellectuals who until then concentrated on the study of the differences in growth and performance existing between companies located in the north of Italy (essentially, in the so-called Turin-Milan-Genoa industrial triangle) and those located in the southern regions of the transalpine country (Bagnasco & Triglia, 1984; Brusco, 1982; Bagnasco, 1977).

The fundamental characteristic of companies in these regions that helped the consolidation of the industrial district model was their ability to adapt to market tastes, demonstrating a productive flexibility capable of satisfying the new typology of consumers in which the taste for standardised goods gave way to a preference for customised goods, adapted to new consumption patterns attentive to fashions (Tattara & Volpe, 2008; Becattini, 2002; Piore & Sabel, 1984). This gave rise to the phenomenon of "Made in Italy" products that have achieved great success competing in international markets (Festa et al., 2019) where products have been recognised for their high quality of manufacture, attention to detail, design form, etc.

Turning now to an academic definition of the term, an industrial district is defined as "a socio-territorial entity characterised by the active presence of both a community of people and a set of firms in a natural and historically determined area. In the district, unlike in other environments, such as manufacturing towns, the community and the firms tend to merge" (Becattini, 1992: 62-63). For his part, author Sebastiano Brusco defines it as "a set of firms located in a relatively small geographical area; that these firms work directly or indirectly for the same end market; that they share the same range of values and set of knowledge, which is important in shaping the cultural environment; and that they are linked together by peculiarities in a complex combination of competition and cooperation" (Brusco, 1992: 236). Table 5 lists some of the main definitions of cluster/industrial district terms proposed by the literature. The following Figure 5 shows the characteristics that make up the reality of an industrial district according to the literature.

Table 5. Main definitions of clusters and industrial districts

Author	Definition	Publication	Nº of citations (Google scholar)
Becattini (1990: 39)	"I define the industrial district as a socio-territorial entity which is characterised by the active presence of both a community of people and a population of firms in one naturally and historically bounded area. In the district, unlike in other environments, such as manufacturing towns, community and firms tend to merge".	The Marshallian industrial district as a socio-economic notion. In: Pyke, F., Becattini, G., Sengenberger, W. (Eds.), *Industrial Districts and Local Economic Regeneration*. International Institute for Labor Studies, Geneva, pp. 37 – 51.	3,342
Porter (1998: 197)	"Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also co-operate"	*On Competition*. Harvard Business School Press	9,389
Krugman (1991) in Boja (2011: 35)	"Clusters are not seen as fixed flows of goods and services, but rather as dynamic arrangements based on knowledge creation, increasing returns and innovation in a broad sense."	*Geography and trade*, London: MIT Press/Leuven UP, p.142.	17,302
Brusco (1992:236)	"A set of enterprises located in a relatively small geographical area; that these enterprises work directly or indirectly for the same end market; that they share the same range of values and set of knowledge, which is important in shaping the cultural environment; and that they are linked together by peculiarities in a complex combination of competition and cooperation."	Brusco, S. (1992). The genesis of the industrial district. *Pyke, F., Becattini, G. and Sengenberger, W., Industrial Districts and Inter-firm Co-operation in Italy, International Institute for Labour Studies, Geneva*.	3,342

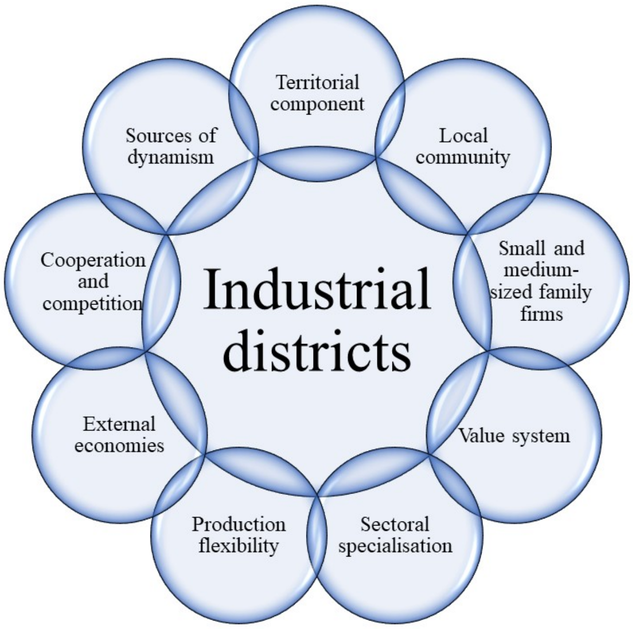
Enright (1996: 191)	"A regional cluster is an industrial cluster in which member firms are in close proximity to each other."	Enright, M. J. (1996). "Regional Clusters and Economic Development: A Research Agenda." In *Business Networks: Prospects for Regional Development*, Udo H. Staber, Norbert V. Schaefer, and Basu Sharma (ed.), 190-213. Berlin: de Gruyter.	922
Rosenfeld (1997: 4)	"A cluster is a very simply used to represent concentrations of firms that are able to produce synergy because of their geographical proximity and interdependence, even though their scale of employment may not be pronounced or prominent."	Rosenfeld, S. A. (1997). Bringing business clusters into the mainstream of economic development. *European Planning Studies*, *5*(1), 3-23.	2,048
Camisón (2001:25)	"An industrial cluster can be understood as an external pool of resources and capabilities to which member companies have access."	Camisón, C. (2001): «La investigación sobre la pyme y su competitividad. Balance del estado de la cuestión desde las perspectivas narrativa y meta-analítica», *Papeles de Economía Española*, 89-90, 43-83	79
Camisón and Molina-Morales (1998:76)	"A concentration of companies in a geographically limited area where they carry out interrelated productive activities, there is an insertion of economic activities in the local system, with a dominance of small companies, identifying itself as a cognitive community where the different agents share values and beliefs. The relationships established between the participants are of a competitive and cooperative nature and, finally, there are a series of external institutions (...)	Camisón C. & Molina-Morales, F. X. (1998). Distritos industriales y recursos compartidos: un enfoque integrador. *Revista de Economía y Empresa*, *12*(32), 65-82.	23

	that play an active role in the development of the system."		
Feser (1998: 26)	"Economic clusters are not just related and supporting industries and institutions, but rather as related and supporting institutions that are more competitive by virtue of their relationships."	Feser, E. J. (1998). Old and new theories of industry clusters. *Clusters and Regional Specialisation*, *18*, 40.	608
Porter (2003: 562)	"We define a cluster as a geographically proximate group of interconnected companies, suppliers, service providers and associated institutions in a particular field, linked by externalities of various types".	The Economic Performance of Regions. *Regional Studies*, *37*(6 & 7), 549-578.	3,520
Swann et al. (1998: 1)	"A cluster means a large group of firms in related industries at a particular location."	Swann, G., Prevezer, M., & Stout, D. (1998). *The dynamics of industrial clustering: International comparisons in computing and biotechnology*. Oxford University Press.	706
Roeland and Den Hertog (1999: 9)	"Clusters can be characterised as networks of producers of strongly interdependent firms (including specialized suppliers) linked each other in a value-adding production chain."	Roeland, T. & Den Hertog, E. (1999). *Cluster analysis and cluster-based policy making in OECD countries: an introduction to the theme*. Paris: OECD	2
Simmie and Sennet (1999: 51)	"We define an innovative cluster as a large number of interconnected companies or industrial services that have a high degree of collaboration, typically through a supply chain, and that operate under the same market conditions".	Simmie, J., & Sennett, J. (1999). Innovative clusters: global or local linkages?. *National Institute Economic Review*, *170*, 87-98.	276

Crouch and Farrell (2001: 163)	"The more general concept of 'cluster' suggests something looser: a tendency for firms in similar types of business to locate close together, though without having a particularly important presence in an area."	Great Britain: falling through the holes in the network concept. In: *Local Production System in Europe: Rise or Demise?* In Crouch, P. Le Gale´s, C. Trogilia & Voelzkow, H. (eds.) pp. 161–211. Oxford: Oxford University Press.	134
Van den Berg et al. (2001: 187)	"The popular term cluster is most closely related to this local or regional dimension of networks…Most definitions share the notion of clusters as localized networks of specialized organizations, whose production processes are closely linked through the exchange of goods, services and/or knowledge."	Van den Berg, L., Braun, E., & Van Winden, W. (2001). Growth clusters in European cities: An integral approach. *Urban Studies*, *38*(1), 185-205.	290
Morosini (2004) in Boja (2011: 35)	"Cluster is a socioeconomic entity characterized by a social community of people and a population of economic agents localized in close proximity in a specific geographic region."	Morosini, P. (2004). Industrial clusters, knowledge integration and performance. *World Development*, *32*(2), 305-326.	624

Source: own elaboration

Figure 5. Main characteristics of industrial districts



Source: own elaboration

The territorial component

As mentioned above, the concept of the industrial district was originally coined by the British economist Alfred Marshall. From a purely economic rationale, Marshall recognised the role that the space shared by the companies integrated in the district played in obtaining certain economic advantages over other companies not integrated in the district. The Italian canonical approach to industrial districts reincorporated Marshallian postulates into the theory of regional development. This stream of literature complemented the visions derived from the traditional Marshallian economic analysis with new nuances that allude to the relevance of the environment and the particular social system that flourishes within its geographical limits (Becattini, 1990).

The territory thus becomes a space of resources to which the organisations embedded in it have access. Michael Storper (1995) uses the term "territorialisation" to refer to the set of economic activities that depend on resources that are specific to a territory. Spatial proximity plays a critical role in regulating district dynamics, reducing transaction costs, and regulating inter-firm coordination and information sharing (Chiarvesio et al., 2010). As reflected in Professor Becattini's seminal definition cited above, the district is the product of interplay of economic and social factors occurring in a particular geographical space over time, not a deliberate decision.

The industrial district is therefore an endogenous form of local development, not the result of urban planning or policy.

The local community and the population of strong family-run businesses

The local production system of industrial districts is thus characterised by the presence of a set of small and medium-sized enterprises interrelated (Markusen 1996) by economic relationships, but also by social aspects resulting from the local community in which they are inserted. The composition of the industrial district by small and medium-sized enterprises is one of the main defining characteristics of its idiosyncrasy (Becattini, 1990; Brusco, 1982). Numerous studies in the literature (e.g., Becattini et al., 2009; Dei Ottati, 2002; Paniccia, 1998) also recognise that these firms are dominated by the family ownership and/or management model. Family firms are thus an important actor in the configuration and performance of any territorial agglomeration such as districts (Bichler et al., 2022; Pucci et al., 2020).

Although the literature abounds with numerous definitions of what a family business should be, there is no universally accepted wording (Memili & Dibrell, 2019; Miller et al., 2007); in this thesis we will follow the proposal of the European Family Business. According to this institution, a family business is one that meets the following requirements:

1. The ownership or the majority of the voting rights of the company is in the hands of the same family.
2. The family exercises voting rights directly or through holding companies.
3. The family may be the founder of the company or may have acquired it.
4. At least one member of the family is involved in the governance or management of the company.

Localisation in territorial agglomerations such as districts is essential for family firms that typically have smaller size, scarce internal resources and financial capabilities (Bichler et al., 2022; Basco & Calabró, 2016). In this way, firms located in the vicinity of an industrial district have access to a pool of shared resources and competences, as well as a reduction in transaction costs that allows them to improve their productivity and thus increase their competitiveness compared to those firms not agglomerated in the district.

Compared to non-family firms, family firms are more rooted in their local networks, routines, values and associated knowledge; therefore, they emphasise the knowledge coming from this local knowledge network, which is more incremental in nature (Pucci et al., 2020; Basco, 2015), based on the continuous transfer of knowledge and information with the closest cognitive, cultural and institutional partners, such as customers, suppliers, distributors and local institutions of basic support and information services (Basco & Calabró, 2016). This strategy of preferring a less diversified set of external relationships for the development of their innovation capabilities is aligned with their family logic (Classen et al., 2012), which leads them to avoid any situation that could jeopardise their socioemotional capital (Gómez-Mejía et al., 2010) and, at the same time, contribute to their reputation strategy (Basco, 2015) by being close to the agents of their commercial and competitive network (Basco & Calabró, 2016).

Family businesses are a unique type of organisation due to the interaction between family and business objectives in decision-making (Basco & Pérez Rodríguez, 2011; Miller, Le Breton-Miller & Lester, 2011). This characteristic has implications for the behaviour of the company, which can make decisions based on social, emotional and economic factors, different from non-family businesses, and which clearly condition its objectives (Basco & Calabró, 2016), strategies (Basco, 2014), management mechanisms (De Clercq & Belausteguigoitia, 2015) and corporate governance (Basco & Voordeckers, 2015), internationalisation capabilities (Sciascia et al., 2012), innovation performance (Christman et al. , 2015; Sciascia et al., 2015), and social (Block and Wagner, 2014) and environmental outcomes (Berrone et al., 2010; Miller & Le-Breton Miller, 2016).

Despite the importance of the research on territorial agglomerations and family businesses, there are few studies that analyse the joint study of both realities from the perspective of interdisciplinary cross-fertilisation (Bichler et al., 2022; Stough et al., 2015), let alone considering the performance of family businesses from the triple perspective of sustainability, where studies are non-existent. This fact represents an important knowledge gap in the literature to be addressed in future lines of research of this doctoral thesis.

The system of local values that regulates the relations

The set of companies that cohabit in an industrial district, unlike other industrial environments, tend to maintain strong social relations that, in some cases, are reinforced by the fact of being a family-owned company with a long history in the territory. Thus, these companies, besides being strongly interrelated by economic aspects, also present a strong social nexus (Morosini, 2004; Pyke et al., 1990), including a system of values that permeates the business culture of the district (Piore, 1992), and that governs the behaviours and relationships of the integrated companies (Becattini, 2002).

Districts are embedded in the culture and social structure of the community in which they are located (Piore, 1992; Granovetter, 1985). This sociological notion, referred to in the literature as embeddedness, points to the blurred distinction between the business, political, social and family relationships that are woven and cohabit in a district (Capecchi, 1992) and how these relationships, together with the explicit and implicit norms that govern them (Dei Ottati, 1994), generate an atmosphere of trust that limits pernicious effects such as opportunism of the parties (Foss & Koch, 1995).

Sectoral specialisation and productive flexibility

Industrial districts are a model of territorial organisation of production in which numerous companies are dedicated to the production of a final good and in which each one of them carries out one or very few phases of the total production, competing as a vertically integrated sector (Becattini, 1992; Sforzi, 1992). On the composition of an industrial district, Brusco (1992) classifies the firms operating in a district according to their position in the production process (or *filière*) into final firms, specialised firms and integrated firms.

The sectoral specialisation that occurs among the companies in a district has a defining characteristic: flexibility. The ability to adapt is key to achieving this productive flexibility that turned industrial districts into a model of success because of their ability to respond to society's needs for increasingly personalised products (Becattini, 1992). As the literature points out, in a district "adaptability and innovativeness is its hallmark, along with the local capacity to cope with rapidly changing product demands, which rely heavily on the flexibility of labour and production networks" (Pyke & Sengenberger, 1992: 15).

Presence of external economies

The sectoral specialisation discussed above among a population of firms united by economic but also social ties gives this model of territorial agglomeration a series of competitive advantages that lie in the exploitation of utilities commonly referred to as external economies, because although they are internal to the district, they are independent of the firms, and are manifested in three generic considerations (Zeitlin, 1992): firstly, the economies of specialisation of the labour force belonging to the district, either formally through technical schools, the local university or through work, or more informally through conversations with social contacts. Particularly in these information economies, geographical proximity between firms and individuals, and between firms and local institutions, improves the effectiveness of local institutions by "facilitating the diffusion of ideas and technical innovations and various forms of inter-firm and political collaboration; enhancing social cohesion; encouraging a sense of collective consciousness; and accelerating inter-firm transactions" (Sengenberger & Pyke, 1994: 29). The second external economy relates to economies of information, as information flows faster in the district than in other industrial environments, and generally through informal social channels (Saxenian, 1994;

Camagni, 1991). Finally, districts tend to develop a wide network of suppliers and ancillary industries linked to the main economic activity of the district (Porter, 1990).

Competition and cooperation

The economic and social networks that are woven between the different agents that make up an industrial district are favoured by the fostering of an atmosphere of trust in which companies compete, but also cooperate, regulated by explicit and implicit rules (Dei Ottati, 1994) that govern this network of relationships and stimulate cooperation with agents integrated in the value chain.

Sources of dynamism

Thus, all of the above idiosyncratic characteristics of the industrial district give firms an important comparative advantage over those firms that are not located in the district. This advantage is called the district effect (Dei Ottati, 2006; Signorini, 1994). Despite the methodological complexities of its measurement (Becattini & Musotti, 2008), some empirical studies have confirmed the presence of this district effect on companies integrated in an industrial district in the late twentieth century (Signorini, 1994) and early twenty-first century (Boix & Galletto, 2009; Fabiani et al, 2000). Previous research provided empirical evidence linking integration or membership in an industrial district with better economic performance (e.g., Camisón, 2001; Becchetti & Rossi, 2000), better export capabilities (e.g., Becchetti et al., 2007), a higher capacity for innovation (e.g., Boix & Galletto, 2009), or with superior learning and innovative performance by integrated firms (e.g., Audretsch, 1998).

However, recent contributions in the literature (e.g., Cucculelli & Storai, 2015) suggest that this effect might be fading due to challenges such as those imposed by globalisation, innovation processes, or the emergence of new technological paradigms (Carbonara, 2017; Belusi, 2015; Belussi & De Propris, 2014; De Marchi & Grandinetti, 2014; Chiarvesio et al., 2010). Nevertheless, recent literature (e.g., Claver-Cortés et al., 2019) points out that the study of the effect of location on firm performance continues to be of broad interest. Nevertheless, districts must have sources of dynamism capable of providing them with a renewal of their capabilities and allowing them to continue to provide advantages to the firms located there. Two sources of dynamism most frequently cited in the literature are globalisation and access to knowledge flows external to the district, and the advance of Industry 4.0. Because of its importance for firms' competitiveness, we will focus on this last aspect of Industry 4.0.

The pace of expansion of new technologies has been unprecedented in speed and scope (OECD, 2017). The confluence of new technological developments such as artificial intelligence, 3D printing, nanotechnology, biotechnology, autonomous driving, the sustainable energy revolution and quantum computing, among others, are amplifying the use and spread of technologies, making the barrier between the physical, digital and biological worlds ever thinner (Schwab, 2017). Although it might be thought that these changes only represent an incremental addition to the characteristics of the third industrial revolution, Schwab (2017) notes the following differentiating characteristics of the Fourth Industrial Revolution:

- Speed. In contrast to previous revolutions, which were characterised by a linear pace of evolution, the Fourth Industrial Revolution has an exponential rate of growth in which technologies, at an ever-faster pace, give rise to new and more powerful technological innovations.
- Breadth and depth. Based on the digital revolution and the combination of multiple technologies, it is causing paradigm shifts in areas such as the economy, business, society and people themselves, influencing not only "what" or "how" we do things, but also determining "who" we are.
- Systems impact. Involving the transformation of complex systems between (and also within) countries, companies, industries, and society as a whole.

Industry 4.0, therefore, is set to have a substantial impact on industrial models as we know them. Camisón et al. (2020) make a very accurate proposal of the list of changes that will occur in industry:

- More efficient and lower cost industrial processes, optimisation of resources and productivity increases.
- Higher quality or precision products, with superior performance resulting from process improvements.
- Increased flexibility and agility, both in the total value chain and in its different links, making it possible to reduce the size of batches and even to personalise production.
- Development of "servitisation", added services that complement the performance of products/equipment and the shift from a product-based to a solution-based business model.
- For companies in the IT sector, the demands related to Industry 4.0 represent an opportunity to verticalise their services and "productise" them. It also presents this sector with opportunities for internationalisation and consolidation.
- New innovations resulting from the combination of skills belonging to different companies, especially between industrial and IT companies.
- Sustainability will be driven by new technologies in the corporate sphere.

However, the previous paradigms of the canonical approach have a weakness: they consider the group of organisations integrated in a district as a perfectly homogeneous conglomerate in its values, behaviours and results. In contrast, recent theoretical contributions abound in the literature (e.g. Camisón, 2012; Ferreira & Serra, 2009; Rabellotti et al., 2009) reinforced by empirical research (e.g. Camisón et al., 2018; Claver-Cortés et al., 2018; Hervás-Oliver et al., 2018; Camisón & Villar-López, 2012; Camisón & Forés, 2011; Camisón, 2004) that illustrate the heterogeneity of industrial districts and the disparity of results that intra-district firms obtain in terms such as organisational performance, the exploitation of knowledge flows, or innovative performance. These disagreements in academia highlight the inconsistencies between the canonical approach to industrial districts and the results obtained in different empirical studies of reality, and open the debate on the sources of competitive advantage of integrated firms. The following fourth chapter will discuss the microeconomic sources of internal firm competitiveness referred to in these studies.

3.2.1. Evolution of the literature on clusters and industrial districts

With the reintroduction of the industrial district concept into the field of economic geography studies, academic research and the practical application of the concepts developed in academia did not stop. Thus, these early works of the Italian school were responsible for the rediscovery of the concept and the establishment of its idiosyncratic characteristics between the seventies and eighties of the last century. In the 1990s, the concept gained a new international dimension with the contributions of Professor Michael Porter of Harvard University from the perspective of the Strategic Management of the company. In his study of the bases of competitiveness, Porter discovered, after examining a large body of data on world trade, that there are groups of products whose manufacture predominates in certain territories (Porter, 1990). His studies concluded that geographical concentration (clustering) was the determining factor explaining the generation of competitive advantages for these regions[11] (Porter, 1990, 1998a). According to the author, competitiveness lies in the improvement of productivity, which ultimately depends on the improvement of microeconomic capacity and the degree of sophistication of local competition revealed at the firm, cluster and regional level.

These previous contributions thus reveal that firms clustered in a district enjoy a number of advantages over those located in another external location. As already indicated, the main

[11] Professor Porter initially confined his analysis to the competitiveness of nations, but by delving into case studies of clusters across the globe and in different economic sectors, the author himself confirms that his analysis has greater applicability to regional units smaller than the nation on a high percentage of occasions (1990, 1998).

economic advantages of integration in a district or cluster are related to three types of external economies or externalities (Krugman, 1991; Marshall, 1890): the availability of abundant skilled labour, the existence of a broad base of supplier and auxiliary firms, and the knowledge spillovers that occur thanks to the combination of economic, but also social and family networks that exist between the agents located in a district; the so-called ‘industrial atmosphere’ (Hart, 2009).

The district effect is precisely "the set of competitive advantages derived from a strongly interconnected set of economies external to the individual firms, but internal to the district" (Dei Ottati, 2006: 74). Numerous studies have tried to empirically evaluate this district effect, including the seminal contributions of Signorini (1994) and Pannicia (1999) for the Italian case and Ybarra (1991) and more recently Boix and Trullén (2011), for example, for the Spanish case. In this context of study, numerous theoretical (Maskell and Malmberg, 1999; Porter, 1998b), but also empirical contributions, both qualitative (Saxenian, 1994) and quantitative (Camisón, 2004), underline the importance of active intra-cluster relationships in accessing the advantages of localisation, especially those linked to knowledge.

Related to the above, from the field of strategic management, a whole chain of studies appeared from the mid-1990s onwards which, extending the Resource-Based Approach[12] (Barney, 1991; Wernerfelt, 1984), pointed out the heterogeneity of intra-cluster companies, as opposed to the canonical consideration that observed the set of companies in the district as a set of homogeneous characteristics (Camisón & Forés, 2011; Camisón, 2004; Boari & Lipparini, 1999; Foss, 1996). This reveals the importance of the firm's internal capabilities, especially its absorptive capacity (Munari et al., 2012; Camisón & Forés, 2011). Thus, these studies allow us to speak of two capabilities in the field of cluster firms: shared capabilities or competences, and individual capabilities (Camisón & Forés, 2011; Camisón, 2004).

At the beginning of the new millennium, the methodology of social network analysis (Nahapiet & Ghoshal, 1998; Burt, 1992; Granovetter, 1973) was incorporated into the study of the heterogeneity of the companies that make up an industrial cluster. These studies of the social capital of a given cluster make it possible to diagnose the extent to which each of the companies and other regional organisations are closely linked and the purpose of their relationship: strictly economic, access to new knowledge, development of innovation projects, etc. A position as central as possible in the networks that are woven between actors in a cluster is essential to have access to all the external economies (especially, knowledge spillovers) that abound in the cluster

[12] See chapter 4 of this doctoral thesis.

(Munari et al., 2012). Morrison and Rabelloti's (2009) study of information and knowledge networks in the case of the Italian wine cluster is an excellent example of this stream of literature.

As the first decade of the 21st century progresses, different studies (e.g., Boschma & Frenken, 2006; Boschma, 2005; Hassink, 2005) point out that the relationship established between companies in a cluster is a necessary, although not sufficient, condition for success in increasingly global and interconnected markets. Thus, it may be the case that the traditional pattern of specialisation in the region, once an indispensable factor for success, leads to an excessive redundancy of the known territorial social networks, causing an enclosure effect, also known as lock-in (Boschma, 2005; Hassink, 2005, 2010). This lock-in of known networks and knowledge can undermine the traditional capabilities and competitive advantages of cluster firms (Ter Wal & Boschma, 2011).

Given the above fact, and in order to mitigate its possible effects, studies such as that of Boschma (2005) illustrate that, although geographical proximity is important, there are four other aspects of proximity between organisations (organisational, social, institutional and cognitive). Other authors such as Knoben and Oerlemans (2006) and Dangelico et al. (2010) add two additional proximity factors to Ron Boschma's classification: cultural proximity and technological proximity. However, cognitive proximity tends to outweigh the rest (Parra-Requena et al., 2010).

The above situation shows that firms located in an industrial cluster must rely on a combination of internal business and information networks (local buzz) together with access to and integration in external business networks, value chains and knowledge (global pipelines) in order to be successful in international markets in a context marked by globalisation (Morrison et al., 2013; Chiarvesio et al., 2010). At this point, the literature has also ventured into the role played by large local companies, international companies installed in the cluster, or other institutions such as technology institutes as brokers and gatekeepers of external knowledge (Boari & Riboldazzi, 2014; Hervás-Oliver & Albors-Garrigos, 2014; Morrison, 2008).

Along with the previous line, at the end of the first decade of the new millennium, both academic and political studies were undertaken to conceptualise the life cycle of territorial agglomerations and to explore aspects such as resilience and the adaptation of clusters to external shocks (see studies such as Suire & Vicente, 2014; Martin & Sunley, 2011; Belussi & Sedita, 2009). On cluster life cycle models from a policy perspective, see Konstantynova and Wilson (2014) for a model proposed by the European Commission that also proposes the four stages previously suggested by other academic models (e.g., Menzel & Fornahl, 2010): birth, growth, maturity, and decline or rebirth.

So far, clusters have been described as groupings of firms and other associated institutions linked to predominantly industrial activities. This has been the generalised treatment in the canonical approach to the term, especially with regard to manufacturing industries in Italy (Becattini et al., 2009). Gradually, however, new research is appearing that addresses the study of districts linked as creative and/or cultural industries (Boix et al., 2016; Lazzeretti et al., 2012), as well as the so-called innovation districts inserted directly in the immediate vicinity of a city (Morrison, 2020; Battaglia & Tremblay, 2011). This research opens up new avenues and possibilities for the study of districts and the advantages they bring to the companies located there, complementing the traditional Marshallian externalities already introduced with others of a Jacobian nature (derived from the complementarity of agents belonging to different fields of activity that are agglomerated in the same environment).

Industrial districts have been defined as concentrations of firms and other organisations in a socially and historically delimited environment. In a large majority of cases, the literature underlines that these firms are owned and managed by entrepreneurial families (Basco et al., 2021). Family businesses represent the bulk of the entrepreneurial population in most countries and have their own characteristics that differentiate them from other business ownership models and deserve to be taken into account (Memili & Dibrell, 2019). However, both streams of literature have followed their own paths and it is only until a very recent body of literature (e.g., Basco et al., 2021; Basco, 2015; Cucculelli & Storai, 2015) that these paths converge. This convergence in the research lines of family business and business location opens new avenues to the study of both fields considering the implications that each element (on the one hand, the family business and its differentiating characteristics; and, on the other, the industrial district and its particularities as a model of territorial agglomeration) can impose on the other, thus stimulating mutual progress.

In the last ten years, the study of industrial clusters does not stop and, in addition to the changes that have occurred in the competitive dynamics due to the globalisation process, the productive and organisational processes derived from the massive introduction of new information and communication technologies are now being incorporated (Porter & Heppelmann, 2014). Manufacturing firms, now more than ever, must offer a sophisticated combination of goods and services that allow them to maintain their competitive advantages in global markets (Cusumano et al., 2015). This strategy of reconfiguring resources and capabilities at the firm level to be able to offer a unique combination of goods and services is known as servitisation (Vendrell-Herrero et al., 2017). The process of servitisation in traditional manufacturing industrial districts has opened a new line of research (e.g., Bellandi & Santini, 2019; De Propris & Storai, 2019; Sforzi & Boix, 2019) aimed at understanding how this process can contribute to the renaissance of productive systems that, following the cluster life cycle approach already introduced, are in a state of advanced maturity.

The so-called Industry 4.0, driven by specific technologies such as big data, the internet of things, or artificial intelligence, among others, are driving the above change towards servitisation; but, in addition, these technologies are driving the digital transformation of companies. Thus, Industry 4.0 is implying a disruptive transformation especially in the supply chains of products and industries (Autio et al., 2018), thanks to the rise of certain digital utilities, such as platforms, whose rise is mediating the global economic and social organisation (Kenney & Zysman, 2016). Beyond improvements in sourcing, customisation of products and services to the customer's taste, or access to new supply chains, technologies linked to Industry 4.0 can make a significant contribution to improving energy efficiency, reducing costs and increasing productivity (Hervás-Oliver, 2021; Büchi et al., 2020). Its importance for the competitiveness of companies located in clusters is such that the number of academic studies on the subject is increasing considerably in recent times (e.g., De Propris & Bailey, 2021; Hervás-Oliver, 2021; Bellandi et al., 2019).

Finally, it cannot be overlooked how the unquestionably topical issues related to the social and environmental improvement of the environment in which industrial clusters are located have permeated both business practice and policy decisions, but also recent academic literature specialising in the topic. The incorporation of sustainability principles (and others of greater applicability to business, such as the circular economy) in a cluster can be done at two levels of aggregation (Camisón et al., 2021; Kalmykova et al., 2018): micro (or company); or meso (cluster or district level). Starting at the latter level, recent research addresses the weaving of industrial symbiosis networks or local energy communities. In the interest of boosting industrial efficiency and improving environmental sustainability, these symbiosis networks or local communities should aim to implement more renewable and circular energy consumption measures, harness and manage industrial water resources, and reduce waste, through its application to other downstream uses (Bressanelli et al., 2022; Bi et al., 2019; Kachacha et al., 2019; Korhonen et al., 2018). At the company level, business models should be adopted that drive the creation of capabilities that support strategies aimed at contributing to the economic, environmental and social improvement in which the company is embedded (Lewandowski, 2016). The next Table 6 summarises the main contributions of the different strands of literature mentioned under this heading but also in the previous chapter on the state of the art of districts and clusters.

Table 6. Theories that have contributed to the cluster literature

	Source of advantage	Degree of localisation	Degree of cooperation and competition	Public implications	Previous background
Marshallian theory of standard territorial agglomeration	The companies share a common supply of labour, infrastructure and business services.	External economies are more likely to occur when common services are preferentially concentrated locally.	The advantages for concentrated firms derive from cooperation, but firms still maintain a high degree of competition.	There are no obvious policy implications unless markets fail to provide the necessary common supply of labour, infrastructure and services.	Marshall (1890) Marshall (1920) Krugman (1991)
Transaction Cost Theory: The Californian School	Transaction costs are lower for firms located in a district, a cost advantage that is assumed to outweigh any increase in production costs.	Some transaction costs reflect the maintenance of personal contact; they tend to vary with distance.	Some transaction costs can be reduced through cooperation, but in general this is not important.	Markets can be assumed to successfully coordinate transactions within industrial districts.	Scott (1988) Storper (1989)
Flexible specialisation, trust, non-commercial (sociological) interdependencies: The Italian school	Companies involved in networks of trust based on the social structure of a territory benefit from	Trust is more likely to be maintained in geographically concentrated networks.	Firms in industrial districts often compete with each other on quality rather than price;	Social and family networks are key to the development of a trusting environment; but economic, legal and	Brusco (1982) Granovetter (1985) Becattini et al. (2009)

	the reciprocal exchange of information.		however, there are strong cooperative relationships.	political norms continue to be relevant.	
Innovative media: The Milieux (GREMI Group)	The environment provides a suitable framework for adequate coordination between regional actors capable of stimulating business innovation.	Institutions and practices that lead to innovation depend largely on personal contact, and are therefore more common within the boundary area of localities.	There is a balance between competitive and cooperative relationships, following the tradition of other schools, although in this approach it is not fully specified, but the latter are presumed to be important.	Policy makers have a role to play in training and supporting the network of companies, research institutes and other entities that make up the innovative environment.	Camagni (1991) Maillat (1993) Maillat y Lecoq (1992)
Institutional and evolutionary economics	The district reflects the impact of past elections and the subsequent development of strengthening institutions.	Particular trajectories can develop at various spatial scales.	Technological change, along certain pathways, is a driver of competitive success.	Policy interventions are only one - and often a minor - determinant of how innovative trajectories develop.	Nelson y winter (1982) Amin y Thrift (1992)

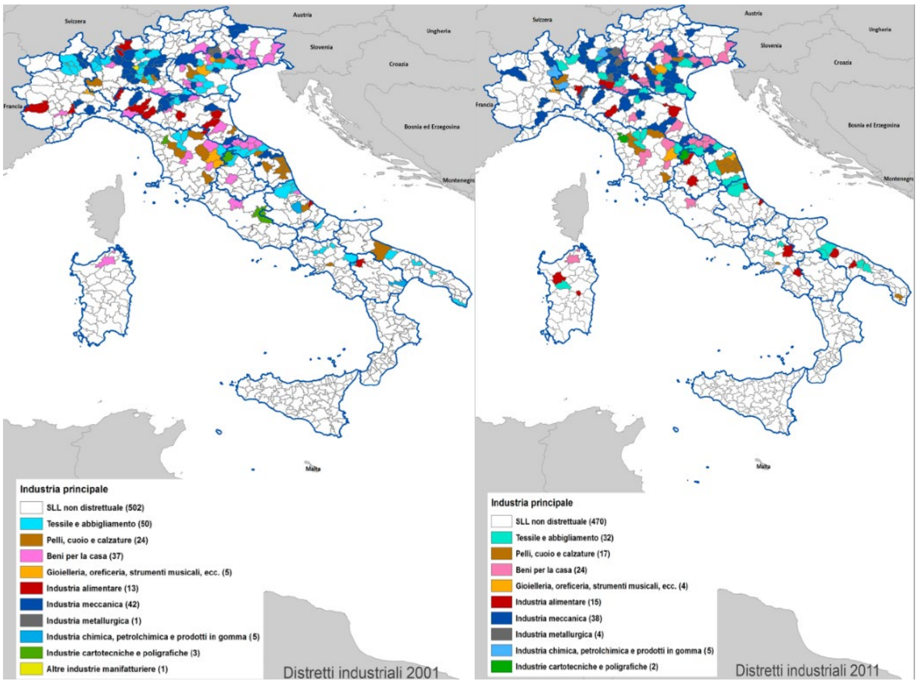
Competitiveness-based approach: the competitive advantage of nations	Firms gain their competitive advantage through acts of innovation in which they benefit from clustering, factor and demand conditions, support from ancillary sectors, rivalry, and their own strategy.	Localisation is important for accessing the regional assets that make up the diamond model, elevating and magnifying their interaction, which stimulates the company's competitiveness.	The model stresses the importance of strong competition with local rivals, but at the same time emphasises the importance of cooperation with local suppliers, ancillary industries and customers.	The role of government is indirect and aimed at amplifying the dimensions or factors of the diamond by creating an environment in which firms can gain a competitive advantage with a focus on innovation.	Porter (1990, 1998, 2003) Delgado et al, (2014)
The pre-eminence of internal company resources: the Scandinavian Approach	The source of competitive advantage is explained by the joint effect of shared competencies in the cluster and the firm's distinctive competencies.	Location is important, but not sufficient. The enterprise must be "embedded" in district networks. The greater this embeddedness, the greater the effect of shared competencies at the district level on organisational performance.	Companies in the districts compete, but also cooperate in order to create valuable and lasting shared competencies.	There are no obvious public implications.	Foss (1996) Camisón (2004) Camisón y Forés (2011)

Source: own elaboration based on Newlands (2003)

3.2.2. Industrial districts that are paradigmatic success stories

Throughout this chapter it has been mentioned that the phenomenon of industrial districts has taken place in many territories. Italy, a paradigmatic case as already indicated, is one of the cradles of this phenomenon of territorial agglomeration of companies and where it can be found most frequently spread across multiple regions of the transalpine country. However, the vast majority of Italian districts are located in the central and north-eastern regions of Italy, each of them specialising in a different product, with different types of technological complexity and different end uses. Thus, for example, Sassuolo, in Emilia-Romagna, specialises in the production of ceramic tiles; Prato, in Tuscany, is a district known worldwide for its textile products; Montegranaro, in Marche, manufactures footwear; Cento, again in Emilia-Romagna, is dominated by mechanical engineering; Nogara, in Veneto, specialises in wooden furniture, while Canneto Sull'Oglio, located in Lombardy, manufactures toys. Figure 6 illustrates the evolution of industrial districts in the decade between 2001 and 2011.

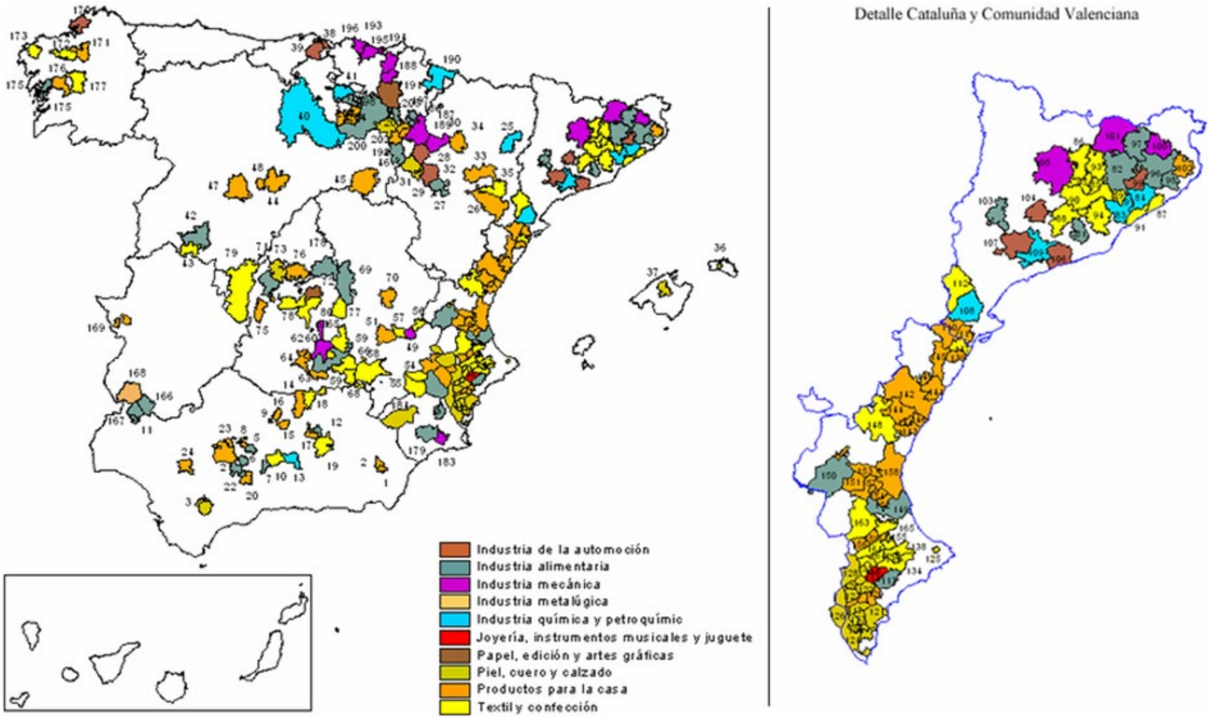
Figure 6. Evolution of Italian districts 2001-2011



Source: ISTAT (2016)

In Spain there have been some attempts to identify industrial districts (see Figure 7), the most outstanding contributions being those made by Ybarra (1991), and Boix and Galleto (2009), the latter following the methodology already applied in other contexts such as Italy (Sforzi, 2009; ISTAT, 2006) or the United Kingdom (De Propis, 2009).

Figure 7. Spanish industrial districts



Source: Boix and Trullén (2011)

Traditionally, Spanish political thought, regardless of its orientation, has been reluctant to accept the political implications of promoting infrastructures such as industrial districts and has opted more for other types of stimuli such as support for large companies, the promotion of the Fordist system, or trust in trade unions as an entity capable of mediating with large vertically integrated companies (Boix & Trullén, 2011; Ybarra, 2006). Despite the lack of stimulus policies, it is possible to highlight three exceptions: the strategies of the Basque Country and Catalonia in the creation and promotion of clusters, and the development policies of the Valencian Community for small and medium-sized enterprises in traditional industrial sectors (furniture, textiles, ceramics) located in industrial districts.

The Valencian Community is characterised by a long industrial history. This economic sector represents 18% of the economic structure of the autonomous community, above the national average of 16% (GVA, 2019). This industrialisation is characterised by the high geographical concentration of productive activities, as mentioned above, in different industrial districts spread throughout the Valencian territory, which also have important support institutions such as sectoral associations and technological institutes supporting innovation.

Industrial districts have a high presence throughout the Valencian Community, mainly in the following industrial sectors (GVA, 2017): textiles, footwear, marble, furniture, ceramics, food, automotive, toys, plastics, chemicals, metal and, to a lesser extent, in other sectors such as graphic arts, paper and cardboard, glass and construction materials. Table 7 below shows the main figures for Valencian industrial districts (GVA, 2017):

Table 7. Main statistics of Valencian industrial districts

District product	Nº of firms	Employment	Aggregate turnover	Linked institutions
Feeding	>2,000	30,000	>9,000 M€	Federación Empresarial de Agroalimentación de la Comunidad Valenciana (FEDACOVA) Instituto Tecnológico de la Industria Agroalimentaria (AINIA)
Footwear	2,500	21,000	2181 M€	Instituto Tecnológico del Calzado y Conexas (INESCOP) Asociación Española de Empresas de Componentes para el Calzado (AEC)
Tile ceramic	300	22,000	6,500 M€	Instituto Tecnológico de la Cerámica (ITC)

				Asociación Española de Técnicos Cerámicos (ATC) Asociación Nacional de Fritas, Esmaltes y Colores Cerámicos (ANFFECC) Asociación Española de Fabricantes de Azulejos y Pavimentos Cerámicos (ASCER)
Metallic and capital goods	>700 enterprises in capital goods >3,000 in metal products	>11,000 in capital goods 22,000 in metal products	2,000 M€ in capital goods 3,400 M€ in metal products	Federación Empresarial Metalúrgica Valenciana (FEMEVAL)
Automobile	--	>23,000	>9,000 M€	Asociación Valenciana de la Industria de la Automoción (AVIA)
Toys	80	--	600 M€	Instituto Tecnológico de Productos Infantiles y Ocio (AIJU)

				Asociación Española de Fabricantes de Juguetes (AEFJ)
Plastic	1,000	15,000	2,700 M€	Instituto Tecnológico del Plástico (AIMPLAS) Asociación de Empresarios de Ibi y Comarca (IBIAE)
Textile	>1,300	>16,000	1,839 M€	Instituto Tecnológico del textil en la Comunidad Valenciana (AITEX) Asociación de Empresarios
Chemicals	529	13,000	4,500 M€	Asociación de Empresas Químicas de la Comunidad Valenciana (QUIMACOVA) Instituto de Investigación en Tecnologías Químicas (Universitat Politècnica de València - Centro Superior de Investigaciones Científicas)
Furniture-Wood	>2,000	>14,000	1,400 M€	Instituto Tecnológico Metalmecánico, Mueble, Madera, Embalaje y Afines (AIDIMME)

				Federación Empresaria de la Madera y el Mueble (FEVAMA)
Marble	588	>4,500	1,000 M€	Asociación Mármol de Alicante (AMA)

Source: own elaboration base on GVA (2017)

Valencian industrial districts bring together different auxiliary industrial sectors around a leading industry, connected in a value chain originating in the territory itself. Thanks to the regional geographical concentration, social capital or a set of relationships is generated between the agents involved in industrial development, whose exchanges of information and knowledge serve to boost the competitiveness of Valencian companies. As an industrial policy instrument, a district should present the following particularities, some of which have already been introduced previously in this thesis, in order to optimise its functioning (Belussi & Hervás-Oliver, 2017):

- Being open to global value chains. This implies not only having a presence in international markets, but also having multinational companies based in the district's infrastructures and maintaining contacts with other foreign production centres. This favours access to flows of knowledge, technologies and global processes.
- Having integrated multinationals belonging to large global groups or knowledge-intensive sectors capable of boosting the capabilities of regional companies.
- To have a continuous movement of companies, both newly created and from spin-off processes of local companies and foreign companies, the latter being able to create new establishments or buy local companies in a search for local skills and knowledge.

3.2.3. An in-depth case example: Castelló de la Plana's ceramics industrial district

The ceramics district is an industrial reality that has aroused wide interest in the academic literature specialising in industrial districts over the last three decades (e.g., Hervás-Oliver et al., 2008, 2017, 2019; Giner and Santamaría, 2002; Camisón & Molina, 1998; Ybarra, 1991). The cluster is established in an area of approximately 30 square kilometres, whose main municipalities in which the activity is based are those of L'Alcora, Vila-Real and Onda (Castelló). As already introduced in the previous section, according to data from the Generalitat Valenciana, the cluster is made up of around 300 companies distributed among the different industries that make up the district (ceramics producers, glaze suppliers, clay suppliers, ceramic machinery suppliers, transport agencies, distributors, etc.). Today it is considered a model of a successful industrial district (Hervás-Oliver, 2008) but its beginnings go back a long time.

The origins of the industrial district date back to the foundation in 1727 of the Royal Fine Earthenware and Porcelain Factory of L'Alcora, promoted by the enlightened Buenaventura Ximénez de Urrea, 9th Count of Aranda. As Renau and Andrés (2018) point out, the existence of pre-industrial workshops in the area, together with the natural conditions of the geographical location (clayey soil, abundance of water and wood for the combustion of kilns) and the family ties that the Count maintained in the municipality were decisive in promoting the project. Inspired by the principles of the French Enlightenment, the Count of Aranda took care to publish the set of ordinances that regulated the operation and government of the establishment.

Following the creation of the factory in L'Alcora, other nuclei were subsequently established in Castelló for the mass production of tiles. 'Les Fabriquetes', as they were popularly known, spread to other towns such as Onda and Ribesalbes, gradually shaping the ceramic industry of Castelló de la Plana throughout the 19th century, until it became firmly established in the 20th century. This progressive growth of this industry in the Valencian territory was spurred on by the revaluation of the tile as a highly valued cladding material in architecture (Gomís Martí, 1990).

The expansion of the ceramic industry in the capital of La Plana, consolidating the municipality of Onda as the main producer of ceramic tiles, inspired the creation in 1925 of the Onda School of Ceramics, responsible for the training of ceramic technical workers in the different specialities needed in the industry: chemistry, decorative arts, etc. In 1927, the Tile Manufacturers' Guild was created, an institution that would play a role in bringing the industry together and which has maintained a central role in the region's industry until it became the current Asociación Española de Fabricantes de Azulejos y Pavimentos Cerámicos (ASCER). This decade can therefore be considered a crucial moment for the establishment of the industrial district with the opening of the first training schools in the factory environment itself and the start of the first business associations.

The next point of interest in the history of the ceramics industry in Castelló took place at the end of the 1950s, with the implementation of the 1st National Housing Plan (1955-1960) and the notable expansion of the tourist industry (particularly the hotel sub-sector) that took place at that time, increasing the demand for this product. Despite the notable growth in sales during this period, the sector continued to suffer from certain problems, as it employed low-skilled labour and products without the slightest hint of technical innovation and design aspects (Gomis Martí, 1990), which hindered the definitive consolidation of the sector.

According to some authors (Ortells Chaberra, 2005; Gomis Martí, 1990) the consolidation of the ceramic industry and, therefore, of the ceramic district of Castelló took place in the 1960s, with the impulse of the II National Housing Plan (1960-1965) and the opening of the sector towards the foreign market, especially the American market. 1965 also saw the first Ceramics and Glass Fair - now CEVISAMA - and the creation of the Onda Municipal Museum in 1968, aimed at preserving the region's ceramic heritage. Moreover, the technical limitations were overcome thanks to the strong business investment in Italian machinery, another producer (and competitor) and pioneer in the ceramics industry. Production levels in the ceramics sector would reach peak levels in the following decade. It is worth highlighting, as Renau and Andrés (2018) point out, the exponential growth of the Valencian industry in this decade, based on the emergence of small and medium-sized family businesses located in areas of traditional craft manufacturing tradition (Onda, L'Alcora, Valencia and its area of influence, L'Alcoià, Elche and Elda) on traditional manufacturing products: such as ceramics, footwear, leather, toys, or textiles.

In addition to the business associations and technical schools, it is worth mentioning the foundation in 1969 of the Institute of Technical Chemistry and Vocational Training and Research, currently known as the Instituto de Tecnología Cerámica (ITC). Initially linked to the Faculty of Chemistry of the Universitat de València, it moved definitively to the vicinity of the city of Castelló once the Universitat Jaume I was founded in 1991 (Renau and Andrés, 2018). Both institutions have been developing the task of structuring the regional innovation system to stimulate the transfer of knowledge that helps the sector to overcome the technical, commercial or managerial resistance that may appear over time.

Manufacturers of specialised industrial equipment and machinery from the district of Sassuolo (Emilia Romagna) co-located from 1970 onwards in the district of Castelló, bringing new technology and consolidating new capacities in the companies of Castelló (Hervás-Oliver et al., 2015). The transition from the kiln to the double-firing process took place. This decade also saw the consolidation of the frits and glazes subsector, and a growth in the importance of the vertical disintegration of companies.

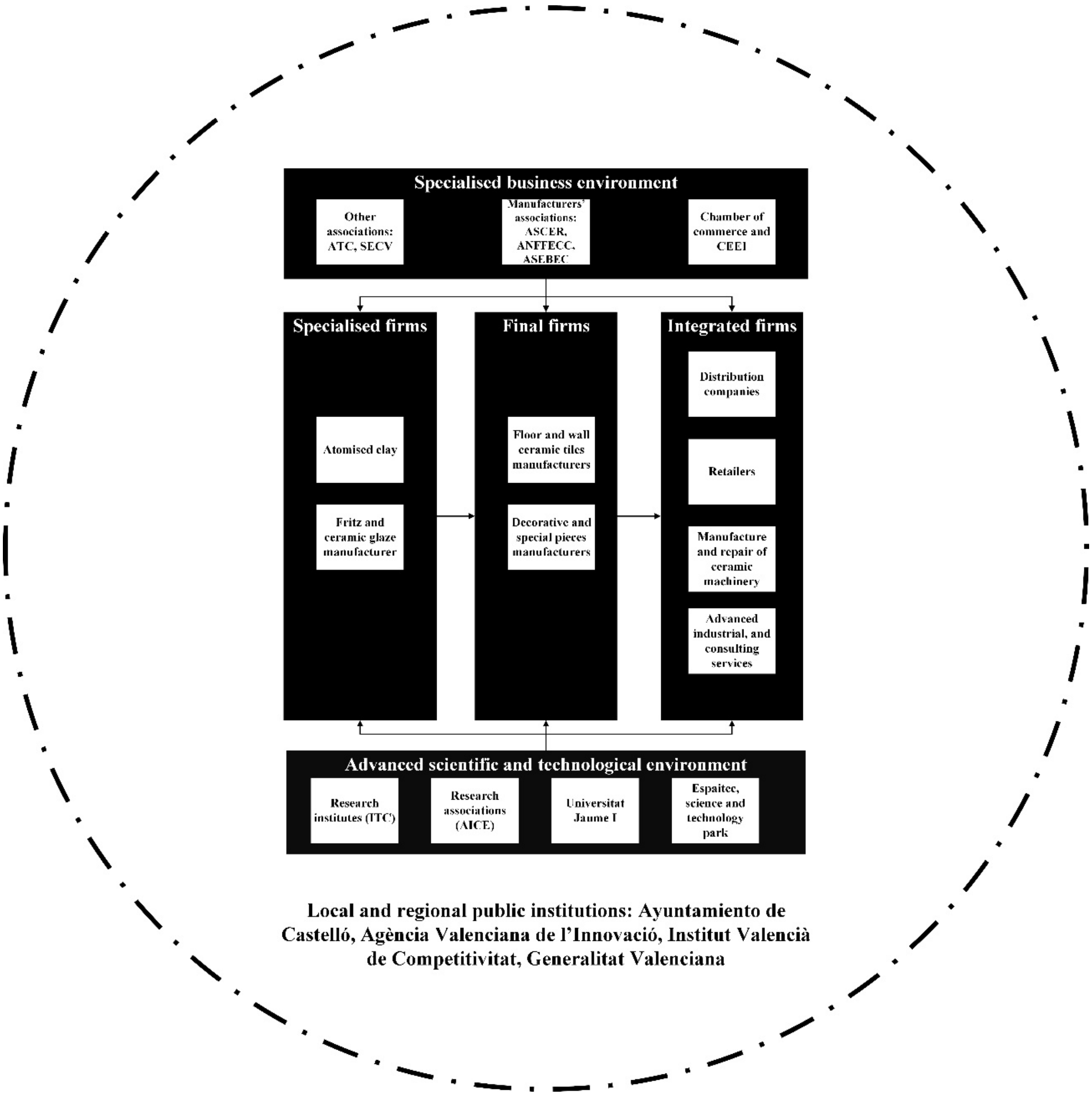
In the 1980s, the disintegration was almost complete, leaving the four sectors that made up the majority of the ceramic cluster very clearly differentiated: machinery, frits and glazes, atomisers (still under development at that time), and tile companies. The frits and glazes companies multiplied through a process of formation by corporate ventures and parent spin-offs (Hervás-Oliver et al., 2015). The role of local institutions (ITC, Alicer, Ascer, etc.) was essential to continue increasing the capabilities of cluster companies and consolidating new technological knowledge.

The cluster was boosted in the 1990s thanks to three important milestones (Hervás-Oliver et al., 2015): firstly, the complementarities that emerged between ceramic tile producers, local glaziers and Italian machinery manufacturers co-located in the Castelló district (e.g., the use of System's Rotocolor technology in Porcelanosa). Secondly, the strong presence of local institutions (business associations, ceramic R&D laboratories, trade fairs, etc.). Finally, the process of transmission of knowledge and routines within the district through personal contacts between technicians, creation of spinoffs, inter-firm cooperation (both vertical and horizontal) and labour mobility, all contributed to the reinforcement of local agglomeration forces.

In the 2000s the ceramic district enjoyed a state in which all the capacities necessary for production were consolidated in the territory. Thus, according to some authors (Hervás-Oliver et al., 2015) Castelló becomes a metacluster with all parts of the value chain present locally. There continues to be a high level of labour mobility in the district, although spinoff processes stagnate. In this decade a key disruption takes place that makes Castelló a global pioneer district thanks to innovation in inkjet printing in the period 2000-2012 among local companies (Kerajet, Ferro, Esmalglass) supported by the Cambridge printing cluster in the UK (Hervas-Oliver & Albors-Garrigós, 2014).

The socio-economic framework of the ceramic district of Castelló is shown below from an analysis of the vertically integrated activities carried out by the companies integrated in a district, as shown in the following Figure 8.

Figure 8. Tile ceramic filière



Source: own elaboration

According to the canonical literature on industrial districts, they are made up of a network of actors and companies linked by economic and social ties that give them, as noted earlier in this manual, an identity far removed from other models of territorial agglomeration of companies, such as an industrial estate. Specifically in the business sphere, Brusco (1992), based on Becattini's ideas of considering the whole vertically integrated sector and not only the set of companies belonging to the main activity, classifies the companies in an industrial district in the following way:

- Final firms: are those companies that produce the final good that characterises the industrial district (furniture, ceramics, textiles).
- Specialised firms: also referred to as 'single-stage companies' as they are involved in only one stage of production. In the ceramics district, the atomisers only carry out the necessary set of processes to prepare the mineral powder suitable for subsequent pressing, firing and dyeing phases. Another example, now in an industrial district specialising in textiles, would be the set of intermediate companies that deal exclusively with weaving, or weaving.
- Integrated firms: in the districts there is a third group of companies, which are those working in a different industry from the one that defines the final product of the district, but which belong to the same vertically integrated sector (in the previous examples, manufacturers of ceramic machinery or buttons, which statistically may belong to other sectors), although service companies (marketing, financial, transport, etc.) are also included here.

Despite the high geographical concentration, which means that 94% of all national production is generated in three regions of the province of Castelló, the ceramics sector has a great impact on the economy not only of the province of Castelló, or of the Valencian Community, but also for Spain as a whole, to which it contributed 2.7% of its industrial GDP in 2019 (Forés et al., 2022).

3.3. ECO INDUSTRIAL PARKS: THE MODEL THAT HAS APPLIED THE PRINCIPLES OF SUSTAINABILITY TO THE REGENERATION OF BROWNFIELD SITES

An eco-industrial park is an infrastructure whose strategy aims to reconcile the competitiveness of industrial enterprises with a more sustainable development in the long term measured under the triple bottom line of sustainability (Bellantuono et al., 2017). In these eco-industrial parks, companies endogenous to a territory contribute to the promotion of industrial activity while adopting a series of individual and collective measures to reconcile economic, social, and environmental expectations (Aviso et al., 2011; Benn & Bolton, 2011), with the aim of preserving natural resources for future generations, promoting a carbon-neutral economy, and raising the quality-of-life standards of the current and future population.

Eco-industrial parks can be seen as an evolution or, if preferred, the most advanced state of traditional industrial parks (Roberts, 2004). A traditional industrial park is defined as "is a large tract of land, subdivided and developed for the use of several firms simultaneously, distinguished by its sharable infrastructure and close proximity of firms" (Peedle, 1990:27). The success of these territorial agglomerations of firms was therefore based on the dialectic of proximity to surrounding markets, preferential access to raw materials, the sharing of infrastructure services and the competitive cost of labour and industrial land (Camisón et al., 2020; Aragón Correa and Senise-Barrio, 2001).

Traditional industrial parks became important as the main policy instrument in the creation of regional growth or development poles (Perroux, 1955)[13]. A development or growth pole is defined as "a set of industries strongly interlinked through input-output linkages around a leading or driving industry, capable of generating dynamic growth of the economy" (Richardson, 1986: 127).

In Spain, Perrouxian ideas of economic development permeated during the stage of the National Development Plans (1964-1975) with the purpose of stimulating industrial growth. Thus, the Spanish government selected a series of urban centres in the less developed Spanish regions (Andalucía, Galicia, Meseta Norte, Ebro Valley, among others) and made concessions to favour the installation of companies in these growth poles (Climent, 1990) whose application resulted in improved GDP and investment growth rates in the mid-1960s (Velasco, 2014). The following Table 8 shows the data on investment and employment in the national poles up to 1979.

Table 8. Spanish poles

Localisation	Duration	Investment in millions of pesetas[14]	Employment
Burgos	1964-1973	19,760	10,832
Huelva	1964-1973	49,694	7,224
La Coruña	1964-1971	11,665	4,188
Vigo	1967-1971	9,669	13,299
Sevilla	1964-1970	9,213	9,666
Valladolid	1964-1970	20,311	20,153

[13] The theory of growth and development poles was developed by the French economist François Perroux in his 1955 work. Later, Professor Jacques Boudeville (1966) adapted it as the theory of economic spaces. This theory proposes as its main idea that, if a new industry is located in a region, this industry is capable of generating a series of positive and negative externalities (although they point out that the net result will be positive) that impact both the region where it is located and nearby places outside the boundaries of the region through a filtering process.

[14] The exchange rate fixed for the euro-peseta is 1 euro = 166 pesetas.

Zaragoza	1964-1969	9,064	8,273
Granada	1970-1979	8,440	1,339
Córdoba	1971-1980	8,412	1,470
Oviedo	1971-1982	34,439	5,049
Logroño	1972-1981	10,826	4,319
Villagarcía	1972-1981	2,253	2,605
TOTAL		193,746	88,417

Source: Camisón et al. (2020)

However, along with the previous beneficial external economies for the competitiveness of companies and the region on which they were based, forming poles of growth or development, the creation of these traditional industrial parks has brought with it a series of negative externalities, especially with regard to the environmental aspects of industrial activity (Camisón et al., 2020; Aragón-Correa & Senise-Barrio, 2001). In some cases, these traditional industrial areas or parks have become "grey" and obsolete spaces, as well as polluting (Camisón et al., 2020; Rodina et al., 2018). For all these reasons, there are growing calls to reverse these negative externalities typical of traditional industrial spaces and place them at a later evolutionary stage, revitalising them as "green" spaces (Mathews et al., 2018; Rodina et al., 2018; Greenberg & Rogerson, 2014).

The interest in promoting a more sustainable industry model has propelled the concept of eco-industrial parks to the mainstream agendas of practitioners, policy makers and academia in recent decades (e.g., Wu & Gao, 2022; Pan et al., 2016; Tessitore et al., 2014; Sakr et al., 2011; Pellenbarg, 2002). As a result, numerous terms synonymous with eco-industrial parks such as eco-industrial network, eco-cluster, sustainable industrial park, or integrated eco-industrial parks abound in the literature (Winans et al., 2017; Dimitrova et al., 2007; Tudor et al., 2007). The same is true for the definition of this particular model of agglomeration of companies concerned with the sustainability of their environment in which numerous examples abound in the specialised literature (Van Berkel, 2009; Chertow, 2000).

One of the most widely used definitions of an eco-industrial park in the literature is that provided by Côté and Hall, as it perfectly captures the impact of an eco-industrial park on the three dimensions of sustainable development. Thus, these authors define an eco-industrial park is “an industrial system, which conserves the natural and economic resources; reduces production, material energy, insurances and treatments costs and liabilities; improves operating efficiency, quality, worker health and public image; and provides opportunities for income generation from use and sale of wasted materials” (Côté & Hall, 1995).

From a less academic sphere and more linked to the public and professional management of eco industrial parks appears the definition of the United States Environmental Protection Agency (US EPA) which holds that an eco-industrial park is "a community of manufacturing and service firms that seek to improve their environmental and economic performance by collaborating on environmental and reuse management issues. By working together, the business community seeks a benefit greater than the sum of the individual benefits that each firm would derive if it only optimised its individual performance" (cited in Heeres et al., 2004: 985). Building on the above definitions, it is also worth mentioning what an eco-industrial park is not, whose complexity and variety of actions to be carried out by a wide set of actors goes far beyond options such as those announced below (Research Triangle Institute and Indigo Development, 1994):

- a single by-product exchange pattern or network of exchanges;
- a recycling business cluster (resource recovery, recycling companies, etc.);
- a collection of environmental technology companies;
- a collection of companies making ‘green products’;
- an industrial park designed around a single theme;
- a park with environmentally infrastructure or construction;
- a mixed-use development (industrial, commercial, and residential).

From the above narrative, it can be deduced that the strategic and operational principles of an eco-industrial park are based on the theoretical-practical principles of the literature streams in industrial ecology and circular economy already introduced earlier in this PhD thesis (Baldassarre et al., 2019; Belaud et al., 2019; Martín-Gómez et al., 2018; Ghisellini et al., 2016; Frosch & Gallopoulos, 1989). Both schools of thought promote the replication of biological archetypes within industrial processes in order to optimise the use of energy and materials, minimise the exploitation of natural resources, and systematically reuse waste and by-products (Forés et al., 2018; Korhonen et al., 2004; Erkman, 1997). Thus, both paradigms contribute to the promotion of more sustainable industrial models, such as eco-industrial parks, specifically with regard to the establishment of industrial symbiosis networks.

Through these industrial symbiosis processes, companies hosted in an eco-industrial park build material and energy exchange flows by mimicking the biological flows of nature with the aim of creating more sustainable industrial ecosystems (Brehm & Layton, 2021; Martín-Gómez et al., 2018). Thus, within the eco-industrial park framework, the focus shifts from minimising waste or reducing pollution levels of a particular process or facility (i.e., through techniques such as pollution prevention or product life cycle analysis), to minimising waste or pollution produced by a much larger system or infrastructure. Processes and industries are thus seen as interacting systems rather than the composition of isolated components linked by linear flows of materials or product transformations into final goods.

In an eco-industrial park, tenant companies establish cooperation networks (i.e., industrial symbiosis) to promote joint actions that have an impact on the improvement of the individual sustainability of each node integrated in the network, but also of the park as a whole and its adjacent communities (Camisón et al., 2021). The specialised literature recognises that these networks make it possible to boost industrial efficiency (Baldassarre et al., 2019; Narodowski, 2007), confer flexibility to companies' internal operations (Motastruc et al., 2013), reduce material and energy consumption needs (Kachacha et al., 2019; Bocken et al., 2016; Hiete & Schultmann, 2012), or reduce the quantity and costs of purifying drinking or industrial water in the eco-industrial park environment (Bi et al., 2019; Aviso, 2014) (see next Table 9).

Table 9. Benefits of eco-industrial parks

Communities	Environment	Business
Larger tax base Community pride Improved environmental health Enhanced quality of life in area near to the Eco-industrial park Good quality jobs	Better resource use Reduced waste Increased protection of natural ecosystems Innovative environmental solutions Increased protection of natural ecosystems	Enhanced market image Increased employee productivity Access to financing Reduction in disposal costs Income from sale of by-products

Source: Own elaboration based on Camisón et al. (2021) and Pellenbarg (2002)

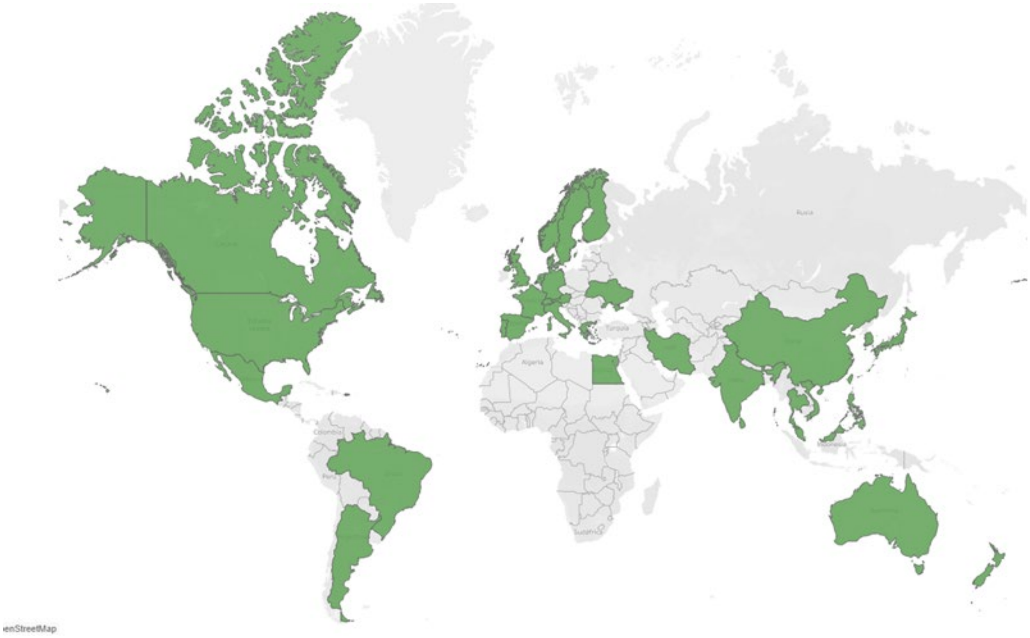
According to the literature (e.g., Boix et al., 2015; Chertow, 2008; Tudor et al., 2007) firms located in an eco-industrial park have four types of opportunities to develop industrial symbiosis networks in an eco-industrial park: (I) By product reuse, which involves the exchange of materials, by-products or waste between two or more firms and which are used as substitutes for marketed products or raw materials in alternative production processes; (II) sharing of utilities and infrastructures, especially energy ones such as cascade water or heat regeneration units; (III) provision of joint services, aimed at covering common needs across firms, such as transport; and, (IV) the transfer of specialised knowledge in environmental management through exchanges of personnel and technical resources.

The eco-industrial park concept is not a recent concept, nor is it a regional adaptation of other international frameworks in the field of sustainability (Heeres et al., 2004). On the contrary, this eco-industrial park model has its genesis in the industrial park of Kalundborg (Denmark) (Ehrenfeld & Getler, 1997), where companies located in this industrial park have spontaneously established industrial symbiosis relationships that, while allowing them to reduce energy consumption, waste use and avoid the exploitation of natural resources, also improve their economic performance (Valentine, 2016; Yu et al., 2014). Kalundborg is a perfect example of the creation of industrial symbiosis networks through free market forces in favour of sustainability improvement (Desrochers, 2001).

Kalundborg's success has inspired and encouraged regional and national governments around the world to launch similar initiatives in their territories. Beyond the academic debate between advocates of policy intervention for the transformation of outdated industrial areas (e.g., Lehtoranta et al., 2011; Mirata, 2004; Lowe, 1997) and proponents of free market action (e.g., Heeres et al., 2004, Desrochers, 2001), it seems clear that collaboration between public entities and private actors should be a constant in promoting the growth and development of any industrial park (Tessitore et al., 2014; Eilering & Vermeulen, 2004). Moreover, as recognised in the most recent literature (e.g., Uusikartano et al., 2021; Pierre Belaud et al., 2018), public actors can diversify their roles in the promotion of eco-industrial parks beyond the mere planning or financing of initiatives.

Nonetheless, it seems that public-private partnerships are becoming a constant feature of many eco-park projects around the world. Notable examples of such programmes include TEDA in China (Qu et al., 2015), NISP in the United Kingdom (Paquin & Howard-Grenville, 2012) and the Ulsan Region in South Korea (Yu et al., 2014). It must be said that the growth of this phenomenon has been contributed to by the enormous progress in the literature on the study of eco-industrial parks over the past decades. The following Figure 9 and Table 10 list some of the most relevant studies in the literature that have identified the presence of eco-industrial parks in a wide range of countries.

Figure 9. Countries that have implemented eco-industrial parks



Source: own elaboration

Table 10. Literature on eco-industrial parks geographically distributed

Country	Author	Country	Author
Argentina	Bellantuono et al., 2017	**Netherlands**	Heeres et al., 2004
Australia	Giurco et al., 2011; Roberts, 2004	**New Zealand**	Ghisellini et al., 2016
Austria	Ashton et al., 2017; Schwarz & Steininger, 1997	**Norway**	Romero & Ruiz, 2013
Brasil	Bellantuono et al., 2017; Ceglia et al., 2017; Veiga & Magrini, 2009	**Philippines**	Chiu & Young, 2004; Lowe, 2004
Canada	Côté & Liu, 2016; Chertow, 2007; Geng & Côté, 2002	**Portugal**	Costa & Ferrao, 2010

China	Huang et al., 2019; Qu et al., 2015; Dong et al., 2013	**Puerto Rico**	Chertow et al., 2008
Denmark	Fraccascia et al., 2017; Heeres et al., 2004; Ehrenfeld, 1995	**United Kingdom**	Gibbs, 2009; Mirata, 2004
Egypt	ElMassah, 2018; Sakr et al., 2011	**Singapur**	Hwang et al., 2017
Finland	Saiku, 2006; Garner & Keoleian, 1995	**South Korea**	Park et al., 2019; Park et al., 2008
France	Ribeiro et al., 2018	**Spain**	Forés et al., 2018; Puente et al., 2015; Zamorano et al., 2011
Germany	Schön et al., 1999	**Sri Lanka**	Lowe, 2005; Chiu & Young, 2004
Greece	Marinos-Kouris & Mourtsiadis, 2013	**Sweden**	Adamides & Mouzakitis, 2009
India	Patnaik & Poyyamoli, 2015; Patel et al., 2001	**Switzerland**	Farer et al., 2016
Iran	Vahidi et al., 2016	**Taiwan**	Maynard et al., 2020
Italy	Taddeo et al., 2017; Tessittore et al., 2015	**Thailand**	Pilouk & Koottatep, 2017; Panyathanakun et al., 2013
Japan	Van Berkel et al., 2009; Côté & Cohen-Rosenthal, 1998	**Ukraine**	Hewes & Lyons, 2008
Malaysia	Chiu & Young, 2004; Lowe, 2003	**United States**	Veleva et al., 2016; Deutz & Gibbs, 2008; Gibbs & Deutz, 2007
Mexico	Martin et al., 1998	**Vietnam**	Van Beers et al., 2019

Source: own elaboration

On the other hand, it is worth noting that companies must also address internally and individually the challenges of their integration as a node in the network of industrial symbiosis that develops in an eco-industrial park (Sousa-Zomer et al., 2018; Rizos et al., 2016). To this end, it is essential that companies reformulate their business models around the principles of the circular economy and sustainability (Joyce & Paquin, 2016; Lewandowski, 2016), based on new organisational capacities that allow them to respond to the new needs of the company and improve its performance under the triple bottom line of sustainability. This set of capabilities must involve all functional areas of the company, from manufacturing (Lacy et al., 2014), logistics and supply chain management (Wang et al., 2019), to marketing (Lacy et al., 2014) and even finance (Sousa-Zomer et al., 2018).

The establishment of an industrial symbiosis network in a traditional industrial park is far from an easy process (Yeo et al., 2019). In addition to the difficulty in orchestrating the resources and capacities between the different nodes that compose the network (Ruggieri et al., 2016), and the strategic change that this process requires within the companies (Lewandowski, 2016), there are also the cultural aspects that determine, in the last vein, the success or failure of the project (Rizos et al., 2016; Lombardi & Laybourn, 2012). Thus, the pre-existence of an innovative business culture, linked to the availability of greater dynamic capacities for learning and innovation (Teece, 2007) is a requirement that can stimulate the company's abilities to successfully engage in the creation of symbiosis networks in an industrial park, as well as to produce higher quality and more environmentally sustainable products (Albort-Morant et al., 2016).

Unfortunately, this typology of territorial agglomeration of companies is not yet present in the Valencian Community, so it cannot be illustrated with a concrete example, as is the case with the other typologies included in this doctoral thesis. However, considering that it is a typology of territorial agglomeration of companies specifically aimed at improving the sustainability performance of integrated companies, we firmly believe that it should appear in this review chapter on typologies of business areas.

3.4. SCIENCE PARKS, TECHNOLOGY PARKS AND HYBRID ALTERNATIVES TO BOOST KNOWLEDGE MANAGEMENT AND BUSINESS INNOVATION

Science and technology parks are organisations designed to accommodate and stimulate the growth of tenant companies by managing the flow of knowledge and technology between universities, R&D institutions, business and markets (IASP, 2002). Inspired by the evolution of industrial districts in the United Kingdom during the industrial revolution (Vilà & Pagès, 2008), this phenomenon of science and technology parks originated in the United States in the 1950s[15] (Grayson, 1993; Macdonald, 1987), with Stanford Research Park (California), Research Triangle Park (North Caroline) and Cummins Research Park (Alabama) being the main exponents of this model of territorial agglomeration of companies (Zhang, 2005).

The above examples, together with the development of other successful infrastructures of a markedly spontaneous nature such as Silicon Valley or Route 128 in Boston or the Cambridge phenomenon in the United Kingdom, encouraged agents in other economies (mainly those responsible for regional development and innovation policies) to favour the promotion and establishment of these park infrastructures (Berry, 1998), thus adopting a more planned approach to their development. According to Castells and Hall (1994) there are three main motivations that explain the strong commitment to the promotion of these infrastructures: reindustrialisation, regional development or the creation of synergies with the rest of the actors that make up a regional innovation system.

In the case of developed economies, science and technology parks play a key role in the conjunction of science-technology-industry systems due to their special multiplier effect on regional innovation and development results (e.g., Hernández-Trasobares & Murillo-Luna, 2020; Leydesdorff, 2018; Etzkowitz & Zhou, 2017; Etzkowitz & Leydesdorff, 1995, 2000). In developing countries, science and technology parks have proven to be an excellent catching-up strategy through the imitation of technological progress developed in more advanced economies (Fan, 2017).

Thus, beyond the phenomena in the United States or the United Kingdom (e.g., Wonglimpiyarat, 2016; Minguillo et al., 2015), it is possible to find examples of this typology of territorial agglomeration of firms in places such as Italy (e.g., Corrocher et al., 2019; Bigliardi et al., 2006; Colombo & Delmastro, 2002), Spain (e.g., Albahari et al., 2017; Díez-Vial & Montoro-Sánchez, 2016), Japan (e.g., Fukugawa, 2006, 2013), Greece (e.g. Bakouros et al., 2002), Australia (e.g., Phillipmore, 1999) or Portugal (e.g., Ratinho & Henriques, 2010). Other examples of the rise of these infrastructures in emerging economies include Taiwan (e.g., Chen et al., 2006), India (e.g., Negendra & Gopal, 2011), Brazil (e.g., Etzkowitz et al., 2005), Iran (e.g., Fazlzadeh & Moshiri, 2010) or Singapore (e.g., Koh et al., 2005), among others.

[15] Some authors (e.g., Vilà & Pagès, 2008) point out that the germ of science and technology parks is even earlier, and that they already played a crucial role during the Second World War by stimulating cooperation between scientists and engineers in the development of innovations linked to the military industry.

The convergence of different actors in planned science park promotion initiatives (e.g., politicians, institutional decision-makers, real estate agents, local development agencies, higher education institutions, etc.) has led to the emergence of different nomenclatures for realities that may or may not be the same in their idiosyncratic characteristics. The differences in nomenclature are also affected by the country of analysis; thus, the term research park is more common in the United States, while science park and technology park are more prevalent in Europe and Asia, respectively (Link, 2009; Link & Scott, 2004).

As pointed out by some authors (Zhang, 2005), the term science park has been used as an umbrella term to catalogue alternative infrastructures, which may share some characteristic elements such as technology parks, but also others that present strong differences, such as incubators. The main purpose of this section is to distinguish between the different types of parks, focusing only on their main defining characteristics, without considering the existing influences derived from the common use of the language in each country.

One of the main differentiating characteristics between a science and technology park and other types of territorial agglomerations of companies such as clusters or other spontaneous forms of business organisation, such as industrial districts, is the presence of a management team permanently involved in achieving the aspirations and objectives of the park owners or promoters (Albahari, 2019; Claver-Cortés et al., 2018). Also, in a classic publication, Massey et al. (1992) lists the following objectives that should guide the actions of a science and technology park, grouped into three main dimensions: economic development, technology transfer and local benefits. The objectives are as follows in Table 11 (Massey et al., 1992: 21).

Table 11. Objectives that should guide the actions of science parks

Economic development
Stimulate the formation of start-up new-technology based firms (NTBFs)
Encourage the growth of existing NTBFs
Commercialise academic research
Foster the technologies of the future
Counter the regional imbalance of R&D capability, investment, innovation
Attract inward investment, mobile R&D
Transfer of technology
Encourage spin-off started by academics
Encourage and facilitate links between higher education institutes and industry
Facilitate technology transfer from academic institution to firms on park
Increase the relevance to industry of the research of higher education institutes
Give academic institutions access to leading-edge commercial R&D
Increase the appreciation of industry’s needs by academics
Stimulate science-based technological innovation
Local benefits

Create employment and consultancy opportunities for academic staff and students
Create synergy between firms
Create new jobs for the region
Improve the performance of the local economy
Stimulate a shift in perceptions
Build confidence
Engender an entrepreneurial culture
Generate income for academic institutions
Improve the image of academic institutions in the eyes of the central government

Source: adapted from Massey et al. (1992)

3.4.1. Science parks

Although some authors (e.g., Grayson, 1993; Lowe, 1985) go even further in the establishment of park typologies, differentiating between a science park and a research park[16], in this research, despite recognising the differences highlighted by the previous authors, due to their insignificant impact on the mission and objectives of the infrastructure, these will be avoided, and these two modalities will be considered synonymous under the more common term science park in the literature.

A very comprehensive definition of the phenomenon is provided by Squicciarini (2008) for whom science parks are "organisations that bridge the gap between research and industry. Their main objective is to promote the competitiveness and innovation culture of their partner companies and knowledge-based institutions. To this end, science parks should stimulate and manage the flow of knowledge and technology between universities, R&D institutions and companies" (p. 45).

Link and Scott (2006) define a science park as "a cluster of technology-based organisations that locate on or near a university campus to benefit from the university's knowledge base and ongoing research. The university not only transfers knowledge, but expects to develop it more effectively by partnering with the research park tenants" (p. 44).

[16] These authors consider that the difference between the two infrastructures lies in the fact that a research park focuses entirely on basic research, the results of which are even more important than the associated income from renting space to house companies. The focus on basic research also means that these infrastructures do not have facilities for the production of prototypes, which may be present in the science park alternative.

In a less academic sphere, although strongly inspired by its postulates, the definition proposed by the International Association of Science Parks (IASP) stands out, defining a science park as one that meets the following characteristics (2001)[17]:

- It maintains operational links with universities, research centres and other higher education units.
- It is designed to foster the formation and growth of knowledge-based industries or high value-added tertiary enterprises, typically hosted in its infrastructure.
- It has a stable management team that is actively engaged in promoting technology transfer to tenant organisations.

Science parks are intended to stimulate the creation and growth of new firms that have a significant technology content or base (Lamperti et al., 2017), diversifying the regional business fabric beyond traditional industries in potential decline (Nauwelaers et al., 2019). New technology-based firms (NTBF) are "small firms that conduct intensive R&D and that are not subsidiaries of established companies"[18] Fukugawa (2006: 383). In addition, science and technology parks are responsible for providing new technology-based firms with physical facilities such as scientific laboratories, high value-added services such as strategic advice; conferring access to certain government subsidies; and, finally, facilitating the establishment of links with customers, suppliers or employees from universities that would otherwise not be available to them during the start-up phase, or would be more difficult to access (Guangzhou Hu, 2007; Phan et al., 2005; Siegel & Wright, 2005; Westhead & Storey, 1995).

There are different institutions linked to science parks (Camisón et al., 2020) that can provide knowledge and promote the innovation of collocated companies; however, the literature (e.g., Ritala et al., 2015; Löfsten & Lindelöf, 2005) seems to point to the preponderance of the university as the main entity in charge of scientific knowledge transfer among all the previous institutions introduced (Bakouros et al., 2002).

[17] In a recent publication, Link (2019) includes other definitions proposed by international organisations such as UNESCO (2018), the UK Science Parks Association (2018) or the American Association of Research Parks (2018), in all of which the author points out that their common element is to consider the park as an infrastructure related to innovation, which stimulates the creation of start-ups and technology companies, and in which there is an exchange of knowledge between agents, where the university acts as a catalyst in the transfer. In another publication, Link and Link underline how difficult it is to establish a definition that covers the great heterogeneity existing in this model of territorial agglomeration of companies: "The definition of a research or science park differs almost as widely as the individual parks themselves" (2003: 81).

[18] The author acknowledges how the literature (e.g., Storey & Tether, 1998a) has considered different terms to categorise these small, highly innovative firms, using new technology-based firms (predominantly in Europe), start-ups (in the United States), or simply ventures (in Japan) as terms. In this thesis we will follow the same approach and no distinction will be made between the above terms.

Firms located in a science park that establish strong links with the university, and which also have a well-developed absorptive capacity, are able to benefit more successfully from the complementary knowledge flows resulting from university and business research (Díez-Vial & Montoro-Sánchez, 2016). It should be noted that not all firms located in a science park benefit equally from knowledge externalities (Díez-Vial & Montoro-Sánchez, 2016; Patton, 2014; Capello, 2009) as knowledge is not a freely available public good (Capello, 2009), but requires efforts for its internalisation (Díez-Vial & Montoro-Sánchez, 2016). Thus, effective internalisation depends on the correct integration into the park's knowledge networks (Löfsten & Lindelöf, 2005), as well as on the firms' own absorption capacity (Ubeda et al., 2019). At this point it should be noted that there is research (e.g., Minguillo et al., 2015) that points out that science parks are the most successful infrastructures in fostering cooperation and research production, above other alternatives such as technology parks, thus reinforcing the specialities of each business agglomeration model.

The problem associated with university-dependent and/or university-affiliated science parks is that the resources provided to companies may be positively biased towards the more academic (and therefore a priori less commercially valuable) side of them (Clarysse et al., 2005; Siegel et al., 2003); and, on the other hand, that the localisation process is subject to a greater internal bureaucracy and decision-making process than would be expected in a science park where the university has no involvement in its management and promotion (Wright et al., 2002).

3.4.2. An in-depth case example: the science park of the Universitat de València

The Science Park of Universitat de València is an innovation ecosystem oriented towards the social profitability of knowledge. This science park was promoted in 2009 as a non-profit organisation of general interest to promote the transfer of knowledge from scientific research to the productive system. Among its founding trustees are the Universitat de València, other local business entities such as the Valencia Chamber of Commerce and the Valencian Business Confederation, as well as financial institutions such as Banco Santander and the Bancaja Foundation.

The Fundació Parc Científic Universitat de València (FPCUV) is a body created ad-hoc to manage and govern the business area of the science park, following the strategic lines defined by its trustees, especially the Universitat de València, to which its manager and the president of the entity are attached. The management team is responsible for stimulating activities and promoting services that actively contribute to the improvement of business competitiveness and the development of a new production model based on knowledge and sustainability. The aims of the foundation are as follows:

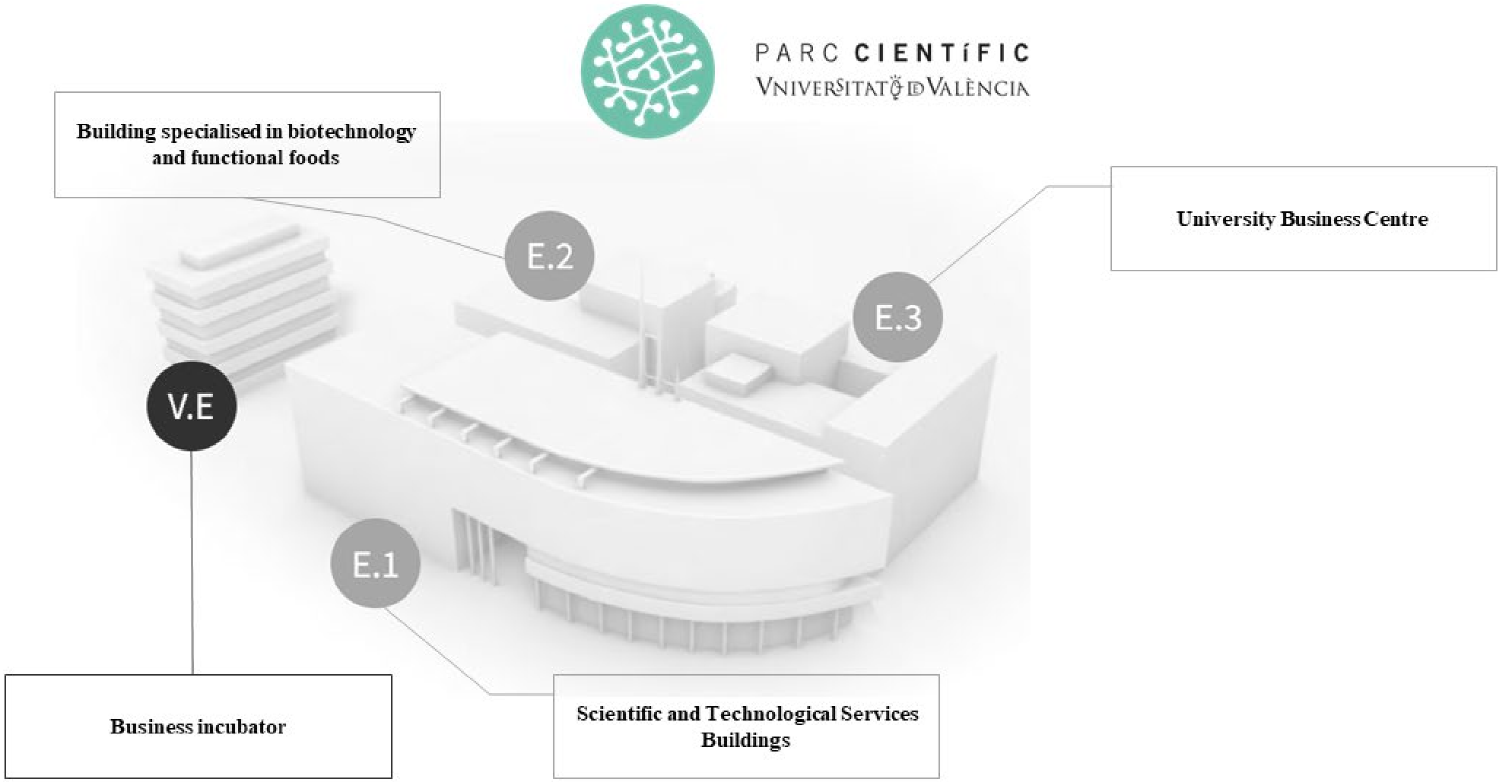
- To promote research on issues of social importance at regional, national and international level.
- To establish cooperation between research groups of the Universitat de València and companies.
- To promote the transfer and dissemination of the results of university research.
- To promote technological development, knowledge transfer and industrial innovation.
- To create innovative companies by facilitating alliances with strategic partners.
- To contribute to the improvement of the competitiveness of companies and the economic development of the Valencian Community.

The park is located on the outskirts of the Burjassot-Paterna university campus, although it carries out activities on the three campuses of the Universitat de València: Tarongers, Blasco Ibáñez, and the aforementioned Burjassot-Paterna campus. The space is divided into two large areas that are perfectly differentiated, although complementary: the business area and the scientific and academic area. The characteristics and facilities of each area would be as follows:

Firstly, the scientific and academic area, which has a space of 45,653 m^2 devoted entirely to the generation of new scientific knowledge. It houses two unique centres (Image Processing Laboratory and the Astronomical Observatory of the University of Valencia) as well as seven basic and applied university research institutes that have received distinctions such as the Severo Ochoa (Institute of Corpuscular Physics) and another with the María de Maeztu accreditation (Institute of Molecular Science), ministerial recognitions for their research excellence.

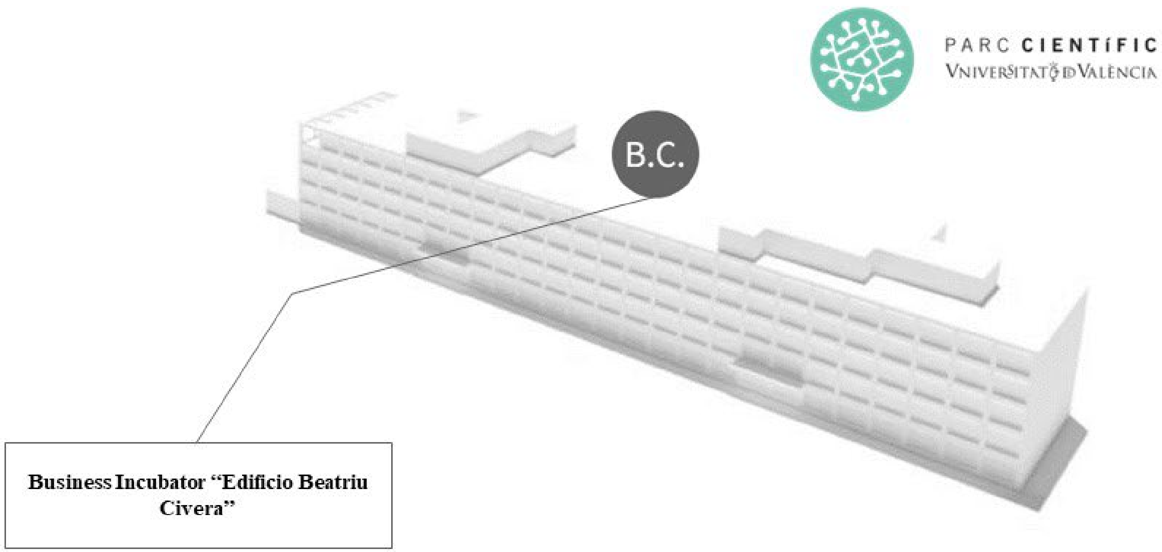
For its part, the business area has 26,700 m^2, divided into three blocks of buildings, which have offices and laboratories of different sizes and features suited to the companies housed in each of them. Building 1 houses companies related to information technology, energy, the environment and advanced services. Building 2 specialises in biotechnology and genomics companies. Finally, building 3 houses the university business centre, a more multi-purpose space. In this business area, the park has a business incubator, three coworking spaces (which acts as a seedbed for new companies). It also has an auditorium with a capacity for 225 people. See Figures 10 and 11.

Figure 10. Universitat de València science park (I)



Source: adapted from Parc Científic Universitat de València

Figure 11. Universitat de València science park (II)



Source: adapted from Parc Científic Universitat de València

3.4.3. Technological parks

A vast body of literature (e.g., Ng et al., 2020; Albahari et al., 2013, 2017; Link & Scott, 2005; Minshall, 1983) has focused on uncovering the differences between a science park and a technology park. Since many of the characteristics of a science park are shared with its relative the technology park, these will be ignored in this section and only the differences will be mentioned.

Technology parks are infrastructures that generally occupy larger spaces, in which companies with strong knowledge-based activities are concentrated, but in which the transfer of knowledge and technologies with university entities is somewhat more tenuous (Porter, 1989)[19]. Other research such as Grayson (1993) or Vaidyanathan (2008) take up Porter's lead in terms of the weak academic involvement in this type of territorial agglomeration of firms, but underline the important role they play in accommodating firms engaged in cleaner production and the commercial application of advanced technologies. They are therefore key infrastructures for encouraging reindustrialisation and ensuring sustained regional development over time (Fazlzadeh & Moshiri, 2010).

3.4.4. An in-depth case example: the Parc Tecnològic Paterna (València)

The history of the Parc Tecnològic de Paterna dates back to the 1980s, when, in the midst of the industrial restructuring process and driven by the first Statute of Autonomy of the Valencian Community, the various departments and bodies responsible for streamlining and promoting all activities related to the industrial development of Valencian companies were created.

The setting up of a technology park responded to the objective of the previous recently created entities to promote the creation and development of new companies based on quality parameters, technological innovation, and to bring them together in a single urban environment. For its design, experiences from the United States and other European countries that have been successful in this type of initiative, already introduced earlier in this thesis, were taken as a reference.

To this end, it was necessary to create an urban area with a good communications system, a pleasant, low-density environment, equipped with advanced services, which would allow companies, technological and scientific agents to meet and generate synergies. Through the joint action of the Regional Ministry of Industry, Trade and Tourism, the S.E.P.E.S. (Public Business

[19] In a study of 31 Italian and 25 Spanish science and technology parks, Albahari et al. (2013) confirm that the university is not part of the founders and promoters of the parks in 37% and 56% of cases, respectively. In the United States, the evidence is more striking, as a survey of a sample of 51 science and technology parks confirms that in 69% of cases the university is not part of the ownership (Link & Scott, 2005).

Land Entity) and the collaboration of the IMPIVA (Institute for Small and Medium Industry of the Generalitat Valenciana), the Paterna Technology Park became a reality.

Today, the Parc Tecnològic Paterna has brought together the infrastructures and workspace that have enabled companies to successfully join a new, highly competitive business environment with the following characteristics: advanced technological resources, value-added services, efficient communications systems, systems and protocols to stimulate business cooperation, research centres at their service, collaboration with universities, wide roads, green areas, car parks, etc. In short, resources that conform to the common denominators that mark the difference between a technology park and other areas or traditional models of industrial implantation (Aragón-Correa and Senise-Barrio, 2001).

The Management and Modernisation Entity of the Paterna Technology Park, the first to be set up in Spain in accordance with Law 14/2018, of 5 June, on the management, modernisation and promotion of industrial areas in the Valencia Region, plays a cohesive and interrelated role in order to enhance the value of a series of positive elements that make this business enclave a privileged area in which to establish new opportunities[20].

The park's management team has worked in recent years to implement measures aimed at increasing the competitiveness of the companies housed in the park. The two main lines of action promoted by the park's management team have been: (I) stimulating open and collaborative innovation (Chesbrough, 2003); and (II) improving the sustainability and non-financial reporting practices (Camisón et al., 2020) of the organisations. The management team has had the collaboration and advice of different Valencian universities (Universitat de València and Universitat Jaume I), as well as the support of governmental bodies (Agencia Valenciana de la Innovación, Conselleria d'Economia Sostenible Sectors Productius, Comerç i Treball) and other regional entities, in a very participative and inclusive approach.

The urban characteristics of the land of the Parc Tecnològic de Paterna are as follows:

- Total area: 1,038,290 m^2
- Roads: 166,985 m^2
- Green areas: 144,820 m^2
- Surface area available for companies and technological institutes: 687,115 m^2

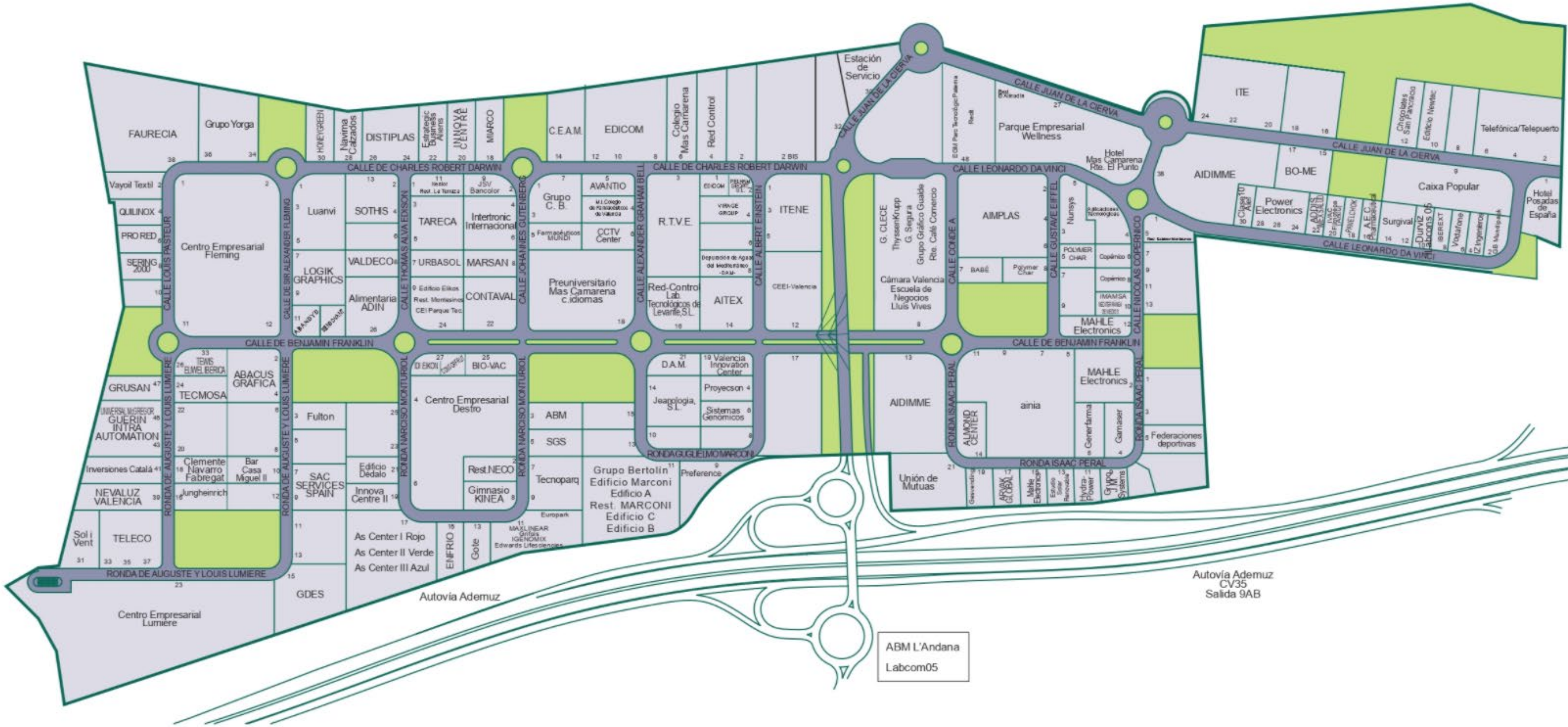
The Parc Tecnològic Paterna is therefore an infrastructure open to companies that value constant innovation, the importance of applied research, quality working conditions, good

[20] For further information on the conversion process of the EGM of the Parc Tecnològic Paterna, see the analysis work collected by Camisón et al., 2020.

communications, cutting-edge technical infrastructures and that are also environmentally friendly (Camisón et al., 2021) (See the following Figures 12 and 13 for the distribution of the park). Types of organisations currently installed in the technology park:

- Technology institutes. The Paterna Technology Park currently houses six of the eleven technology institutes in the Valencia Region, which are linked to different technologies such as wood, metal, energy, IT, transport and packaging, and food, among others.
- Business incubators (European Centre for Innovative Enterprises, -CEEI-).
- Business Training Centres (Chamber of Commerce and Luis Vives Business School).
- Companies with a firm commitment to R&D&I.
- Technological services and consultancy companies, in innovation or market consultancy.
- Clean industries and non-polluting manufacturing.

Figure 12. Map of Parc Tecnològic Paterna



Source: Parc Tecnològic Paterna (2022)

Figure 13. Services available at Parc Tecnològic Paterna

Source: Parc Tecnològic Paterna (2022)

3.4.5. Professional methodologies for diagnosing park typology

Despite the efforts made in the previous section to try to establish a clear conceptual line between both types of realities, including both the main contributions of the literature and very specific examples of each type of park, the reality is that heterogeneity is a defining characteristic of these models of territorial agglomeration. Amoroso et al. (2019) point out that the wide variety of agents that converge in the formation of this type of business agglomerations, including universities, government economic promotion agents, or other entities specialising in innovation management or with real estate interests, make it very difficult to establish a universal category that covers all the realities, their objectives and strategies (Kotlar et al., 2018).

In order to help in the above purpose of understanding the different strategic taxonomies of science and technology parks from a professional point of view, there is a specific software for this purpose called Strategigram[21]. The Strategigram is composed of seven strategic axes referring to the activity and objectives of the park as an institution in which the people who assume the management and responsibility for the infrastructure must make a decision (Lund, 2019; Bellavista & Sanz, 2009; Sanz, 2006, 2007) between two possible alternatives in each strategic axis[22]. As Lund (2019: 10) points out, the axes are strategic because there is a broad consensus on the importance of the factors included in this software solution, due to their long-term implications. The seven axes that make up the Strategigram are the following (Bellavista & Sanz, 2009; Sanz, 2006):

1. *Location and environment*

This axis reflects the degree of urbanisation of the science and technology park (Bellavista & Sanz, 2009). Thus, the extremes that make up this axis are the location in an urban or non-urban environment, with the midpoint corresponding to parks located in semi-urban environments. Although this axis may be subject to changes over time due to variables exogenous to the park's management, it is essential to take this variable into consideration when deciding on the creation of this type of business agglomeration (Lund, 2019; Bellavista & Sanz, 2009).

2. *Position in the knowledge or technology stream*

The main objective of a science and technology park is to increase the competitiveness of the hosted companies, regardless of whether they are mature or new technology-based firms (Lund,

[21] The Strategigram is a software tool developed in 2010 by IASP President Luis Sanz and made available to all parks that are members of this international association.

[22] The software not only provides a picture of the strategic profile to science and technology park managers, but also gives them access to a database in which they can identify other parks anywhere in the world with similar strategies and is therefore an excellent way to establish new contacts, or to carry out meaningful benchmarking processes (Bellavista & Sanz, 2009).

2019). To this end, it is essential to implement processes, mechanisms and actions that stimulate the generation and flow of knowledge from its creative sources (upstream) to its recipients (downstream) and even allow for feedback (Bellavista & Sanz, 2009). Although it is possible to assume that a successful science and technology park will work simultaneously with both knowledge-creating sources (research institutes, departments) and market sources, one of the two should predominate. In this sense, some recent research (e.g., Lund, 2019) points out that a park identified with the upper deciles in the upstream zone responds to the science park model; while one that is closer to the downstream zone would respond more to the characteristics of a technology park.

3. *Target firms*

This third strategic axis concerns the park management's predilection for attracting and hosting mature or existing companies in the market or whether it prefers to support the creation of new technology-based firms and spin-offs. Although many science and technology parks have both types of companies in their infrastructures, it is important to determine which group to focus efforts and priorities on, as this will determine how effectively the park can meet its expectations (Bellavista & Sanz, 2009; Sanz, 2006).

4. *Specialisation*

This axis determines to what extent the park management chooses to specialise in a single or a few technology sectors or whether, on the contrary, it adopts a more generalist approach in which companies belonging to numerous technology sectors of activity and fields of knowledge have a place in the park (Bellavista & Sanz, 2009). This selection largely determines the objectives, mission and specific programmes to be deployed in the park's infrastructures (Lund, 2019). Likewise, the choice will also be a good indication of the externalities that will occur between the resident organisations in the park: Marshallian if they belong to a few closely related industries, or Jacobian if they are from a priori unrelated industries.

5. *Target markets*

The fifth strategic axis analyses the emphasis that the park management places on attracting international companies as opposed to companies whose headquarters are located in the town or region where the science and technology park is located (Bellavista & Sanz, 2009). As in previous axes, there is no one positioning that is better than another, but it is important for park management to bear in mind that this choice conditions, among other variables, marketing objectives and budgets. It should be added that the focus on internationalisation is not only to attract international companies to the park, but also to ensure that the companies currently hosted in the park initiate and/or consolidate their own internationalisation process (Lund, 2019).

6. *Networking strategy*

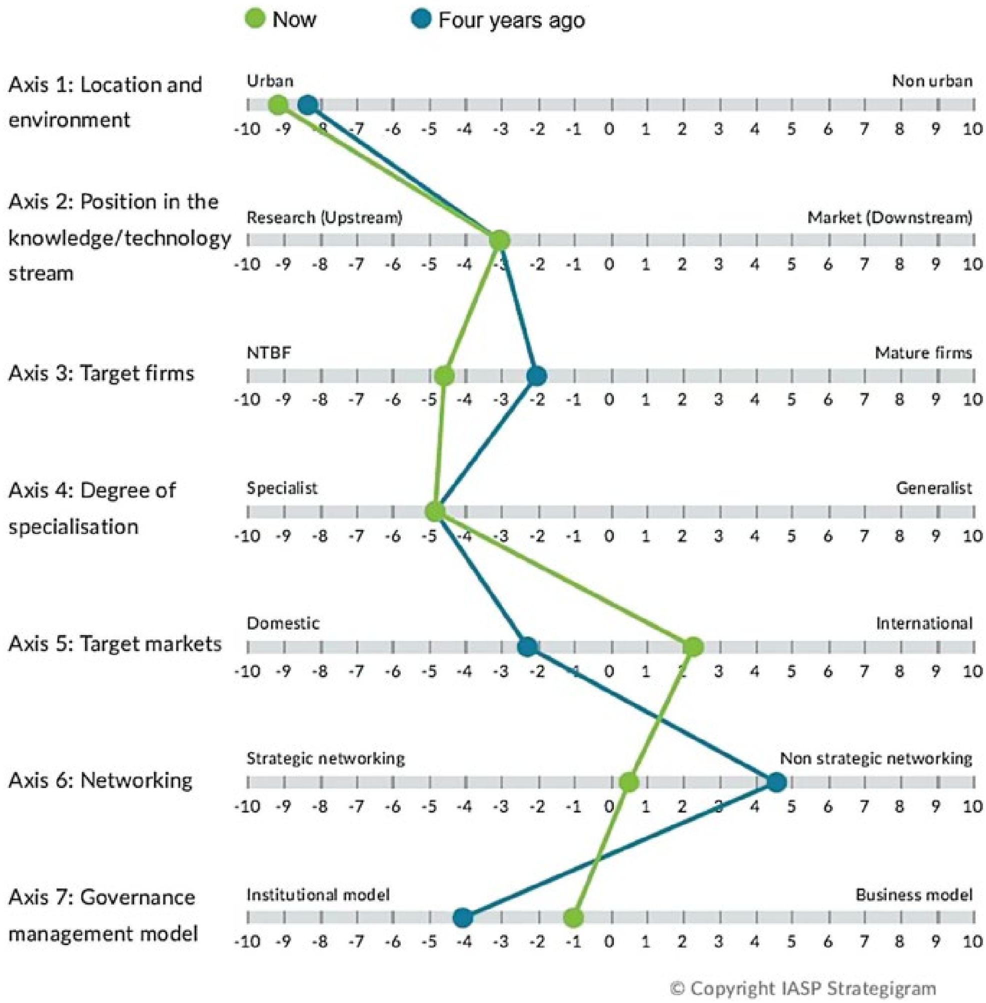
As in the previous axes, here the park's management team must also make a decision as to whether the management of the park's networks and its hosted companies are managed strategically or whether they prefer not to get involved (Bellavista & Sanz, 2009). Network management is not a simple task, but it is possible to foster the establishment of new ties between agents through events such as business events, workshops, entrepreneurship clubs, events for the park community, among other options. As the literature on knowledge management (e.g., Parry, 2017) points out, it is essential that the nodes of a network, such as that of a science and technology park, get to know and talk to each other, as this is how knowledge spillovers occur and the absorption of this knowledge can be improved. Science and technology parks that have reached a state of maturity not only focus on networking among internal agents, but also tend to involve institutions and organisations beyond their borders.

7. *Governance / management model*

Finally, the seventh axis of the Strategigram analyses the governance and management model of the science and technology park. It goes without saying that properly implemented governance and management institutions are essential for the success of the park. There are a number of variables to consider here (Lund, 2019; Bellavista & Sanz, 2009): composition of the governing bodies, profile of the park's CEO, human resource management policies (e.g., whether non-university staff will be allowed to hold management or governance positions), the legal form (foundation, private company, public ownership, etc.), to name but a few. Whatever formula is chosen, the contingencies it may impose in terms of bureaucracy of processes and decision-making must be taken into account.

Once the seven strategic axes have been completed, the Strategigram produces a graphical representation of the strategic profile of the science and technology park in question (see Figure 14 below). As can be seen in this example, the Strategigram has the advantage that it not only allows the strategic profile to be established at a given moment, but also facilitates the diagnosis of the park's evolution over time or, as mentioned above, benchmarking processes with other science and technology parks.

Figure 14. Example of Strategigram



Source: Lund (2019: 19)

3.5. LITERATURE REVIEW ON SCIENCE AND TECHNOLOGY PARKS USING BIBLIOMETRIC ANALYSIS AS A SUPPORT

In order to assess the contribution that previous literature has made to the state of the art on science and technology parks in the field of management, a bibliometric analysis based on keyword co-occurrence will be used here (Lou & Qiu, 2014). This type of word co-occurrence analysis reveals the structure of a certain topic in a discipline, as well as the most relevant related key concepts (Waltman et al., 2010). Bibliometric analysis is a widely used technique in the business organisation and strategic management disciplines in general (e.g., Farrukh et al., 2021; Forés et al., 2021; Mas-Tur et al., 2020), but also in the agglomeration literature in particular (e.g., Fuentes-Barrera et al., 2021; García-Lilllo et al., 2015).

This technique has also been used previously in the analysis of the literature on science and technology parks, although it is true that five years have passed since the last publication on this topic (Mora-Valentín et al., 2018). This last major bibliometric study also analyses the entire literature on science and technology parks; therefore, although it is a valuable study, it does not focus on the main contributions of the study of science parks in the field of management. Other research (e.g., Bengoa et al., 2021; Yeo et al., 2015) on topics closely related to the science and technology park literature, such as technology transfer, addresses the study of this business agglomeration model, albeit very succinctly. All this makes it necessary to carry out a new analysis that provides us with knowledge and helps us in the bibliographical review of the main contributions in the literature.

For the identification and collection of scientific articles following previous articles in the literature (e.g., Forés et al., 2021) we have chosen to use and combine the results of two of the most prestigious academic databases in the world, Clarivate Web of Science (WOS) and Scopus. The last data retrieval was carried out in July 2022 in order to keep the analysis as up to date as possible. To obtain an overview of the literature on science and technology parks in the field of management, we entered the following search instruction in the Clarivate WOS search engine: TS=("science and technology park*" OR "technology park*" OR "research park*" OR "technopole*" OR "science park*"). Filters were applied so that the search engine only returned scientific articles in the subject area of management. The result obtained after applying the above filters was 433 records.

We repeated the process in the Scopus database, replicating the search instruction, for those scientific articles that contained any of the words included in the instruction in the title, abstract or keywords. Again, the results were filtered only for the category of management, business and accounting, and for publications of scientific articles. The result obtained was slightly higher with 573 records. The specific instruction for the Scopus database was as follows: TITLE-ABS-KEY (("science and technology park*" OR "technology park*" OR "research park*" OR "technopole*" OR "science park*")) TO (DOCTYPE, "ar")) AND (LIMIT-TO (SUBJAREA, "BUSI")). Therefore, without performing any additional procedure for the time being, a total of 1006 results have been obtained between the two databases.

The above summation of records does not take into account that there may be some duplicate records. In order to solve this problem, to facilitate the review of the records and to integrate the output of both databases into a single file for further processing, Zotero software has been used.

This software allows sorting and organising bibliographic records, detecting duplications and exporting the researcher's entire library in Research Information System (RIS) format, useful for the use of other bibliographic and network analysis software (Ahmed & Dhubaib, 2011; Duong, 2010). In addition, it also allows export in other formats useful for research purposes such as .CSV. Thus, after dumping both databases, we were able to detect with the software that there was a total of 223 duplicate records. After this first cleaning, the resulting database remained at 783 records.

Occasionally, the Scopus and Clarivate WOS databases, due to the high volume of records they handle, can make errors in the categorisation of records. With Zotero we were also able to verify that, in the databases integrated in our library, book chapters were catalogued as scientific articles. Specifically, 15 records were removed from our library because they were incorrectly identified as scientific articles when in fact, they were book chapters. After this filtering process, our library with the two integrated databases has a total of 767 records.

Likewise, in order to ensure that the results are as reliable and aligned with our objectives as possible, the 767 records are exported in .CSV format so that, from a spreadsheet, each of them can be reviewed in depth[23]. In this spreadsheet we have marked records to be deleted for one of the following five reasons: (I) the language is not English (we find articles in Spanish, Portuguese, Russian, or German, among others); (II) because they are introductions to special issues and, therefore, do not provide disruptive knowledge to the research; (III) because they are studies that address parallel but differentiated realities, as noted earlier in this doctoral thesis (such as industrial districts or incubators); (IV) because although some of the search terms are included, they are not the object of study or are not linked to business management; or, (V) because their information records were incomplete and could therefore be misleading. Using the spreadsheet, a new process of double-checking duplicate items could be carried out. Subsequently, the records flagged in the spreadsheet (a total of 381) were removed from the Zotero library, resulting in a final base of 386 records.

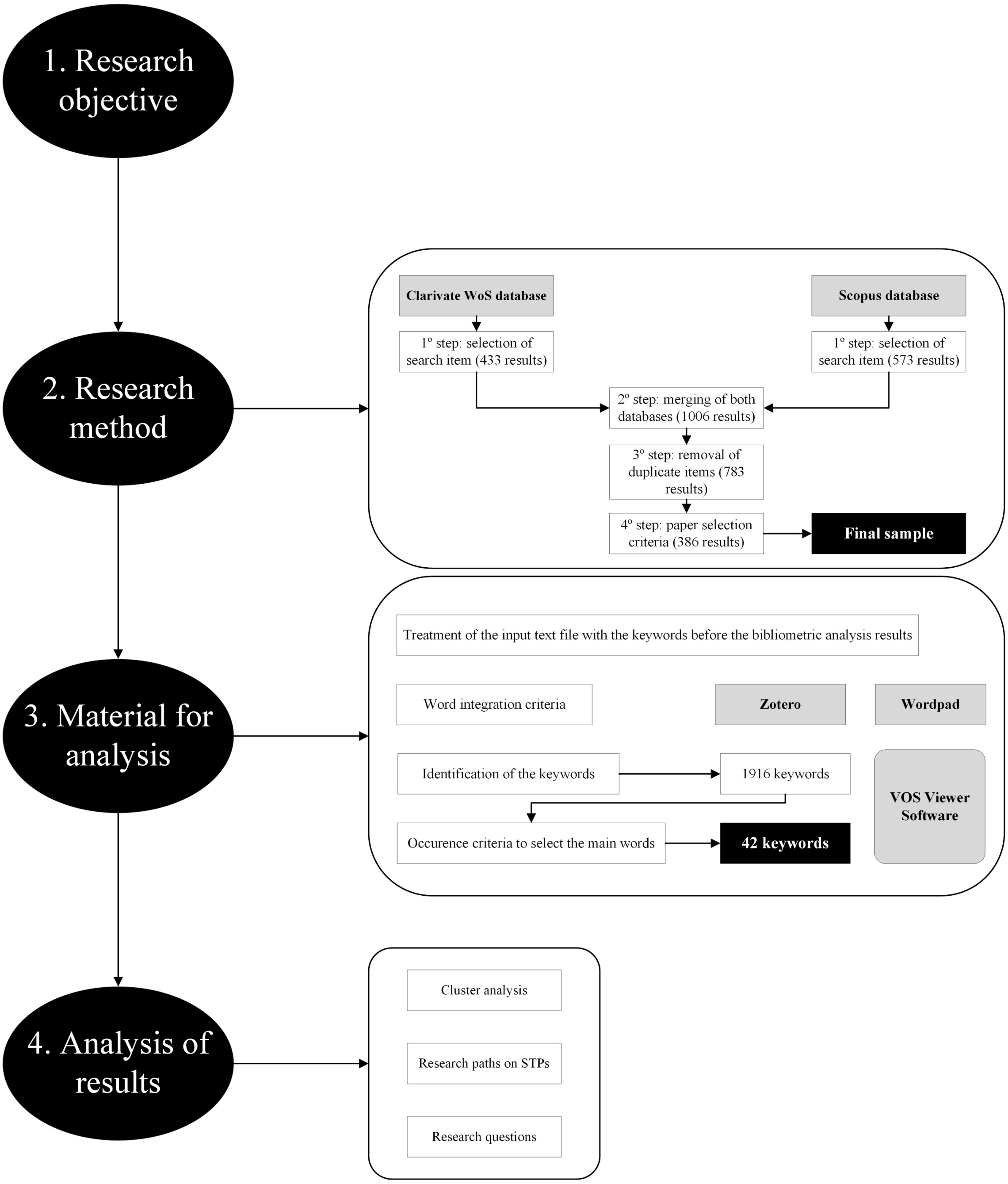
This final database has been exported again in RIS format in order to be able to dump its content in the specific software for bibliometric analysis VOSviewer. As in previous research (e.g., Forés et al., 2021), we performed a treatment of the exported file before exploiting the final results with VOSviewer. Specifically, we integrated words that had similar meanings (e.g., cooperation, collaboration), acronyms (STP) and the singular and plural forms of the keywords. In this way, the results truly reflect the weight of the concepts in the literature and avoid biases (Forés et al.,

[23] The export contains, among other publication data, aspects such as title, abstract, keywords, authors, or journal. In those records in which this information was insufficient to carry out an adequate filtering, it has been decided to directly access the complete publication.

2021). Subsequently, for the preparation of the bibliometric analysis, the data linked to the 386 scientific articles obtained after the previous research process were dumped into the VOSviewer software tool. The following Figure 15 shows the whole procedure for the elaboration of the bibliometric analysis.

The VOSviewer programme allows the analysis of scientific literature through the visualisation of the most frequent keywords and their connecting links by weaving bibliometric networks. These bibliometric networks can be established on the basis of citation, bibliographic coupling, co-citation, co-occurrence or co-authorship relationships (van Eck & Waltman, 2010; Waltman et al., 2010). In our case, we will use the option of co-occurrence of keywords entered by authors when writing scientific papers (van Eck & Waltman, 2010; Waltman et al., 2010).

Figure 15. Bibliometric research procedure



Source: own elaboration

Figure 16 visualises the word networks, while Figure 17 shows the densities of the words. Finally, Figure 18 shows the evolution of the network and the terms most frequently used by scientific research over time. The above figures were drawn up by taking the 1916 keywords (entered by the authors), to which the filter was applied to obtain a minimum number of 10 co-occurrences between them. The literature specialising in the elaboration of bibliometric studies (e.g., Appio et al., 2014) suggests that a minimum of 5 co-occurrences is required to obtain reliable results. In our case, we have doubled this figure and introduced a minimum of 10 co-occurrences in order to obtain results that reflect as closely as possible the most recurrent words that make up the fundamental corpus of the literature on science and technology parks.

After applying the above minimum co-occurrence filter, VOSviewer indicates that there are 49 keywords to create the bibliometric network. Prior to the final step and allowing the software algorithm to build the bibliometric network based on a cluster analysis of the concepts (van Eck & Waltman, 2010), 7 words have been excluded due to their high degree of ambiguity or low possibility of relationship with the rest of the keywords (e.g., determinants, impact). Therefore, the bibliometric networks shown in Figures 16, 17 and 18 below are based on a co-occurrence analysis of a total of 42 keywords. The software has grouped these keywords into 3 clusters. The composition of each of these clusters is shown in the following Table 12. Through this process it will be easier to assess the main theoretical and empirical contributions to the literature on science and technology parks, to check the areas of further study and to detect possible gaps to contribute to future lines of research (e.g., Forés et al., 2021).

Table 12. Keyword clusters

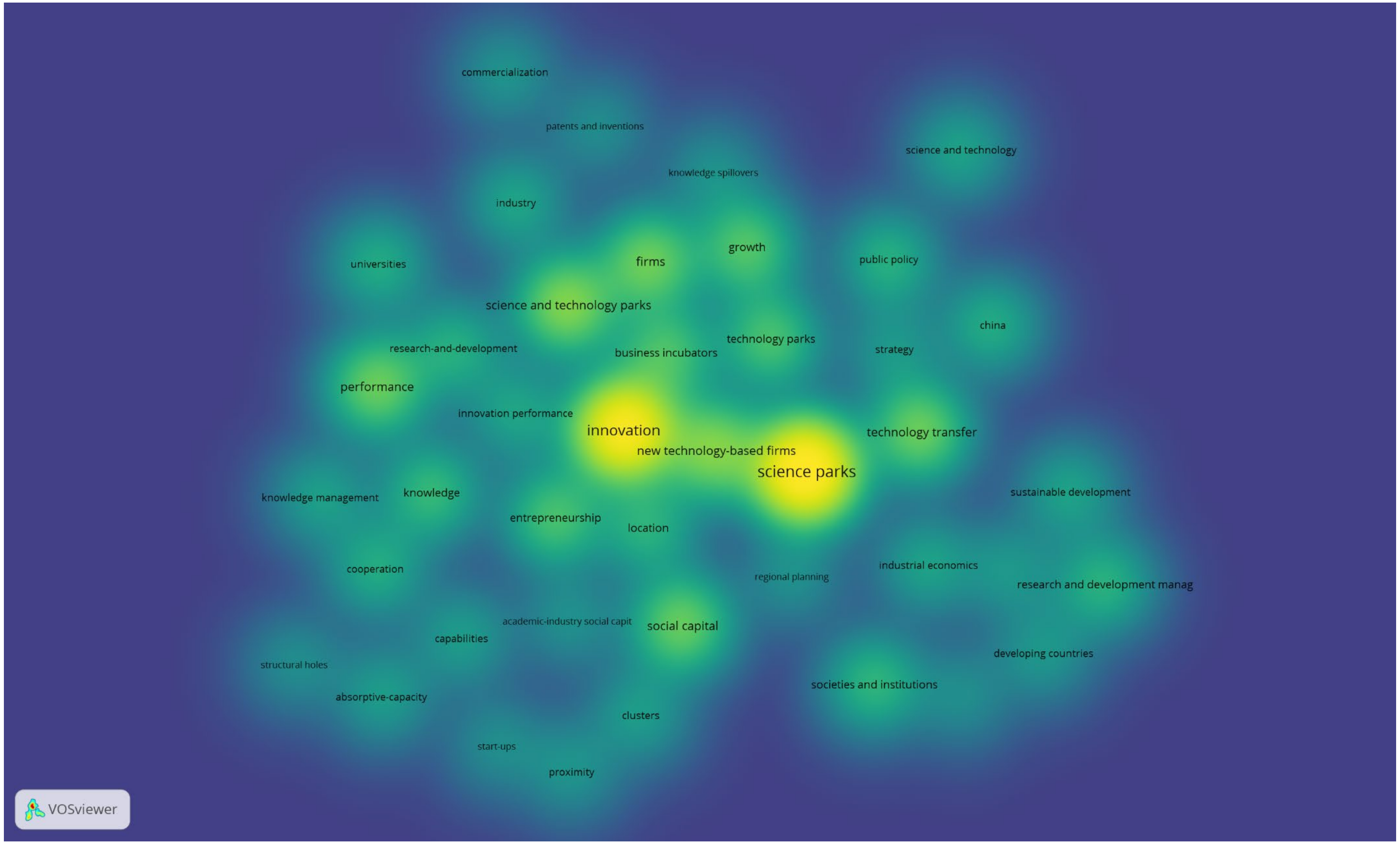
Cluster 1	Cluster 2	Cluster 3
-Absorptive-capacity -Academic-industry social capital -Business incubators -Capabilities -Clusters -Cooperation -Entrepreneurship -Innovation -Innovation performance -Knowledge -Knowledge management -Proximity -Social capital -Start-ups -Structural holes -Technology parks	-China -Developing countries -Industrial economics -Industrial management -Industrial research -Public policy -Regional planning -Research and development management -Science and technology -Science parks -Societies and institutions -Strategy -Sustainable development -Technology transfer	-Commercialisation -Firms -Growth -Industry -Knowledge spillovers -Location -New technology-based firms -Patents and inventions -Performance -Research and development -Science and technology parks -Universities

Source: own elaboration

Figure 16. Co-occurrence word network

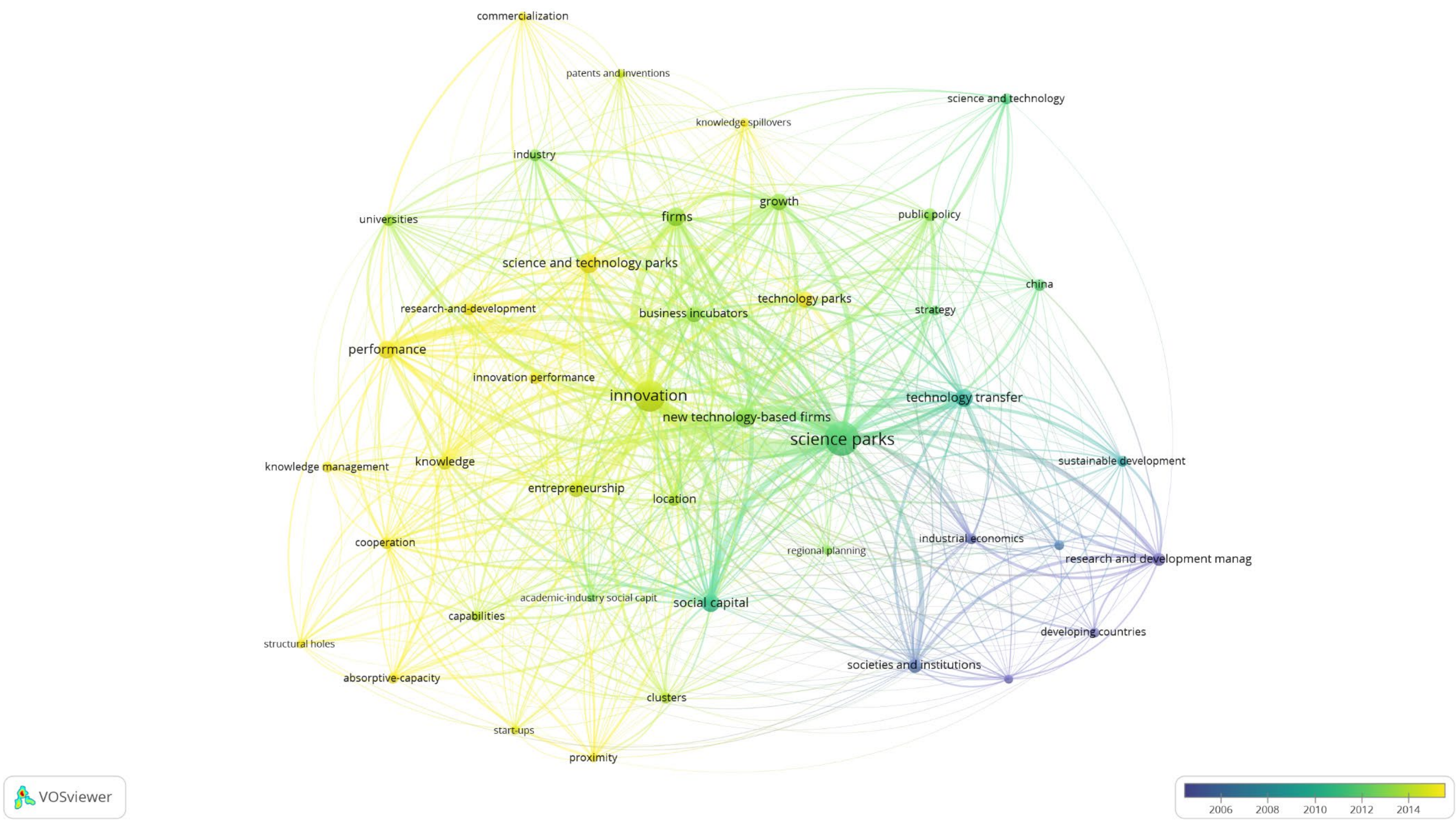
Source: own elaboration with VOSviewer

Figure 17. Density of the network



Source: own elaboration with VOSviewer

Figure 18. Network evolution



Source: own elaboration with VOSviewer

3.5.1. Theoretical and empirical studies assessing the contribution of science and technology parks at the business and regional level in the management literature

Theoretical studies

Theoretical contributions seek to delve deeper into the key factors that condition the successful promotion of a science and technology park. Poonjan and Nygaard (2020) conduct a systematic literature review to assess the impact of five regional factors (university and other research institutions, industrial structure, institutional context, financial support and urbanisation) that need to be fully assessed and understood in order to properly estimate their impact on the performance of the science and technology parks. The authors' framework of regional factors is useful for improving the design and performance of projects to promote this type of infrastructure. They conclude by conceptualising parks as structures that are adaptable or mouldable to the conditions of their environment and, therefore, heterogeneous, in which coordination between regional and national policies is essential for their correct development and performance.

Given that the science and technology parks are characterised by being territorial agglomerations of companies planned on numerous occasions by national or regional governments (Magro and Wilson, 2018), Millar et al. (2005) analyse for the specific case of China the potential role that the state has in the promotion of entrepreneurial activities and in the promotion of science and technology parks. The study also introduces a theoretical typology for the classification of science and technology parks according to the degree of state involvement in their creation and promotion. Given that this classification does not add new knowledge to others previously discussed (see section 3.4.), its commentary does not require further clarification.

In a combination of the above aspects (the role of the state and the importance of regional factors) Russell and Moss (1989) make recommendations for the planning and successful implementation of science and technology parks in developing economies or less developed areas in established economies. This research focuses on the fit between regional circumstances and endowments, the strength of the university system, and the requirements and demands of the market to achieve successful deployment of the science and technology park project. This research also recognises the heterogeneity of each project, and therefore new initiatives should not be conceived as mere imitations of other infrastructures developed in contexts that differ in the above-mentioned aspects, but which are considered models for imitation (e.g., Silicon Valley). Failure to take this into account may lead to the failure of the initiative to create a new science and technology park.

With respect to the morphology of science and technology parks, Gibson et al. (2013) conceptualise science and technology parks as micro-clusters to analyse the anatomical composition of these infrastructures and their internal functioning, as well as their impact on the local economy. The components of their model comprise: park management support organisations, export-oriented technology firms, incubator-based technology firms, park tenant support organisations and community service support organisations.

Unlike other models of territorial agglomeration, the science and technology parks have been characterised since their beginnings, with the first experiences in the United States and the United Kingdom, by having a management and administration team for the facility (Camisón et al., 2020; Lecluyse et al., 2019). However, the responsibilities of this management body must go beyond mere economic-financial management. Huibing and Nengli (2005), through an analysis of the state of science and technology parks in China, state that for these infrastructures to act as real hubs in the information networks between different regional actors (universities, R&D centres, companies), the managing bodies of science and technology parks must adopt measures to promote and stimulate the flow of information through interaction between these agents.

Leyden et al. (2008) note that a firm's decision on whether or not to locate in a science and technology park will be strongly influenced by its ability to take advantage of externalities (especially knowledge spillovers) from other organisations hosted in the park and from the university, if the latter has links with the science and technology park. In this sense, the study by Albahari et al. (2010), also through a review of the literature, explains that science and technology parks infrastructures can provide important support to the R&D activities of both host companies and other organisations such as public research organisations.

Theoretical studies also appear in the literature which, after analysing recent contributions on the subject, propose new lines of future research. This is the case, for example, of Link and Scott (2007), who point to the need to delve more deeply into the aspects linked to knowledge transfer and the impact of these science and technology parks on regional economic development. In this article, the authors make an interesting contribution to political agents involved in the promotion of this type of infrastructure, encouraging them to participate as investors in projects that do not have sufficient economic profitability, but which offer high social value. Link and Scott (2015) update and expand on these recommendations.

Phan et al. (2005), based on a review of articles, analyse the state of the art of the science and technology parks literature at four levels of analysis: science parks and incubators, the companies hosted in these infrastructures, the entrepreneurs and entrepreneurial teams belonging to the companies and, finally, the systemic level (university, region or country) in which the science and technology parks infrastructures are based. The review concludes by pointing out that, although there is no common framework for thinking about the study of the science and technology parks phenomenon, there are still numerous opportunities for further advancement of theoretical construction and subsequent empirical validation.

Lecluyse et al. (2019), after conducting an in-depth analysis of the literature published on the subject, propose an input-mediation-output research model aimed at advancing the state of the art. Their proposal brings together in each of the three clusters that make up the model the variables of interest that previous research considers relevant in the study of the reality of science and technology parks, and groups them according to whether they are related to regional variables (e.g., creation of new companies, economic growth), represent idiosyncratic characteristics of the science and technology park under study (e.g., ownership and management structure, image, prestige), or are qualities of the host companies (technological and financial resources, network of contacts, innovative performance).

In the theoretical literature it is also possible to find research that presents a more pessimistic view of the contribution of science and technology parks to the dynamics of regional growth and the positive effects for host firms that some of the previous studies have pointed to. Thus, Quintas et al. (1992), after reviewing the studies published for the case of science and technology parks in the United Kingdom, conclude that the existing evidence does not confirm the canonical statement that science and technology parks act as a mediating infrastructure between academic research and industrial activity. The authors consider that the science and technology model remains anchored to the linear model of innovation and suggest other alternatives for closer links between academia and industry, such as technology transfer offices and collaborative R&D programmes.

Following the previous approach, Siegel et al. (2003b) conduct a new review of the existing empirical literature comparing the performance of firms located in a science and technology park versus their non-hosted counterparts for the case of the UK. Their analysis shows that the benefits of locating in a science and technology park in terms of performance are negligible. The authors conjecture that the absence of the location effect may be due to imprecise estimates of the results in the literature, but they argue more strongly for an effect caused by the heterogeneity of the science and technology parks (closer to the science or technology subtypes) in the research reviewed.

Along the same lines, Massey et al. (1992), in an extensive monographic volume, reviews the foundations on which the phenomenon of science and technology parks is based, their relationship with local economies (analysing cases such as those of the cities of Aston and Cambridge) and the political implications in the promotion of these infrastructures. This study shows that it is very difficult for tenant firms to access the university knowledge needed to generate innovation. The scarce presence of links between academia and business leads the authors to conclude that the science and technology parks are just a "technological fantasy" or "political myth" that have induced a set of unsuccessful knowledge transfer policies.

Empirical studies

The empirical literature on the effect of science parks on aggregate variables at regional and firm level is far from conclusive. Thus, as will be reported below, there are studies that obtain conflicting results on certain variables at both firm and regional level. However, it is worth noting that the studies that conclude that the effects of science parks are beneficial for the companies that are hosted in their infrastructures and the regions in which they are deployed are in the vast majority. Even so, in many cases, the scarcity of adequate indicators to assess the contribution, the lack of information on the total investments made and, particularly, "the excessive political use that has been made of these initiatives" make it difficult to draw irrefutable conclusions about the effect of these technological enclaves (Vedovello et al., 2006: 2). In the following, we will present a list of the various outcomes expected from the creation and development of science parks at the regional and company levels indicated above, based on the literature obtained from the above bibliometric analysis.

Beginning with the contributions that science and technology parks can make to the region they create and promote, there is an abundance of literature indicating that one of the main effects of the deployment of this type of technology enclaves is the creation of new companies. Numerous studies abound in the literature confirming this driving effect of science and technology parks on the birth of new businesses. Studies such as Ratinho and Henriques (2010) for Portugal, Hansson et al. (2005) on the experience in Denmark and the United Kingdom, Link and Scott (2005) in the United States and Wonglimpiyarat (2010) in a Thai study stand out here. Science and technology parks are infrastructures whose promotion lies precisely in this objective of stimulating entrepreneurship and the creation of innovative companies (e.g., Amoroso et al., 2019).

Another of the main regional objectives that the promotion of a science and technology park should aim to meet, and which in fact lies in its very *raison d'être* as an instrument of industrial policy and stimulus to regional growth, is the attraction of international companies. The attraction of external companies to the region can be beneficial either because of the size of these companies or because of their innovative capabilities which, in any case, have a powerful tractor effect on the regional fabric, which may be lagging behind or lacking in such capabilities (e.g., Camisón et al., 2020; Zou & Zhao, 2014; Hansson et al., 2005). Special mention should be made of the article by Zou and Zhao (2014), in which the authors conduct an in-depth case study of the Tsinghua University Science Park in China. The authors highlight how the boost to university research and the active search to attract large companies has turned this technological enclave into a pole of attraction for large international companies of renowned prestige, providing a boost for the local fabric.

A third effect expected by the promoters of a science and technology park in a region is that it will help to improve employment ratios in the region, especially in skilled employment or to reorient the regional workforce towards new skills (Amoroso et al., 2019). This is particularly pressing when a science and technology park is located in countries or regions with high structural unemployment, as is the case in Spain (e.g., Vilà & Pagés, 2008), Portugal (e.g., Ratinho & Henriques, 2010); or Greece (e.g., Sofouli & Vornotas, 2004). However, there are also studies that analyse job creation in countries that lack this problem of high structural unemployment, such as the United States (e.g., Goldstein, 1992) or Canada (e.g., Shermaur & Doloreux, 2000). Interestingly, Shearmur and Doloreux (2000), using data from 17 science and technology parks opened in Canada, claim after an empirical study that there is no direct link between the opening of a science and technology park and regional employment growth in high-tech sectors of the economy.

Another expected objective of the promotion of a science park in the region is to strengthen the links between business and universities. The results of the literature in this regard are ambiguous. In the case of Spain, a study by Caldera and Debande (2010) states that universities with established science and technology parks have better knowledge transfer results, measured by the volume of university research units contracted by companies. In contrast, Dierdonck et al. (1991), using a database of firms located in eleven science parks in Belgium and the Netherlands, confirms that there is a certain isolation of these firms, as less than one third worked closely with the local university. Surprisingly, these same companies do have close relationships with other entities in other regions of the country or abroad. The above results yield interesting conclusions by pointing to this tension between regionally localised knowledge, which may be redundant and known, and how these firms choose to use the park as a platform for accessing new, possibly unfamiliar, and more exploratory sources of knowledge (March, 1991; Granovetter, 1985).

The degree of formality of information flows is also variable and seriously influences the establishment of these university-business relationships. Thus, a study by Bakouros et al. (2002) of three Greek parks confirmed that only in one of them had formal links developed between the companies in the park and the university. However, more informal links did exist. Vedovello (1997) critically notes in this respect that research in this area has traditionally focused only on formal relationships (e.g., consultancy contracts) while neglecting the importance of more informal relationships (e.g., social relationships). In this respect, studies of Swedish science and technology parks by Lindelöf and Löfsten (2001, 2002) empirically confirm that a relatively high percentage of companies and parks maintain links with local universities, with collaboration being formalised through informal contacts or through job offers to university graduates. Other research confirming the importance of informal contacts in different geographical contexts include Phillipmore (1999)[24] and Massey et al. (1992). Another study focusing on Spanish parks questions the importance of informal links for non-market issues, such as innovation management, as it states that this type of collaboration is channelled through formal contracts and agreements (González Vázquez, 2006).

Finally, this sub-section cannot be closed without dedicating a small note to the main concern of the more classical views of territorial agglomerations of firms already explained in chapter two of this doctoral thesis, which is their impact on the economic growth of the region. Here it should be said that multiple case studies abound in numerous regions across the world: Sweden (e.g., Feldman, 2007), United Kingdom (e.g., Minguillo & Thelwall, 2015), China (e.g., Miao & Hall, 2014), or France (e.g., Barbera and Fassero, 2013). Here again, there is no single answer in the literature. While the study by Chow (2007) explains that China's Hsinchu Science Park has become the hub of polycentric development in the region on which it sits, promoting its development, other research presents fewer flattering results. Thus, a qualitative study on a set of cases in Portugal (Ratinho & Henriques, 2010) highlights that the contribution of science and technology parks to the growth of the national aggregate is modest, and that it will depend fundamentally on the management skills and practices of the entity that coordinates the day-to-day running of the park.

The management literature has also put a lot of emphasis on trying to uncover the benefits that integrating a company into a science and technology park can have for certain measures of firm performance. We will concentrate on two that seem to be the most recurrent in the literature, economic performance and innovative performance. In both cases, although the vast majority of the literature agrees that the positive effects derived from the location in a science and technology park are beneficial for the above performance measures, there are also studies that point to a non-significant effect.

Starting with the impact of location in a science park on the economic performance of the firm, there are numerous studies that have tried to explore this relationship (e.g., Arauzo-Carod et al.,

[24] It is important to note that Phillipmore's (1999) study for the Australian case points out that informal linkages occur with universities that are local or adjacent to the science and technology park where the firms are hosted. In contrast, in other studies such as that of Vedovello (1997) for the British case, these informal links occur to a greater extent with non-local universities. Miguillo et al. (2015) also point out that the relationships of organisations hosted in a science and technology park often involve non-collocated agents. This disparity in results underlines that the value of geographical proximity is different in different contexts, and that the importance of other types of proximities should be taken into account in these analyses (Knoben & Oerlemans, 2006; Boschma, 2005).

2018; Lamperti et al., 2017; Dettweiler et al., 2006). Some studies such as Colombo and Delmastro (2002) confirm a statistically significant effect between location and economic performance. Other recent studies, such as Arauzo-Carod et al. (2018) validate the previous statement, although they qualify it and indicate that this positive relationship only occurs for firms with high growth potential.

However, there are also abundant studies such as Lamperti et al. (2017) on a sample of 256 Italian firms that confirm a statistically non-significant effect of location in a science and technology park on firm performance. The same results are obtained by Ferguson and Olofsson (2004) for the Swedish case and Liberati et al. (2016) again, in the Italian context. Vásquez Urriago et al. (2010) in an econometric study on a broad base of Spanish firms conclude that the location of firms in science and technology parks contributes to improve the rates of new product sales (measured as a percentage of total sales). However, in the limitations of the paper the authors argue that the microeconomic reasons for such effects need to be further explored. Löfsten and Lindelöf (2001) make a comparative analysis between a group of new technology-based firms located in Swedish science and technology parks and a group of firms with similar characteristics outside the parks and conclude that there is no direct relationship between the location in a science and technology park and the profitability of these firms.

Regarding the effects of the location in a science park on the improvement in the innovative performance of the firm, a study by Albahari et al. (2017) on the case of Spanish science and technology parks concludes that the effect is beneficial if the innovative performance is measured through patents. However, the effect is negative when performance is measured through the number of new products launched on the market. Díez-Vial and Fernández-Olmos (2016), also claim that the positive effect of location on innovative performance only occurs during the earliest stages of the life cycle of the firm hosted in a science and technology park. Moreover, Ubeda et al. (2019) confirm this beneficial effect, but only when the hosted firms have adequate absorptive capacity (Cohen & Levinthal, 1990). This study points to one of the main axioms that will guide the drafting of the hypotheses in chapter 5 of this PhD thesis: firstly, the effect of the science and technology park on firm performance can never be direct, it will depend on certain mediating variables, as in this case absorptive capacity; and secondly, it recognises through the above that collocated firms are highly heterogeneous.

Other studies such as Filatochev et al. (2011) or Montoro-Sánchez et al. (2011) confirm that the company integrated in a science and technology park can improve its innovation ratios by taking advantage of the knowledge spillovers that are concentrated in these environments, derived from their relationships with universities and higher research centres. In contrast, Löfsten and Lindelöf empirically confirm that firms located in Swedish science and technology parks do not show a better innovative performance (measured in the form of new product development, patents, etc.) than those located in other external environments (Löfsten and Lindelöf, 2001). The authors conclude in this paper by arguing that science and technology parks are perhaps more suited to the purposes of a learning centre rather than innovation promotion.

In developing countries, these infrastructures have also been used to promote business competitiveness and regional development, although the results of existing work question the ability of science and technology parks to improve the innovation ratios of host firms. A study by Radosevic and Myrazkhmet (2009) on science and technology parks in Kazakhstan confirms that these spaces are ideal for business incubation processes, but these firms are not found to be more innovative than their non-located counterparts. The authors suggest that the strongest incentive for Kazakhstani firms to locate in a science and technology park rests on financial and image variables, such as a comparatively lower rental price, and better access to financial funds. This coincides with the results obtained by Felsenstein (1994) for the Israeli case, where the role of science and technology parks is to strengthen the position of innovative firms by conferring them status and prestige, although they have had less impact on technology transfer and the channelling of information flows to spur innovation in firms. However, from the above review there is a gap in reference to the measurement of firm performance from the triple lens of sustainability, a gap that this thesis aims to help fill. The following Table 13 lists some of the most representative empirical contributions to the literature on science and technology parks[25].

[25] In this Table 13, as in chapter 6 on methodology and results, the acronym STP will be used to refer to science and technology parks and NTBF to refer to new technology-based firms.

Table 13. Most representative empirical research in STP literature

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
Arauzo-Carod et al., 2018	The role of science and technology parks as firm growth boosters: an empirical analysis in Catalonia	Regional Studies	Quantitative	Sample set composed of 170 companies hosted in 12 STPs in Catalonia and 7190 companies not located in STP.	-Sales growth - Employment growth	-The effect of location in a STP on firm growth is dual, benefiting firms with a high growth rate and harming those with a lower growth rate. On the other hand, differentiating between the sub-types of parks (science or technology), the effect of location on business growth is greater in the first case.
Albahari et al., 2017	Technology Parks versus Science Parks: Does the university make the difference?	Technological Forecasting and Social Change	Quantitative	A sample of 37,201 Spanish companies, 849 of which are located in STP. In total there are 25 STPs belonging to 12 Spanish regions.	-Innovative performance (sales of new products) -Cooperation agreements with the university	-Firms located in science parks perform better in patents, but perform worse in the sale of new products. The pattern is the opposite for firms located in technology parks. -With respect to the probability of establishing cooperation agreements with universities, the results show a positive effect, although not significant for any type of park considered.
Berbegal-Mirabent et al., 2020	Mission statements and performance: An	Long Range Planning	Qualitative	20 questionnaires completed by STP	STP performance (budget,	Including more mission components in a STP's mission statement does not necessarily lead

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
	exploratory study of science parks			managers located in 11 Spanish regions.	established companies, turnover of companies, creation of spin-offs)	to a positive impact on technology transfer outcomes and STP performance. The authors suggest using short and concise mission statements that clearly articulate who the customers are, what products/services are offered and what the geographical scope is.
Blázquez et al., 2020	Science and technology parks: measuring their contribution to society through social accounting	CIRIEC-España, Revista de Economía Pública, Social y Cooperativa	Quantitative	Data from 346 organisations hosted in 4 STPs (Basque Country and Sweden) and from 30,609 organisations belonging to the regions of these STPs but not located in their infrastructures.	Social value	The social value created by firms located in STPs is higher compared to their regional counterparts not located in their infrastructures. However, when considering the social value created per employee, the results differ.
Colombo y Delmastro, 2002	How effective are technology incubators? Evidence from Italy	Research Policy	Quantitative	Sample of 45 technology-based companies located in Italian STP and a similar sample set of companies not located in STP.	R&D intensity	Firms' R&D intensity, an indicator of innovative input, is not significantly different between the categories inside and outside the STP; the difference in innovative output measured by patenting activity is also insignificant in the authors' sample. However, the authors find positive effects of park

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						integration on variables such as firm growth, university links or reputation in terms of marketing.
Díez-Vial y Fernández-Olmos, 2016	The effect of science and technology parks on a firm's performance: a dynamic approach over time	Journal of Evolutionary Economics	Quantitative	A total of 9,612 Spanish companies of which 456 are located in STP.	- Growth of the company (sales and employment) -Innovative performance (percentage of sales accounted for by new products)	Park membership has a positive effect on the growth and innovativeness of a company. This effect is not constant over the life cycle of the firm. Maturity has a negative effect on firm growth and innovation because, as the industry matures, opportunities to increase sales and innovate tend to diminish. Park membership does not mitigate this problem; on the contrary, it accentuates it.
Díez-Vial y Montoro-Sánchez, 2016	How knowledge links with universities may foster innovation: The case of a science park	Technovation	Quantitative	76 enterprises located in the Madrid Science Park.	Innovation capacity	The study empirically evidences the importance of maintaining formal and informal links with universities in order to obtain greater technological knowledge. This knowledge is also relevant for improving firms' innovation capabilities. Firms that act as technological knowledge intermediaries also improve their innovation performance.

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
Díez-Vial y Fernández-Olmos, 2015	Knowledge spillovers in science and technology parks: how can firms benefit most?	Journal of Technology Transfer	Quantitative	11,201 enterprises located in 76 Spanish science and technology parks (PITEC longitudinal dataset).	Product innovation	Prior co-operation links with universities and other research organisations are key to absorbing new knowledge applied to more innovative products. In order to improve the performance of product innovation, internal R&D efforts must be combined with knowledge exchange with other companies in the park.
Ubeda et al., 2019	Do firms located in science and technology parks enhance innovation performance? The effect of Absorptive capacity	Journal of Technology Transfer	Quantitative	3,844 enterprises of which 345 are located in a STP (PITEC longitudinal dataset).	Innovation performance (percentage of new products over turnover for the firm and market at time *t*)	These authors make a taxonomic classification of firms according to their degree of absorptive capacity, which is a determining factor in considering whether their location in a STP is beneficial for their innovative performance. Interestingly, the firms that benefit most are those with a medium level of absorptive capacity.
Filatotchev et al., 2011	Knowledge spillovers through human mobility across national borders: Evidence from	Research Policy	Quantitative	1,318 high-tech enterprises localized in Zhongguancun Science Park (panel dataset 2000-2003).	Innovation performance (number of patents)	The study demonstrate that returnee entrepreneurs are an important source of external knowledge spillovers. This knowledge spillovers positively impacts on innovation performance

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
	Zhongguancun Science Park in China					of local firms. However, the impact is moderated by the absorptive capacity of local firms.
Fukugawa, 2013	Heterogeneity among science parks with incubators as intermediaries of research collaboration between start-ups and universities in Japan.	International Journal of Technology Transfer and Commercialisation	Quantitative	7,330 Japanese firm-year observations and 165 of them are located in science parks with incubators.	Interactive university linkages (measured as cooperative research)	The mere proximity of a science and technology park to a university does not guarantee the establishment of joint research projects between on-park firms and university research teams. On the contrary, the author's results point to the importance of the park's management team in facilitating the establishment of these links between companies and universities. However, it is not a matter of having a large management structure, but rather a specific number of managers with a varied professional background, and with ample social capital that facilitates the weaving of social networks between on-park firms and university research teams.

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
Fukugawa, 2006	Science parks in Japan and their value-added contributions to new technology-based firms	International Journal of Industrial Organization	Quantitative	Panel dataset that consists of 3 periods, 74 on-park and off-park NTBFs, and 138 observations. We also identified 31 NTBFs located in incubation centers and 34 NTBFs located in industrial parks. All the firms are located in Japan.	knowledge interaction with HEIs	NTBFs located in Japanese science parks are more knowledge intensive than their off-park counterparts. On-park NTBF tend to involve high education institutions as research partners. The level of education of the park manager has no influence on the establishment of links between companies and universities. On the other hand, the study takes into account the differences between the different models of territorial agglomerations focused on the creation and development of innovative companies (science park, incubator, technology park) in the probability of establishing cooperative links between companies and universities. No significant differences are found between the different models that comprise the typology studied.

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
Guadix et al., 2016	Success variables in science and technology parks	Journal of Business Research	Qualitative	10 science and technology parks located in the Autonomous Community of Andalusia (Spain).	Combination of variables that explain the success of a Science and Technology Park (turnover and employment between 2010-2012)	The authors derive three clusters of the sample parks according to different factors identified by previous literature that may affect their success. These factors can affect positively, negatively, or simply have no effect.
Jongwanich et al., 2014	Science park, triple helix, and regional innovative capacity: Province-level evidence from China	Journal of Asia Pacific Economy	Quantitative	Panel data model composed of regional dates from 31 Chinese provinces for the period 1997-2009.	Regional innovative capacity (measured as the number of inventions and utility patents granted to a Province)	The results illustrate that science and technology parks play an important role in local development by acting as umbrella organisations for R&D promotion arrangements. In addition, the results of the study suggest that the effects of networked collaboration between companies and universities improve regional innovation capacity and point to a very interesting effect. Interestingly, this positive network effect on regional innovative

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						capacity is not witnessed in the R&D collaboration between research institutes and companies.
Larsen (2004)	Science and technology parks and the integration of environmental policy	Innovation: Management, Policy, and Practice	Qualitative	Two Scandinavian science parks, one located in Sweden (Kista science and technology park) and one in Finland (Tampere science and technology park).	The study wants to know what are the main drivers of environment al policy integration in science and technology parks	This research suggests that the integration of good environmental practices by ICT companies located in the science parks studied is not only due to the logic of geographical proximity between companies. On the contrary, it is due to the companies' efforts to actively interact with their counterparts in the park in order to exchange environmental knowledge and practices. The most proactive companies also benefit from the contributions of partners outside the park, but epistemological, technically or organisationally close to the companies. The paper also suggests the relevant role played by park managers in these issues.

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
Lamperti et al., 2017	The role of science parks: A puzzle of growth, innovation and R&D investments	Journal of Technology Transfer	Quantitative	A database of 296 Italian companies, 150 of which are located in science and technology parks.	-Growth (sales) -Innovation performance (cumulative number of patents firms apply to during the period 2004-2012)	After applying a matching analysis, the authors find that there are statistically no significant differences in sales growth between companies located in Italian science and technology parks and their off-park counterparts. However, in terms of innovation, the differences are statistically significant. On-park firms invest more in R&D activities and their innovative performance is, on average, three times higher.
Lay y Shyu, 2005	A comparison of innovation capacity at science parks across the Taiwan Strait: The case Zhangjiang High-Tech Park and Hsinchu Science-based Industrial Park	Technovation	Quantitative	The database used by the authors consists of 263 questionnaires from the main stakeholders (business managers, R&D institutions, and members of local government) associated with two Asian science and technology parks (Zhangjiang High-Tech Park -ZJHP- of China and the Hsinchu	Innovation capacity	The authors apply Michael Porter's diamond model to assess the innovation capacity of both science and technology parks by diagnosing their strengths in each of the drivers that make up the model. With some exceptions, the results illustrate that Taiwan's HSIP is a model with superior innovation capabilities to China's ZJHP according to the empirical results obtained. The authors report

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
				Science-based Industrial Park -HSIP- of Taiwan).		the main strengths and weaknesses of each of the parks analysed.
Lindelöf y Löfsten, 2004	Proximity as a resource base for competitive advantage: University–industry links for technology transfer	Journal of Technology Transfer	Quantitative	Data from 273 Swedish NTBFs (134 of which are located in science and technology parks).	Firms' growth (sales and employment)	Although still at a low level, companies located in science and technology parks interact more with universities for the purpose of exchanging ideas and knowledge than their off-park counterparts mainly based on recruiting university graduates or informal meetings. On-park NTBF obtain higher level of technological innovations and performance (growth).
Lindelöf y Löfsten, 2003	Science park location and new technology-based firms in Sweden: Implications for strategy and performance	Small Business Economics	Quantitative	Data from 273 Swedish NTBFs (134 of which are located in science and technology parks).	Firms' growth (sales and employment)	Based on different predictor variables, the results show that on-park NTBF have a rate of job creation and sales growth which is substantially higher than that for their off-park counterparts. However, no statistically significant differences between Science Park NTBFs and off-Park NTBFs

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						were recorded with regard to patents/products launched in the last three years.
Link y Scott, 2005	Opening the Ivory tower's door: An analysis of the determinants of the formation of US university spin-off companies	Research Policy	Quantitative	Dataset on American university science and technology parks that authors developed for the National Science Foundation. The information was collected through interview surveys for 51 of the 81 U.S. science and technology parks.	Percentage of park organizations that are university spin-off companies (in year 2002)	As the authors hypothesise, older parks tend to host more university spin-offs. However, there are other characteristics that play a role, such as the distance of the park from the university, or the degree to which the university specialises in research.
Montoro-Sánchez et al., 2011	Effects of knowledge spillovers on innovation and collaboration in science and technology parks	Journal of Knowledge Management	Quantitative	A sample of 784 companies (half of them located on a Spanish STPs) selected from the Technological Innovation Panel (PITEC).	Firm innovation and inter-organizational collaboration	Beyond the contributions that the article brings to the relationship between knowledge spillovers and innovation, this paper confirms that STPs are ideal habitats for stimulating and managing the flow of knowledge between companies and other entities, such as universities or research centres. Thus, the authors empirically confirm that knowledge spillovers have a more decisive impact on the

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						innovation performance of companies located in a STP than those companies that are not located. However, the authors qualify that the effect is higher only for product innovations.
Matias Ramirez et al., 2013	Comparing the Impact of Intra- and Inter-regional Labour Mobility on Problem-solving in a Chinese Science Park	Regional Studies	Quantitative	The database consists of a total of 381 questionnaires completed by R&D managers and employees working in seventy-one companies in the information and communication technology (ICT) sector in the Zhongguancun Science Park (ZGC) in Beijing (China).	Problem-solving ability derived from the question "Do you regularly develop new solutions and procedures?"	The authors' empirical results confirm that problem-solving knowledge related to R&D projects can be effectively transferred through workforce mobility. The effect is beneficial for both intra- and inter-regional mobility. However, the impact of mobility is greater when it is locally and geographically concentrated.
Squicciarini, 2009	Science parks, knowledge spillovers, and firms' innovative performance: Evidence from Finland	Economics	Quantitative	The database consists of questionnaire responses from 252 companies located in 15 science parks in Finland.	Innovation performance (patents and models of utility applications)	Being located in an STP is positively related to the innovative performance of member firms. The positive effect is due to the benefits of inter-organisational interaction and knowledge spillovers both within and between science parks. The author points out the

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						heterogeneity of the location effect according to the variable of the age of the parks. Thus, older parks seem to have a smaller effect on the innovative performance of the hosted companies.
Teng et al., 2020	Government support and firm innovation performance in Chinese science and technology parks: The perspective of firm and sub-park heterogeneity	Growth and Change	Quantitative	The study uses two datasets: a first one with data from 2,750 companies based in the Zhangjiang National Innovation Demonstration Zone (Shanghai); and a second one with data on the characteristics of the 22 STPs where the above companies are hosted.	-Patents -New products	Both in-house investment and government R&D funding have a significant and positive influence on firms' innovation. However, the study underlines the heterogeneity of firms and how those with higher in-house R&D investment make better use of government funding. On the other hand, the study underlines that park-level factors such as university links or innovation services do not seem to play an important role in influencing firms' innovative activities.
Vásquez-Urriago et al., 2016	Science and technology parks and cooperation for innovation: Empirical	Research Policy	Quantitative	The database is taken from an Appendix to the Spanish CIS Survey introduced in 2007 (1820	Engaging in formal collaboration	Firms located in an STP are 15-21% more likely to establish formal innovation co-operation agreements than their non-localised counterparts. Localisation

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
	evidence from Spain			companies with 150 located in Spanish STP.		positively affects the results linked to intangible aspects of the collaboration with the main partner in the agreement. However, localisation does not seem to affect the economic performance of the collaboration agreement, at least in the short term.
Vásquez-Urriago et al., 2014	The impact of science and technology parks on firms' product innovation: Empirical evidence from Spain	Journal of Evolutionary Economics	Quantitative	Data from the Spanish Survey on Technological Innovation in Companies, with a sample comprising 39,722 companies, 653 of which are located in 22 Spanish STPs.	Product innovation by companies	The statistical analysis applied by the authors allows them to conclude that the location of Spanish firms in STP positively stimulates their innovative performance as measured by the number of innovative products. This effect also leads to a substantial improvement in firms' product performance.
Watkins-Mathys y Foster, 2006	Entrepreneurship: The missing ingredient in China's STIPs?	Entrepreneurship & Regional Development	Qualitative	15 interviews and facilitated 3 focus groups linked to e Shanghai regional hi-tech STP.	--	The Chinese government has played an active role in promoting entrepreneurship and knowledge transfer through the promotion of spaces such as science and technology parks, and other preferential measures for high value-added enterprises. The

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						authors stress that having spaces such as STPs provide firms with benefits such as intellectual property protection, access to venture capital, and an environment conducive to networking and learning.
Westhead et al., 2000	Technology-based firms located on science parks: The applicability of Bullock' 'soft-hard' model	Enterprise Innovation and Management Studies	Quantitative	Two databases of UK companies. The first, obtained in 1986, consists of a total of 183 interviews with managers of companies located in science parks and 101 complementary interviews of non-located counterparts. The second database, obtained in 1992, consists of a total of 217 companies, 88 of which were located in STP.	There is no independent variable in this study, instead, several comparative statistical tables are constructed	In this exploratory study, the authors find that firms located in a science and technology park have an evolutionary tendency towards the provision of high value-added services. These firms provide jobs and wealth to the location in which they are located, and their outstanding contribution should not be ignored by policy makers.
Yang et al., 2009	Are new technology-based firms located on science parks	Research Policy	Quantitative	247 electronic companies listed on the Taiwan Stock Exchange, 57 of	R&D productivity (R&D	The R&D productivity of companies located in Taiwan's science and technology park is up to twice as high as that of their

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
	really more innovative? Evidence from Taiwan			them located in a STP of Taiwan.	expenditure to sales)	non-localised counterparts. The reasons for this superiority lie in the tax benefits that the government confers on companies hosted in science parks, but also in the advantages of the clustering of multiple technology companies in the park infrastructure.
NO SIGNIFICATIVE STUDIES						
Bakouros et al. 2002	Science Park, a high-tech fantasy: An analysis of the science parks in Greece	Technovation	Qualitative	24 firms located in three Greek STP.	-	Connections between companies located in science parks and universities are generally poor and characterised by a high degree of informality. On the other hand, relations between on-park companies are limited to the establishment of commercial ties and social interactions.
Chan et al., 2010	Knowledge exchange behaviors of science park firms: The innovation hub case	Technology Analysis & Strategic Management	Quantitative	25 technological firms located on TIH in Pretoria, South Africa.	Several descriptive statistics are analysed	The results of the study show that on-park firms interact much more with other off-park firms. These relations with external firms are more frequent, in closer technological domains, and in which a richer exchange of knowledge takes place. The less

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						optimistic view suggested by the authors is that perhaps the STP does not adequately fulfil its networking function. Or, simply, that the benefits of the location in this particular case respond to other advantages linked to the prestige and firm image.
Ferguson y Olofsson, 2004	Science parks and the development of NTBFs: Location, survival and growth	Journal of Technology Transfer	Quantitative	Sample of 66 Swedish companies, 30 of which located in two science and technology parks.	-Firm survival -Firm growth	The authors find mixed empirical results in their study. On the one hand, this study confirms that firms located in science and technology parls have better survival rates. On the other hand, they do not observe statistically significant differences in terms of sales or employment variables between the two groups of firms (in-park firms vs. off-park firms).
Liberati et al., 2016	Science and technology parks in Italy: main features and analysis of their effects on the firms hosted	Journal of Technology Transfer	Quantitative	A sample of 425 Italian companies located in STP and a similar control group of off-park firms.	-Business performance -Propensity to innovation	The authors underline that on-park obtain higher sales and value-added rates compared to their off-park counterparts. However, these differences are not statistically significant in terms of profitability or patenting. It is worth noting that

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
						this contribution also points to the fact that the effect of science and technology park on firms is not homogeneous and that the age variable of the parks should be taken into account as a key explanatory factor of the advantages that firms enjoy by integrating into these science and technology parks.
Malairaja y Zawdie, 2008	Science parks and university–industry collaboration in Malaysia	Technology Analysis & Strategic Management	Quantitative	Database of 101 companies located in the technology park in Malaysia and a comparable group of firms sited off-park.	Number and types of links between universities and firms (on-park and off-park firms)	Companies hosted in the science park establish a greater number of links with universities than their off-park counterparts. However, the differences are not statistically significant. According to the authors, Malaysian R&D institutions have not been sufficiently effective in upgrading the technological capabilities of firms.
Salvador, 2011	Are science parks and incubators good 'brand names' for spin-	Journal of Technology Transfer	Qualitative and quantitative	30 questionnaires to spin-off firms from the University of Turin and a similar control group of start-ups.	Added value	The regression model applied by the author underlines a lower performance of spin-offs compared to start-ups counterparts.

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
	offs? The case study of Turin					
Shearmur y Doloreux, 2000	Science parks: Actors or reactors? Canadian science parks in their urban context	Environment and Planning A	Quantitative	Database comprising data from 27 Canadian regions, 13 of which have a science park in place.	Employment in high-tech sectors	The empirical study carried out by the authors confirms that there have been no significant changes in employment linked to high-tech sectors in Canadian regions where a science and technology park has been implemented. Thus, they conclude that employment in these sectors is independent of the presence of a science and technology park and that its effect is not discernible in either manufacturing or service sectors.
Westhead, 1997	R&D 'inputs' and 'outputs' of technology-based firms located on and off science parks	R&D Management	Quantitative	The author uses two sets of samples. The first sample is drawn in 1986 and consists of interviews with a total of 284 firms (183 of which are located in the science and technology parks of Great Britain). The second sample is obtained in	-R&D intensity -R&D spending -R&D as a percentage of sales -New products or services for	After performing the appropriate statistical procedures, the author finds no statistically significant differences between the two sets of firms (on-park firms and off-park firms) in several variables such as R&D expenditure intensity, R&D expenditure as a percentage of sales, number of patents and other forms of intellectual capital such as

Study	Títle	Source	Type of research	Sample	Dependent variable	Main results
				1992 and consists of a total of interviews with a set of 95 firms (47 of which are located in science and technology parks in Great Britain).	existing customer base -New patents or other intellectual capital resources (i.e., copyrights) -New products or services to new markets	copyrights, or launch of new products or services (either new for their existing customer base or for new customer segments). The results allow the author to question the goodness of fit suggested by the literature regarding the beneficial effects of integrating firms into a science and technology park.

Source: own elaboration

3.6. SCIENCE AND TECHNOLOGY PARKS IN SPAIN AT PRESENT

The history of science and technology parks as a political instrument to support innovation policies in Spain goes back several decades (Ondategui, 2001). Thus, the first science and technology park built in Spain was the Zamudio Technology Park (Vizcaya), closely followed by the Vallés Technology Park (Barcelona) in 1987. Since then, the growth of these technological enclaves has been unstoppable, reaching a total of 53 operational infrastructures and fully integrated in the Association of Science and Technology Parks of Spain (APTE) at present. Of course, although each park has its own idiosyncratic characteristics, the literature on the evolution of science and technology parks in Spain groups the parks into three generations (e.g., Annerstedt, 2011; Allen, 2009):

1. First generation parks. These are the parks that best correspond to the sub-typology of technology parks. These parks, conceived as high-quality business spaces, were promoted by regional governments, and universities had little or no role in their creation. The main objective of these industrial parks was to attract leading international companies in technology or innovation, especially in sectors such as information technologies, new materials, or aerospace. They were located in well-communicated suburban areas, with high environmental quality and high-quality facilities compared to other types of infrastructures such as typical industrial parks. Although these technology parks have gradually incorporated centres dedicated to R&D production and transfer, their indicators of success have almost always been based on real estate criteria, job creation or the establishment of links with their surroundings (Ondategui, 2001). The Parc Tecnològic Paterna introduced above fits very well as a paradigmatic example of this first generation of first-generation parks that has also been able to renew and update itself with the times (Camisón et al., 2021).
2. Second generation parks. This new generation of parks took off with the opening of the Parc Científic de Barcelona, promoted by the Universitat de Barcelona in 1997. It is in this period of time when the concept of "entrepreneurial university" came onto the scene and, as in the case of Stanford University in California (Saxenian, 1994), these higher education institutions are the promoters of these science parks with the aim of making progress in research, possible commercialisation and the transfer of knowledge to the productive fabric. However, they can also count on the support of regional or national governments for their promotion and development. The indicators of success in these science parks are no longer so closely linked to economic performance; on the contrary,

they pay greater attention to the scientific results obtained, measured fundamentally through scientific publications, patents and associated R&D&I projects (Ondategui, 2001). The science park of the Universitat de València would be another paradigmatic example of those previously mentioned in this doctoral thesis that fits perfectly into this second-generation model of parks.

3. Third generation parks. Emerging in the last two decades as a fusion of the strengths of both generations. These parks, which correspond to the sub-typology of science and technology parks, are characterised more by changes in their organisational structure or relationships than by their morphology or the type of entities housed in their infrastructures. Their promotion is the most diverse of all the aforementioned alternatives, including governments, universities, and other agents such as public research bodies or other social agents. They therefore consolidate a mixed management model in a space that can combine productive scientific and technological activities, as long as they are "clean production" activities (Camisón et al., 2020, 2021). As Allen (2009) points out, their objective is to create, in a given metropolitan centre or its surroundings, a globally recognised pole of attraction for companies.

Figure 19 below shows, according to data updated by the APTE, the current distribution of science and technology parks in Spain (without distinguishing between their generation). Table 14 shows the main data for each of these science and technology parks, but does not attempt to be exhaustive, as the degree of heterogeneity between each of them would require an in-depth study which is beyond the scope of this doctoral thesis.

Figure 19. Location of science and technology parks in Spain

Source: APTE (2021)

Table 14. Main characteristics of Spanish science and technology parks

Digit / membership number	Facility name	Date of establishment	Main services and data	Main developer entity
1	Aerópolis, Parque tecnológico Aeroespacial de Andalucía	2002	-568,387 m^2 -Park specialised in aeronautics and aerospace industries	-Agencia de Innovación y Desarrollo de Andalucía IDEA
2	Barcelona Activa – Parque Tecnológico	1999	-10,000 m^2 -Prototyping and innovation services	-Ayuntamiento de Barcelona
3	Centro de Desarrollo Tecnológico de la Universidad de	1999	-6,500 m^2 -Programs to assist entrepreneurs and spin-offs	-Universidad de Cantabria

	Cantabria (CDTUC)			
4	Ciudad del Conocimiento. Parque de Investigación y Desarrollo Dehesa de Valme, S.A.	2004	-500,000 m^2 -Pre-incubation and incubation services	-Excmo. Ayuntamiento de Dos Hermanas -Universidad de Sevilla -Universidad Pablo de Olavide -Fundación Universidad Loyola Andalucía
5	Ciudad Politécnica de la Innovación	2002	-130,000 m^2 -Intellectual capital management services	-Universitat Politècnica de València -Fundación Ciudad Politécnica de la Innovación
6	Esade Creapolis, Parque de la Innovación Empresarial	2005	-20,000 m^2 -Prestige of the Esade brand and access to its knowledge and talent	-Fundación Esade -Empresa de Promoción y Localización Industrial de Catalunya, S.A.U. -Ayuntamiento de Sant Cugat del Vallès
7	Espaitec, Parc Científic i Tecnològic de la Universitat Jaume I de Castelló	2007	-64,776 m^2 -Physical or virtual membership	-Fundació General Universitat Jaume I de Castelló
8	Fundación Canaria Parque Científico – Tecnológico de la Universidad de las Palmas de Gran Canaria	2008	-568,387 m^2 -Partnerships for the circular economy, blue biotechnology platform and aquaculture	-Universidad de Las Palmas de Gran Canaria -Cabildo de Gran Canaria
9	Fundación de Innovación y Transferencia Agroalimentaria de Aragón (FITA)	2006	-1,500,000 m^2 -Specialised in agri-food industry	-Gobierno de Aragón -Consejo Superior de Investigaciones Científicas (CSIC)

10	GARAIA Parque Tecnológico S. Coop.	2000	-440.000 m^2 -Installed companies specialised in advanced manufacturing, big data, new materials, and sustainability	-Fundación Mondragón -Sprilur, S.A. (Gobierno Vasco) -Diputación Foral de Gipuzkoa -Ayuntamiento de Mondragón
11	GEOLIT, Parque Científico y Tecnológico	2000	-1,566,428 m^2 -Services for cooperation, open innovation and internationalisation	-Diputación de Jaén
12	La Salle Technova Barcelona	2001	-30,000 m^2 -Specific incubator and accelerator programmes	La Salle – Universitat Ramon Llull
13	Málaga TechPark	1992	-3,750,734 m^2 -World-leading ICT companies hosted in the park -Digital technologies observatory	-Agencia de Innovación y Desarrollo de Andalucía -Agencia de Vivienda y Rehabilitación de Andalucía -Sociedad para la Proción y Reconversión Económica de Andalucía S.A. -Ayuntamiento de Málaga -Unicaja -Universidad de Málaga
14	Parc Científic de Barcelona	1997	-100,000 m^2 -Specialised in the health sector -It has six research institutes	-Universitat de Barcelona -Generalitat de Catalunya -Ajuntament de Barcelona -Fundació Bosch i Gimpera -CSIC

15	Parc Científic de la Universitat de València	2009	-200,000 m^2 -It has research institutes and CSIC centres	-Universitat de València -Confederación Empresarial Valenciana -Cámara de Comercio de Valencia
16	Parc Científic i Tecnològic Agroalimentari de Lleida	2005	-110,000 m^2 -Specialised in the agri-food sector	-Universitat de Lleida -Ayuntamiento de Lleida
17	Parc de Recerca UAB	2007	-5,000 m^2 -Hosted sectors such as biotechnology, health, ICT, environment, materials science or agri-food	-Universidad Autónoma de Barcelona -CSIC -Instituto de Investigación y Tecnología Agroalimentaria (IRTA) -Banco Santander
18	Parc UPC – Universitat Politècnica de Catalunya – BarcelonaTech	2005	-104,000 m^2 -Pre-incubation, incubation and post-incubation services	-Universitat Politècnica de Catalunya – BarcelonaTech
19	Parque Balear de Innovación Tecnológica (ParcBIT)	1997	-1.400.000 m^2 -Comprehensive services for innovation management	-Govern de les Illes Balears
20	Parque Científico de Alicante	2010	-159,773 m^2 -Hosted companies in the biotech and ICT sector	-Universidad de Alicante
21	Parque Científico de la Universidad Miguel Hernández de Elche	2005	-7,832 m^2 -Support services for business growth, strategic monitoring, and in the search for private financing	-Universidad Miguel Hernández de Elche

22	Parque Científico de Madrid	2001	-8,400 m^2 -Hosted companies from sectors such as life science and chemistry, ICT, nanotechnologies, or environment and renewable energies	-Universidad Autónoma de Madrid -Universidad Complutense de Madrid -CSIC -Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas -Ayuntamiento de Madrid
23	Parque Científico de Murcia	2001	-3,200 m^2 -Hosted companies from different sectors of activity	-Instituto de Fomento de la Región de Murcia
24	Parque Científico Tecnológico Avilés Isla de la Innovación	2015	-761,000 m^2 -Technological pole of the steel industry in Spain	-Ayuntamiento de Avilés
25	Parque Científico-Tecnológico de Almería (PITA)	2002	-1,000,000 m^2 -Hosted companies in agrotechnology, renewable energies or sustainable construction	-Sociedad para la Promoción y Reconversión de Andalucía -Agencia Andaluza de Gestión Agraria y Pesquera -Inversión y Gestión del Capital Semilla de Andalucía -Cajamar Caja Rural -Gestión de Inmuebles Adquiridos -Universidad y Ayuntamiento de Almería -Fundación Tecnova
26	Parque Científico – Tecnológico de	2001	-1,500,000 m^2	-Grupos de Empresas Cajasur

	Córdoba. Rabanales 21		-The main sectors of the hosted companies are ICT and engineering, energy and environment, and the agri-food sector	-Corporación Empresarial de la UCO, SAI -Promoción y Reconversión Económica de Andalucía -Grupo de Empresas Prasa -Ayuntamiento de Córdoba -Corporación Industrial Córdoba Este -La Caixa
27	Parque Científico Tecnológico de Gijón – Milla del Conocimiento Margarita Salas de Gijón	2000	-235,000 m^2 -Extensive funding programmes for technology companies, including public seed and venture capital funds	-Ayuntamiento de Gijón que tiene como entidad gestora el Promoción Empresarial y Turística de Gijón, S.A. (Gijón Impulsa)
28	Parque Científico Tecnológico de Huelva, S.A.	2008	-2,000 m^2 -Hosted companies specialised in the chemical industry and R&D in mining	-Agencia IDEA
29	Parque Científico y Tecnológico de la Universidad Politécnica de Madrid	2006	-582,000 m^2 -Hosted companies specialised in engineering and architecture	-Universidad Politécnica de Madrid -Fundación General de la Universidad Politécnica de Madrid
30	Parque Científico Universidad Carlos III de Madrid – Leganés Tecnológico	2000	-2,804,878 m^2 -Business incubation and acceleration programmes	-Universidad Carlos III de Madrid -Ayuntamiento de Leganés -Comunidad Autónoma de Madrid

31	Parque Científico Universidad de Valladolid	2006	-15,000 m^2 -Dedicated buildings for com	-Universidad de Valladolid -Ayuntamientos de Valladolid, Palencia, Segovia y Soria -Grupo Santander -Cámara de Comercio de Valladolid -Junta de Castilla y León
32	Parque Científico y Tecnológico Cartuja	1991	-497,809 m^2 -Business incubation services for technological start-ups	-Comunidad Autónoma de Andalucía -Empresa pública de Gestión de Activos, S.A. -Ayuntamiento de Sevilla -Diputación Provincial de Sevilla -Universidad de Sevilla
33	Parque Científico y Tecnológico Bizkaia	1985	-3,003,669 m^2 -Green and smart infrastructures, with value in excellence, social commitment and sustainability	-Grupo Spri -Diputación Foral de Bizkaia -Azpiegiturak -Universidad del País Vasco -Ayuntamiento de Zamudio
34	Parque Científico y Tecnológico de Cantabria	2004	-237,000 m^2 -Services to promote and encourage research, development and innovation	-Gobierno de Cantabria -Suelo Industrial de Cantabria -Sdad. para el Desarrollo de Cantabria -Universidad de Cantabria
35	Parque Científico y Tecnológico de Castilla La Mancha	2001	-75,000 m^2 -Hosted companies specialised in sectors such as	-Junta de Comunidades de Castilla La Mancha

			ICT, agrotechnology, aeronautics, renewable energies, engineering and robotics	-Ayuntamientos de Guadalajara y Albacete -Diputaciones Provinciales de Guadalajara y Albacete -Universidad de Castilla la Mancha -Universidad de Alcalá
36	Parque Científico y Tecnológico de Extremadura	2008	-20,000 m^2 -Technology supply/demand matching system	-Junta de Extremadura -Universidad de Extremadura
37	Parque Científico y Tecnológico de Gipuzkoa	1994	-431,923 m^2 -Green and smart infrastructures, with value in excellence, social commitment and sustainability	-Grupo SPRI -Diputación Foral de Gipuzkoa -Kutxabank -Ayuntamiento de Donostia – San Sebastián
38	Parque Científico y Tecnológico de Tenerife	2006	-600,000 m^2 -Programmes to provide technological training to the young people, generating qualified employment and promoting the transfer of knowledge	-Cabildo Insular de Tenerife -Ayuntamiento de Santa Cruz de Tenerife -Autoridad Portuaria de Tenerife -Gerencia de urbanismo de Santa Cruz de Tenerife -Autocartera
39	Parque Tecnológico de Álava – País Vasco	1992	-1,913,033 m^2 -Green and smart infrastructures, with value in excellence, social commitment and sustainability	-Grupo Spri -Diputación Foral de Araba -Ayuntamiento de Vitoria – Gasteiz
40	Parque Tecnológico de Asturias	1991	-478,111 m^2 -Patent information centre	-Instituto de Desarrollo Económico del

				Principado de Asturias
41	Parque Tecnológico de la Salud de Granada	1997	-626,614 m^2 -Park specialised sectorially in life sciences and health	-Junta de Andalucía -Universidad de Granada -Diputación Provincial -CSIC -Ayuntamientos de Granada, Armilla y Ogíjares -Caja Rural y Bankia -Cámara de Comercio, Industria y Navegación -Confederación Granadina de Empresarios
42	Parque Tecnológico de Fuerteventura SA MP	2010	-756,433 m^2 -Knowledge promotion and technology transfer building	-Parque Tecnológico de Fuerteventura S.A. MP -Instituto Tecnológico de Canarias S.A.
43	Parque Tecnológico de Gran Canaria (PTGC)	2013	-174,060 m^2 -Specific programmes for entrepreneurs, training and fundraising	-Sociedad de Promoción de Gran Canaria
44	Parque Tecnológico de Vigo – Galicia	2003	-1,500,000 m^2 -Special infrastructures for companies linked to the aerospace, biotechnology, metal, automotive, ICT and food sectors	-Consorcio de la Zona Franca de Vigo
45	Parque Tecnológico TecnoCampus	2008	-46,940 m^2 -It shares the location with three	-Ayuntamiento de Mataró

			university centres attached to Universitat Pompeu Fabra	
46	Parque Tecnológico Walqa	2002	-534,655 m^2 -Hosted companies specialised in ITC, biotechnologies, and renewable energies	-Gobierno de Aragón -Ayuntamiento de Huesca -Caja Rural de Aragón, SCC
47	Parque Texnolóxico de Galicia – Tecnópole	1991	-594,000 m^2 -Specialised centres for companies linked to the health sector and renewable energies	-Xunta de Galicia -Abanca Cooperación Bancaria S.A. -Diputación de Ourense -Universidad de Vigo -Universidad de Santiago de Compostela
48	Parques Tecnológicos de Castilla y León	1991	-2,740,000 m^2 - Three locations: León, Boecillo, Burgos. Multisectoral parks	-Junta de Castilla y León
49	TechnoPark Motorland	2005	-212,345 m^2 -Park specialised in the automotive industry	-Ciudad del Motor de Aragón, S.A. -Corporación Empresarial Pública de Aragón, S.L. -Caja Rural de Teruel, S.C.C.
50	TecnoAlcalá	2003	-370,705 m^2 -Hosted companies from different sectors, the most representative being the ITC, health and industrial sectors	-Madrid Activa S.A.U.
51	Tecnoparc, Parc Tecnològic i d'innovació	2009	-1,650,000 m^2 -The park focuses on the ICT, agri-	-Reus Desenvolupament Econòmic, S.A.

			food and tourism sectors	-Ayuntamiento de Reus
52	Parc Tecnològic Paterna	1990	-1,038,290 m^2 -Multi-sectorial enclave divided in three areas: technology, business and clean industry. It is home to 5 technological institutes	-Generalitat Valenciana. -Instituto Valenciano de Competitividad Empresarial (IVACE) -SEPES. Ministerio de Fomento

Source: own elaboration based on APTE data

In the following, using APTE data, a series of figures will be presented in which the aggregate contribution that Spanish science and technology parks make in such crucial variables as the number of organisations hosted in their infrastructures, employment generated (and of this total, the employment of personnel dedicated to R&D tasks), the income of the companies located in these science and technology parks, and the main business sectors hosted, and the basic typology of Spanish science and technology parks, according to their fiscal denomination, can be observed.

Starting with the number of companies and other institutions (such as technology institutes, chambers of commerce, public research institutes, etc.) located in Spanish science and technology parks, Figure 20 represents the evolution of this magnitude since 1997. As can be seen, the trend has been upward if we disregard the post-crisis period of 2011 and the year 2020, the year in which COVID-19 is dispersed on a large scale, to reach the figure of 8,146 hosted organisations.

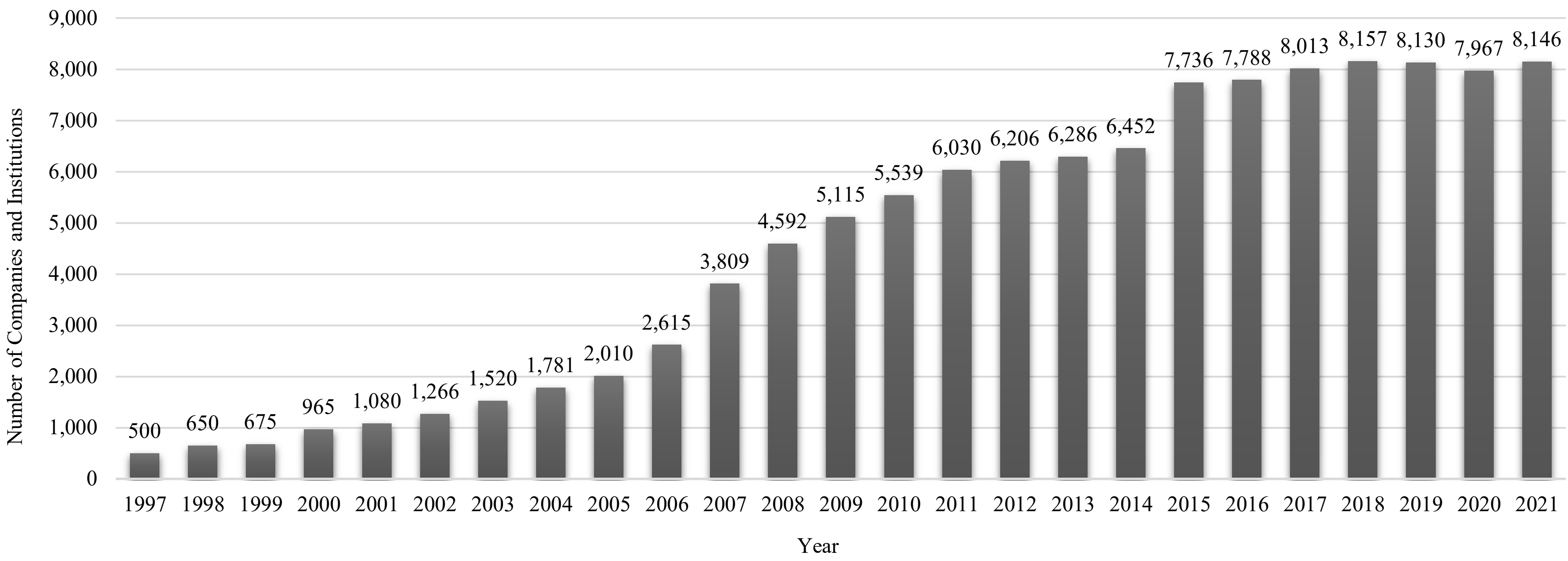
Figures 21 and 22 below illustrate the significant growth in terms of employment generated in these science and technology parks. Again, an increasing trend can be observed only affected by the aforementioned Spanish public spending crisis of 2011. The employment variables were not affected by the dispersion of COVID-19. Beyond the spectacular total employment figure, it is worth highlighting the employment figure for R&D personnel, which accounted for 20.21% of total employment in 2021.

Figure 23 shows the evolution of the approximate turnover at an aggregate level of all the organisations that make up the Spanish science and technology parks. Following the previous figures, the aggregate turnover has also historically shown an upward trend only interrupted by the aforementioned crises. In 2021, aggregate turnover will reach €28,004 M, a not insignificant figure, although still below pre-pandemic levels.

The organisations hosted in Spanish science and technology parks, as illustrated in Figure 24, belong to various industries. However, the three industries with a majority presence are: (I) information technologies, computing and telecommunications (40.38%); (II) consulting services and engineering (23.10%); and, (III) medicine and health (8.14%).

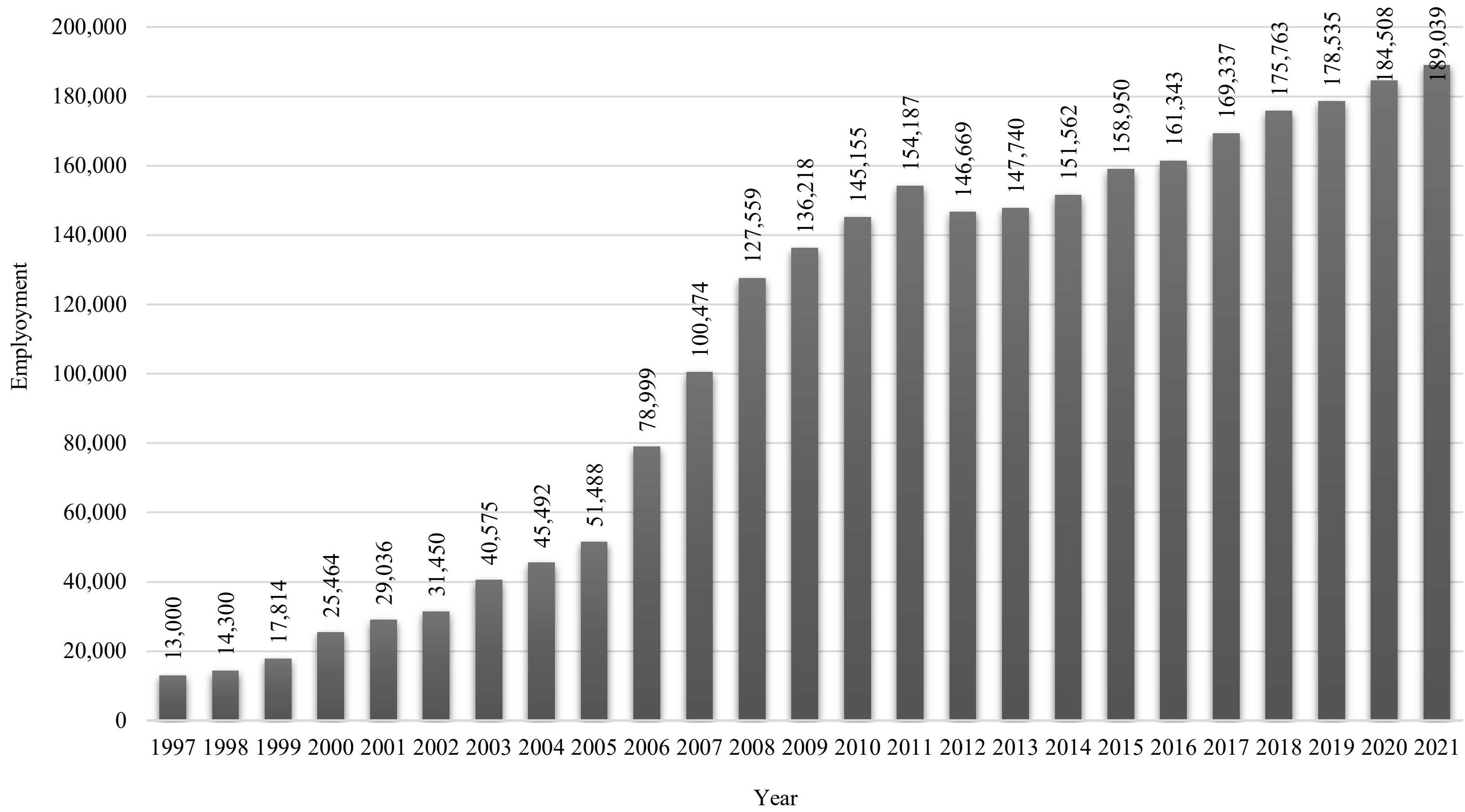
Finally, Figure 25 aims to represent the distribution of Spanish science and technology parks by typology according to their denomination. Although this criterion may not be absolutely perfect to be able to delimit whether the parks really correspond to the typology that their name indicates, it may represent a first step to recognise the distribution of Spanish parks by sub-typology. Thus, 40.38% of Spanish parks correspond to the hybrid alternative already introduced above (the commonly used science and technology parks), followed by technology parks (38.46%) and, lastly, science parks (21.15%).

Figure 20. Companies and institutions hosted in Spanish science and technology parks



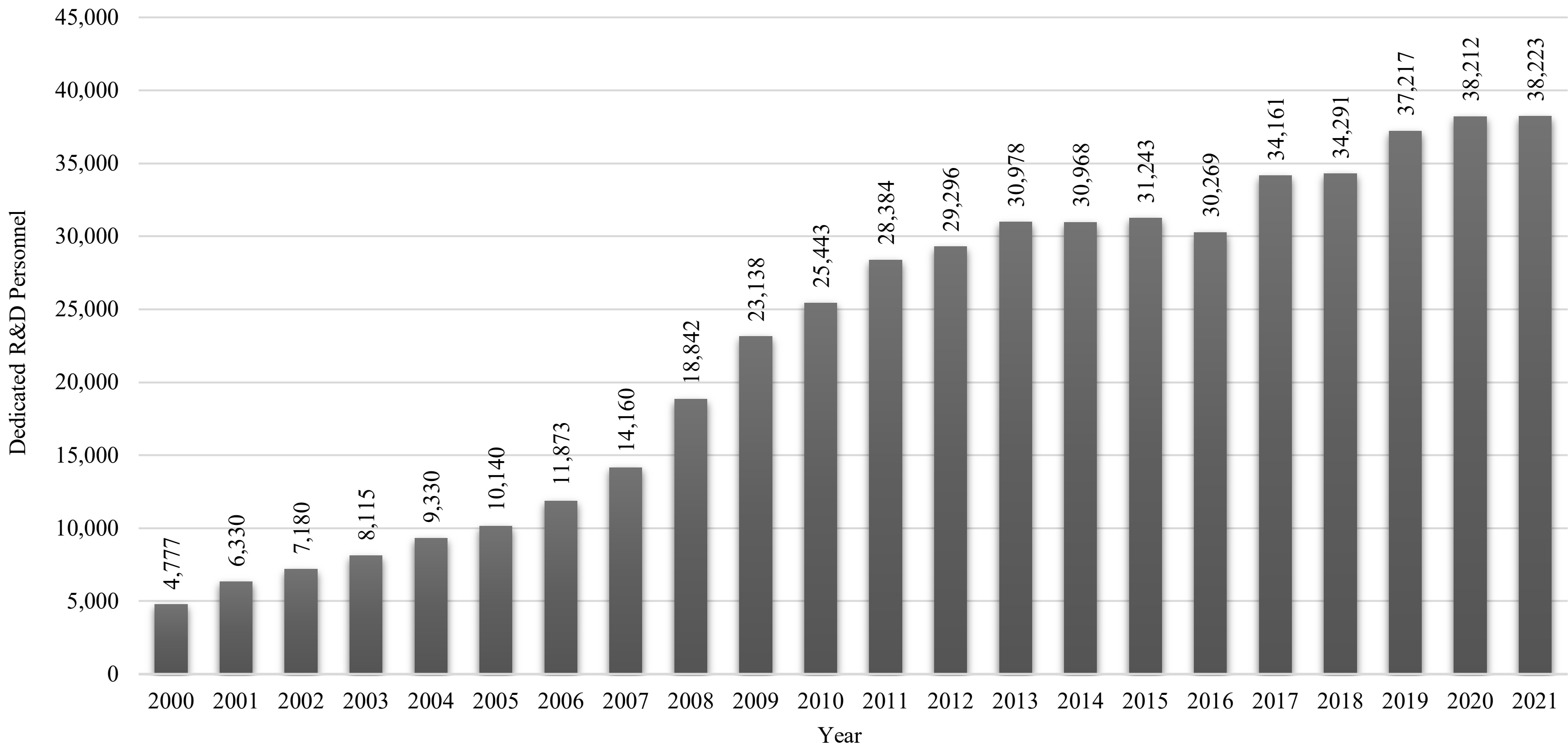
Source: own elaboration based on APTE (2022)

Figure 21. Employment at Spanish science and technology parks



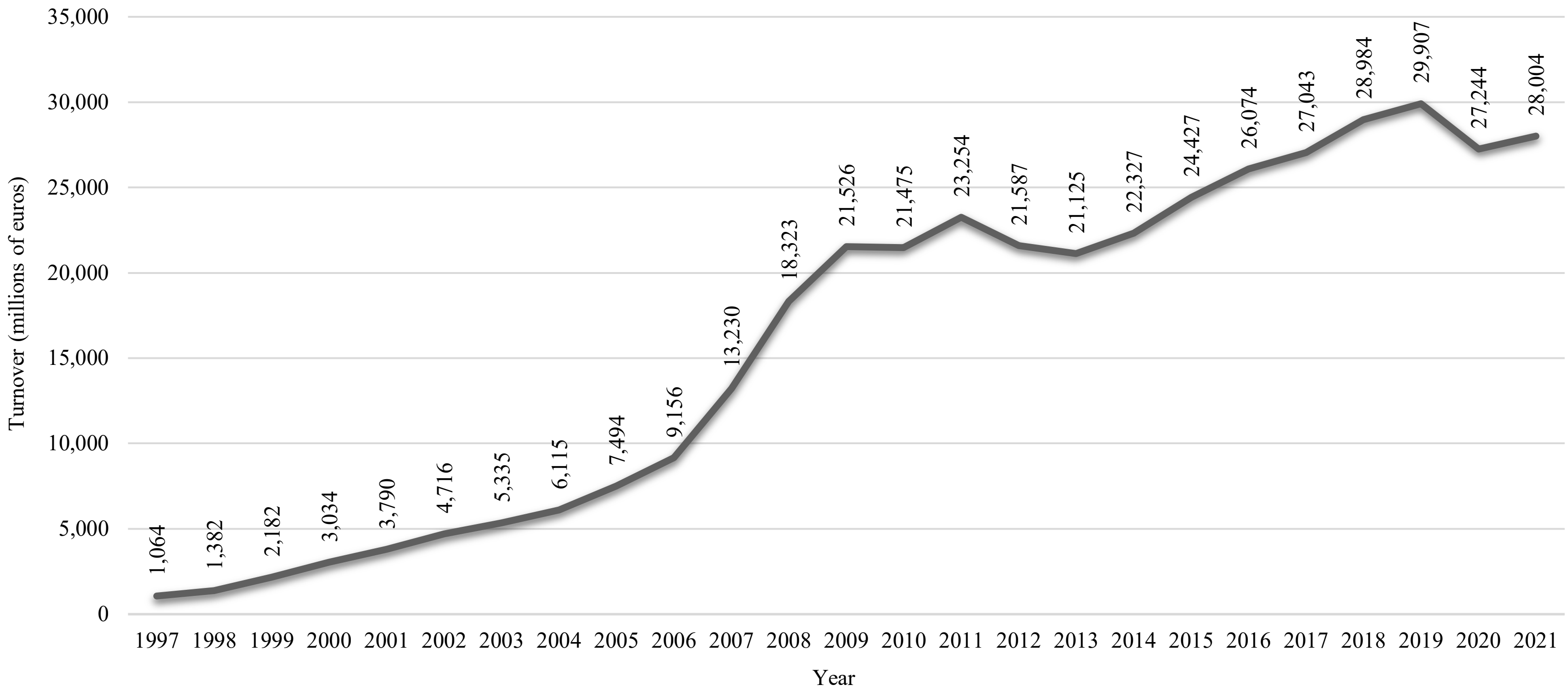
Source: own elaboration based on APTE (2022)

Figure 22. Employment in R&D tasks in Spanish science and technology parks



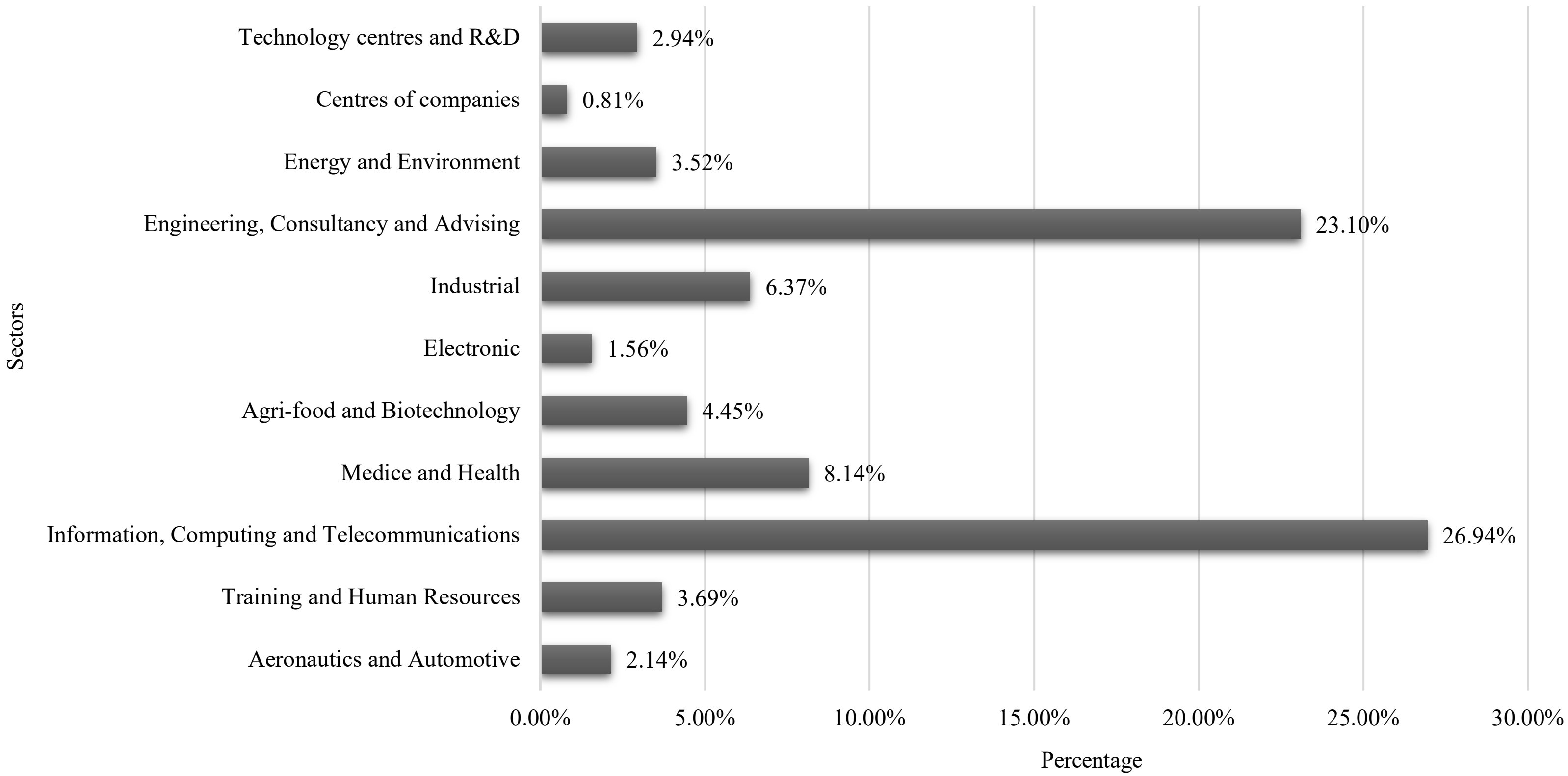
Source: own elaboration based on APTE (2022)

Figure 23. Turnover of the organisations located in Spanish science and technology parks



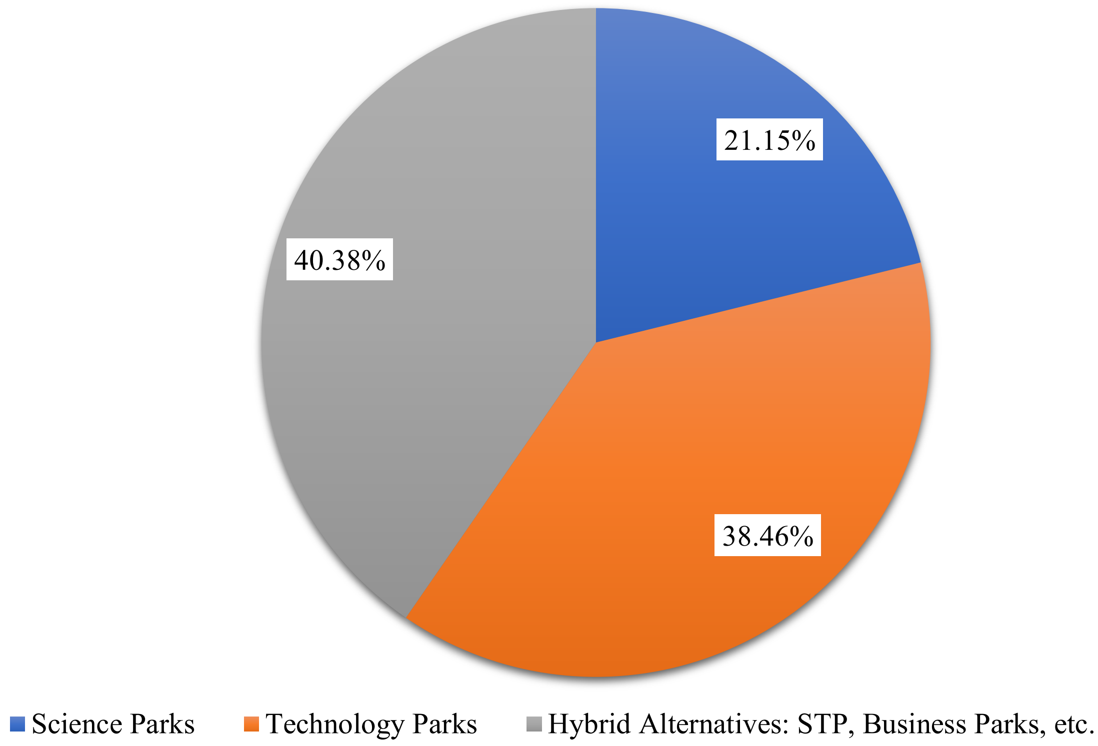
Source: own elaboration based on APTE (2022)

Figure 24. Main economic sectors to which organisations hosted in Spanish science and technology parks belong



Source: own elaboration based on APTE (2022)

Figure 25. Typology of Spanish science and technology parks



Source: own elaboration based on APTE (2022)

3.7. CONCLUSIONS OF THE CHAPTER

As this chapter has shown, the umbrella concept of territorial agglomerations of enterprises encompasses other terms such as industrial districts, industrial parks or science and technology parks. In turn, each of these typologies in turn contains typologies with subtle differences and implications especially for the companies that are hosted in their infrastructures and for the regions in which they are located. In addition to reviews of the state of the art in these types of territorial agglomerations of companies, an attempt has been made, where possible, to illustrate this with examples of similar infrastructures located in the Valencia Region.

Focusing on the typology of most interest in this study, science parks, a review of the main contributions in the literature has been carried out based on a bibliometric study merging contents from two prestigious academic databases (Scopus and Clarivate WOS). After this analysis, it can be deduced that science and technology parks are spaces that, if they have appropriate processes, can become spaces that generate resources (especially knowledge) that can be made available to their companies. However, the contributions point out that not all companies benefit equally from the externalities that can be generated in a science park. On the contrary, integrated firms show a high degree of heterogeneity when it comes to taking advantage of these resources to improve their performance. The following chapter will help to understand how microeconomic sources of individual firm competitiveness influence the exploitation of location advantages.

4. THE MICROECONOMIC SOURCES OF FIRM COMPETITIVENESS

4.1. INTRODUCTION

However, as already indicated in this thesis, the previous paradigms of the canonical approach to agglomerations have a weakness: they consider the group of organisations integrated in a district as a perfectly homogeneous conglomerate in its values, behaviour, organizational practices and results. In contrast, recent theoretical contributions abound in the literature (e.g. Camisón, 2012; Ferreira & Serra, 2009; Rabellotti et al., 2009), reinforced by empirical research (e.g. Ubeda et al., 2019; Camisón et al, 2018; Díez-Vial & Montoro-Sánchez, 2016; Camisón & Villar-López, 2012; Camisón & Forés, 2011; Camisón, 2004) that illustrate the heterogeneity of industrial districts and the disparity of results that intra-district firms obtain in terms such as organisational performance, leveraging knowledge spillovers, or innovative performance. These disagreements in academia highlight the inconsistencies between the canonical approach to territorial agglomerations of firms and the results obtained in the different empirical studies, and open the debate on the sources of competitive advantage of integrated firms.

The above premise that questions the internal homogeneity of the constituent members of a territorial agglomeration, such as a science park or an industrial district, emerges from the application of the theory of strategic management; specifically, the Resource Based View approach (RBV) (Wernerfelt, 1984; Barney, 1991; Grant, 1991) and, within its more dynamic perspective (Teece et al., 1997; Zollo & Winter, 2002; Teece, 2007, 2014), the Competence-Based View (CBV) (Foss & Knudsen, 1996; Grant, 1996; Foss, 1993, 1997). These strands of literature analyse the composition of the internal portfolio of resources and capabilities of organisations to explain their strategic heterogeneity and differences in performance. Thus, according to the above authors, only those firms that have rare, valuable, durable, inimitable, inimitable internal factors and whose rents generated can be appropriated (Amit & Schoemaker, 1993; Peteraf, 1993; Barney, 1991) will gain a competitive advantage over their competitors.

4.2. RESOURCE BASED VIEW AND COMPETENCE BASED VIEW

The Resource Based View (Barney, 1991; Rumelt, 1984; Wernerfelt, 1984) is a theory that shows the primacy of the company effect in explaining performance differences between intra-industry companies, belonging to the same strategic group or agglomerated geographically. Thus, the RBV is capable of explaining the results offered by certain empirical investigations that gather evidence of the existence of both greater differentials in performance between companies belonging to the same industry (e.g., Roquebert et al., 1996; Rumelt, 1991) and companies belonging to the same strategic group (McNamara et al., 2003).

From the RBV, the company goes from being a set of businesses with greater or lesser relationship to each other to being conceived as a conglomerate of resources and capabilities applicable to different areas of activity. Although this theory was deployed at the end of the last century (Amit & Schoemaker, 1991; Barney, 1986, 1991; Grant, 1991, Rumelt, 1991; Peteraf, 1993; Wernerfelt, 1984), Edith Penrose (1959), in his seminal work already defended the conception of the company as a set of productive resources whose correct use allowed the growth of the company. This new vision of strategic thinking is based on the following propositions (Hunt & Madhavaram, 2020; Camisón & Forés, 2011; Camisón, 2009): (I) the key determinants of competitiveness are distributed unevenly among competing companies within a certain industry; (II) neither industry structure, agglomeration effect, nor competitive similarity capture the importance of each competitor's factor endowments, which may be idiosyncratic; and, (III) the heterogeneity of the resources handled by each company can be long-lasting.

The CBV places even more intensely the company as the epicentre of the competitive game and supports the role that the specific factors of the company have in the generation of competitive advantages. Special attention deserves the possession of a portfolio of intangible assets and competencies that, due to their qualitative, immaterial nature and imperfect mobility, are not subjected to market transactions, and condition the form of differentiation of each company (Camisón, 2009). A vast set of works qualified with this label of Competency-Based Approach (CBV) (Camisón, 2004, 2009; Foss, 1996, 1997; Foss & Knudsen, 1996) highlight the importance that the group has for strategy and business success. of company-specific competencies, especially those related to tacit knowledge and shared within the organization (Camisón & Forés, 2011; Camisón, 2005).

At this point, a distinction needs to be made between resources and organizational capabilities or competencies[26]. Resources are the stock of inputs owned or controlled by the company, available for the production process and which, through their use together with other assets such as technology or information systems, allow the company to obtain final products[27] (Amit & Schoemaker, 1993; Barney, 1991; Grant, 1991). According to the seminal study by Wernerfelt (1984), within the resources, it is possible to distinguish between those of a tangible and intangible nature. Tangible resources include physical assets (such as the company's offices or production plants) such as monetary or financial assets. On the other hand, intangible resources are those non-monetary assets, without physical substance, controlled by the company as a result of past events that are kept for use either in production or for administrative purposes (Camisón, 2005; cite). Intangible resources, then, include technological and human assets and represent forms of tacit and explicit knowledge (Hall, 1992, 1993).

Within the group of intangible assets, together with the intangible resources already described, are the capabilities of the organization[28]. Using the terminology of Aaker (1989) to distinguish a resource from a capacity, the resources are having, “what one has”; while capabilities are doings, “what the company does”. Capacities are, therefore, forms of knowledge in their technical dimension (Nonaka & Konno, 1998). Capacities are the "know how" linked to the organization itself, and as such, cannot function independently of the people who make it up and their legal protection is impossible or very complicated, unlike resources, which have legal instruments to ensure their protection (Black & Boal, 1994; Hall, 1992, 1993; Aeker, 1989). The capacities must be capable of organizing, coordinating and deploying the resources available to the company (Camisón, 2005; Grant, 1991; Nelson & Winter, 1982). The following Table 15 collects the main definitions of capacity proposed by the strategic management literature.

[26] Although we recognize that there are contributions that make a distinction between both constructs (e.g., Javidan, 1998; Teece et al., 1994), in this thesis, following the vast majority of studies in the literature (e.g., Spanos & Prastacos, 2004; Fuchs et al., 2000; Collis & Montgomery, 1995; Prahalad & Hamel, 1990) the concepts of capacity and competence will be used interchangeably as synonymous terms.
[27] According to Camisón (2002), a resource can be understood in a broad or strict conception. The broadest conception encompasses all production factors available to the company, thus including capabilities. This conception underlies works such as those by Peteraf (1993), Barney (1991), or Wernerfelt (1984). The strictest conception, which will be followed in this doctoral thesis, assumes the differentiated use of the capacity construct, following contributions from the literature such as Camisón (2002), Amit & Schoemaker (1993), Grant (1991) or Teece, Pisano & Shuen (1990).
[28] In this doctoral thesis, following the contributions of Turner & Crawford (1994), the concept of capacity encompasses both personal and corporate capacities.

Table 15. Definitions of capacity in the Strategic Management literature

Author	Definition	Publication	Nª of citations (Google Scholar)
Winter (2003:991)	"An organizational capability is a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type"	Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, *24*(10), 991-995.	7398
Collis (1994:145)	"Socially complex routines that determine the efficiency with which firms physically transform inputs into outputs"	Collis, D. J. (1994). Research note: how valuable are organizational capabilities?. *Strategic Management Journal*, *15*(S1), 143-152.	3687
Amit & Schoemaker (1993)	"Refer to a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end"	Amit, R., & Schoemaker, P. J. (1993). Strategic assets and organizational rent. *Strategic Management Journal*, *14*(1), 33-46.	15712

Source: own elaboration

If capabilities are identified with the skill with which an organization executes an activity through the joint and coordinated deployment of resources, they necessarily have an intention component in the sense that the company has previously had to accumulate knowledge and skills for the correct execution of the activity (Foss, 1996; Hamel, 1994; Black & Boal, 1994). Thus, capabilities are based on organizational processes aimed at the development, management and exchange of information and knowledge based on human capital (Sánchez & Heene, 1997; Collis, 1994; Amit & Schoemaker, 1993). Based on these arguments, it is appropriate to make a distinction between the possession of a resource, regardless of its nature, and the ability to effectively and efficiently use the services that said resource can provide to the company (Camisón, 2005; Ventura, 1996). It is the governance of capabilities over resources that stimulates the creation of value in the company, either through improvements in efficiency or through improvements in effectiveness.

Thus, capabilities are combinations of knowledge and skills embedded in the activities and structures of the company that are absorbed by all its members and, for this reason, are independent of people, lasting in the organization when an individual decides to leave it (Turner & Crawford, 1994). Studies such as those by Leonard-Barton (1992), Grant (1991) or Roehl (1987) indicate in this sense that corporate capabilities fundamentally reside in internal organizational rules and procedures, thus being complex patterns of coordination between people, and of people with other resources (Grant, 1991). Therefore, capabilities depend not only on the company's resource endowment but also on the ability of its members to combine, integrate and modify them through organizational procedures and coordination guidelines (Camisón, 2005; Cuervo, 1995; Nelson & Winter, 1982). As Grant (1991) points out, organizational rules and procedures are the main stores of knowledge in the organization, they determine the regular patterns of behaviour and guidance of the organization.

The canonical approach to RBV (Barney, 1986, 1991) explains that the efficient exploitation of certain productive assets called ‘strategic assets’ (Amit & Schoemaker, 1993), also called critical resources (Wernerfelt, 1984) or ‘strategic factors’ (Barney, 1991), gives the company the ability to generate extraordinary income that produces sustainable competitive advantages. As a consequence of these contributions, research in strategic management of the company has since been reoriented towards the study of strategies that allow sustaining and protecting these strategic assets so that they can confer competitive advantage to companies at a given time (Peteraf, 1993; Barney, 1991; Grant, 1991; Prahalad & Hamel, 1990; Wernerfelt, 1984). Following the postulates of industrial economics (Bain, 1968; Mason, 1957) and the rational strategic approaches proposed by Michael Porter (1980)[29], adding that competitive advantage can only be considered as such

[29] However, it is worth noting a subtle difference between both approaches, while Porter and other authors (e.g., Jacobsen, 1988) refer to sustainable competitive advantage as one that lasts for a long period of time, while the concept proposed by the RBV does not refers to the time frame, but rather to the fact that it cannot be easily eliminated by the duplication efforts of other competing companies. However, Barney himself (1991) points out in his seminal article that the fact that competitive advantage is sustainable does not mean

when it is sustainable (Camisón, 2001; Amit & Schoemaker, 1993; Barney, 1991; Grant, 1991; Rumelt, 1984). As Camisón (2001: 136-137) points out, sustainable competitive advantage can only be perennial if it is based on assets with certain attributes. The academy on business strategy points out that, in general, strategic assets, in order to give the company a sustainable competitive advantage, must be valuable, rare, non-substitutable, not easily imitable, and also the company must have the capacity to appropriate the rents they generate (Amit & Schoemaker, 1993; Peteraf, 1993; Strategor, 1993; Grant, 1991; Barney, 1986). The following Table 16 lists the main strategic requirements that strategic resources must meet.

Table 16. Strategic resources requirements

Amit & Schoemaker (1993)	Barney (1986, 1991)	Grant (1991)	Peteraf (1993)	Strategor (1993)
Durability Scarcity	Valuable Scarcity (rare)	Durable	Heterogeneity	Rare
Non-imitable Non-substitutable	Not imitable: -Path dependent -Causal ambiguity -Social complexity Non-substitutable	Imperfect transparency Imperfect replicability	Ex-post limits to competition: non-imitable, non-substitable	Hardly accessible
No tradable Complementary (specific) Appropriability		Imperfect transferability: -Geographical immobility -Imperfect information -Specific resources	Ex ante limits to competition: imperfect resource mobility	Inimitability: -Ambiguity of the causal relationship -Complex and confidential organizational procedures

that it is eternal, since it can be eroded by external aspects such as changes in the structure of the industry or internal to the competing companies, through organizational learning and innovation.

		-Immobility of capabilities Appropriability		
Overlap with strategic industry factors				Insustitutability

Source: own elaboration

In short, the firm effect points to the persistence of heterogeneous scenarios derived from asymmetrical endowments of resources and capabilities, in the development of complementary and specialized assets will be predominant when determining the differences in the performance of companies above the industry or location effects (Camisón & Forés, 2015; Teece et al., 1997; Rumelt, 1994; Teece, 1986). In order to offer competitive advantage to companies, such resources and capabilities must therefore be scarce, long-lasting, of limited transferability, non-imitable due to barriers to duplication (Barney, 1991; Grant, 1991; Rumelt, 1991; Dierickx & Cool, 1989), of imperfect substitutability for strategically equivalent assets and whose rents are appropriable by the company (Collis & Montgomery, 1995; Amit & Schoemaker, 1993; Peteraf, 1993; Barney, 1991). All in all, the RBV makes a static description of the competitive situation within a business, thus leading to a definition of competitive advantage for a situation of equilibrium in the markets.

The study of the company's competitive advantage in a dynamic context has been supported by the dynamic capabilities approach (Forés & Camisón, 2016; Helfat & Peteraf, 2015; Ambrosini & Bowman, 2009; Helfat et al., 2007; Teece, 2007; Eisenhardt & Martin, 2000; Helfat, 1997; Teece et al., 1997; Winter, 1995; Nelson & Winter, 1982). The main anomaly underlying the static version of the RBV is that, as highlighted by authors such as Teece (2007) or Teece et al. (1997)[30], in a context of changing the value of the current resources and capabilities of the company always ends up being eroded. Therefore, the role of the company's strategic management must consist of "adapting, integrating and reconfiguring internal and external organizational skills, resources and functional competencies toward the changing environment"

[30] The working paper by Teece et al. (1990) is probably the first contribution in the literature that introduces the notion of dynamic capacities, extending the previous work of Nelson and Winter (1982) in which these authors proposed, under the evolutionary economics approach, how organizational routines are capable of to shape the growth of the company so that it can adjust to changing environments. This more dynamic vision of the RBV has also been nourished by the Schumpeterian contributions of creative destruction (1934), the behavioural aspects of the company (Cyert & March, 1963), or the role of the specific assets of the company and the isolating mechanisms (Rumelt, 1984, Teece, 1982).

(Teece & Pisano, 1994: 537). Shortly thereafter, in their seminal article, Teece et al. (1997) introduce the first formal definition of dynamic capabilities conceptualizing them as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (p.516). This definition has been followed by others widely cited in the literature that are listed in the following Table 17.

Table 17. Dynamic capabilities definition

Author	Definition	Publication	Citations (Google Scholar)
Eisenhardt and Martin (2000: 1107)	"The firm's processes that use resources - specifically the processes to integrate, reconfigure, gain and release resources- to match or even create market change. Dynamic capabilities are the organizational and strategic routines by which firms achieve new resources configurations as markets emerge, collide, split, evolve and die"	Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they?. *Strategic Management Journal*, *21*(10-11), 1105-1121.	21,595
Zollo and Winter (2002: 340)	"A dynamic capability is a learned and stable pattern of collective activity through	Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic	9,718

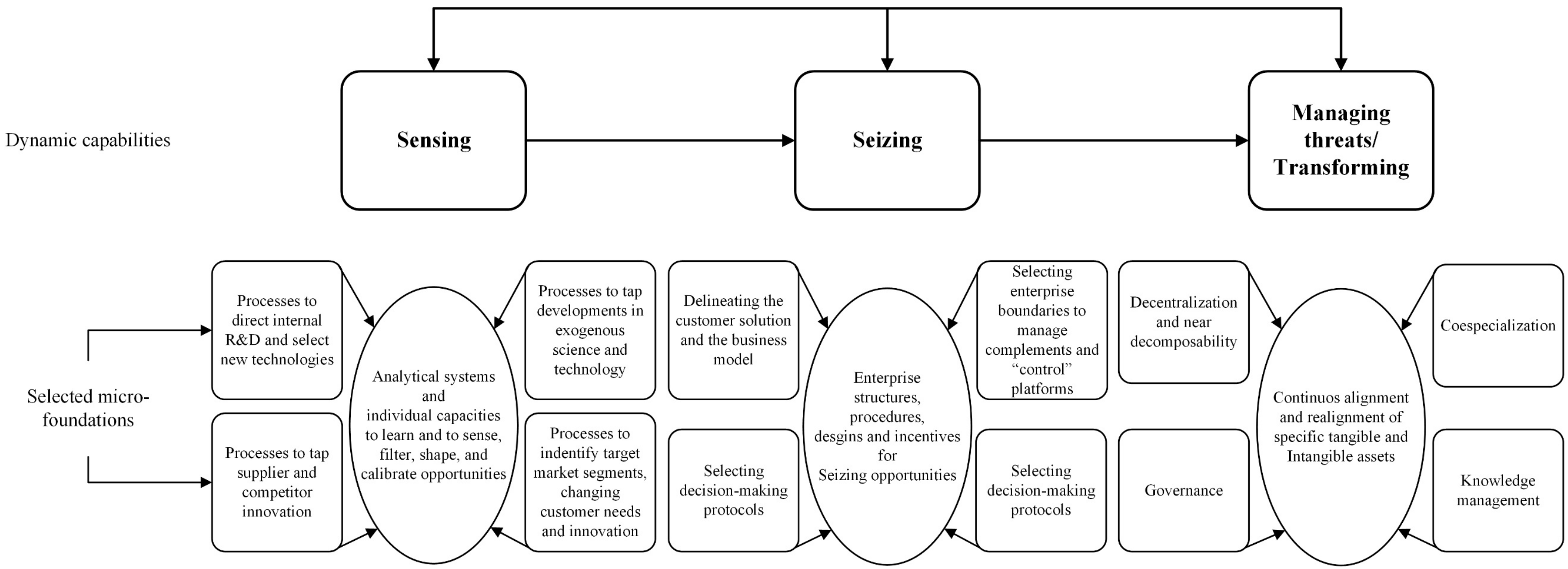
	which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness”	capabilities. *Organization Science*, *13*(3), 339-351.	
Winter (2003: 991)	“Dynamic capabilities are those that operate, extend, modify or create ordinary capabilities”	Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, *24*(10), 991-995.	7,392
Zahra et al. (2006: 918)	Dynamic capabilities are “the abilities to reconfigure a firm’s resources and routines in the manner envisioned and deemed appropriate by its principal decision-maker”	Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: A review, model and research agenda. *Journal of Management studies*, *43*(4), 917-955.	4,064
Helfat et al. (2007: 1)	“The capacity of an organization to purposefully create, extend or modify its resource base”	Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. G. (2007). *Dynamic capabilities: Understanding strategic change in organizations*. London: Blackwell.	5,479

Teece (2007: 1319)	"Enable firms to create, deploy, and protect the intangible assets that support superior and long-run business performance"	Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319-1350.	14,366
Teece (2014: 329)	"Enable the firm to integrate, build and reconfigure internal and external resources to maintain leadership in continually shifting business environments"	Teece, D. J. (2014). The foundations of enterprise performance: Dynamic and ordinary capabilities in an (economic) theory of firms. *Academy of Management Perspectives*, *28*(4), 328-352.	1,424

Source: own elaboration

Specific examples of dynamic capabilities could be those related to acquisitions and alliances, development of new products, learning or the absorption of new knowledge (Helfat & Winter, 2011; Ambrosini & Bowman, 2009; Helfat, 1997; Teece et al., 1997). However, perhaps the most widespread and used classification of dynamic capabilities in the literature is the one proposed by David Teece (2007). This author makes a proposal of three dynamic capabilities: Sense, Seize and Managing threats/Transforming, as well as the main microfoundations and internal processes that help the company achieve excellence in each of the three dynamic capabilities described below. Sense is the ability to scan, create, learn and interpret events and opportunities that occur in the markets. Involves investment in research activities, detection of new consumer needs, and exploration of the new possibilities offered by new technologies (Teece, 2007: 1322). As the author points out, once the possible path of evolution is detected and it is apparent, it is necessary to adopt rapid measures. The Seize capability is precisely responsible for the development of new products, processes or services capable of taking advantage of existing opportunities. Addressing these opportunities based on Seize's capabilities requires increasing the company's technology capabilities and complementary assets. Teece also emphasizes that changes to the business model that define business strategy and investment priorities should not be neglected at this stage. Finally, Reconfiguration ensures that the business can maintain a fit between its resource endowments and its environment. This avoids that, due to the accumulation of resources that can be made in growth, they can generate dependencies on the path and rigidities that prevent this fit with the environment through the deployment of new investments and innovations. The following Figure 26 collects the proposal of the dynamic capabilities of Teece (2007) and his micro-foundations.

Figure 26. Dynamic capabilities microfoundations by Teece (2007)



Source: Teece (2007)

However, in order to identify them, it is appropriate to make a distinction between static and dynamic capacities as proposed by the specialized literature (e.g., Teece, 2014; Helfat & Winter, 2011; Ambrosini & Bowman, 2009; Zahra et al., 2006; Camisón, 2005; Winter, 2003; Danneels, 2002). Static capabilities, also called ordinary (Teece, 2014), zero-level (Winter, 2003) or represent the organizational skills to replicate previously developed tasks with a certain degree of sufficiency and even possible excellence (Teece, 2014; Camisón, 2005). On the contrary, dynamic capabilities are understood as the ability of the organization to integrate, build, adapt and reconfigure its initial resources and capabilities in order to be able to respond quickly to changes in the environment, explicitly targeting learning and the development of new skills. products and processes (Teece, 2007, 2014; Eisenhardt & Martin, 2000; Teece et al., 1997).

Likewise, just as it is possible to make a distinction between static capabilities and dynamic capabilities, a distinction can also be made between first-order dynamic capabilities and second-order dynamic capabilities (Schilke, 2014; Ambrosini et al., 2009). Second-order dynamic capabilities, also known as metacapacities (Collis, 1994), higher-order capabilities (Winter, 2003), or regenerative dynamic capabilities (Ambrosini et al., 2009)[31]. These second-order dynamic capabilities are the ones in charge of creating, developing and transforming the current dynamic capabilities of an organization (Schilke, 2014; Teece, 2014; Ambrosini et al., 2009; Collis, 1994). According to Zollo and Winter (2002), it is the organizational learning routines that underlie these second-order dynamic capabilities. In other words, they comprise a process of reflection in the organization to assess which learning processes need to be modified in order to introduce changes in the current first-order dynamic capacity endowments that help the organization maintain adjustment with its environment. (Schilke, 2014; Helfat et al., 2007; Zollo & Winter, 2002). Once the main differences between organizational capacities have been succinctly established, the following Table 18 summarizes the main typologies pointed out in the literature.

[31] Ambrosini et al. (2009) even establish a classification for first-order dynamic capabilities according to the degree of dynamism of the environment in which the company is inserted, distinguishing between incremental dynamic capabilities (for stable environments) and innovative dynamic capabilities (for turbulent and dynamic environments). Although we recognize the validity of this proposal, we consider that the comment does not deserve greater precision.

Table 18. Main typologies of capabilities

Collis (1994)	Danneels (2002)	Winter (2003)	Zahra et al. (2006)	Ambrosini et al., 2009	Schilke (2014)
First category	First-order capabilities	Zero-level capabilities	Substantive capabilities	Resource base	Ordinary capabilities
Second and third categories	Second-order capabilities	First-order capabilities	Dynamic capabilities	Incremental dynamic capabilities Renewing dynamic capabilities	First-order dynamic capabilities
Meta-capabilities		Higher order capabilities		Regenerative dynamic capabilities	Second-order dynamic capabilities
Ad infinitum meta capabilities					

Source: own elaboration based on Ambrosini et al. (2009)

Dynamic capabilities have become a useful construct for the field of strategic management to explain how companies generate and sustain their competitive advantage (Ambrosini et al., 2009; Teece, 2007). Dynamic capabilities are shaped by the company's previous positions and trajectories (Teece et al., 1997); Therefore, these capabilities cannot be easily acquired in factor markets (Teece, 2007) and are embedded in the firm (Eisenhardt & Martin, 2000). It is precisely this idiosyncrasy that allows companies to generate new value-creating skills, as well as to respond consistently in situations of changing environment (Teece, 2007, 2014; Ambrosini et al., 2009; Grant, 1996). Numerous studies empirically report the relationship between dynamic capabilities and organizational performance (e.g., Schilke, 2014; Stadler et al., 2013; Morgan et al., 2009). Likewise, other research has recently highlighted the importance that dynamic capabilities represent in improving company performance in the field of sustainability (Buzzao &

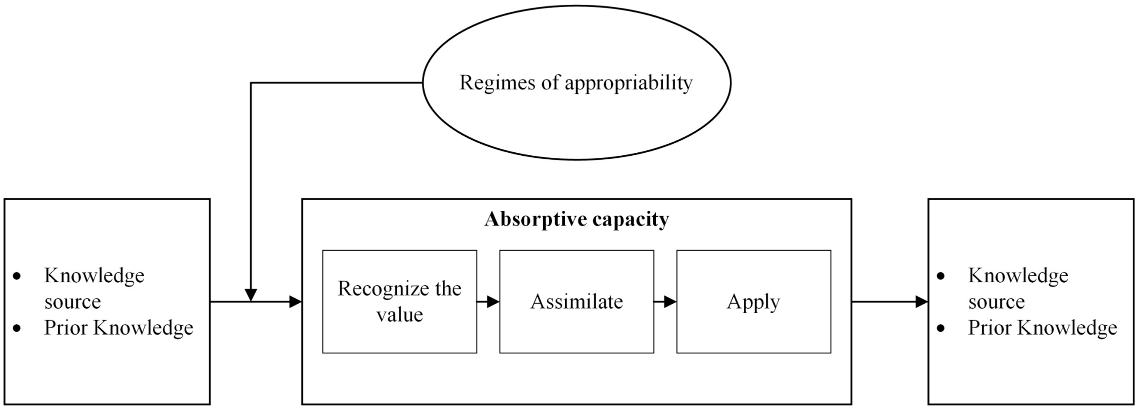
Rizzi, 2021; Eikelenboom & de Jong, 2019; Mousavi et al., 2018; Dangelico et al., 2017; Wu et al., 2013; Aragón-Correa & Sharma, 2003).

4.3. ABSORPTIVE CAPACITY

Although its origins fall within the tradition of industrial economics (Hussain et al., 2022; Cohen & Levinthal, 1989), interest in the study and development of the concept of absorptive capacity takes off with the most dynamic contributions of the RBV (Forés & Camisón, 2016; Camisón & Forés, 2010; Zahra & George, 2002), who point out that knowledge is a strategic asset for the firm and the ability to learn is the true guarantor of a sustainable competitive advantage. For this reason, the literature on absorptive capacity has evolved in tandem with that on dynamic capacities (Teece, 2007; Winter, 2003) and the literature focused on knowledge management and innovation, and organizational learning (Lane & Lubatkin, 1998; Grant, 1996a, b; Nonaka & Takeuchi, 1995). The importance of the concept is such that a wide range of studies have been developed having as units of analysis not only organizations (e.g., Forés and Camisón, 2016), but also individual units, such as people (e.g., Tortoriello, 2014), and even regional and supranational units (Lau & Lo, 2015; Roper & Love, 2006) or groups or clusters of companies (e.g., Camisón & Forés, 2011; Lazaric et al., 2008; Volberda et al., 2001).

Cohen and Levinthal (1989, 1990, 1994) were the pioneers in providing the most influential concept of absorptive capacity (Hussain et al., 2022). Cohen and Levinthal define absorptive capacity as firm's ability to "recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990: 128). For these authors the absorption capacity depends on the sources of knowledge, but also on the related prior knowledge of the company. The possibilities of absorbing such knowledge are influenced by appropriability regimes. According to the authors, absorptive capacity is made up of three dimensions: recognize the value, assimilate and apply. In his study, the main outputs derived from absorptive capacity are innovative performance. Likewise, Cohen and Levinthal introduce the importance of the feedback loop between internal creation and external absorption of knowledge. This feedback is justified by the cumulative and dependent nature of the path of knowledge, and by the proximity between the new knowledge to be absorbed and that previously existing in the company. Figure 27 below illustrates the Cohen and Levinthal’s (1990) absorptive capacity model.

Figure 27. Cohen and Levinthal's (1990) absorptive capacity model



Source: Cohen and Levinthal (1990)

Since the publication of this seminal article, academic research on absorptive capacity has not stopped, with the aim of understanding all the ins and outs and applications of the concept, as well as providing new clarifications that might have been vague in the original proposal (Song et al., 2018). Cohen and Levinthal again make an adjustment to the definition of the concept of absorptive capacity in an article in 1994. In this new proposal, the authors define absorptive capacity as "The capacity to "exploit" outside knowledge is compressed of the set of closely related abilities to evaluate the technological and commercial potential of knowledge in a particular domain, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1994: 227). The new definition thus underlines the importance of absorptive capacity in anticipating and exploiting emerging opportunities. Following this line, Mowery and Oxley (1995) emphasize that the factors that contribute most decisively to absorption capacity are the investment in R&D and the availability of qualified labour in the company. Kim (1998) supports these contributions by Mowery and Oxley, pointing out that the intensity of the effort made by employees in their development is a key determinant of absorptive capacity.

The first reinterpretation of the absorptive capacity construct was by Lane and Lubatkin (1998) in the context of interorganizational learning. In this sense, while the seminal articles by Cohen and Levinthal analyse the absorption capacity of a company from the competition of its own sector, Lane and Lubatkin (1998) analyse the relative absorption capacity of a student or recipient organization towards another teacher or station (the learning dyad)[32]. These authors point out in their study that the main antecedents of the relative absorptive capacity depend on the similarity in three factors between both organizations: (I) knowledge bases (although with different specialized knowledge; (II) organizational structures and compensation policies; and, (III)

[32] In their article, they assess the relative absorptive capacity based on empirical analysis of alliances between pharmaceutical and biotech companies.

dominant logics and organizational problems. These authors also conclude that spending on R&D, contrary to what might be expected, does not have sufficient explanatory capacity in the variance of interorganizational learning. On the contrary, the capacity of absorption of one organization from another is determined by the similarity of characteristics and relationship of their knowledge management systems Dyer and Singh (1998), continuing this line of research, confirm that the absorption capacity is largely determined by motivation existing by the organization to establish sociological interactions with other agents[33].

Influenced by the knowledge management literature (e.g., Grant, 1996a, b), Van den Bosch et al. (1999) carry out an analysis of the absorption capacity based on three characteristics: efficiency, scope and flexibility. The efficiency refers to the cost and economies of scale that the organization can obtain in absorbing new knowledge. The scope is related to the breadth of existing knowledge. Finally, flexibility implies the extent to which a company is able to access new knowledge and reconfigure existing knowledge. It should be noted that the authors establish in this work a link between the literatures on absorptive capacity and organizational ambidexterity[34] and the concepts of exploration and exploitation (March, 1991). Thus, they link the efficiency factor with the concept of exploitation, arguing that this can have a negative impact on the absorption capacity by concentrating more on the exploitation of existing knowledge in the company. In contrast, the scope and flexibility factors are related to exploration; that is, with the absorption of new external knowledge, thus impacting the absorption capacity. Finally, it should be noted that these authors argue that the implicit feedback of the Cohen and Levinthal[35] model will be conditioned by the environment in which the company is inserted. Therefore, according to Van den Bosch et al. (1999) the absorption capacity of a company "co-evolves" with knowledge environments and in this use the organizational structure of the company also plays a relevant role.

Probably the most profound reconceptualization of the absorptive capacity construct initially proposed by Cohen and Levinthal is that carried out by Zahra and George (2002). In their article,

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[33] For Dyer and Singh (1998) the absorption capacity gives rise to relational income derived precisely from this interaction and collaboration between different organizations or members of the same organization. They point out that there are four determinants of relational income and its potential to confer competitive advantage: relation-specific assets, knowledge-sharing routines, complementary resources and capabilities, and effective governance.

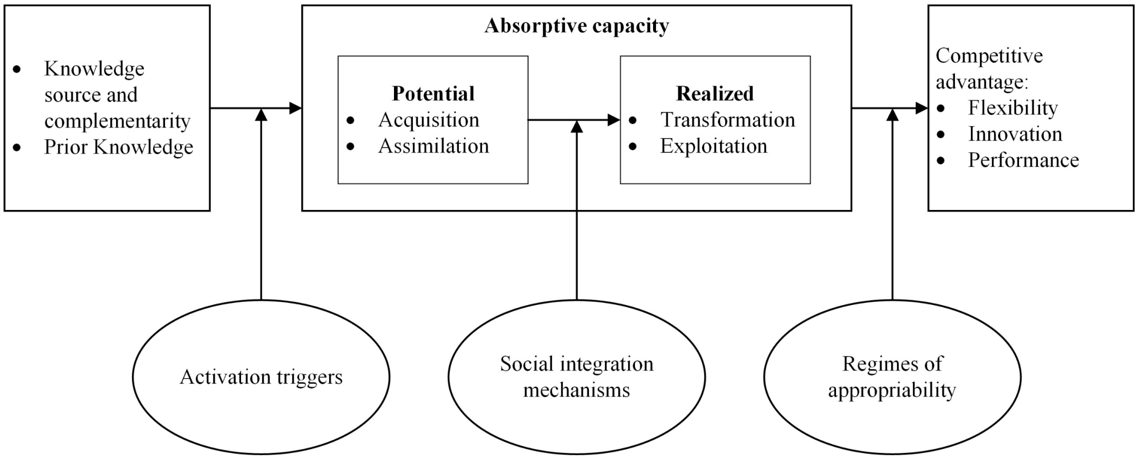
[34] Ambidexterity refers to the balance that an organization can obtain by carrying out exploration and exploitation activities simultaneously. According to James March, exploration consists of experimenting, adapting, changing and innovating to respond to new market demands. On the contrary, exploitation consists of being more efficient, achieving a higher degree of alignment in the current activities of the company, and achieving excellence. An excellent organization must try to balance both positions (Gibson & Birkinshaw, 2004; March, 1991). For further information on this concept of ambidexterity, the following bibliography can be consulted: Luger et al. (2018); O'Reilly & Tushman (2013); Raisch & Birkinshaw (2008).

[35] As noted above, this relationship implies that absorptive capacity stimulates further learning internally, which in turn further reinforces absorptive capacity.

Zahra and George argue that the advancement of the study of absorptive capacity is limited by the ambiguity and diversity of its definitions, the components of said capacity, its antecedents and results. Trying to provide clarity on the above aspects, they reconceptualize absorptive capacity as a dynamic capacity capable of influencing the creation of other ordinary organizational capacities (e.g., marketing, production, distribution), a source of competitive advantage (Teece et al., 1997). To this end, the authors define absorptive capacity as "as a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability" (2002:186). The contribution of these authors goes further and reveals that absorption capacity is made up of four dimensions or individual capacities of a combinatorial nature: knowledge acquisition (Mowery & Oxley, 1995), assimilation (Cohen & Levinthal, 1990), transformation (Kim, 1998) and exploitation (Cohen & Levinthal, 1990).

The capacity or acquisition dimension is defined as the ability of a company to identify, value and acquire critical external knowledge for its operations (Zahra & George, 2002). Assimilation capacity refers to the ability of a company to absorb external knowledge through its routines and processes. The transformation dimension is the ability of a company to develop and refine internal routines that facilitate the transfer and combination of prior knowledge with new knowledge acquired and assimilated. Lastly, exploitability refers to a company's ability to apply new external knowledge in its operations for business purposes to achieve its objectives. Zahra and George group the four capacities into two complementary components: on the one hand, the acquisition and assimilation capacities make up the potential absorption capacity component; on the other hand, the transformation and exploitation capacities are grouped in the realized absorption capacity component. Their roles are complementary and, although differentiated, they need to coexist so that the absorption capacity can contribute to the creation of value and improvement of the company's performance. These authors also contemplate the existence of different external and internal contingencies that affect each of the dimensions of absorption capacity. Figure 28 below shows the model proposed by Zahra and George.

Figure 28. Zahra and George's (2002) absorptive capacity model



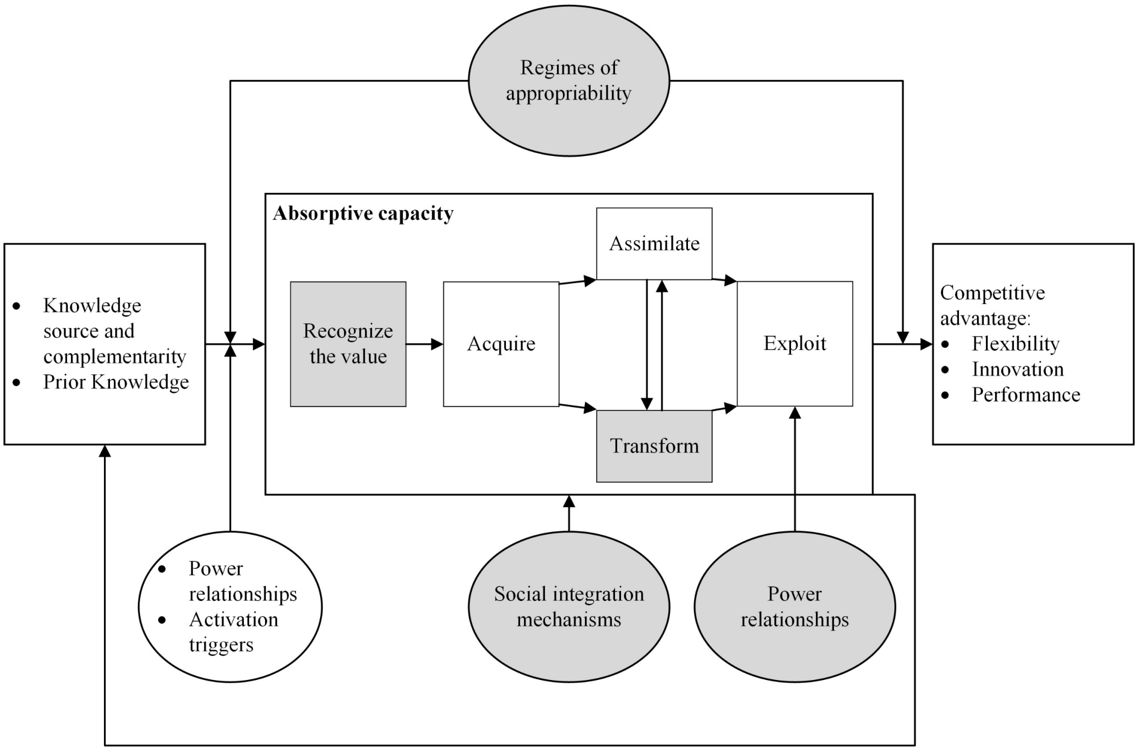
Source: Zahra and George (2002)

Later, Lane et al. (2006), based on a thematic analysis of 289 scientific articles related to absorptive capacity, carry out a new reconceptualization or proposal of the processes that underlie absorptive capacity, its antecedents and its impact on company results. With respect to the antecedents, the authors make a distinction between internal antecedents to the company and external ones. Starting with the latter, they refer to the degree of similarity between the internal and external knowledge that is intended to be acquired, as well as the degree of cultural and strategic adjustment between the organizations. The antecedents at the internal level of the firm are related to aspects such as the mental models shared by the members of the organization, the structural characteristics of the company, and its organizational strategies. Regarding the absorption capacity, according to these authors, it is made up of three sequential processes: (I) exploratory learning, which is the recognition and understanding of potentially valuable external knowledge; (II) transformative learning, which includes the process of assimilation of new valuable knowledge; and, (III) exploitative learning, which consists of using the new assimilated knowledge to create new knowledge and improve its commercial exploitation.

The following academic work that makes a clear contribution to the revision, reconceptualization and clarification of the absorptive capacity construct is that of Todorova and Durisin (2007). These authors make a constructive criticism of the model proposed by Zahra and George (2002), arguing that the latter's proposal does not integrate as it should some of the most seminal aspects of the construct proposed by Cohen and Levinthal (1989, 1990) and, for this reason, they make a proposal to refine the model. Todorova and Durisin's first critique focuses on the lack of capacity to assess the potential of new knowledge in Zahra and George's model. On the other hand, the authors, from an approach rooted in psychology, also question the sequentiality between the capacities of assimilation and transformation, proposing a more complex and recursive relationship between both capacities. Thus, they maintain that the use of one or another capacity will depend largely on the degree of familiarity of the new knowledge acquired with the structures and current knowledge bases of the company, being the assimilation capacity used when the absorbed knowledge is similar to the pre-existing one in the organization and the capacity for transformation in the case of new knowledge that does not fit with the previous cognitive schemes of the organization[36]. This new contribution to the literature also modifies the contingency factors of Zahra and George's absorptive capacity model, including new factors such as power relations. Furthermore, following the contributions of Cohen and Levinthal (1990), they add new feedback loops to capture the dynamic essence of the model. Todorova and Durisin's (2007) proposal does not alter the antecedent factors already included in the Zahra and George (2002) and Cohen and Levinthal (1990) models. The following Figure 29 collects the model of Todorova and Durisin (2007).

[36] Other recent studies such as that of Dzhengiz and Niesten (2020) from the point of strategic management pick up the witness of Todorova and Durisin (2007) but point out that the difference between assimilation and transformation capacities does not reside in the degree of similarity with the pre-existing knowledge bases in the company, but rather at the ontological level at which the assimilation or transformation of new knowledge occurs. Thus, Assimilation implies the interpretation, dialogue and exchange of knowledge between members of a sub-unit or group within the same organization that share the same culture, mental models and knowledge bases. Rather, transformation occurs when the knowledge of one subunit is transferred to the rest of the organization.

Figure 29. Todorova and Durisin's (2007) absorptive capacity model

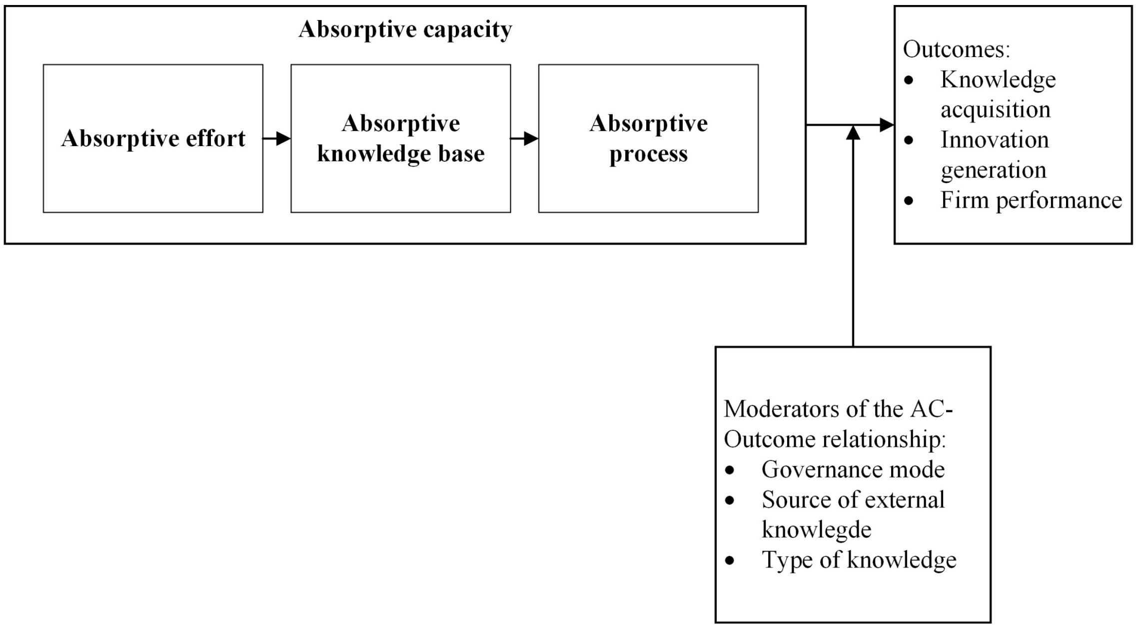


Source: Todorova and Durisin (2007)

More recently, Song et al. (2018), collecting previous contributions regarding the existing confusion in the literature regarding the meaning and nature of absorptive capacity (e.g., Volberda et al., 2010; Lane et al., 2006), make a new attempt to reconceptualization of the construct. According to these authors, the search for greater precision in the concept of absorption capacity is more pressing if one takes into account that studies of an empirical nature have used the same measures as indicators of absorption capacity (e.g., De Faria et al., 2010) and as its outcomes (e.g., Arbussà & Coenders, 2007). Based on an exhaustive review of the literature, and supported by a meta-analytic study of 193 previous publications in prestigious academic journals, the authors propose a reconceptualization of absorptive capacity in three dimensions or capacities: absorptive effort, absorptive knowledge base, and absorptive process. Absorptive effort refers to the investments made by the company to facilitate the search, identification and acquisition of external knowledge. Absorptive knowledge base comprises the company's previous stock of knowledge that allows it to understand, recombine and transform external knowledge (Cohen & Levinthal, 1990). Finally, absorptive process refers to the procedures and practices intended to facilitate the sharing and dissemination of external knowledge throughout the organization.

With regard to the main outputs or results of absorption capacity, the authors have introduced three fundamental outputs in their model, as they are the most used among a total of 50 possibilities previously used in the literature. These outputs are knowledge acquisition, innovation generation and firm performance. Interestingly, the authors show through the meta-analytical study that firm performance is partially measured by the other two outputs, knowledge acquisition and innovation generation, thus distinguishing between the effects of absorptive capacity to create value (knowledge acquisition and innovation generation) and to capture value (firm performance) (Song et al., 2018: 2370). Likewise, Song et al. (2018) also include new moderating factors in the relationship between absorptive capacity and outcomes. These moderating factors are the governance mode (or "how" knowledge is accessed); the external knowledge source (or from "who absorbs the knowledge); and, finally, the type of knowledge (distinguishing between technological and non-technological knowledge). Figure 30 below presents the model of Song et al. (2018).

Figure 30. Song et al. (2018) absorptive capacity model



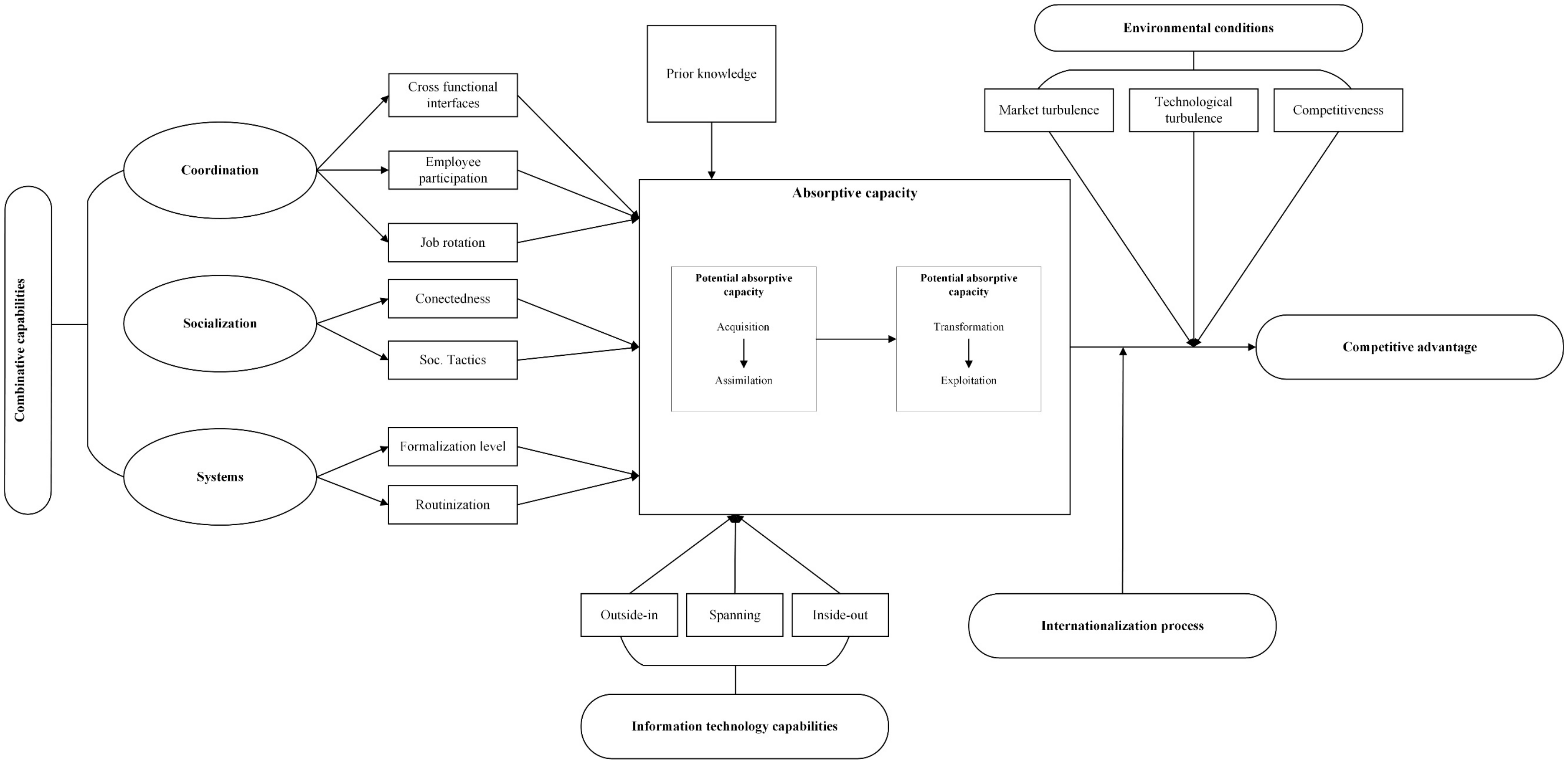
Source: Song et al. (2018)

Lastly, one of the most recent reconceptualisations of the concept of absorptive capacity is that carried out by Hussain et al. (2022). These authors, through a profuse review of the literature, extend the original conceptualization of the absorptive capacity of Zahra and George (2002) as a dynamic capacity (Eisenhardt & Martin, 2000). In this way, they include within the antecedent factors of the absorption capacity not only the prior knowledge of the company, widely recognised in previous studies since the seminal contribution of Cohen and Levinthal (1990), but also delve deeper into the micro-foundations of these antecedent factors, responding to the call of previous studies in the field of business strategy (e.g., Yao & Chang, 2017; Felin et al., 2015; Helfat & Peteraf, 2015). According to the authors, their unit of analysis "is an individual managing the firm" (Hussain et al., 2022: 2).

Turning to the analysis of the model, the authors first comment on the possible antecedent factors of the absorptive capacity and include as a novelty to the model of Zahra and George (2002) the combinative capacities (socialization, systems and coordination), mentioned in other previous antecedents of the literature (e.g., Jansen et al., 2005). Likewise, considering the conditions of the current competitive environment in business, the authors also incorporate into their theoretical model the antecedent role that information technology capabilities (outside-in, spanning, inside-out) can play and the synergistic effect that information technology capabilities can play with the combinative capacities already mentioned previously (Roberts et al., 2012).

Regarding the construct of absorption capacity, the authors maintain its multidimensional nature (Diestel et al., 2019; Song et al., 2018) composed of four capacities or dimensions proposed by Zahra and George (2002) and that make up the capacity of absorption as a dynamic capacity. Finally, regarding the factors that moderate the relationship between absorptive capacity and competitive advantage (output of their model), Hussain et al. (2022) underline the importance of the company's internationalization process in the current arena (e.g., Vahlne & Johanson, 2017), as well as the influence of environmental conditions or the external environment, highlighting market turbulence, technological turbulence and competitiveness turbulence (Lichtenthaler, 2009; Jansen et al., 2005; Van de Bosch et al., 1999). The following Figure 31 shows the proposal of Hussain et al. (2022).

Figure 31. Hussain et al.'s (2022) absorptive capacity model



Source: Hussain et al.'s (2022)

4.4. CONCLUSIONS OF THE CHAPTER

The resources and capabilities approach emerged in the 1990s with the aim of providing the literature on strategic management with an explanation of the sources of a firm's competitive advantage (e.g., Barney, 1991). Thus, in contrast to other approaches that focus on the analysis of the external environment and the positioning of the firm, the resource-based approach points out that firms are highly heterogeneous, and that only those with rare, valuable, inimitable and non-substitutable resources and capabilities will gain sustainable competitive advantages. However, in today's dynamic business environment, driven by new technologies, societal pressures for greater business sustainability, or globalisation, possessing valuable resources and capabilities in a static manner does not guarantee long-term survival. On the contrary, firms must develop dynamic capabilities (Teece et al., 1997) that enable them to renew, improve, upgrade or increase their portfolio of resources and capabilities in order to cope with the new demands of the new competitive arena. Two fundamental conclusions can be drawn from the chapter: knowledge is a highly valuable resource for dealing with this complex, volatile and dynamic environment; and absorptive capacity is the guarantor of the company's learning. This absorptive capacity, as a dynamic capacity, has an impact on the renewal of the organisation's stock of knowledge resources and cognitive models, stimulating the regeneration of its functional capacities in order to improve its performance. In this thesis we intend to find out whether absorptive capacity is, therefore, also a fundamental antecedent of performance in the triple perspective of sustainability, i.e., in economic, social and environmental terms.

5. RESEARCH HYPOTHESES

5.1. EFFECTS OF KNOWLEDGE SPILLOVERS AND FIRM'S ABSORPTIVE CAPACITY ON SUSTAINABILITY PERFORMANCE

5.1.1. Direct effects of knowledge spillovers and absorptive capacity on sustainability performance

A company's ability to adapt to changes in its environment is essential to sustain its competitive advantage and ensure its long-term survival (Teece, 2014; Helfat et al., 2007). Sustainability, whose fundamental premise lies in the holistic reconciliation of economic, social, and environmental performance, now represents a paradigm shift in competitive markets and in the way companies create and sustain competitive advantages (Shahzad et al., 2020). Such competitive advantages are based on building a differentiated positioning by companies that are sufficiently motivated and skilled to implement strategies to build resources and capabilities that effectively bridge the triple bottom line of sustainability performance (Tsai & Liao, 2017). To meet the challenges that sustainable development imposes on companies, there is a consensus in the literature that companies will need to increase their knowledge base on new sustainability practices, technologies, legal requirements, and solutions (Walsh et al., 2020; Abbas & Sagsan, 2019; Forés, 2019; Imaz & Sheinbaum, 2017; Mol & Birkinshaw, 2014; Grant, 1996; Nonaka & Takeuchi, 1995).

In the contemporary competitive arena, numerous pieces of research underline the importance of external knowledge in complementing a company's internal knowledge to meet new business challenges, as it is questionable whether a single company can have all the necessary knowledge in such a complex area as sustainability within its boundaries (Hernández-Trasobares & Murillo-Luna, 2020; Rauter et al., 2018; Roper et al., 2017; Chesbrough, 2003, 2012; Teece, 1986). Therefore, the literature points out that leveraging external knowledge is key to the improvement of sustainability performance in the firm (e.g., Abbas & Sagsan, 2019; Tang et al., 2019; Tseng, 2014; Katila & Ahuja, 2002). Knowledge spillovers, understood as the process in which knowledge is transferred from the producer or source of that knowledge to the recipients or users of knowledge (Wang et al., 2017), represent one of the main forms of external knowledge that the firm can access. Implicit in the conception of knowledge spillovers is the effort that the company should make to be an active part of the community of agents, processes and networks in which these knowledge flows are generated (Becattini et al., 2009; Camisón, 2004; Granovetter, 1985). Without this conscious effort on the part of organisations, the identification of these knowledge flows (not to mention their valuation, acquisition and subsequent application of those knowledge flows of a complex and tacit nature) would not be possible.

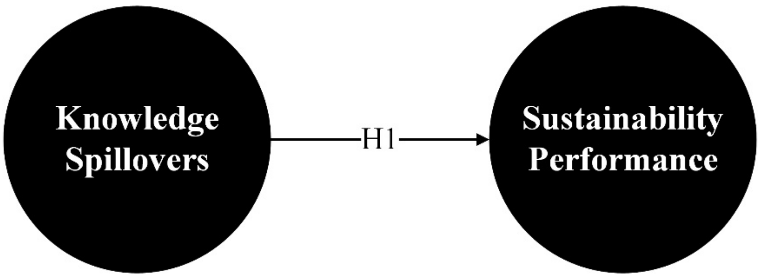
As such, these knowledge spillovers that firms can make use of to improve their performance can come from different sources (Hernández-Trasobares & Murillo-Luna, 2020; García-Martínez et al., 2017; Rodríguez et al., 2017). Thus, market sources include knowledge spillovers from suppliers, customers, or competitors of the firm (Rodríguez et al., 2017; De Marchi, 2012). On the other hand, education and research sources comprise knowledge spillovers from entities such as universities, research or technology centres, and consultants (Rodriguez et al., 2017; Löfsten & Lindelöf, 2005; Monjon & Waelbroeck, 2003). Finally, there are other sources where relevant knowledge spillovers are easily produced and distributed such as conferences and trade fairs, or scientific journals and trade publications, among others (Rodriguez et al., 2017; Laursen & Salter, 2006).

Knowledge spillovers from market sources such as suppliers can provide the company with key information on the supply of more sustainable inputs or components, but also of more environmentally responsible complementary technologies (Hernández-Trasobares & Murillo-Luna, 2020; Hájek & Stejskal, 2018; De Marchi & Grandinetti, 2013; De Marchi, 2012; Seuring & Müller, 2008). Likewise, knowledge spillovers from customers or key competitors are also useful for the company to improve sensitivity to market needs and can contribute to the adoption of more efficient and sustainable business practices (Hernández-Trasobares & Murillo-Luna, 2020; Segarra-Oña et al., 2016; De Marchi & Grandinetti, 2013; Peiró-Signes et al., 2013). Moreover, universities and other research centres possess high endowments of intellectual capital and talent that produce theoretical knowledge externalities applicable to different firm contexts (Hájek & Stejskal, 2018; Roessner et al., 2013; Bayona-Sáez & García -Marco, 2010; Fabrizio, 2009; Spender & Grant, 1996). Consultants or business laboratories are sources of information that produce more complex and applied knowledge both in terms of technical and organisational business knowledge (Rodríguez et al., 2017; Laursen & Salter, 2006). Last but not least, scientific events such as conferences and professional meetings, or high-impact scientific publications produce spillovers of novel knowledge that can be useful for the company's purposes (Rodriguez et al., 2017).

Sometimes, some of the above knowledge spillovers, because of their degree of similarity with the firm's existing knowledge and experiences, are able to enhance efficiency or provide new solutions to develop skills, products, or processes on this existing knowledge base in the firm, stimulating the creation of synergies between both sets of knowledge without requiring dynamic learning capabilities (Camisón et al., 2018; March, 1991). These knowledge spillovers provide the basis for continuous organisational improvement, impacting on sustainability performance through the exploitation, or refinement in the use of the firm's current endowment of knowledge resources and capabilities (Camisón et al., 2017, 2018; Clausen et al., 2013; Levinthal & March, 1993; March, 1991). Therefore, following these contributions from the literature, we propose as the first hypothesis of this research a positive relationship between knowledge spillovers and sustainability performance, depicted in Figure 32.

H1: *Knowledge spillovers have a positive effect on sustainability performance*

Figure 32. Hypothesis 1



However, it should be noted that not all external knowledge aimed at the more efficient deployment and exploitation of the company's current capabilities and creation of new ones for the improvement of its sustainability performance is related to the company's existing knowledge background and cognitive models (Camisón et al., 2017, 2018). It is in these situations where knowledge spillovers are characterised by their uplifting tacit, complex and innovative nature, not related to the knowledge cognitive patterns, in which absorptive capacity (Zahra & George, 2002; Cohen & Levinthal, 1990) becomes crucial for firms. In this sense, absorptive capacity should rely on both the accumulation or internal generation of knowledge, mainly through the promotion of R&D and employee's continuous training, and the assimilation and exploitation of new external knowledge (Cohen & Levinthal, 1989, 1990, 1994).

Knowledge acquired from external sources can be of great use to the firm as the combination of new ideas together with the firm's previously existing knowledge may serve for the deployment of new capabilities and more sustainable practices (Shahzad et al., 2020; Camisón et al., 2018; Chesbrough & Appleyard, 2007; McEvily & Chakravarthy, 2002). Cohen and Levinthal (1989;

1990) were the first authors to point out that the firm's absorptive capacity required to assimilate and exploit external knowledge in its environment is useful for improving its organisational performance. These same authors define a firm's absorptive capacity as a firm's ability to "recognise the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990: 128). Since then, considerable efforts have been made to advance the absorptive capacity construct, its main triggers, and the performance outcomes it helps to predict (e.g., Hussain et al., 2022; Song et al., 2018; Forés and Camisón, 2016; Camisón and Forés, 2010; Volberda et al., 2010; Zahra and George, 2002). In this thesis, following Camisón and Forés (2010), absorptive capacity thus comprises strategies for acquiring, assimilating, transforming, and exploiting the knowledge that enhances organisational capabilities so that these can impact some measure of organisational performance.

At present, some studies analyse the relationship between absorptive capacity and higher sustainability performance, complementing seminal studies that assess the link between absorptive capacity and variables such as innovative performance (e.g., Forés & Camisón, 2016) or the financial performance of the company (e.g., Lichtenthaler, 2016). According to Albert-Morant et al. (2018), absorptive capacity contributes to firms having the most up-to-date knowledge of technologies and innovations that promote more sustainable products and processes[37]. In empirical work with a sample of 152 Dutch companies in the agri-food sector, Ingenbleck and Dentoni (2016) note that the value of absorptive capacity lies in the ability of the company to recognise and value its obligations towards society and its stakeholders, beyond legal compliance, allowing it to outline actions that contribute to the promotion of a more sustainable society (e.g., through internal training programmes, incorporating new technologies, or by implementing proactive environmental strategies). The same authors propose a redefinition of absorptive capacity in the field of sustainability as "the ability of the firm to recognize the value, assimilate, and apply knowledge on its obligations towards society and its stakeholders beyond legal compliance" (Ingenbleck & Dentoni, 2016: 4).

It is this dynamic capability nature (Teece et al., 1997) that allows absorptive capacity to combine various internal (e.g., R&D investment) and, especially, external (e.g., knowledge absorption) processes applicable to the improvement of the firm's sustainability performance. Accordingly, absorptive capacity enables the exploration, assessment, integration, and use of new knowledge in the organisation to improve its performance, taking into account social, economic, and environmental aspects in a holistic manner (Abbas & Sagsan, 2019). Shahzan et al. (2019) in an

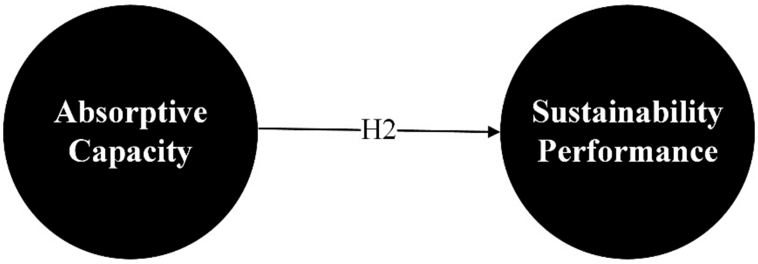
[37] In fact, concern for improving corporate sustainability is often one of the main triggers for innovation as pointed out by an extensive body of literature (e.g., Inigo et al., 2020; Hájek & Stejskal, 2018; Rauter et al., 2018; Tsai & Liao, 2017; Adams et al., 2016; Doran & Ryan, 2014; Aragón-Correa & Sharma, 2003).

empirical study of 587 manufacturing firms located in countries such as China, Taiwan or Malaysia, confirm that absorptive capacity has a direct and significant effect on improving sustainability performance. Similar results are found by Abbas and Sagsan (2019) on a sample of 302 Pakistani manufacturing and service firms, confirming that absorptive capacity influences the adoption of more sustainable technologies and management practices, impacting the triple social, environmental, and economic performance, especially in the latter two dimensions.

Contrary to the previous hypothesis, absorptive capacity always implies exploring new combinations of internal and external knowledge whose integration requires greater learning efforts on the part of the firm (Camisón et al., 2018; March, 1991; Cohen & Levinthal, 1990). In order to increase this absorptive capacity, the firm may resort to increasing its internal R&D endowments, resorting to external R&D, acquiring new technologies and software equipment, or improving the training of the workforce (Song et al., 2018; García-Martínez et al., 2017; Camisón & Forés, 2010; Cohen & Levinthal, 1990). Drawing parallels with the literature in innovation management, an empirical study by Claver-Cortés et al. (2020a) on a set of 1437 Spanish firms in the medium and high-tech sectors confirms the direct effect that absorptive capacity has on the improvement of the firm's innovative performance. Therefore, absorptive capacity, as a dynamic capacity (Hussain et al., 2022; Forés & Camisón, 2016; Camisón & Forés, 2010; Zahra & George, 2002), leads to disruptive changes in the company's stock of knowledge, technological assets, and functional capabilities (Danneels, 2002) that have a direct impact on the development of new products, the redeployment of production processes, market positioning and compliance with legal requirements in the field of sustainability, thus helping to meet the requirements of stakeholders and society at large (Shahzad et al., 2020; Abbas & Sagsan, 2019; Dangelico et al., 2017; Tsai & Liao, 2017). Therefore, we expect a positive relationship between absorptive capacity and sustainability performance in the second hypothesis of this PhD thesis, depicted in Figure 33 below.

H2: *Absorptive capacity has a positive effect on sustainability performance*

Figure 33. Hypothesis 2



5.1.2. The mediating effect of absorptive capacity

One of the contributions of Cohen and Levinthal's (1990) seminal article is the incentive of abundant knowledge spillovers in the environment for the firm to develop its absorptive capacity[38] (Hussain et al., 2022). As technologies become increasingly sophisticated, product life cycles shorten, competition sharpens across industries, and society's sensitivity to social and environmental causes increases, firms cannot rely solely on their internal knowledge creation capabilities or the adoption of new incremental knowledge aimed at increasing efficiency in the exploitation of the firm's existing capabilities (Guisado-González et al., 2021; Forés and Camisón, 2016). Strategic management literature highlights the risks of obsolescence and myopia in the assessment of market trends and industry evolution that companies incur when they entrust their knowledge accumulation capabilities to sources closely related to pre-existing knowledge or local search (Song et al., 2018; Forés & Camisón, 2016; Leiponen & Helfat, 2010; Teece, 2007; Laursen & Salter, 2006; Eisenhardt & Martin, 2000).

De Marchi (2012) argues that accessing the knowledge, experiences, and skills of external counterparts is essential in knowledge domains outside the company's realm. The purpose is that this new knowledge helps to leverage and regenerate the firm's existing cognitive bases. Yet, for the development of resources and capabilities that can truly have a disruptive impact on firm performance, exposure to a wide range of novel sources of knowledge and their identification is not enough, but the correct evaluation, assimilation and institutionalisation of these is necessary to be able to apply the new radical knowledge absorbed to the firm's purposes (Hussain et al., 2022; Song et al.,2018; García-Martínez et al., 2017; Forés & Camisón, 2016; Nieto & Quevedo, 2005). This process is not free of costs, as to be able to access and correctly take advantage of

[38] Cohen and Levinthal (1990) themselves point out the disruption of this new relationship, for as they explain in their article, previous research (e.g., Spence, 1984; Arrow, 1962; Nelson, 1959) had traditionally established a negative relationship between the existence of knowledge spillovers and the incentives to undertake knowledge generation and accumulation activities due to competitors' appropriability of the firm's efforts.

these knowledge spillovers, the company must first generate a critical mass of knowledge internally that allows it to understand, evaluate, assimilate and apply the radical new knowledge that emerges in its environment (Song et al., 2018; Claver-Cortés et al., 2016; Camisón & Forés, 2010; Nieto & Quevedo, 2005; Cohen & Levinthal, 1990).

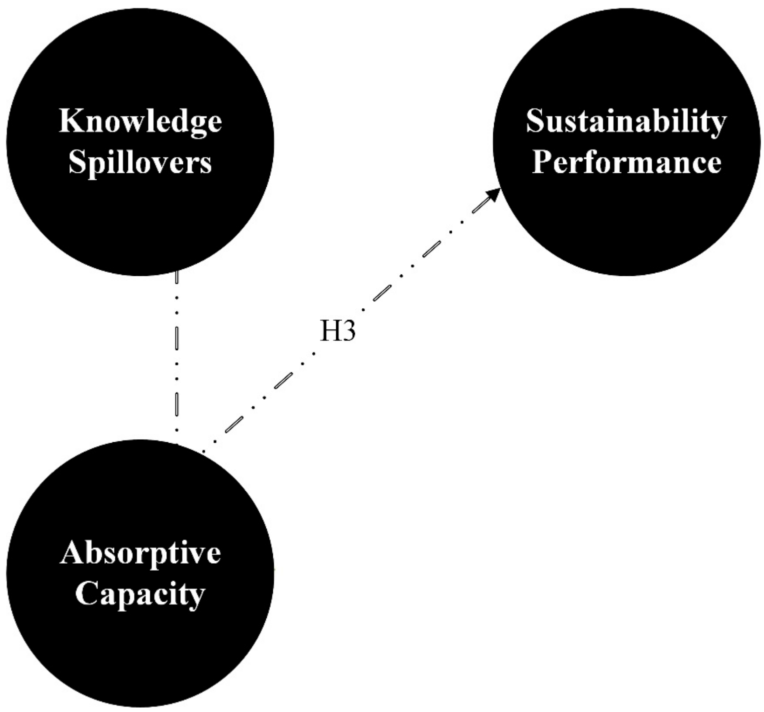
This fact explains why a set of firms may be exposed and identify to the same knowledge spillovers and yet cannot absorb and exploit them to the same extent (Camisón et al., 2018; Claver-Cortés et al., 2016; Camisón & Forés, 2011; Camisón, 2004; Zahra & George, 2002). The abundance of knowledge spillovers from different knowledge sources also poses a challenge for the firm's management, as it makes it difficult to assess, assimilate and directly combine them with the firm's previous knowledge bases (García-Martínez et al., 2017; Claver-Cortés et al., 2016; Laursen & Salter, 2006). Based on the complexity of reconciling performance from the triple bottom line of sustainability, the inability of organisations to absorb and take advantage of knowledge spillovers in their environment limits their possibilities to generate new resources and capabilities that lead precisely to the improvement of the organization's sustainability performance (Dzhengiz & Niesten, 2020; Teece, 2018; Laursen & Salter, 2006).

Reconceptualised as a dynamic capability (Hussain et al., 2022; Dzhengiz & Niesten, 2020; Camisón & Forés, 2010; Zahra & George, 2002), absorptive capacity helps firms in bringing all the organisational changes that are strategic in nature to develop competitive advantages over other firms (Hussain et al., 2022; Song et al., 2018). This requires an active stance on the part of firms to develop the absorptive capacity to acquire knowledge spillovers that further enhance sustainability performance (Dzhengiz & Niesten, 2020; Shahzad et al., 2019, 2020). Without this absorptive capacity, it will be difficult for companies to take advantage of the most disruptive and novel knowledge spillovers from different sources in their environment to improve their performance (Forés & Camisón, 2016). Finally, it should be said that, beyond the possible knowledge leakage that inevitably occurs in a territorial agglomeration of firms, if firms have a properly developed absorptive capacity, they will obtain greater knowledge resources than they will lose through their own knowledge spillovers (Expósito-Langa et al., 2015; Hervás-Oliver & Albors-Garrigós, 2009).

In this doctoral research we consider that absorptive capacity, as a dynamic capacity, ensures the acquisition, assimilation, transformation, and exploitation of different knowledge spillovers, impacting the generation of new functional capabilities (e.g., production, marketing, etc.) that stimulate the improvement of the sustainability performance of organisations to maintain the strategic fit with the demands of their environment and stakeholders. We believe that a company with an adequate absorption capacity will be able to multiply the effects of the knowledge spillovers obtained from its environment, exploring new combinations of knowledge resources, discovering other possible more innovative applications, and incorporating green technologies. This will ultimately have a more significant impact on improving sustainability performance. Therefore, we propose the following third hypothesis, depicted in Figure 34 below:

H3: *Absorptive capacity mediates the relationship between knowledge spillovers and sustainability performance*

Figure 34. Hypothesis 3



5.2. EFFECTS OF THE ORGANIZATION BELONGING TO A SCIENCE AND TECHNOLOGY PARK ON SUSTAINABILITY PERFORMANCE

5.2.1. Direct effects of integration in a science and technology park on knowledge spillovers

Since the pioneering work of Alfred Marshall (1890) there is a consensus in the academic literature that the creation of knowledge applicable to new innovations and capable of boosting the competitiveness of firms is a more successful process when it is geographically bounded (e.g., Ascani et al., 2020; Arranz et al., 2019; Hervás-Oliver et al., 2018; Camisón & Forés, 2011 Becattini et al., 2009; Castells & Hall, 1994; Porter, 1990). Science and technology parks are a policy tool aimed precisely at fostering the creation of knowledge and the development of innovations in a concrete environment by stimulating the links between industry and academia, encouraging the creation of new knowledge-based companies, as well as providing the hosted companies with other benefits such as image and prestige reinforcement, or easy access to customers, technological research centres and highly trained workforce (González-Masip et al., 2019; Gwebu et al., 2019; Arauzo-Carod et al., 2018; Vásquez-Urriago et al., 2016; Link & Scott, 2015). The political interest in the creation and promotion of this type of infrastructure is awakened by the success of successful initiatives such as the Stanford Research Park (predecessor of Silicon Valley), which have served as an incentive and example for new initiatives in America, Asia, and Europe, turning science and technology parks into a global phenomenon, and of broad academic and professional interest (Mian et al., 2016; Rowe, 2014; Anttiroiko, 2004; Saxenian, 1994).

A widely used definition of the science and technology park phenomenon in academia is provided by the International Association of Science Parks and Areas of Innovation (IASP), which states that a science and technology park is an “organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated business and knowledge-based institutions. To enable these goals to be met, a Science Park stimulates and manages the flow of knowledge, and technology amongst universities, R&D institutions, companies, and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with a high-quality space and facilities” (IASP, 2017). Although there may be idiosyncratic differences between the typology of pure science parks and technology parks (e.g., Ng et al., 2020; Albahari et al., 2017; Guadix et al., 2016), following previous contributions from the literature (e.g., Claver-Cortés et al., 2018; Vásquez-

Urriago et al., 2016), no distinction will be made between the two realities and the term science and technology park will be used generically.

However, the above statements directly associating science parks with an endowment of knowledge spillovers and a capacity to promote the innovative results of their host companies are, to a certain extent, far from the reality. This fact helps to explain why while some studies in the academic literature confirm the beneficial effect of location in a science and technology park for higher innovative performance in the firm others find a non-significant effect on this relationship. A science and technology park provides to hosted organisations access to cutting-edge technological infrastructures and specialised R&D agents due to its proximity to knowledge-producing centres, such as universities. Intra-park organisations also enjoy the presence of agents that can integrate their value chain -such as suppliers, subcontractors, and customers-, which facilitate complementarity, cost scale advantages, and maximum joint efficiency.

Notwithstanding, the endowment of these bundle of market resources, derived from the purely reductionist perspective of localisation, are insufficient to explain why some science and technology parks are able to helps host companies to improve their performance. Therefore, this colocation of organisations should serve as a trigger or driver for enhancing localised knowledge spillovers through the relationships between companies, R&D institutions, experts and consultants, and local institutions. To this end, an atmosphere of openness to cooperation and knowledge exchange between actors must be forged in the science and technology park, guided by explicit and implicit rules (Lazerson & Lorenzoni, 1999) that generate lower transaction and coordination costs (Shaw & Williams, 2009). Moreover, in order for these knowledge spillovers to be correctly identified by organisations, as noted above, they must have a sense of embeddedness or belonging to the processes, networks and institutions found within the science and technology park (Camisón, 2004; Porter, 1998b, Granovetter, 1985).

Therefore, a science and technology park can create an enabling environment for the generation and dissemination of knowledge (González-Masip et al., 2019; Gwebu et al., 2019; Lecluyse et al., 2019; Arauzo-Carod et al., 2018; Claver-Cortés et al., 2018; Link & Scott, 2018) as long as a series of practices, such as those detailed below, are stimulated within it. Firstly, the physical proximity between different organisations such as companies, technology centres or research institutes should be exploited to stimulate the establishment of both formal and informal links (Agostini & Nosella, 2018; Díez-Vial & Fernández-Olmos, 2015). These social networks that are established within the science and technology park can be considered a cognitive community in which, thanks to the physical, but also organisational and technological proximity (Dangelico et al., 2010; Knoben & Orleans, 2007; Camisón, 2004) that is fostered in these environments and the continuous daily interaction, relationships of trust are developed that greatly facilitate the transmission of knowledge and the creation of a shared identity (Arranz et al., 2019; Kogut & Zander, 1992). As underlined by numerous studies (e.g., Claver-Cortés et al., 2018; Díez-Vial & Fernández-Olmos, 2015; Cantù, 2010; Camisón, 2004; Malmberg & Maskell, 2002; Maskell & Malmberg, 1999), these everyday interactions that take place between organisations in a science and technology park stimulate the rapid dispersal of ideas and information, activating knowledge spillovers. Depending on whether the science and technology park specialises in hosting organisations from a particular economic sector, knowledge spillovers will be Marshallian in the case of firms belonging to the same sector or Jacobian when firms do not belong to the same sector (Glaeser et al., 1992).

On the other hand, it is worth highlighting the relevance of establishing relationships between the science and technology park and the university to generate more knowledge spillovers (Díez-Vial & Montoro-Sánchez, 2016; Guadix et al., 2016; Squicciarini, 2008). Science and technology parks are an incubator for new knowledge-based companies, which in many cases can be university spin-offs or start-ups to commercialise new scientific discoveries (Ritala et al., 2015; Link & Scott, 2006). This is crucial, as it allows the interaction of the staff of the companies housed in the park with the faculty and researchers, as well as to easily update their knowledge through different training initiatives. Furthermore, the proximity of the companies to the university facilitates the attraction of a highly trained and knowledge-intensive workforce (González-Masip et al., 2019). The labour force is a source of knowledge spillovers thanks to its embodied human capital derived from previous work experience or academic training (González-Masip et al., 2019; García-Martínez et al., 2017; Hair Awang et al., 2013; Chang et al., 2012). In this sense, the literature (e.g., González-Masip et al., 2019; Yang & Steensma, 2014) points out that science parks are a lure that attracts a highly educated workforce to join the hosted companies.

Furthermore, the role played by the management bodies of science and technology parks in the production of greater knowledge spillovers in the science and technology park environment by orchestrating the aforementioned actions cannot be ignored. Unlike other models of territorial agglomeration of companies, science parks have a team of managers dedicated precisely to promoting interaction between the hosted organisations, and between these and other centres such as universities (Raymundo-Balle et al., 2019; Ubeda et al., 2019). The parks' management bodies work to generate environments of trust that facilitate knowledge spillovers between entities and, to this end, they can resort to formal events, such as the promotion of informal ones that help the transmission of knowledge (Raymundo-Balle et al., 2019).

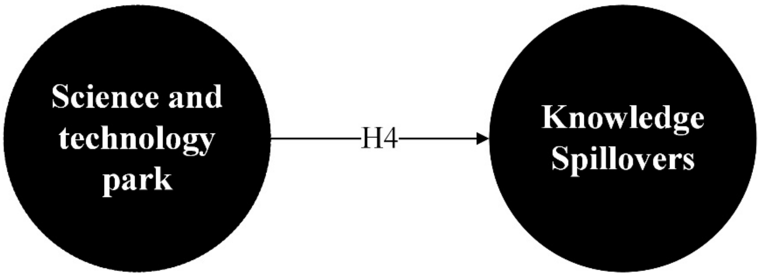
Both professional and academic research on science and technology parks recognise the need for this territorial agglomeration model of firms to develop their capacity to generate knowledge spillovers and, in fact, consider this capacity as a determinant of its success (Gwebu et al., 2019; Rowe, 2014). Thus, this ability of science and technology parks to generate localised knowledge spillovers is considered a measure of their performance (e.g., Gkypali et al., 2016). Even some science and technology parks, when selecting which companies to host in their infrastructures, take into account the potential knowledge spillovers that these new embedded companies can generate, and the impact that these knowledge spillovers can have on the organisations already installed in the science and technology park (Leyden et al., 2008). Several empirical studies such as Squicciarini (2009) for the case of Finnish science and technology parks or Montoro-Sánchez et al. (2011) and Díez-Vial and Fernández-Olmos (2015) for the case of Spanish science and technology parks, confirm that these sets of parks analysed have undertaken actions to be able to configure themselves as spaces rich in knowledge spillovers.

Considering the possible effect that organization location and embeddedness in a science and technology park have on knowledge development and sharing among a broadly composed set of agents this study connects with the milieu perspective (Saxena, 2005). The consideration of firm's embeddedness for approximating the construct of knowledge spillovers allows us the recognition of those organisations which, although entirely integrated physically within a science and technology park, remain isolated at the atmosphere that characterises it[39]. Therefore, a firm located inside a science and technology park but maintaining independence and absolute reservation with respect to the other internal agents colocalised will be deprived of access to these knowledge spillovers, or even incapable to correctly identify them. Therefore, following the previous reasoning, we propose the following fourth hypothesis, depicted in the next Figure 35:

H4: *The organization belonging to a science and technology park has a positive effect on knowledge spillovers*

[39] Since in our subsequent empirical study we distinguish science and technology park-hosted firms from their non-hosted counterparts, we expect that the volume of knowledge spillovers to which in-park firms have access will be comparatively higher than that of their off-park counterparts.

Figure 35. Hypothesis 4



5.2.2. The mediating effects of knowledge spillovers and absorptive capacity on sustainability performance

From all of the above, it can be elucidated that science and technology parks are an instrument capable of stimulating key variables of firm success, such as better economic performance (e.g., Arauzo-Carod et al., 2018; Lindelöf & Löfsten, 2003), higher business growth (e.g., Díez-Vial & Fernández-Olmos, 2016; Dettweiler et al., 2006) or better innovation performance (e.g., Ubeda et al., 2019; Lamperti et al., 2017), to name just some of the most relevant ones. The canonical approach to the study of science and technology parks has traditionally opted to consider the group of companies housed in these infrastructures in a homogeneous way. These studies, when empirically assessing the effect that location in a science and technology park can have on the improvement of certain business success ratios, carry out contrasts comparing the results of a set of firms located in a science and technology park with another control set composed of firms with similar characteristics, but not located in science and technology parks (e.g., Arauzo-Carod et al., 2018; Liberati et al., 2016; Yang et al., 2009; Fukugawa, 2006; Lindelöf & Löfsten, 2003, 2004; Westhead et al., 2000). In this way, the effect of location in a science and technology park can be isolated.

Despite the value and contribution made by these types of studies, there is no clear consensus in the literature as to whether the location of an organisation in a science and technology park is a factor or driver of the business success variables discussed above, especially concerning sustainability performance due to the high scarcity of empirical studies in academia. Thus, while certain empirical studies confirm the beneficial effect of location in a science park on variables such as economic or innovative performance (e.g., Arauzo-Carod et al., 2018; Albahari et al., 2017; Díez-Vial & Fernández-Olmos, 2016; Vásquez-Urriago et al., 2014; Montoro-Sánchez et al, 2011), other researchs reports opposite results or, at best, declares a non-significant effect of the science and technology park (e.g., Lamperti et al., 2017; Liberati et al., 2016; Hansson et al., 2005; Ferguson & Olofsson, 2004; Massey et al., 1992; Quintas et al., 1992), and excludes it as a determinant of business success. As Ubeda et al. (2019) point out if we disregard the heterogeneity that exists between the samples used in previous studies, the possible differences in the variables measuring firm performance, or the endogeneity control in the models, perhaps the most plausible explanation for the discordance in the literature regarding the park effect lies in other sources.

In this sense, several empirical studies, using as an analytical basis the contributions of the more dynamic approach of resource-based view theories (Teece et al., 1997), point out that the disparity in the above debate in the analysis of the effect of location in a science and technology park lies in the internal dynamics of the firm and how it can take advantage of the benefits and opportunities offered by these science and technology parks (e.g., Ubeda et al., 2019; Claver-Cortés et al., 2018; Hervás-Oliver et al., 2018; Díez-Vial & Montoro-Sánchez, 2016; Camisón & Forés, 2011). According to the above contributions, it is possible to conclude that the mere location in a science and technology park, by itself, does not guarantee the improvement of any performance variable of the firm, including performance in terms of sustainability. Instead, a company that is located in a science and technology park and aims to improve its performance, especially if this performance is measured from the triple bottom line of sustainability, must make conscious efforts to take advantage of the knowledge and resources that this technological environment makes available to it. Thus, empirical studies such as the one carried out by Larsen (2004) in two Scandinavian science and technology parks confirm that the efforts made by companies to identify and take advantage of knowledge spillovers from other co-located agents are the basis for improving their own internal knowledge and practices in corporate environmental management.

Therefore, companies staying in a science and technology park should leverage the exploitation, development and refinement of their individual capabilities internally within the firm by making use of the knowledge stocks and flows that converge in the park environment and that have a high degree of similarity with the firm's current knowledge base (Camisón et al., 2017, 2018). Identifying and accessing the knowledge spillovers that occur in a science and technology park by the different scientific, technological and business organisations that come together in it is vital for improving sustainability performance (e.g., Demir et al., 2021; Walsh et al., 2020; Jongwanich et al., 2014). An empirical study conducted by Squicciarini (2009) on 252 firms located in 15 Finnish science and technology parks confirms the important role of harnessing knowledge spillovers in a science and technology park for firms to improve their performance. Therefore, in our view, the exploitation of knowledge spillovers is useful for organisations to increase their operational efficiency and improve their profits, but also reduce their environmental impacts, and improve the management of human capital through the use of existing capabilities. Following the above postulates, we propose the following fifth hypothesis, depicted in Figure 36:

H5: *Knowledge spillovers mediate the relationship between the organization belonging to a science and technology park and sustainability performance*

Figure 36. Hypothesis 5

Science and technology parks justify their existence by their ability to offer their host organisations technological infrastructures, high value-added services and, especially, an idyllic atmosphere that combines cooperative and competitive relationships between co-located agents that promote the generation of knowledge spillovers (e.g., Amoroso et al., 2019; González-Masip et al., 2019; Díez-Vial & Fernández-Olmos, 2015; Saxenian, 1994). In fact, some authors such as Lindelöf and Löfsten (2004) qualify science and technology parks as learning centres. Access to this knowledge can occur through formal mechanisms such as the establishment of alliances and research contracts or the hiring of new staff; but also, through more informal mechanisms, such as daily interaction due to friendship ties or in shared spaces, through the so-called 'cafeteria' effect (González-Masip et al., 2019; Saxenian, 1994; Camagni, 1991).

Thus, as suggested by the most dynamic approaches from a resource-based view of strategic management literature (e.g., Ubeda et al., 2019; Collison & Wang, 2012; Zahra & George, 2002), a science and technology park is an enabling space for firms to access knowledge resources that they cannot develop internally easily. As such, science and technology parks act in a way as a large collective research and development laboratory in which innovation and knowledge constantly germinate (Camisón, 2004). As previously indicated in hypothesis 5, organisations properly rooted in the agglomeration of firms will be able to take advantage of some of these knowledge spillovers that occur between co-located agents in a straightforward manner, stimulating the more efficient exploitation of their existing capabilities to improve their sustainability performance (e.g., Camisón et al., 2018). However, a vast majority of these knowledge spillovers will have a much more complex, tacit and innovative nature precisely because of the science and technology system agents involved in their development (Ubeda et al., 2019; Song et al., 2018; Forés & Camisón, 2016). It is precisely this wealth of complex knowledge spillovers that flourish from embeddedness in a science and technology park, as stated in the seminal article by Cohen and Levinthal (1990), that can exert a push effect on co-located organisations to increase their absorptive capacity (Song et al., 2018).

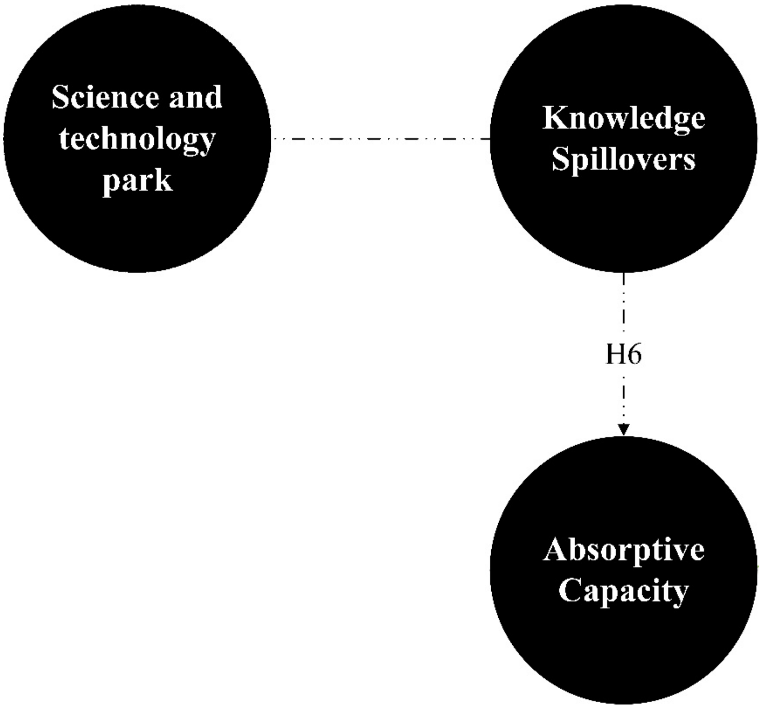
This increase in absorptive capacity of on-park organisations is explained by the fact that knowledge is cumulative and path-dependent (Forés & Camisón, 2016; Camisón & Forés, 2010; Cohen & Levinthal, 1990). So, to access, understand and exploit the most complex, radical and tactic knowledge that can flourish in an environment such as a science and technology park, companies must make a series of efforts internally through new R&D expenditure or workforce training in order to increase their own knowledge base to a level that is on a par with that knowledge stocks of the organisations in their environment (e.g., Dzhengiz & Niesten, 2020; Ubeda et al., 2019; Shahzad et al., 2019, 2020; Song et al., 2018; Forés & Camisón, 2016).

Location in a science and technology park with a high endowment of knowledge spillovers should serve as a stimulus to increase a firm's absorptive capacity, both to improve the knowledge exploitation of co-located agents and to avoid possible isolation effects of those agents that make huge R&D efforts and thus possess cutting-edge knowledge (Huang et al., 2012; Morrison and Rabelloti, 2009). In this vein, knowledge spillovers often arise as a consequence of cooperation between public and private institutions to promote the scientific and technological park beyond its own boundaries, and to stimulate new disruptive innovations and infrastructures that even go beyond the park limits.

Therefore, following previous contributions from the literature, we propose the following sixth hypothesis, represented in Figure 37:

H6: *Knowledge spillovers mediates the relationship between the organization belonging to a science and technology and absorptive capacity.*

Figure 37. Hypothesis 6



International frameworks for action in the field of sustainability, such as the Agenda 2030, show that organisations can no longer delay their contribution to solving problems such as climate change or reducing levels of social inequality (Hernández-Trasobares & Murillo-Luna, 2020; Walsh et al., 2020; Forés, 2019). To improve their performance and ensure that it meets not only the expectations of their shareholders, but also those of the rest of the stakeholders, companies must resort to new knowledge endowments that allow them to boost their performance from the triple perspective of sustainability. Science and technology parks, categorised as spaces for organisational learning (Gwebu et al., 2019; Lindelöf and Löfsten, 2004), can be an excellent environment for companies to improve their sustainability performance. This impact on the triple sustainable organisational performance will be produced to the extent that an atmosphere is created within the park in which the confluence and interaction between agents generates a milieu that fosters the development and sharing of knowledge (Saxena, 2005).

However, mere localisation is not enough, and performance improvement will depend on the company's ability to identify and take advantage of the knowledge spillovers that flourish in these environments derived from the confluence of multiple agents belonging to the science, technology, and business system (e.g., Claver-Cortés et al., 2018; Camisón & Forés, 2011). The company must therefore make an active effort to 'embed' itself in the social fabric of the science and technology park, to acquire the status of 'insider', taking advantage of the benefits that daily face-to-face interaction and the development of networks that provide to access the most valuable knowledge assets that emerge in the environment (Raymundo-Balle et al., 2019; Díez-Vial & Montoro-Sánchez, 2016; Bryson, 2015; Dangelico et al., 2010; Malmberg & Maskell, 2002; Porter, 1998b).

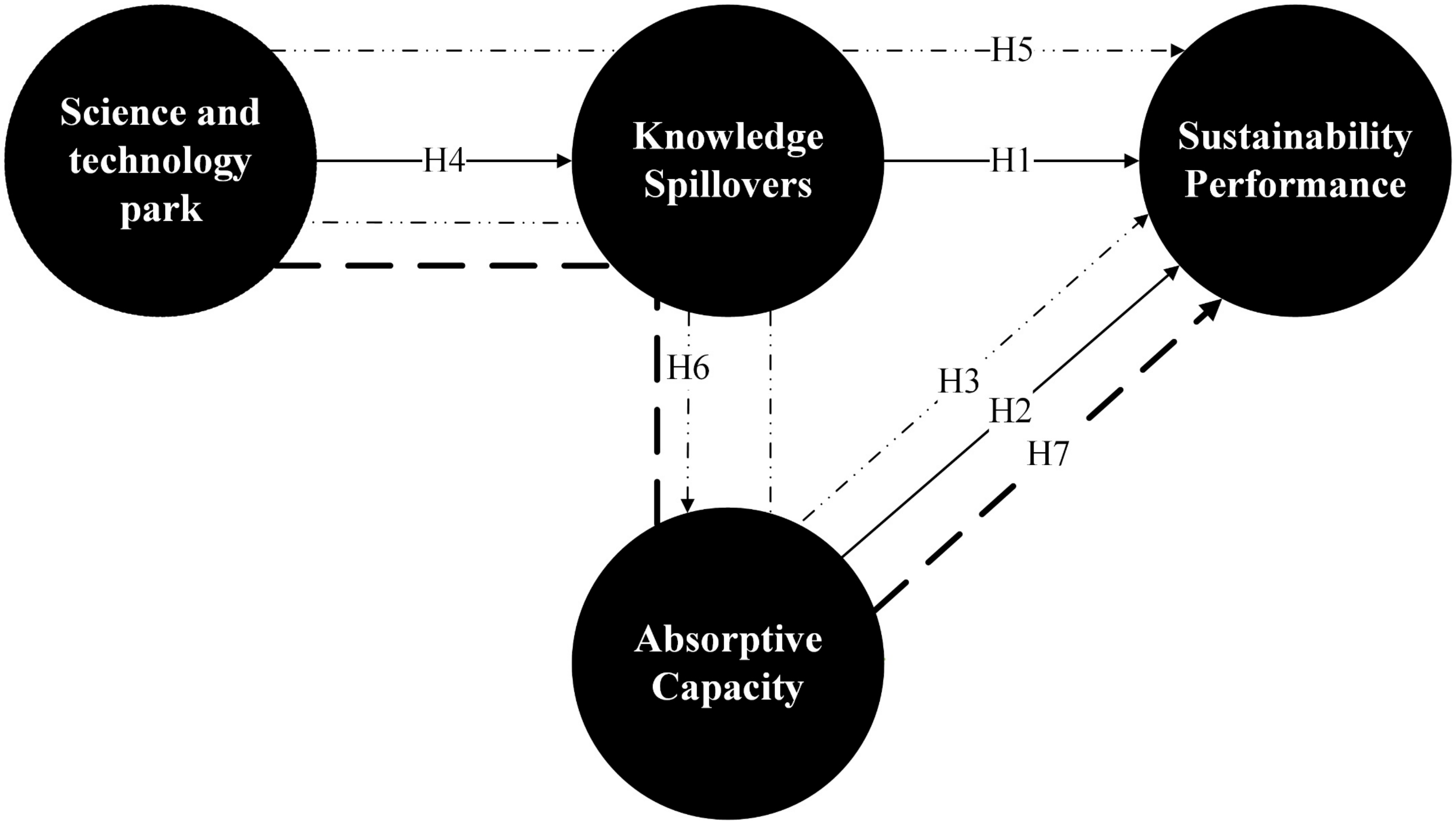
Hence, the existence and exploitation of knowledge spillovers can be recognised as a mediating variable in the relationship between the location in a science and technology park and the improvement of the sustainable performance of the organisations that are hosted in them. Some of these knowledge spillovers, due to the degree of similarity with the firm's current knowledge bases, mental models, and cognitive patterns can be easily harnessed, making it more efficient to exploit the firm's existing capabilities to improve its sustainable performance (Camisón et al., 2017, 2018; Clausen et al., 2013; March, 1991). However, a vast majority of tacit, socially complex, and higher-value knowledge requires a greater effort for the firm to acquire, assimilate, transform and exploit it (Dzhengiz & Niesten, 2020; Shahzad et al., 2019, 2020; Forés & Camisón, 2016).

Thus, an empirical study by Ubeda et al. (2019) confirms that firms with a high or intermediate absorptive capacity obtain a better innovative performance. Likewise, Claver Cortés et al. (2018) find similar results for a set of Spanish firms, confirming the mediating effect of absorptive capacity between the location in a science and technology park and the improvement of their innovative performance. Considering that innovation can be a driving source of environmental (e.g., Parrilli et al., 2022; Shahzad et al., 2020; González-Blanco et al., 2018) and social (e.g., Cillo et al., 2019) performance improvement, and the importance given by recent literature to absorbed knowledge in improving not only economic, but also environmental and social performance (e.g., Walsh et al., 2020; Albort-Morant et al., 2018; Segarra-Oña et al., 2016; De Marchi & Grandinetti, 2013), we consider absorptive capacity is thus a second indispensable mediating factor to be considered in the relationship between the location of an organisation in a science and technology park and the improvement of its triple performance. From this perspective absorptive capacity amplifies for sustainability aims the benefits of park location in terms of knowledge generation and sharing. Therefore, following this reasoning, and considering the arguments stated in H3 and H6, we raise the following final hypothesis:

H7: *The impact of the integration in a science and technology park on sustainability performance is mediated by knowledge spillovers, at first, and absorptive capacity*

Figure 38 below presents the model as a whole as well as all the previously hypothesized relationships between the variables.

Figure 38. Hypothesis 7



6. METHODOLOGY AND RESULTS

6.1. DATA AND SAMPLE

We use the Technological Innovation Panel (PITEC) data for Spanish companies. The PITEC is based on the Community Innovation Survey (CIS) database to analyse EU firms' innovation activities and results (Estrada & Zhou, 2022). This survey has been conducted bi-annually by National Statistics Institute (INE), the Spanish Science and Technology Foundation (FECYT) and the Foundation for Technological Innovation (COTEC) since 2003. PITEC replicates for Spain the questionnaire used by The Community Innovation Survey (CIS) by Eurostat, following the guidelines of the Oslo Manual and the Frascati Manual (Gault, 2013).

This method is the most suitable for international standardisation and comparison between different branches of activity. Questionnaires are sent to the CEOs of organisations from all sectors, and the response rate across the survey period is approximately 92% (Escribano et al., 2009). PITEC has a panel structure. The panel of companies available in the PITEC is unbalanced during the period 2002–2010, as per mergers, closure, and liquidation. To preserve representativeness, new companies have been incorporated into the survey since 2004. However, as pointed out by previous studies (e.g., Chapman et al., 2018) it is a small share of dropouts in the panel to be an attrition problem for our research.

PITEC contains organization-level data and provides information about the basic descriptors company (size, age, sector of activity, geographic market, etc.), as well as detailed information on the employment, sales and exportation activity. However, most of the information in this database is related to innovation activity (expenditures, outputs, external sources of knowledge or spillovers, cooperation activity, public financial support, barriers to innovation, etc.).

The reference period for the research is 2009-2016, as there is no previous information on some of the study variables (e.g., sustainability performance). In our analysis, we use an unbalanced panel of 8.874 companies which have conducted some sort of sustainability performance throughout the period studied of 7 years, yielding a total sample of 47.870 observations. In each survey wave, economic units are asked to provide information regarding the current year and the past two years.

Two of the most important advantages that have the use of data from the PITEC are the important volume of observations and the confidence in the reliability and validity of the data (Alarcón et al., 2019). In addition, another important advantage of this data for our research is the fact a representative sample of manufacturing and service companies is observed repeatedly over a long period, which allows us to deal with unobserved heterogeneity and simultaneity problems between innovation outputs and outputs.

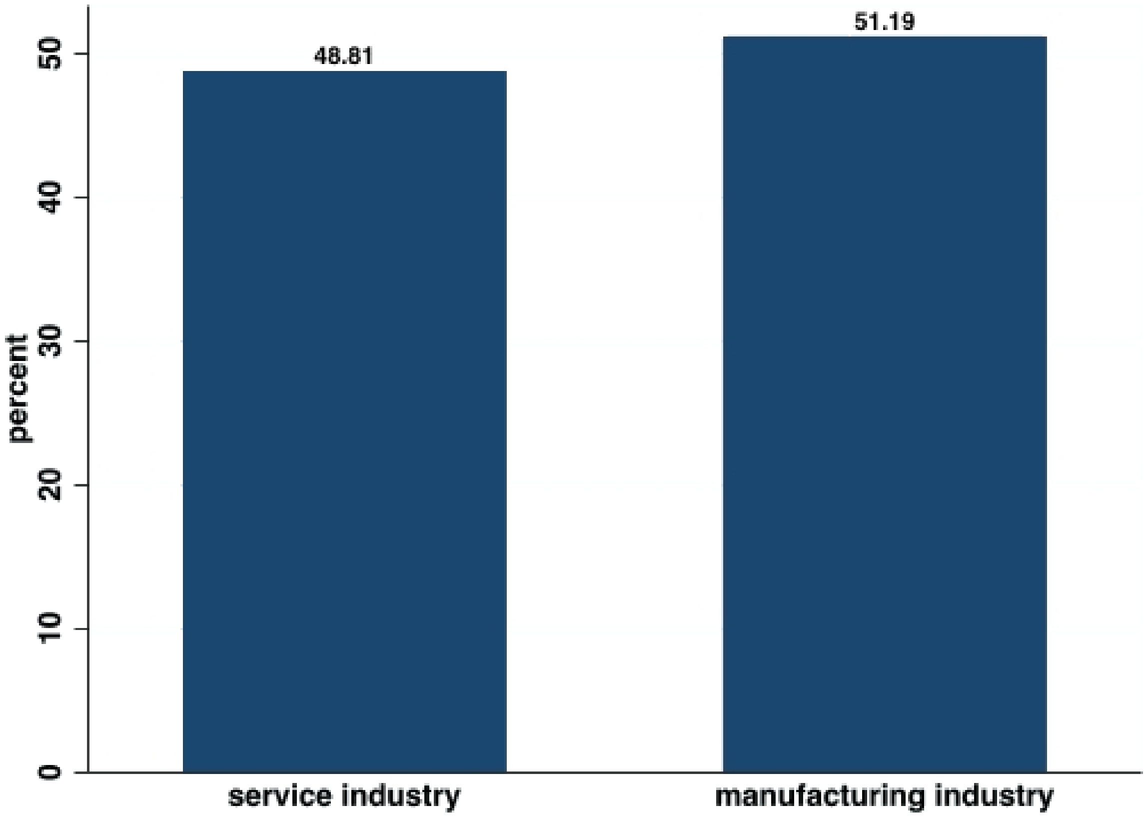
However, the use of the PITEC data also has drawbacks related to the collection through self-report by respondents. In spite of the associated subjectivity in the response, previous studies on CIS database and methodology confirm that the subjective measures of innovation surveys tend to be consistent with the corresponding objective measures of innovation (González-Blanco et al., 2018).

PITEC is one of the most used datasets in innovation studies (e.g., Guerrero et al., 2022; Zouaghi et al., 2020; Alarcón et al., 2019; Arranz et al., 2019a; Rodríguez et al., 2017). Various authors (e.g., Chapman et al., 2018; Diez-Vial and Fernández-Olmos, 2017; Diez-Vial and Fernández-Olmos, 2015; Montoro-Sánchez et al., 2011) have also used PITEC to advance the understanding of location in STP and innovation activities of organizations in Spain.

In addition, there is an increasing trend to use the data from the PITEC to carry out studies on social (e.g., González-Masip et al., 2019; Kunapatarawong & Martínez-Ros, 2016) and environmental aspects (Diez-Martinez et al., 2022; Torrecilla & Fernández, 2022; Acebo et al., 2021; Arranz et al., 2021; Cornejo-Cañamares et al., 2021; Guisado-Gonzalez et al., 2021; Arranz et al., 2019b; Jové-Llopis & Segarra-Blasco, 2018; Peiró-Signes & Segarra-Oña, 2018; González-Blanco et al., 2018; Del Río et al., 2017; De Marchi, 2012). This tendency is explained by the incorporation in 2008 (extended with the additional items in 2009) of variables related to environmental and social innovation objectives, following Oslo Manual, and for the increasing efforts shown by Spanish organizations in eco-innovation (Acebo et al., 2021) as their increasing relevance for the Spanish economy (Kunapatarawong & Martínez-Ros, 2016).

Similarly, CIS has already been used in other eco-innovation European studies (e.g., Parrilli et al., 2022; Rodríguez-Rebés et al., 2021; Jové-Llopis & Segarra-Blanco, 2019; Ghisetti et al., 2015; Horbach, 2008). But as yet no publications have analysed the contributions of Spanish science parks on sustainability performance, by considering their impact on knowledge spillovers and the different ways firm absorb external knowledge. Figure 39 shows the distribution of the sample in service and manufacturing companies according to the Spanish National Classification of Economic Activity (CNAE-2009).

Figure 39. Distribution of the sample by industry

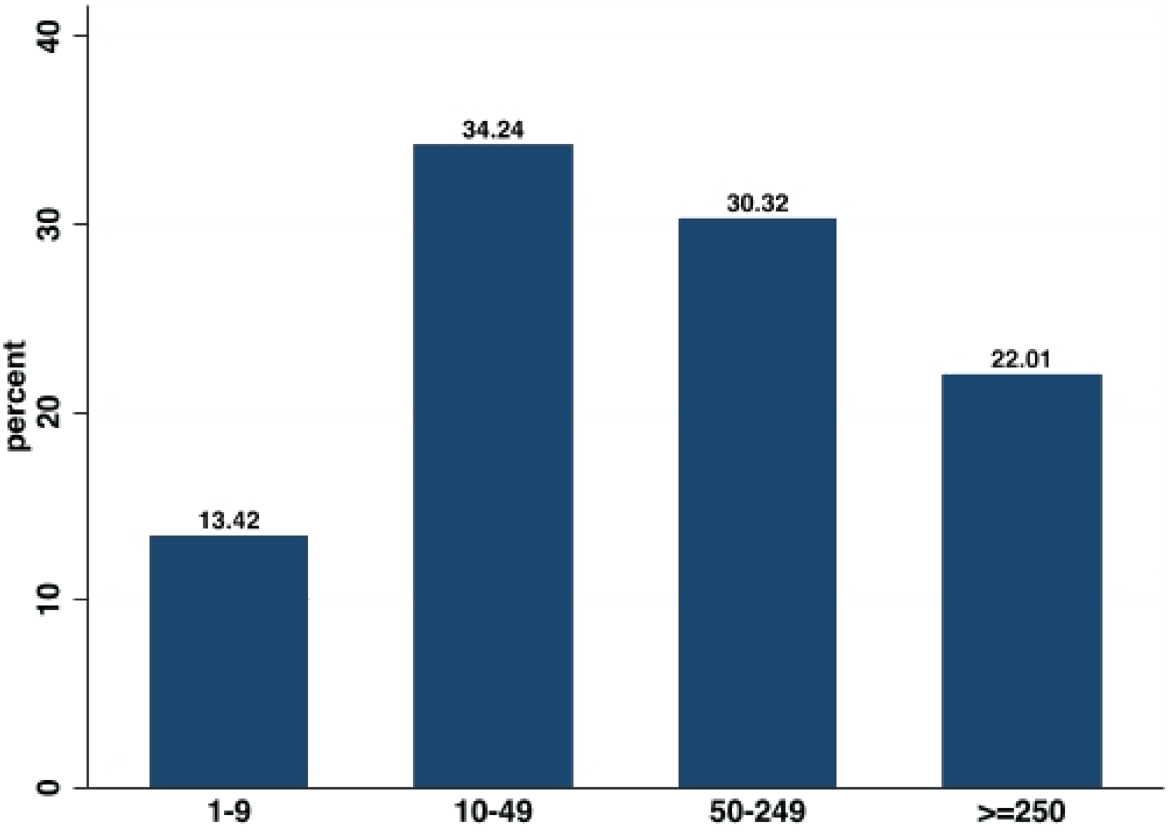


Source: own elaboration

As we can see from Figure 39 there is a balanced number of firms according to the belonging to service or manufacturing industry, which guarantees the representativeness of our sample. Thus, firms belonging to manufacturing industries account for 51.19% of the sample, while firms belonging to service industries account for 48.81%.

Figure 40 presents the distribution of the sample according to the number of employees of the company. The groups to control are four, considering the most common used criteria of the European Union. We aggregate self-employment (1 employee) with micro-firms (with employees between 2 and 9) as the reduced number of companies in the group. We also consider small firms (with employees between 10 and 49), medium-sized firms (with employees between 50 and 249) and large firms (with 250 or more employees).

Figure 40. Distribution of the sample by size

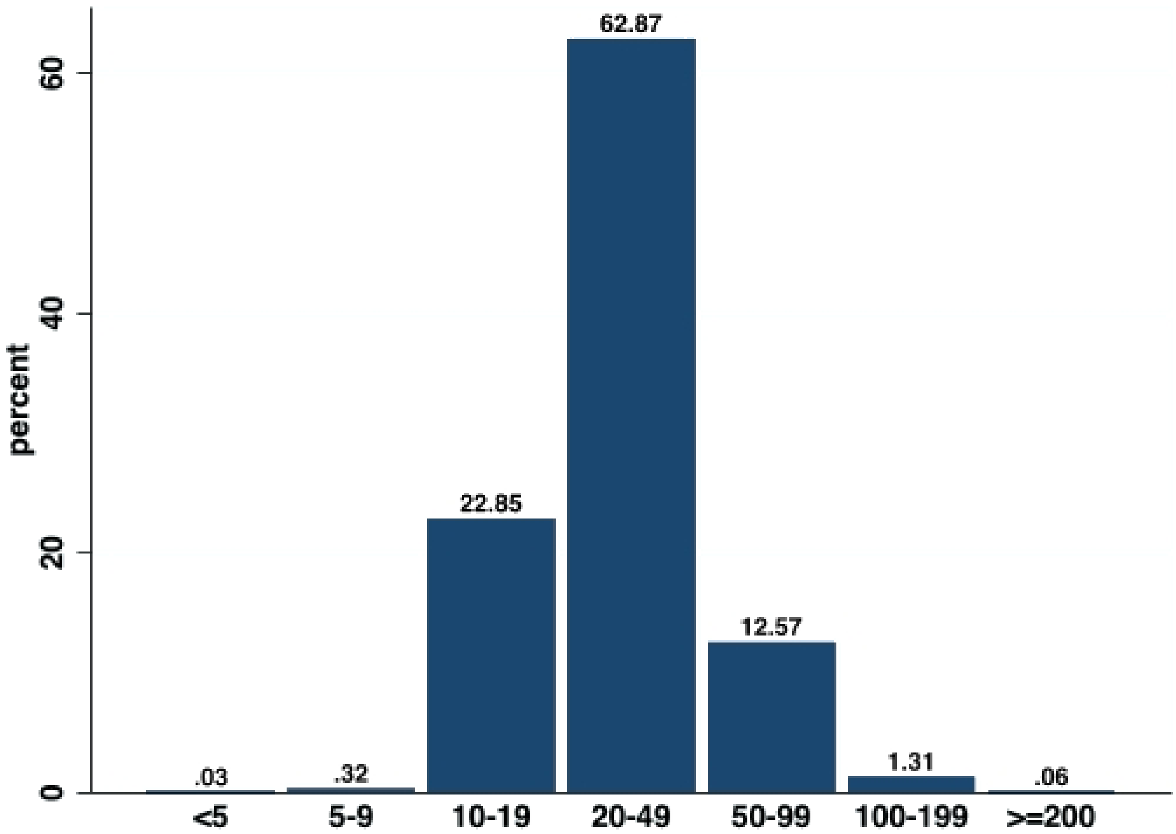


Source: own elaboration

As we can see, the majority of the companies in the PITEC database are small and medium-sized enterprises, with a combined representation of 64.56 % of the sample. Large companies are also surprisingly well represented (22.01%). Micro enterprises are the segment with the lowest representation in the sample with only 13.42%.

Finally, we present the distribution of the sample by age in Figure 41. We consider seven groups for: start-ups (with minor than 5 years old, and between 5 and 9 years old), young companies (between 10 and 19 years old), mature companies (between 20 and 49 years old), and long-lived companies (between 50 and 99 years old; between 100 and 199 years old; and equal or more than 200 years old).

Figure 41. Distribution of the sample by age

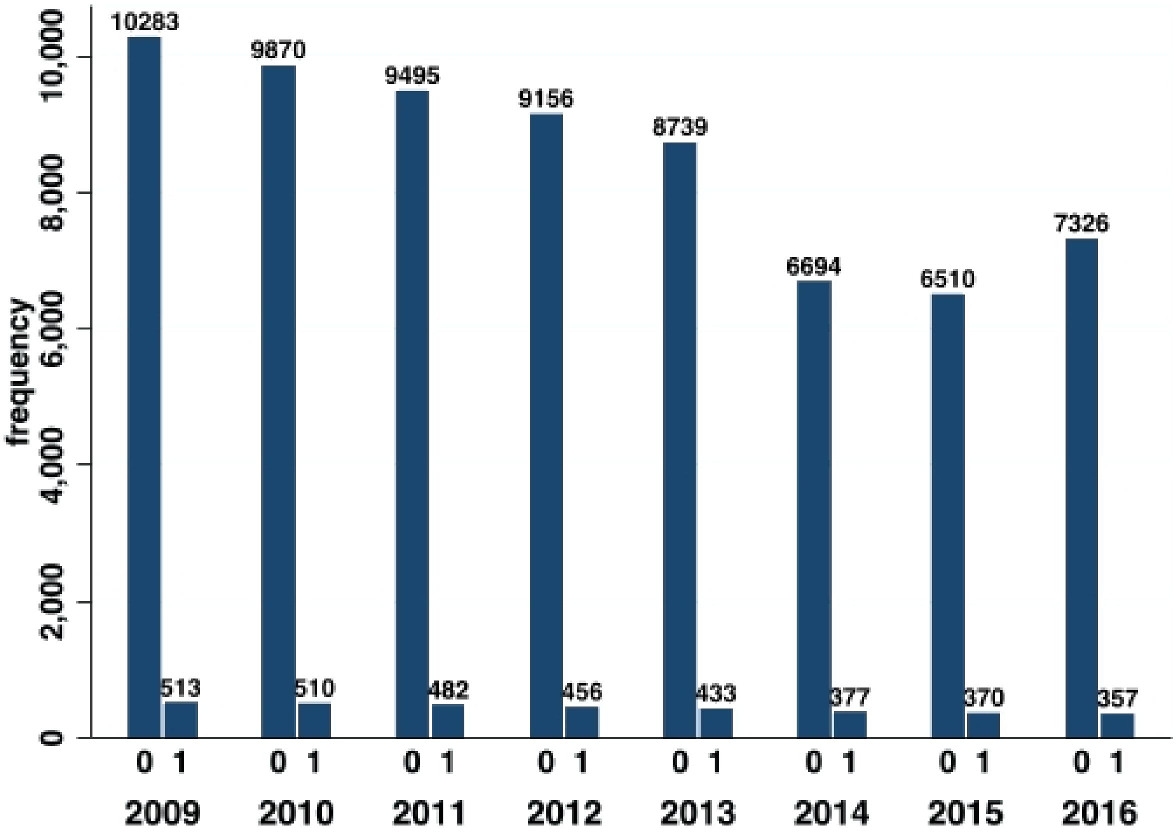


Source: own elaboration

The majority of the companies in the PITEC data panel (62.87%) have a moderate longevity, between 20 and 49 years. The next most representative subset of the sample is made up of companies aged between 10-19 years. The third most representative group (12.57%) is made up of companies between 50 and 99 years old. It should be noted that the panel also includes centenarian (1.31%) and even bicentenarian (0.06%) companies. The remaining sizes do not merit further consideration.

Figure 42 show the evolution of the number on- and off-park companies from 2009 to 2016. AS er can see from the results there has been a general decline in the sample of companies that make up the PITEC panel database. This decrease in the number of companies surveyed occurs both for companies not located in science and/or technology parks (0) and for those that are located in science and/or technology parks (1).

Figure 42. Evolution of the number of on- and off-park companies from 2009 to 2019



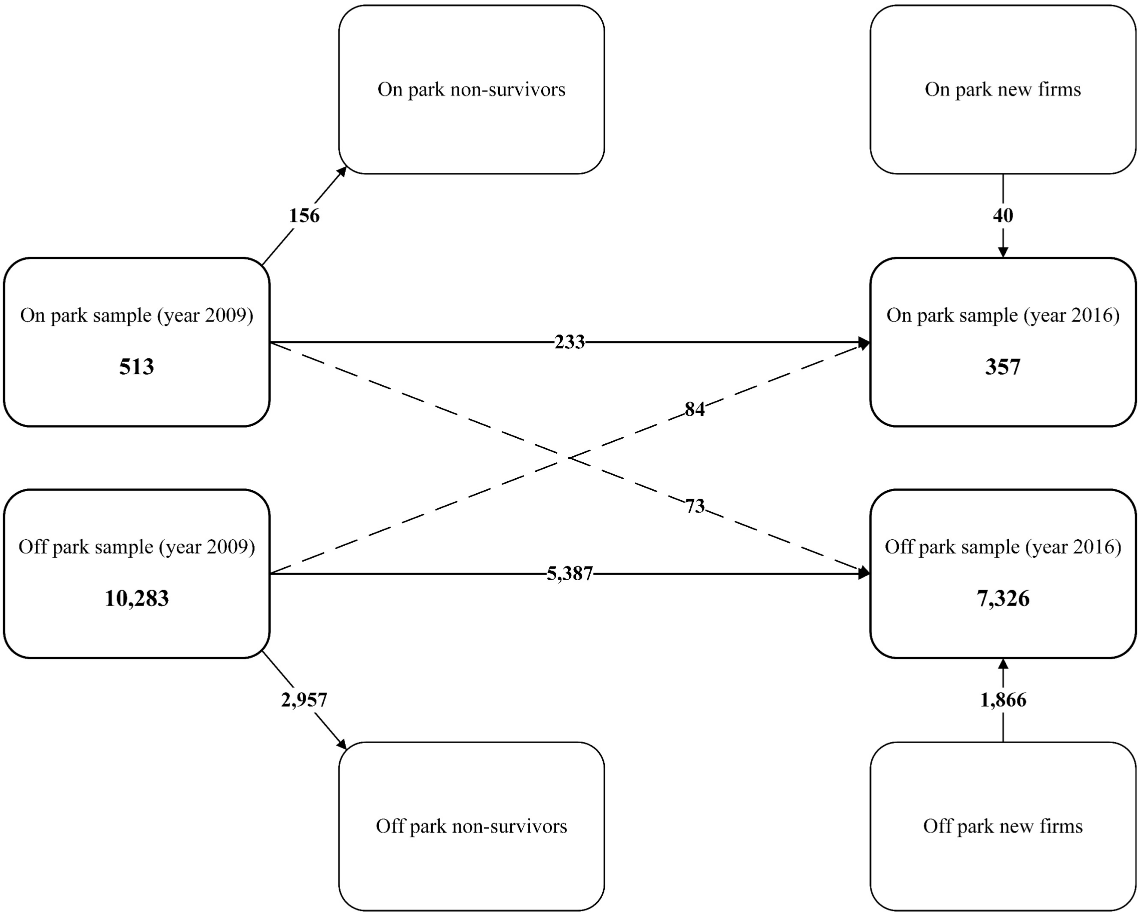
0=off park; 1=on-park

Source: own elaboration

In addition, Figure 43 presents the evolution of on- and off-park companies from 2009 to 2016 in PITEC, considering not only movements to and from the STP, but also business that just disappear or begin to exist during this period. 30.40% of the companies that were originally located in a science and/or technology park did not survive in 2016, while 45.41% did survive and maintained their location. 14.23% of the companies that were located in a science and/or technology park in 2009 survive but decide to relocate to other external locations. During the period 2009-2016, 40 new companies joined PITEC, which are also located in science and technology parks.

With regard to the sub-sample of off-park companies that make up the PITEC, it should be noted that there have also been several movements during the period analysed (2009-2016). Thus, 28.75% of the original companies do not survive in 2016 while 52.38% do survive and maintain off-park locations. 0.81% of the companies that in 2009 were located off-park, in the course of the period up to 2016, are now located in a science and/or technology park. Finally, 1,866 new off-park located companies were added to the panel.

Figure 43. Evolution of the organisations in the panel dataset



Source: own elaboration

6.2. MEASURES

6.2.1. Dependent variable

Sustainability performance (SUSTAIN) is the dependent variable of the model. This variable is measured through an organization's engagement in sustainability performance, based on their ex-post self-assessment. For that and following previous research approaches to measure this dependent variable (Acebo et al., 2021; González-Blanco et al., 2018; Segarra-Oña et al., 2015), we capture sustainability performance as the sum of scores about the importance of 16 actions//objectives while developing market, social and environmental innovations. These questions were on a 4-point scale: 0 (not used) and 3 (high); but, before the total addition of the items, we coded these questions as binary variables (1 if the company responds ‘medium’ and ‘high importance’, 0 otherwise). Specifically, we consider the following items:

Economic dimension related to market (product and process) innovations

Products

(i) Increase in the offered number of products or services

(ii) Old product substitution

(iii) New markets penetration

(iv) Increase in market share

(v) Increase in quality

Processes

(vi) Increase in production flexibility

(vii) Increase in production capacity

(viii) Labor cost reduction (per unit)

Environmental dimension (green innovation and compliance)

(ix) Material cost reduction (per unit)

(x) Energy cost reduction (per unit)

(xi) Reduce in environmental impact

(xii) Compliance with environmental, health and security regulatory

Social dimension

(xiii) Increase in the total employment

(xiv) Increase in the qualified employment

(xv) Maintenance of the employment

(xvi) Increase employees’ health and security

6.2.2. Independent variable

Belonging to an STP (STP)

To measure the STP effect we created a binary variable (0-1) called belonging to a park that takes a value of 1 if the company is located in a science and technological park and zero otherwise, following previous literature (Díez-Vial & Fernández-Olmos, 2017; Díez-Vial & Fernández-Olmos, 2015; Yang et al. 2009; Ferguson & Olofsson 2004).

6.2.3. Mediator variables

Knowledge spillovers (SPILL)

Knowledge spillovers represent the external information sources that provided information for new or existing innovation projects (Diez-Martinez et al., 2022). Considering previous research (Rodríguez et al., 2017; Guisado-González et al., 2017) we measure knowledge spillovers as the sum of scores about the importance of the following information sources for the innovation process: (i) sources within your enterprise group, (ii) suppliers, (iii) clients[40], (iv) competitors, (v) consultants and commercial labs, (vi) universities or other higher education institutions, (vii) public research institutes, (viii) technological institutes, (ix) conferences, trade fairs and exhibitions, (x) scientific journals and technical publications and (xi) professional and industry associations.

Each source was measured with an item capturing the degree of importance (between 0 for 'not used' and 3 for 'high'). We rescaled each item, before aggregating them, between 0 (not used and reduced degree of importance) and 1 high (medium and high importance). In this vein, the final knowledge spillovers measure ranges from 0 to 11 values.

Absorptive capacity (ACAP)

According to the Oslo Manual and following previous studies (e.g., Diez-Vidal & Fernández-Olmos, 2017), we consider five items that describe the innovation capabilities linked to a company's absorptive capacity construct: (i) internal research and development; (ii) external research and development; (iii) acquisition of machinery and equipment; (iv) acquisition of external knowledge; and (v) internal and external training for innovation activities.

Internal Research & Development. This binary variable (0-1) will take the value 1 if the organization has carried out internal research and development activities during the year.

[40] We consider the mean of the degree of importance of clients, divided into clients from the private sector and clients from the public sector for the year 2016 of the panel data, for building the panel data until 2016.

External Research & Development. This binary variable (0-1) will take the value 1 if the organization has carried out external research and development activities during the year.

Acquisition of machinery and equipment. This binary (0-1) variable will take the value 1 if the organization has acquired advanced machinery, equipment, hardware or software intended for the production of new products or processes during the year. This category only includes the acquisition of capital goods for innovation that is not included in R&D activities.

Acquisition of external knowledge. This binary variable (0-1) will take the value 1 if the organization has acquired external knowledge for innovation, such as licenses, patents, disclosures of know-how, trademarks, designs or other inventions during the year.

Internal and external training for innovation activities. This binary variable (0-1) will take the value 1 if the organization has trained (internal or external training) its personnel for *t*he development or introduction of new products or processes.

To measure absorptive capacity, we sum the scores obtained in these five binary variables. The value of an organization's absorptive capacity variable ranges, thus, from 0 to 5.

6.2.4. Control variables

Different factors that could have an effect on sustainability performance are also included in the model as control variables (e.g., De Marchi 2012).

Size (SIZE). To capture the effect of the company's size on sustainability performance, we use a dummy variable (0-1) that takes the value 1 if the organization has equal or more than 200 employees, and 0 otherwise (e.g., Guerrero et al., 2022; Lopez et al., 2022; Claver-Cortés et al., 2016).

Business group affiliation (GROUP). This variable will take the value 1 if the business is part of a group as either the parent company, a subsidiary, a joint venture or an associate (e.g. Lopez et al., 2022; Guisado-González et al., 2021; Alarcón et al., 2019; Arranz et al., 2019a, b; Chapman et al., 2018; Rodríguez et al., 2017; De Marchi, 2012).

Exports (EXPORTS). This variable will take the value of 1 if the business is an exporter, and 0 otherwise (e.g., Guerrero et al., 2022; Lopez et al., 2022; Alarcón et al., 2019; Chapman et al., 2018; Rodríguez et al., 2017; De Marchi, 2012).

The use of external public funding to develop innovation processes (FUNDS). PITEC distinguishes public funding according to origin: i) from local or regional governments; ii) from the national government; iii) from the European Union. This reflects the use of public funding with a dummy variable (Public Funding) equal to 1 if the company receives any public funding from any of the above-mentioned institutions, and 0 otherwise. This control variable has also introduced in previous related literature (e.g., Alarcón et al., 2019; Arranz et al., 2019a; Rodríguez et al., 2017; De Marchi, 2012).

Industry (INDUSTRY). We introduce a dummy variable that takes the value 1 if the business belongs to the manufacturing industry and 0 to the service industry (Arranz et al., 2019b).

Cooperation (COOP). We also introduce a dummy variable that takes the value 1 if the company cooperates with other companies or institutions (Guisado-González et al., 2021; Alarcón et al., 2019; Rodríguez et al., 2017; Díez-Vial & Fernández-Olmos, 2015; De Marchi, 2012).

Newness (NEWNESS) is measured through the share of products or services new to the market *(*Alarcón et al., 2019).

We could not control for the film's age as per multicollinearity problems in the panel regression.

We use Cronbach's alpha to evaluate the internal consistency for each construct. The minimum acceptable alpha level is 0.7 for each item loading or 0.6 in exploratory studies (Hair et al., 1998; Nunnally, 1978). The results show that the constructs had values greater than the minimum threshold (see Table 21). The absorptive capacity construct has a value close to 0.6 we consider acceptable for this study.

As shown by Table 20 correlation values among all variables are generally low to moderate, suggesting there is a low risk of facing collinearity issues or redundancies with this set of variables. The highest correlation is 0.578, less than the problematic level. The general rule of thumb is that correlation values should not exceed 0.75 (Tsui et al., 1995) or, being stricter, 0.6 (Churchill, 1979). This is confirmed by the analysis of Variance of Inflation (VIF). The maximum VIF value is 1.39, well below the rule of thumb cut-off of 10, which again indicates that there are no serious multicollinearity problems in the models (Hair et al., 2006; Neter et al., 1996). Table 19 presents the summary statistics and Table 20 the correlations among the study variables.

Table 19. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
SUSTA overall	8.502	4.998	0	16
between		4.285	0	16
within		3.061	-5.498	21.377
STP overall	1.049	0.216	1	2
between		0.203	1	2
within		0.071	0.174	1.924
SPILL overall	4.502	3.041	0	11

between		2.568	0	11
within		1.798	-4.998	13.127
	5.870	1.049	5	10
ACAP overall				
between		0.856	5	10
within		0.600	3.120	9.995
SIZE overall	1.263	0.440	1	2
between		0.405	1	2
within		0.134	0.388	2.138
	1.436	0.496	1	2
GROUP overall				
between		0.468	1	2
within		0.164	0.561	2.311
EXPORT overall	0.634	0.482	0	1
between		0.444	0	1
within		0.208	-0.241	1.509
FUNDS overall	0.265	0.441	0	1
between		0.350	0	1
within		0.265	-0.610	1.140
INDUST overall	0.512	0.500	0	1
between		0.492	0	1
within		0.090	-0.363	1.387
COOP overall	1.403	0.491	1	2
between		0.390	1	2
within		0.305	0.528	2.278
NEW overall	7.247	20.009	0	100
between		14.248	0	100
within		14.567	-79.003	94.747

Table 20. Correlation and VIF coefficients

	SUSTAIN	STP	SPILL	ACAP	SIZE	GROUP	EXPORTS	FUNDS	INDUSTRY	COOP	NEWNESS	VIF
SUSTAIN	1											Mean VIF=1.24
STP	0.0411***	1										1.06
SPILL	0.578***	0.123***	1									1.34
ACAP	0.386***	0.100***	0.409***	1								1.39
SIZE	0.0548***	-0.0329***	0.0487***	0.122***	1							1.22
GROUP	0.0800***	-0.0156***	0.0686***	0.121***	0.392***	1						1.22
EXPOR	0.179***	-0.0184***	0.128***	0.151***	-0.0208***	0.109***	1					1.24
FUNDS	0.228***	0.154***	0.349***	0.390***	0.0146**	0.0335***	0.115***	1				1.34
INDUS	0.158***	-0.155***	0.0159***	0.0627***	-0.117***	0.0118**	0.399***	-0.0179***	1			1.25
COOP	0.246***	0.116***	0.368***	0.353***	0.114***	0.149***	0.0607***	0.376***	-0.0624***	1		1.33
NEW	0.124***	0.0561***	0.129***	0.116***	-0.0383***	-0.0287***	0.0425***	0.115***	-0.0173***	0.106***	1	1.03

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

In addition, we performed a number of statistical analyses to assess the severity of common method bias. First, the Harman one-factor test on the items indicated that this bias was not an issue. That is, multiple factors were detected, and the variance did not merely stem from the first factors (Podsakoff et al., 2003). In fact, the independent variables included in the model form several factors with eigenvalues higher than 1 and the first two factors capture only 22.25 and 15.8% of the total variance, respectively. We also included control variables that have a bivariate correlation below 0.4 (Siemsen et al. 2010) between the other variables in the model. Table 21 describes the variables used in this study.

Table 21. Variables' description

Variables	Range/Codification	Description
SUSTAIN	0-16 Cronbach´s α = 0.91	Sum of the scores about the importance of the following 16 organization's sustainability objectives (a number between 0 (not used) and 3 (high)): (i) increase in the offered number of products or services; (ii) old product substitution; (iii) new markets penetration; (iv) Increase in market share; (v) Increase in quality; (vi) Increase in production flexibility; (vii) Increase in production capacity; (viii) Labor cost reduction (per unit); (ix) Material cost reduction (per unit); (x) Energy cost reduction (per unit); (xi) Reduce in environmental impact; (xii) Compliance with environmental, health and security regulatory; (xiii) Increase in the total

		employment; (xiv) Increase in the qualified employment; (xv) Maintenance of the employment; and (xvi) Increase employees' health and security. Rescaled between 0 (not used and reduced degree of importance) and 1 high (medium and high importance).
STP	If Yes=1 If No=0	Organization belonging to an STP.
SPILL	0-11 Cronbach´s α = 0.82	Sum of scores about the importance of the following 11 information sources for the innovation process (a number between 0 (not used) and 3 (high): (i) sources within your enterprise group; (ii) suppliers, (iii) clients; (iv) competitors; (v) consultants and commercial labs; (vi) universities or other higher education institutions; (vii) public research institutes; (viii) technological institutes; (ix) conferences, trade fairs and exhibitions; (x) scientific journals and technical publications; and (xi) professional and industry associations. Rescaled between 0 (not used

		and reduced degree of importance) and 1 high (medium and high importance).
ACAP	0-5 Cronbach´s α = 0,55	We sum the scores obtained in these five binary variables: (i) internal research and development; (ii) external research and development; (iii) acquisition of machinery and equipment; (iv) acquisition of external knowledge; and (v) internal and external training for innovation activities.
SIZE	If Yes=1 If No=0	Number of employees in t equal or greater than 200.
GROUP	If Yes=1 If No=0	Business group affiliation.
FUNDS	If Yes=1 If No=0	The organisation received EU, regional or local funding.
INDUSTRY	If the organisation belongs to the manufacturing industry =1 If the organization belongs to the service industry=0	Belonging to an industry.
EXPORTS	If Yes =1 If No=0	The organization sells abroad.

COOP	If Yes=1 If No=0	The company has some cooperative arrangements.
NEWNESS	Continuous variable	Share of products or services new to the market.

6.3. MODEL AND ESTIMATION

Although the present study tests the hypotheses using multiple linear regression, a variety of models are estimated because not all hypotheses can be tested in the same way. Taking into account the panel nature of our database, and as in previous literature to control for unobservable influences of endogeneity, we estimate the determinants of sustainability performance with fixed effects multiple linear regression models (e.g., Acebo et al., 2021; Alarcón et al., 2019) with robust standard errors, which accounts for unobserved firm fixed effects and firm-specific autocorrelation.

The fixed effects model is adequate when it is assumed that there are unobservable effects correlated with the independent variables in the model (Greene, 2012). These fixed or invariant effects over time would be associated with the unities under study individually (in our case, each organization), and generate an unobservable heterogeneity constant over time. The unique characteristics of business should not be compared with other companies, so in fixed effects models, the time-invariant effects are eliminated. By contrast, in a dynamic or variable effects model, the variations between entities are assumed to be random, and, more importantly, they are not correlated with the independent variables (Greene, 2012). We also tried random effects linear models, but the Hausman specification test rejected the null hypothesis of un-correlation between individual effects and regressors (see Annex I).

H1, H2 and H4 predict direct effects among the study variables. However, H3, H5, H6 and H7 forecast mediating effects.

Our mediations hypotheses postulate a mediation effect: (i) of absorptive capacity on the impact of knowledge spillovers on sustainability performance (H3), (ii) of knowledge spillovers on the impact of belonging to an STP and sustainability performance (H5), (iii) of knowledge spillovers on the impact of belonging to STP and absorptive capacity, (iv) of knowledge spillovers, at first, and absorptive capacity on the relationship of the organization belonging to sustainability performance (H7).

To test these mediation hypotheses, we follow the methodology proposed by Baron and Kenny (1986). According to Baron and Kenny (1986), the analysis of the mediating effect requires the formulation of three equations. In the first equation, the dependent variable is estimated using independent and control variables, and the equation is the same as that of the direct effect. In the second equation, the mediator variable is estimated using independent and control variables.

Regarding the third, the dependent variable (Y) is simultaneously estimated using the independent (X), mediator (Me), and control variables (c), for organization i at time t:

$$Y_{i,t} = \beta 10 + \beta 11 * X_{i,t} + \beta 12 * C_{i,t} + \varepsilon 1_{i,t}$$

$$Me_{i,t} = \alpha 20 + \alpha 21 * X_{i,t} + \alpha 22 * C_{i,t} + \varepsilon 2_{i,t}$$

$$Y_{i,t} = \beta 30 + \beta 31 * X_{i,t} + \beta 32 * Me_{i,t} + \beta 33 * C_{i,t} + \varepsilon 3_{i,t}$$

In this vein, in Step 1 of the test for mediation is to show that a significant relationship exists between the independent variable and the dependent variable; step 2 is to show that a significant relationship exists between the independent variable and the mediator; step 3 is to show that the mediator variable is related to the dependent variable. In other words, $\beta 11 \neq 0$, $\alpha 21 \neq 0$, $\beta 32 \neq 0$ and $/\beta 31/ < /\beta 11/$ –all of these coefficients must be statistically significant.

The final, step 4 is to show that the effect of the independent variable on the dependent variable is less when the mediator variable is included in the model. If these four conditions described by Baron and Kenny (1986) are met, we are able to conclude that a mediation effect occurs. Additionally, we use Sobel tests (Baron & Kenny, 1986; Sobel, 1982) and bootstrapping confidence intervals (CIs) to test all these indirect effects on absorptive capacity and sustainability performance

The Sobel test of significance assumes that the indirect effect of the independent variable is normally distributed, an assumption that may make this a conservative test (Mackinnon et al., 1995). The indirect effect is considered to be significant when the Sobel test Z value is significant (>1.96).

Bootstrapping (Shrout & Bolger, 2002; Bollen & Stine, 1990) is a non-parametric method that takes into account the skew of the distribution. When the resultant bootstrapped confidence intervals (CIs) do not contain the value 0, the indirect effect is different from 0. Since these tests make different assumptions, it is advisable to use them both.

The Stata Statistical Package version 17 was used to conduct the calculations.

6.4. RESULTS

Table 22 presents the models for testing the hypotheses. As can be seen, the F-test of significance is acceptable for all the models estimated. For the complete model (Model 4), the value of overall R^2 indicates that it explains 36,5% of the variance in sustainability performance, higher than the threshold of 0.1 determined by Falk and Miller (1992).

The results from the regression analysis in Model 1 indicate that unlike the company's belonging to a group (GROUP) and a specific industry (INDUSTRY), which have not a significant effect on sustainability performance, all the control variables considered (size, exportations, funding, cooperation, and newness) have a positive significant effect on sustainability performance. When we introduce all the effects of the explanatory variables knowledge spillovers and absorptive capacity (Model IV) the direction and significance of the control variables remain the same, except for the control variable size (SIZE), which loses its significance.

Model 4, which contemplates the effects of all independent variables considered on sustainability performance, shows the positive and significant direct effect that both knowledge spillovers (β=0.781, $p<0.001$) and absorptive capacity (β=0.561, $p<0.001$) have on sustainability performance, providing support for our hypotheses 1 and 2, respectively.

Results of Model 3 confirm the positive and significant impact that knowledge spillovers have on absorptive capacity (β=0.0666, $p<0.001$). Considering the results obtained in hypotheses 1 and 2 (Model 4), this model 3 provides evidence of the partially-mediating effect that absorptive capacity has on the relationship between knowledge spillovers and sustainability performance (β=0.038, $p<0.001$), pointed out in hypothesis 3. This indirect effect is confirmed using bootstraping tests (see Appendix I).

Model 4 also shows that the direct effect of an organization belonging to an STP on sustainability performance is positive but not significant (β=0.105, $p>0.05$). However, Model 1, in which only the effect of an organization belonging to an STP on sustainability performance is posited, supports the existence of a significant positive effect between both variables (β=0.463, $p<0.05$). If the impact of an organization belonging to an STP on mediating variables is confirmed in Model 2 and Model 3, we can, thus, ensure our results meet all the requirements of mediation analysis.

Model 2 shows that belonging to an STP is positively related to knowledge spillovers (β=0.406, $p<0.01$), providing support for our hypothesis 4. Considering the results of the previous hypotheses 4 and 1, we can confirm the mediating effect that knowledge spillovers have on the relationship between an organization belonging to an STP and sustainability performance

(β=0.317, $p<0.01$), pointed out in hypothesis 5. This indirect effect is also confirmed using bootstraping tests (see Appendix I).

Model 3 shows that organization belonging to an STP has no direct effect on absorptive capacity (β=0.046, $p>0.05$). This result, thus, confirms that the relationship between belonging to an STP and absorptive capacity is fully-mediated by knowledge spillovers (β=0.027, $p<0.001$), as pointed out by hypothesis 6. We also checked the robustness of this mediating effect using bootstrapping (see Appendix I).

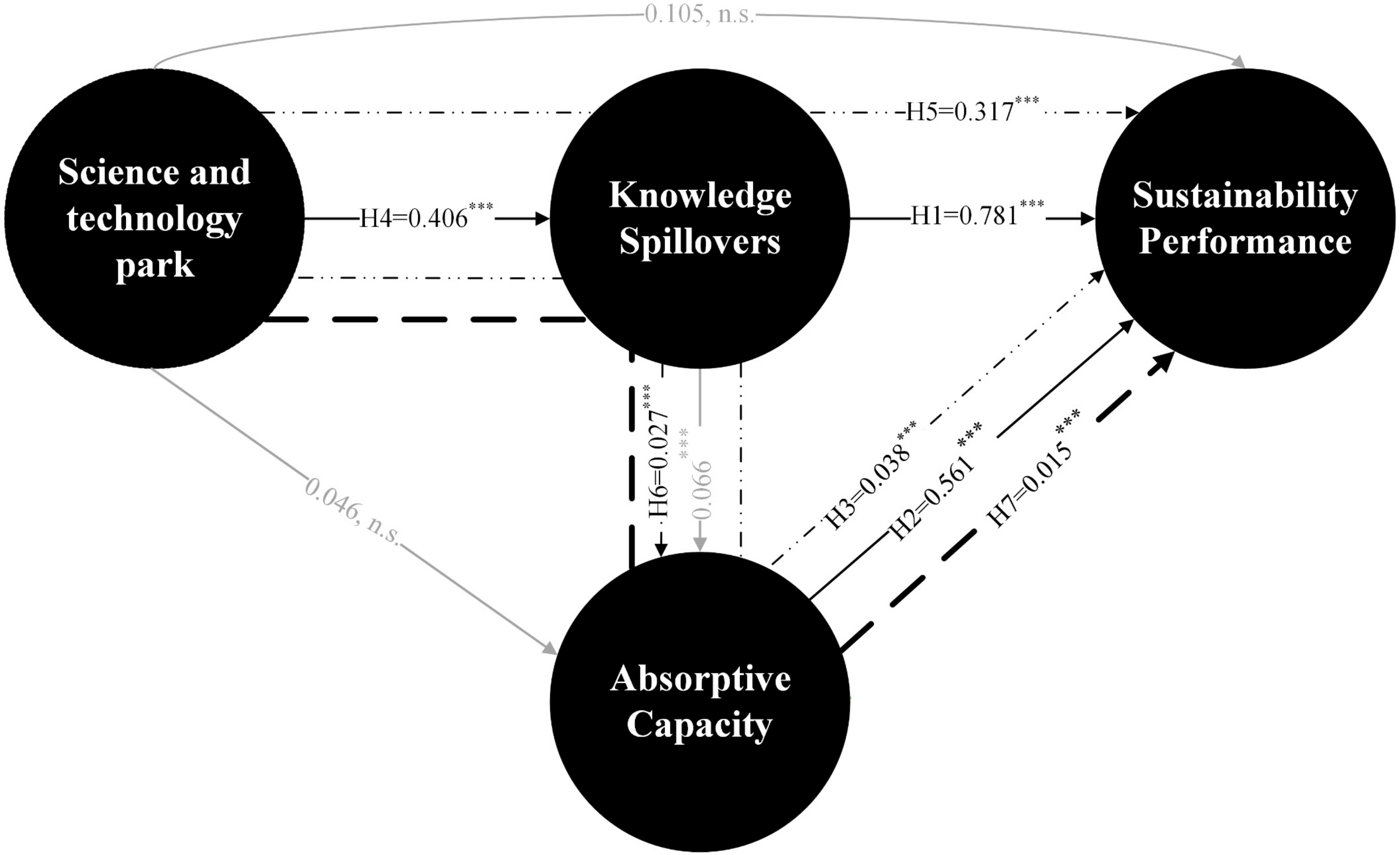
Therefore, and considering all previous results, we can confirm our hypothesis 7, specifying that the relationship between an organization belonging to an STP and sustainability performance is, firstly, fully-mediated by knowledge spillovers and, secondly, by partially-mediated by absorptive capacity (β=0.015, $p<0.01$). We also confirm these mediating effects through boostraping confidence intervals (see Appendix I). Figure 44 below model with the above statistical estimation results.

Table 22. Estimation results

VARIABLES	(1) Model I SUSTAIN	(2) Model II SPILL	(3) Model III ACAP	(4) Model IV SUSTAIN
STP	0.463*	0.406**	0.0460	0.105
	(0.0228)	(0.0328)	(0.0108)	(0.00517)
SPILL			0.0666***	0.781***
			(0.194)	(0.475)
ACAP				0.561***
				(0.117)
SIZE	0.487***	0.310***	0.223***	0.109
	(0.0424)	(0.0443)	(0.0931)	(0.00948)
GROUP	0.0757	0.0294	-0.0270	0.0668
	(0.00756)	(0.00483)	(-0.0129)	(0.00667)
EXPORTS	0.355***	0.216***	-0.0190	0.189**
	(0.0318)	(0.0318)	(-0.00816)	(0.0169)
FUNDS	0.844***	0.555***	0.407***	0.163***
	(0.0824)	(0.0890)	(0.190)	(0.0159)
INDUSTRY	0.271	0.0853	0.0716	0.161
	(0.0267)	(0.0139)	(0.0339)	(0.0159)
COOP	1.292***	1.007***	0.195***	0.358***
	(0.127)	(0.163)	(0.0916)	(0.0352)
NEWNESS	0.00842***	0.00377***	0.00108***	0.00472***
	(0.0398)	(0.0294)	(0.0245)	(0.0224)
Constant	4.639***	1.760***	5.241***	0.261
Observations	47,870	47,870	47,870	47,870
Number of ident	8,874	8,874	8,874	8,874
R-squared within	0.031	0.046	0.092	0.265
R-squared between	0.189	0.295	0.444	0.474
R-squared overall	**0.112**	**0.195**	**0.270**	**0.365**
F statistics	80.55***	110.54***	257.86***	559.22***
rho	0.587	0.581	0.442	0.539

Notes: Robust standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Figure 44. Results obtained for the hypotheses set out in our research model



6.5. ROBUSTNESS TESTS AND ALTERNATIVE MODELS

In addition to the common tests for the quality of fit and performance, which support the acceptability of estimates, we performed the robustness analysis of our principal panel fixed-effects model.

6.5.1. Balanced panel considering the dependent, independent and moderated variables

We, first, ran the fixed effect model using a balanced panel of 27,560 observations and 3,445 firms. Results shown in Table 23 ratify those ones obtained for the entire panel of 8,874 firms, considered in our first estimation (see previous Table 22), except for the control variable external funding (FUNDS), which loses the significance of their positive impact on sustainability performance (see Table 23).

Table 23. Estimation results using a balanced panel

VARIABLES	(1) Balanced model SUSTAIN
STP	0.396
	(0.0233)
SPILL	0.667***
	(0.428)
ACAP	0.424***
	(0.0911)
SIZE	0.0923
	(0.00908)
GROUP	0.123
	(0.0135)
EXPORTS	0.218*
	(0.0191)
FUNDS	0.107
	(0.0117)
INDUSTRY	0.224
	(0.0237)
COOP	0.290***
	(0.0318)
NEWNESS	0.00390***
	(0.0210)
Constant	1.885***
Observations	27,560
Number of ident	3,445
R-squared overall	0.191

Notes: Robust standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001

6.5.2. SEM model using the medsem command in Stata

We also ran the analysis of the main relationships of our model using SEM techniques, as they are highly useful for analysing the mediation hypotheses (James et al., 2006). Results in Table 24 and Figure 45 show we also obtain consistent results of the main independent variables. We do not consider the control variables for estimation problems. Additionally, tests were performed to verify the consistency, goodness of fit and predictive relevance of the model. With respect to model consistency -R^2 value of the dependent variable- the model explains 36.20% (see Figure 45) of the total variance of sustainability performance, similar to the baseline model with fixed effects. The CFI and TLI fit statistics are close to 1, and the RMSEA value is minor than 0.05 with a probability also near to 1 (Bentler, 1990; Jöreskog & Sörbom, 1982), showing a good fit and predictive capacity of the model (see Annex II).

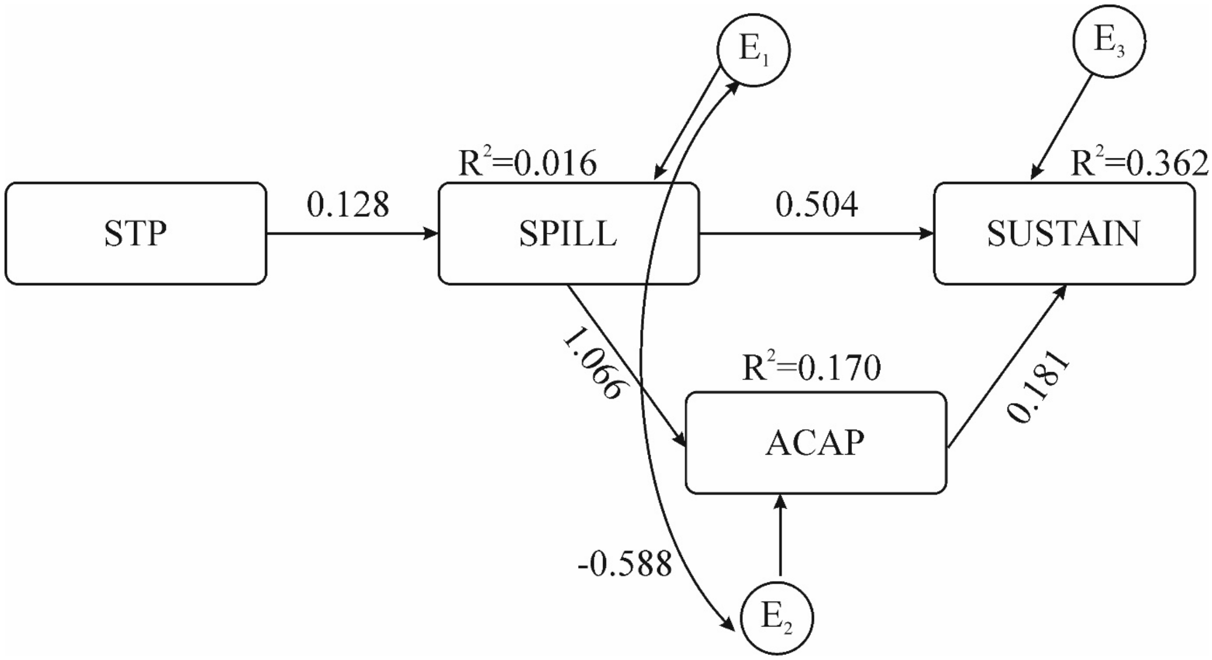
Table 24. SEM model estimation results

Structural equation model Number of obs = 71,571
Estimation method = mlmv
Log pseudolikelihood = -346907.37

Standardized	Coef.	Robust Std.Err.	z	P>z	[95%Conf.	Interval]
Structural SPILL						
STP	0.128	0.004	31.000	0.000	0.120	0.136
_cons	0.687	0.021	32.570	0.000	0.645	0.728
SUSTAIN						
SPILL	0.504	0.004	129.700	0.000	0.496	0.511
ACAP	0.181	0.004	46.350	0.000	0.174	0.189
_cons	-0.135	0.022	-6.160	0.000	-0.178	-0.092
ACAP						
SPILL	1.066	0.037	29.050	0.000	0.994	1.138
_cons	4.199	0.051	82.350	0.000	4.099	4.299
var(e.SPILL)		0.984	0.001		0.982	0.986
var(e.SUSTAIN)		0.638	0.004		0.630	0.645
var(e.acapsinFG)		1.256	0.049		1.164	1.357
cov(e.SPILL,e.ACAP)	-0.588	0.022	-27.010	0.000	-0.630	-0.545

LR test of model vs. saturated: chi(2) =117.4

Figure 45. SEM model estimation results



The mediating effects established in the model are all confirmed using additional Monte Carlo tests (see Appendix II).

6.3.3. Fixed-effects regression model for each dimension of sustainability performance

Finally, we crosschecked our results with alternative measures for sustainability performance based on the conceptualization made of the construct. Specifically, we consider each dimension compounding sustainability performance construct: economic (comprising items related to market product and process technology), environmental (comprising items related to green technology and compliance with standards), and social (comprising items related to employment and employees' qualification and welfare). We, thus, run five additional and different model specifications.

Table 25. Estimation results for each of the sustainability performance dimensions

VARIABLES	(1) Model I Product dimension	(2) Model II Process dimension	(3) Model III Economic sustainability performance	(4) Model IV Environmental sustainability performance	(5) Model V Social sustainability performance	(6) Model VI Sustainability performance
STP	0.0147	0.0398	0.0546	0.0354	0.0152	0.105
	(0.00199)	(0.00783)	(0.00511)	(0.00595)	(0.00229)	(0.00517)
SPILL	0.247***	0.144***	0.391***	0.180***	0.209***	0.781***
	(0.414)	(0.350)	(0.454)	(0.376)	(0.391)	(0.475)
ACAP	0.186***	0.153***	0.339***	0.101***	0.121***	0.561***
	(0.107)	(0.127)	(0.135)	(0.0720)	(0.0774)	(0.117)
SIZE	0.0605	-0.00665	0.0539	-0.00668	0.0616	0.109
	(0.0145)	(-0.00232)	(0.00895)	(-0.00199)	(0.0165)	(0.00948)
GROUP	-0.0318	-0.0231	-0.0549	0.0705*	0.0511	0.0668
	(-0.00875)	(-0.00921)	(-0.0105)	(0.0241)	(0.0157)	(0.00667)
EXPORTS	0.110***	-0.0160	0.0944**	0.0612**	0.0331	0.189**
	(0.0272)	(-0.00573)	(0.0161)	(0.0187)	(0.00908)	(0.0169)
FUNDS	0.0861***	-0.0164	0.0696**	0.0264	0.0666***	0.163***
	(0.0231)	(-0.00642)	(0.0130)	(0.00882)	(0.0199)	(0.0159)
INDUSTRY	0.0836	-0.0594	0.0242	0.0463	0.0901	0.161
	(0.0227)	(-0.0235)	(0.00456)	(0.0157)	(0.0273)	(0.0159)
COOP	0.159***	0.0547***	0.214***	0.0594***	0.0853***	0.358***
	(0.0429)	(0.0215)	(0.0400)	(0.0199)	(0.0257)	(0.0352)
NEWNESS	0.00231***	0.000441	0.00276***	0.000756**	0.00121***	0.00472***
	(0.0302)	(0.00834)	(0.0249)	(0.0123)	(0.0176)	(0.0224)
Constant	0.631***	0.129	0.760***	-0.184	-0.316**	0.261
Observations	47,870	47,870	47,870	47,870	47,870	47,870
Number of ident	8,874	8,874	8,874	8,874	8,874	8,874
R-squared within	0.200	0.134	0.239	0.147	0.169	0.265
R-squared between	0.397	0.223	0.420	0.326	0.365	0.474
R-squared overall	0.289	0.160	0.314	0.237	0.269	0.365
F statistics	368.57***	272.25***	459.38***	307.56***	358.57***	559.22***
rho	0.560	0.526	0.550	0.508	0.520	0.539

Notes: Robust standard error in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Regarding the estimates compared to the baseline model, we can confirm the main results and insights from the baseline model are maintained with very minor variations. The direction of the effects of the explanatory variables remains the same across the models.

As for the control variables, the organization's belonging to a group (GROUP) is significant for explaining the environmental sustainability performance (see Model IV in Table 25). The organization's selling abroad (EXPORTS) seems not to have a significant impact on the process dimension of economic sustainability performance (see Model II), and social sustainability performance (see Model V). The external funding (FUNDS) is not significant for the process dimension of economic sustainability performance (see Model II), and environmental sustainability performance (see Model IV). Finally, the introduction of new products to the market (NEWNESS) also seems not to have a significant positive effect on the process dimension of economic sustainability performance (Model II).

The process dimension of sustainability performance is, thus, the construct that shows a minor level of explanatory power (R^2=0.160). However, is on this specific dimension linked to market-pull new processes and technologies where the effect of absorptive capacity (β=0.153) is greater than knowledge spillovers (β=0.144). The only control variable that has a significant effect on this process dimension is cooperation agreements.

7. DISCUSSION

Since the beginning of the Industrial Revolution in England in the second half of the 18th century, the modern company has been a backbone of society and key to the progress of nations (Camisón et al., 2020; Morrar et al., 2017). The phenomenon of modern enterprise drove the growth of per capita income to previously unimagined levels. However, despite this and other multiple benefits, the economic and business model that has prevailed to the present day has not been without its costs. In purely socio-economic terms, the distribution of wealth continues to show strong inequalities both between social strata within the same society and between nations (Wadanambi et al., 2020; Morrar et al., 2017). But the worst impacts of this intense economic progress have undoubtedly fallen on the environment. Thus, the current economic and business model is characterised by a linear logic of production-consumption-waste of products that has had a severe impact on natural ecosystems, exacerbating problems such as climate change (e.g., Sharma et al., 2020; Korhonen et al., 2018).

Concern for sustainability is not an issue that has become faddish; on the contrary, numerous efforts have been made over the last few decades by supranational bodies such as the United Nations to make society aware of the dangers of continuing to increasing levels of pollution and resource exploitation (Salvia et al., 2019; UN, 2015). Thus, the latest attempt to make society conscious of the importance of achieving a balance between economic profit, environmental protection, and social progress has been embodied in the 2030 Agenda, which contains the Sustainable Development Goals (SDGs). The SDGs represent a turning point in unifying the efforts of all the actors that make up economies in favour of sustainable development. The differential element concerning previous calls for collective action is the fundamental role that the 2030 Agenda confers on business as the holder of useful resources and capacities to achieve the goals that sustainable development requires.

In the corporate sphere, sustainability requires both the refinement of the existing capabilities and the implementation and development of new ones based on technological and non-technological knowledge (e.g., Dzhengiz & Niesten, 2020; Shang et al., 2020; Forés, 2019; Khan et al., 2016). To do so, organisations will need to broaden their knowledge bases and deploy learning processes. These learning processes aimed at broadening the organisation's cognitive bases and mental models can take place in a localised manner in a specific environment (Hervás-Oliver et al., 2018; Munari et al., 2012; Camisón & Forés, 2011; Morrison & Rabelloti, 2009; Giuliani & Bell, 2005). Science and technology parks have been categorised as learning centres, and cognitive laboratories in which there is a confluence of scientific, technological, and business actors (Amoroso et al., 2019). These technology parks should be munificent enclaves; that is, an innovative milieu capable of bringing together basic and complex knowledge spillovers produced by the agglomeration and interaction of multiple organisations, as well as offering the organisations housed in their infrastructure's technological equipment, high added-value services, and image benefits. If the science and technology park is not able to provide a munificent environment for knowledge spillovers to companies, the decision to locate a company in its infrastructures could be motivated by image or prestige reasons, but not for sustainable performance benefits.

As we confirmed in our H1, a greater diversity of knowledge spillovers positively impacts triple bottom line sustainability performance. When these knowledge spillovers from market sources, research organisations, and other sources have a high degree of similarity with the firm's current knowledge bases and cognitive models we assume that their impact on sustainability performance is direct. The capacity of the firm to accumulate new knowledge, encapsulated in the absorptive capacity construct, is also shown as an important determinant of sustainability performance, confirming our hypothesis 2. This result also provides support to previous literature on the importance that dynamic capabilities have on the generation of results in new products, processes, organisational forms that have an impact on the market, the environment, and the society.

In addition, this study recognizes that certain knowledge spillovers, due to their degree of novelty and radicality concerning the firm's previous knowledge stock, require a prior absorption process to have an impact on improving sustainability performance. In this vein, and recognizing knowledge spillovers as the basic trigger of absorptive capacity, this study shows the absorptive role as a catalyst of knowledge spillovers' effect on sustainability results, providing support for the hypothesis 3.

Having analysed these antecedents of sustainability performance, the next step in the ambition of this Ph.D. thesis is to test whether localisation can or not enhance these effects. As the literature on knowledge management and innovation has extensively underlined, the mere location of an organisation in a space rich in knowledge spillovers does not necessarily imply the correct identification, assimilation, and exploitation of new external knowledge (e.g., Ubeda et al., 2019; Claver-Cortés et al., 2018; Munari et al., 2012; Camisón & Forés, 2011). Our longitudinal analysis of Spanish firms using the PITEC panel database allows us to confirm previous findings in the academic literature about the role that knowledge flows in the first place and absorptive capacity in the second place have in the relationship between the location of an organisation in a science park and better performance in sustainability. This ratifies that mere location is not enough for ensuring the long-term competitiveness of the firm through the improvement of the triple bottom line.

Nor are the park effects equal for these two antecedents of sustainability performance. Thus, while location in a park has a direct impact on knowledge spillovers that the firm can identify and exploit absorptive capacity does not. Our empirical study recognises the impact of location in a park on the generation of spillovers, and their degree of diversity by the number of agents that make them up, confirming hypothesis 4. It also confirms the fully-mediating role that knowledge spillovers exert on the relationship between the organisational belonging to a science and technology park and sustainability performance considered in hypothesis 5.

In this vein, this study's results show that organisations should establish a strong internal commitment and make an active effort to identify the knowledge spillovers coming from market sources, educational and research bodies, or other informal sources that should firstly converge in science and technology parks to generate these knowledge spillovers. Thus, the company should be able to integrate into the social structure of the science and technology park, joining the cognitive community and getting the status of insider of the network, so that it can access and correctly identify the knowledge spillovers that are agglutinated there (Porter, 1998b; Granovetter, 1985). Otherwise, the organization will be isolated and will not be able to take advantage of the knowledge spillovers to improve its sustainability performance (Boschma, 2005). When the latter is the case, an organisation may benefit from its location in a science park to improve, for example, its image, but, as we stated previously, it will not capitalise on the benefits to increase its sustainability performance.

Some of the knowledge spillovers present within the boundaries of a science and technology park, due to their degree of similarity with the company's current cognitive bases, mental models, or knowledge resources, will be more easily exploitable by the company, i.e., without requiring a complex absorption process (Camisón et al., 2017, 2018). These knowledge spillovers contribute to more efficient exploitation of the company's current capacities, increase productive flexibility, to consolidate current knowledge. In this way, synergies are generated between both knowledge endowments (the company's previous internal knowledge and the new knowledge) applicable to the improvement of the company's triple sustainability performance through this incremental improvement and the refinement in the exploitation of the company's existing functional capacities. This should result in the replacement of outdated products or processes with more efficient ones, more flexible processes, less environmental impact derived from the company's activity, and closer compliance with legal regulations in the field of sustainability.

In contrast, the science and technology park environment also abounds with other kinds of knowledge spillovers that are not so directly exploited by the organisation (Ubeda et al., 2019; Claver-Cortés et al., 2018; Forés & Camisón, 2016). To benefit from the impact that these more complex, tacit, and novel knowledge spillovers can have on improving environmental performance, the organisation should have a sufficiently developed absorption capacity (Song et al., 2018; Cohen & Levinthal, 1990). To this end, the literature on strategic business management points out that internal R&D activities, the acquisition of external R&D, the incorporation of new green equipment and technologies, or the training of the workforce are crucial actions to increase the absorptive capacity of the company (e.g., González-Masip et al., 2019; Ubeda et al., 2019; Camisón & Forés, 2011). This ensures the correct acquisition, assimilation, transformation, and exploitation of the novel and complex knowledge spillovers that flourish in a science and technology park.

This study shows that the effect of location in a park on the development of this absorptive capacity of the company is not direct either, confirming the fully mediated effect of knowledge spillovers on this relationship, established in our hypothesis 6. However, those companies embedded in parks capable of spurring the knowledge flows that form them will multiply the effects of the knowledge derived from this location, stimulating their knowledge capacities that can be applied to the development of new capacities that boost the company's performance under the triple bottom line of sustainability. Therefore, absorptive capacity has a multiplier effect on the impact of knowledge spillovers on sustainability performance. By increasing its absorptive capacity, the company has a greater knowledge background and can evaluate different possibilities of combination and application of external knowledge spillovers to sustainability ends. Ultimately, increasing this dynamic capacity will give the company the possibility to make more radical changes in its functional capabilities applicable to improving sustainability performance (e.g., Camisón et al., 2018).

Thus, for the location effect to have an impact on improving the firm's absorptive capacity, a knowledge space should first germinate in which the properly embedded firm can identify knowledge flows. All in all, this study evidence could suggest that firms that are better endowed with resources and capabilities and are previously embedded in knowledge spillovers find it easier to develop sustainable competitive advantages by locating within a science and technology park, as they are more capable of extracting more of the potential for economic rents to be found there.

Seven control variables have also been introduced in our empirical model: (i) size; (ii) business group affiliation; (iii) exporting abroad; (iv) the use of external finance to develop innovative processes; (v) membership in manufacturing or service industries; (vi) cooperation agreements; (vii) the percentage of products and services that are new to the market. Statistical tests indicate that all these variables have a positive and significant effect on sustainability performance except for group affiliation and industry affiliation. Each of these effects is discussed below.

Starting with size, this variable has a positive and significant effect on sustainability performance in Model I in which only control variables are considered. However, when the effects of the explanatory variables knowledge spillovers and absorptive capacity are introduced, the impact of the size variable on sustainability performance loses significance. The original postulates of the resource-based view can provide a plausible explanation for this loss of significance (e.g., Barney, 1991; Wernerfelt, 1984; Penrose, 1956). Thus, what seems to be happening is that, when the explanatory variables are omitted in the first statistical model, the positive and significant effect of size on sustainability performance is masking the mediating effect of the explanatory variables.

In other words, it is not size per se that has an impact on sustainability performance, but rather how the firm's management can take advantage of this size to create a portfolio of knowledge resources and deploy learning processes. Larger firms have larger endowments of financial resources and better-trained human resources (Cáceres et al., 2011) compared to smaller firms. They also enjoy economies of scale in R&D processes and can diversify risks more broadly across a wide set of products and organisational processes (Levinthal & March, 1993) applicable to improving sustainability performance.

Business group membership has not been found to be a significant control variable in our model. A meta-analytical study by Carney et al. (2011) on 141 previous publications collecting data from 28 countries empirically confirms that, in general, business group affiliation decreases performance. This reduction is explained by coordination costs and strategic actions that seek optimisation as a business group rather than as individual units. Moreover, the same study confirms that the integration of a company into a business group is more beneficial to its performance in underdeveloped institutional environments. This may explain the lack of statistical significance for the database used. On the contrary, other studies, such as Bohdanowicz (2005) and Pereira-Moliner et al. (2015), point precisely in the opposite direction and show that, in terms of environmental performance, belonging to a business group offers advantages in resources and costs for individual companies. This discordance in the literature, present in the different performance measures that make up our sustainability performance construct, maybe the reason for the lack of significance.

As for exporting to foreign countries, previous precedents in the literature (e.g., Temouri et al., 2011; Fryges & Wagner, 2010) confirm that both manufacturing and service exporting firms perform better than their non-exporting counterparts. Exporting firms tend to have higher productivity than non-exporting firms due to their greater exposure to external competitive pressures (Fryges & Wagner, 2010). On the other hand, these exporting firms may be embedded in global value chains with other organisations at the knowledge frontier (e.g., De Loecker, 2007), which adds additional pressure for these firms to introduce newer products or refine their processes. In addition, taking into account increasing social and environmental regulations (e.g., Camisón, 2010), the exporting company is forced to improve its triple bottom-line sustainability performance to compete successfully in international markets.

The lack of statistical significance of industry can be reasoned by resorting again to the classical postulates of the resource-based view. Thus, a seminal empirical study by Rumelt (1991) on a US firm basis confirms that intra-industry performance differences are larger than inter-industry performance differences. With this, the author confirms the preponderance of the firm effect over other external effects such as the environment effect or industry effect, as also pointed out by other more recent research (e.g., Camisón & Forés, 2015). We find in this doctoral thesis support for these classic postulates of strategic management, then, also about performance measured from the triple perspective of sustainability.

Regarding the use of external funds, government action to address market failures such as a lack of funds at the firm level to undertake projects with a clear innovation component is a widely recognised mechanism in the literature (e.g., Hall & Lerner, 2010). A study by Lerner (1999) with panel data confirms the beneficial effects of public funding in improving firm performance. Improving sustainability performance requires, as has been pointed out in this thesis, the incorporation of new knowledge, and the adoption of new green technologies and innovations (e.g., Abbas & Sagsan, 2019; Forés, 2019). Therefore, it is feasible to justify maintaining this positive effect of external funds on improving sustainability performance.

Cooperation with other partners is essential in the search for new solutions to improve firm performance through product or process improvements (Dangelico, 2016; Díaz-García et al., 2015) or management innovations (He et al., 2018). Cooperation is a source of new ideas that increase the firm's capabilities to create, use and recombine new and existing knowledge (Lausen and Salter, 2006; Chesbrough, 2003). Therefore, not only does it seem logical that its impact is positive in improving sustainability performance, but also, given the complexity of reconciling economic, social, and environmental dimensions, it is the control variable with the greatest impact of all those introduced in our model.

Finally, the newness variable is a proxy for strategic proactivity (Miles et al., 1978) in the absence of other indicators to diagnose the strategic typology of organisations in the PITEC questionnaire. Maintaining a proactive strategy induces pressure on organisations to offer not only more technologically innovative products, but also to be more sustainable according to the new demands of the environment (Forés, 2019; Aragón-Correa, 1998). On the other hand, strategic proactivity is also essential when it comes to adopting improvements within the company to meet and even exceed the new legal requirements in terms of sustainability (Camisón, 2010).

Additional analysis performed using a balanced panel and SEM analysis confirmed the robustness of the results. In addition, we crosschecked our results with alternative measures for sustainability performance based on the conceptualization made of the construct. Specifically, we consider each dimension compounding sustainability performance construct. The direction of the effects of the explanatory variables remains the same across the models. However, the magnitude of the effects of the explanatory variables across the different models considered changes.

In this vein, from this second statistical process, it is possible to delve deeper into the heterogeneity of the impact of both constructs (knowledge spillovers and absorptive capacity) on each dimension of sustainability performance. Specifically, although the impact of knowledge spillovers is greater than that of absorptive capacity on all sustainability dimensions considered economic, social, and environmental, the impact of absorptive capacity is more relevant for the achievement of higher economic sustainability performance compared to the direct exploitation of knowledge spillovers. In the case of improved environmental and social sustainability performance, the pattern is reversed.

Furthermore, looking deeper into the product and process dimensions that make up economic sustainability performance, it can be observed that absorptive capacity is the variable that contributes to explaining more of the process sustainability performance. We expected that, as an essentially technological capability, absorptive capacity would have also the greatest impact on environmental sustainability performance. However, this does not occur as expected. We consider that the minor explanatory power of absorptive capacity in comparison to knowledge spillovers is related to the measurement items considered for the environmental sustainability performance construct. Specifically, we believe that changing the item "compliance with environmental, health and security regulatory " to the social sustainability performance sphere, as previous studies have done (e.g., Gutierrez et al., 2022), would have favoured a greater impact of absorptive capacity on environmental sustainability performance. In addition, in this process dimension of sustainability performance which is the construct that shows a minor level of explanatory power, the only control variable that has a significant effect on this process dimension is cooperation agreements.

According to our results, environmental performance requires the organisation to gain more explicit knowledge about practices in its industry, the value chain, and green technologies that can be rapidly incorporated into the organisation to reduce material and energy consumption, lessen environmental impacts, or ensure compliance with the latest environmental regulations.

Similarly, in improving social performance, it is reasonable to think that improving the company's internal capabilities for promoting the health and safety of the workforce, or implementing improvements in internal training processes to ensure skilled employment, require improvements in the exploitation and refinement of the company's existing capabilities. Therefore, knowledge is required not so much on the cutting edge, but rather on how to incrementally refine the company's existing capabilities and organisational procedures, especially in terms of human resource management.

As for the control variables, the organization’s belonging to a group (GROUP) is significant for explaining the environmental sustainability performance (see Model IV in Table 25). This result support previous research such as those of such as Bohdanowicz (2005) and Pereira-Moliner et al. (2015), pointing out that group membership is key to improving the environmental performance dimension of the company. On the other hand, cooperation is the only control variable that has a positive and significant impact in all models analysing the partial effects on the individual dimensions of the sustainability construct: economic (both process and product), social and environmental. It follows that the improvement of sustainability, as derived from international frameworks such as the Sustainable Development Goals, is a collaborative project. Indirectly, this result reinforces our assertion of the importance of joint action to generate knowledge and enhance capacities that can have a significant positive impact on improving triple-bottom-line sustainability performance.

7.1. THEORETICAL IMPLICATIONS FOR ACADEMIA

After obtaining and discussing the previous empirical results, the elaboration of this doctoral thesis allows us to extract a series of implications for academia. Thus, this research confirms that knowledge is a key strategic resource capable of impacting performance both through improving the exploitation of functional capabilities and through the development of absorptive capacity. Absorptive capacity has been shown in this study to be crucial for firms to achieve holistic social, economic, and environmental performance, as this absorptive capacity enables the firm to be fully aware of the knowledge and technologies available in its environment. So, this doctoral thesis contributes to the strands of the literature on open innovation and knowledge management by pointing out how localised knowledge spillovers impact their sustainability performance determining the long-term competitiveness of a firm.

Our empirical evidences answer one of the main questions of this research, which is to confirm that where firms operate does matter but not impact directly on the performance of the company; but to set the preconditions capable of impacting on performance (Bellandi & De Propis, 2015). As stated by Professor Michael Porter (1998b), there is a paradox that in an increasingly globalised and hyper-connected world, regional factors (especially, geographically bounded knowledge) continue to be a source of competitive advantage in the long run that non-colocalised rivals cannot easily imitate. This assertion, according to our study on a longitudinal database, also holds when a company performance is measured from the triple bottom line of sustainability. Therefore, our findings highlight the need to delve further into the impact that the location in a territorial agglomeration of companies (such as a science and technology park) has on the organisations that are hosted in its infrastructures, especially in the realms of sustainability.

Traditionally, the literature specialised in science and technology parks has focused on the beneficial effects that the location of companies in these technological enclaves can have on variables such as growth in sales, increased employment, increased productivity, or better innovative performance. However, research focusing on the effects that location in a science and technology park can have on the performance of companies measured from the triple perspective of sustainability remains largely unexplored. This study, therefore, opens a new line of research that confirms the beneficial effects of the location in a science and technology park on the improvement of the triple bottom line of a hosted company, provided that there are optimal conditions for the generation of more knowledge spillovers available to the company and that the company can take advantage of them.

This thesis also confirms the classical tenets of industrial agglomerations on the impact that these realities have on increasing the volume of knowledge spillovers by stimulating the interaction of co-located agents and firms. Classical contributions from the literature on industrial districts confirm the impact that these knowledge spillovers can have on improving the performance of agglomerated firms that properly identify and exploit them (e.g., Camisón, 2004; Signorini, 1994). Our research extends these contributions toward a more holistic approach to corporate performance, including social and environmental dimensions.

Furthermore, previous research also highlights the role that absorptive capacity, as a dynamic capacity, can play in harnessing the most novel, tacit, and cutting-edge external knowledge flows and applying them to improve their sustainability performance. Our study with longitudinal data allows us not only to corroborate this previous academic background but also to infer causality in the relationship that could not be established using a cross-sectional database. However, this research goes further and assesses how the impact of this absorptive capacity is especially significant for the economic dimension of sustainability. Therefore, the results obtained confirm previous studies in the field of strategic management that point to the importance of the firm's internal capabilities as the ultimate guarantors of its superior performance and long-term competitiveness (Teece et al., 1997; Barney, 1991).

On the other hand, as has been indicated throughout this dissertation, the literature on corporate sustainability performance has traditionally focused on the environmental performance variable with much greater emphasis (Huqand Stevenson, 2018; Mani et al., 2018). However, this thesis has developed a measure of sustainability performance that holistically integrates the three widely recognised dimensions of sustainability: social, economic, and environmental (e.g., Hashemi et al., 2019; Hussain et al., 2018; Engert et al., 2016; Marshall et al., 2015; Zijp et al., 2015; Pagell and Wu, 2009; Pullman et al., 2009). We, therefore, respond to the call of recent research to continue to explore further a sustainability measure such as the one presented here (e.g., Ben Arfi et al., 2018; Adams et al., 2016; Engert et al., 2016).

7.2. IMPLICATIONS FOR PRACTITIONERS

The development of this doctoral thesis also has important practical implications that can be disaggregated into three levels depending on whether they are addressed to policymakers, managers of science and technology parks, or managers of companies. As far as policymakers are concerned, especially those responsible for industrial and territorial development policies, the importance of science and technology parks as instruments to support business competitiveness and stimulate regional development is evident from our study. Previous research highlights how science parks are capable of increasing the competitiveness of companies through the provision of higher value-added services, improvements in image and reputation, and the increase of certain variables such as innovative performance or business growth. Likewise, science parks are a lever for regional development, acting as poles of attraction for other international companies, spurring the creation of qualified employment, creating technological development centers, and facilitating, in short, the exploitation and commercialization of knowledge developed by universities.

The results of this research also show that science and technology parks, insofar they are capable of hosting numerous scientific, technological, and business agents and that these agents generate knowledge spillovers through socialisation and networking processes, can be a space in which companies can improve their performance from the triple perspective of sustainability. Thus, science and technology parks are seen as a driving factor in the sustainable development of a region when in addition to providing technological structures and value-added services to their host organisations, they create an atmosphere of knowledge that helps companies that actively embed themselves in the park's networks and processes to identify the knowledge that is most valuable for improving their sustainability performance. Therefore, public actions aimed at improving the infrastructure endowments of these spaces, the provision of high value-added services to the hosted organizations, and the creation of in-park organisations networks are justified. The provision of value-added services can be assigned to park management teams, freeing them from traditional infrastructure conservation and maintenance tasks so that they can concentrate on the provision of these higher-value services. Public stakeholders should also increase their efforts to link science and technology parks with other regional infrastructures such as industrial clusters, business schools, industry associations, etc. Efforts should be made to build truly cohesive and integrated regional innovation systems.

This research also provides recommendations for the management entities of science and technology parks. Management entities play an essential role as the coordinating and integrating body for all the organizations hosted in the park. To help hosted organizations improve their sustainability performance, management entities should concentrate their efforts on two objectives. The first is to ensure that there is maximum availability of scientific, technical, and business knowledge spillovers. To this end, efforts should be made not only to attract new companies, but also to encourage public administrations to establish advanced research centers in the park and increase the provision of new technological infrastructures, and finally work hand in hand with universities to find new ways of bringing cutting-edge knowledge to the business sector. Secondly, these management entities should carry out actions to stimulate the socialization and cooperation of the organizations that coexist in the park. New information technologies can support this objective, especially those technologies aimed at fostering the pairing of partners to generate knowledge synergies around a specific innovation or sustainability improvement project. Some localised circular economy and industrial symbiosis networks are already based on powerful information systems.

Finally, about company management, this study suggests that even in a highly globalized and connected world through new technologies, location remains a strategic decision. Thus, company management should carefully select its location in areas where there is an abundance and a flow of knowledge spillovers about markets, green technologies, and the latest management trends to improve its sustainability performance. This research confirms that the knowledge spillovers that can occur in a science and technology park stimulate not only the economic performance of the company but also environmental and social performance. Therefore, the decision to locate in a science and technology park rich in knowledge spillovers can be a wise choice to improve the company's performance from this triple perspective of sustainability and contribute to the achievement of international frameworks such as the 2030 Agenda.

Company management should be careful in selecting a location and not be guided by image or instinct alone. Instead, they should scrutinize to select a location that, while meeting the above image criteria or others such as proximity to markets, is also an environment where competitors, agents in the company's value chain, universities, and technology centers, among others, converge and socialise. However, the company's management should be aware that mere location alone will not be enough for the knowledge spillovers available in the environment of the science and technology park to have an impact on its performance in terms of sustainability. Company management should make decisive efforts to be integrated into the social networks, processes, and cognitive communities of the science and technology park, either by using formal market mechanisms (e.g., incorporating companies as suppliers), or through informal mechanisms (e.g., participating in social events or training courses). Additionally, science and technology parks are spaces in which strategic alliances are usually established to form innovation consortia. Our study controls these strategic alliances (control variable of cooperation) and, in additional robustness tests, has been found to be significant for all sub-models of individual sustainability performance. So, the importance of strategic alliances cannot be overlooked by the management of companies aiming to improve their performance. Also, these consortia are usually made up of a wide range of entities and, in general, they tend to apply for competitive public funding. Therefore, they are an excellent opportunity for the company to join knowledge networks that can improve its performance.

Lastly, the company's management should increase its efforts internally to create capabilities that enable it to acquire, assimilate, transform and exploit the knowledge that flourishes in its environment. Developing absorptive capacity should, therefore, be a priority on the management agenda. To this end, the company can resort to increasing its internal R&D endowments to increase the volume of knowledge that can be used to improve internal products and processes. It can also resort to the acquisition of R&D carried out by public and/or private organizations outside the company, especially those linked to more sustainable green technologies. The training and updating of the company's human capital are also essential to increase the absorption capacity and take advantage of knowledge flows from its environment. The proximity and relationship between science parks and universities should facilitate this task. In short, the above should serve, then, to increase the company's stock of knowledge and apply it to improve its triple performance in sustainability, as this study has allowed us to conclude.

7.3. LIMITATIONS AND FUTURE LINES OF RESEARCH

Even though we strongly believe that this dissertation makes several contributions to the literature, it is not free of limitations. The first evident limitation is that our study uses a database that only covers data from Spanish companies. Therefore, future research should first extend the study of the relationships between the variables presented here to other subsets of the data, especially if they can respect a panel structure such as the one used here, which allows inference of the relationships between the variables. Science and technology parks are a global phenomenon, so it would be of high academic interest to test whether our hypotheses hold in culturally different environments such as America, Europe, or Asia. It may even be interesting to carry out intra-continental contrasts; for example, in the European case, to validate whether the results obtained in a southern European country are corroborated in a sample from a northern European country.

Focusing now on the knowledge spillovers construct, it is composed of 11 items representing knowledge spillovers produced by market sources, education and research sources, and other sources such as conferences or professional associations. The PITEC database developed by the Spanish National Institute of Statistics assesses the importance that business management assigns to each of these sources of information during the two years before the survey process. Therefore, although this questionnaire design solves the endogeneity problems between the knowledge spillovers variable and absorptive capacity, future research with this database should introduce a lag in the measurement of the knowledge spillovers variable. That is, the measure of management's assessment of the importance of knowledge spillovers should be taken from the questionnaire of the year before the year in which the measures of absorptive capacity and sustainability performance are taken. This would eliminate any endogeneity problems. It would also be interesting in future research to work with another database to use alternative measures of these knowledge spillovers, such as previously validated scales in the literature. Either of these two options is excellent to validate in future studies whether the results obtained here about the relevance of knowledge spillovers to improve firms' sustainability performance hold or, on the contrary, differ.

In future lines of research, it would be interesting to obtain a more precise view of the specific impact of each knowledge spillover on both the absorptive capacity of the company and also in each of the variables that make up the sustainability performance measure in our study. On the other hand, as is already the case in the literature on strategic alliances and cooperation agreements for innovation, it is of particular interest for future research to continue to deepen the distinction between knowledge spillovers more linked to the exploitation, refinement, or incremental innovation of the firm's current capabilities from those that are more linked to exploration or more radical innovation; that is, in other words, to make a deeper distinction of the degree of novelty that external knowledge represents concerning the firm's current knowledge base. This thesis has provided an entry point for this future line of research by considering that certain knowledge spillovers will be easily adopted by the company, while others will require the mediating effect of absorptive capacity to multiply their impact on the triple bottom line of companies. However, we consider that this is a line of research that should be explored in the future, validating which specific kind of these knowledge spillovers (i.e., explorative or exploitative) have the greatest influence on each of the dimensions of sustainability performance.

The way knowledge spillovers are measured in the PITEC survey also has certain implications that should be noted. Firstly, the confluence of agents in a geographically bounded space (i.e., a science and technology park) in which social and professional interrelationships spur the generation of knowledge spillovers; that is, they create the knowledge atmosphere already recognised in Alfred Marshall's seminal studies. Secondly, the company's identification of these knowledge spillovers by being embedded itself in social networks and processes and achieving insider status.

Additionally, since agglomerations of companies are characterised by a high mobility of the workforce (González-Masip et al., 2019; Becattini et al., 2009), future research should ask how this workforce can act as a transmitter of knowledge flows so that they permeate into organisations to improve their performance in terms of sustainability. To this end, given the limitations of the PITEC database, it would be appropriate to conduct a new primary survey that would provide the most appropriate data for this purpose.

We recognise that the fact that firm’s ability to identify knowledge flows is separated from the absorptive capacity construct may arouse suspicion among scholars specialising in this concept. Nevertheless, it is worth noting that in previous studies there continues to be some quarrels between studies that favour the inclusion of the ability to identify external knowledge as an integrated dimension of the absorptive capacity construct (e.g., Song et al, 2018; Todorova & Durisin, 2007; Zahra & George, 2002; Cohen & Levinthal, 1990), and those studies that consider a necessary condition or antecedent for the processes of evaluating, assimilating, transforming and institutionalizing, dealing with the specific analysis and combination of both internal and external knowledge (e.g., Hussain et al., 2022;). Therefore, this limitation opens a new opportunity for future work on the reification of the absorptive capacity construct based on systematic literature reviews of the construct (e.g., Hussain et al., 2022) and supporting this reification with empirical analyses (e.g., Camisón & Forés, 2010).

Regarding our measure of absorptive capacity, the proxy variable used in this study as a unit of measurement is supported by the literature and has obtained statistical reliability and validity indexes, allowing us to analyse its impact on triple sustainability performance. However, it remains for future research to assess whether the effects presented in this study are modified when this absorptive capacity is measured with multi-item scales previously validated in the literature (e.g., Camisón & Forés, 2010). The use of such scales will also allow observing the dimensionality of absorptive capacity, which is widely recognised in the literature on strategic management, thus broadening and completing our analysis.

Concerning the measure of sustainable performance, future studies can assess whether our empirical results hold up using a performance measure constructed from concrete objective indicators for each of the three dimensions of sustainability. Examples of possible objective indices already reported in previous literature could be: decreases in variables such as material consumption or emissions, degree of material recirculation, decreases in occupational accidents, and increase in profitability, to name but a few possibilities.

Science and technology parks are also units that are embedded in regional innovation systems that may be much larger. In these regional innovation systems, relevant partners or sources of knowledge may be located outside the vicinity of the park, but within the boundaries of the regional innovation system. Therefore, future research should consider extending the analysis to knowledge sources that are not located in the vicinity of the science and technology park. The analysis should not be limited to the local scale; on the contrary, in today's globalised world, it is especially relevant to analyse the interactions that take place with sources of knowledge beyond regional and national borders, a source of spillovers of new knowledge (global pipelines). This proposal makes even more sense if we take into account that science and technology parks can house subsidiaries of large international groups in their infrastructures, or that innovation projects (not only in the traditional field focused on new products and services, but increasingly incorporating elements of sustainability) are increasingly carried out by consortia of organisations belonging to multiple countries.

In this thesis, it has been indicated that science and technology parks are one of the many models of territorial agglomeration of companies that currently exist, such as clusters or industrial districts. In this sense, as the academic literature on these issues points out, not all science and technology parks respond to a standard pattern, but rather present a high degree of heterogeneity. Recently, research has begun to appear that tries to reveal the heterogeneity of science and technology parks according to criteria such as their type of ownership, their relationship with the university, or the composition of the organisations that are hosted in them, among other variables.

The PITEC questionnaire contains a question aimed at finding out the name of the science and/or technology park of the companies that state that they are located in one of these technological enclaves. However, this information is not usually provided by the National Statistics Institute to researchers. The same applies to the question aimed at finding out the year in which companies joined a science and technology park. These two gaps in the database represent both a limitation and a new opportunity for future research. As such, future studies could assess whether the effects of location on sustainability performance through the mediating variables of knowledge spillovers and absorptive capacity are maintained or differ between firms hosted in a pure science park and those hosted in a technology park. It would be of particular interest to diagnose how the effects of different knowledge spillovers may change on each of the dimensions of the sustainability construct taking into account the subtypology of science and technology park. These limitations also open up opportunities to assess how entry into a science and technology park affects the performance of an existing and fully operational firm.

The previous hypotheses, empirical results, and discussion have shown that, contrary to the postulates proposed by canonical studies on territorial agglomerations (such as science and technology parks, but also other realities such as industrial districts), this doctoral thesis considers that firms located in these territorial agglomerations are characterised by being highly heterogeneous (Gwebu et al., 2019; Ubeda et al., 2019; Claver-Cortés et al., 2018, 2020b; Díez-Vial & Montoro-Sánchez, 2016; Hervás-Oliver and Sempere-Ripoll, 2014; Camisón & Forés, 2011). Therefore, future studies at the level of the individual company could also consider assessing how certain internal characteristics of the company hosted in science and technology parks may influence the achievement of better sustainability performance. In this sense, it would be worth mentioning elements susceptible to further academic clarification such as the role played by the ownership of the company, which may differ from subsidiaries of international groups to small start-ups or spin-offs with equity participation from external investors or from the university itself. It may also be of interest to know the role that information and competitive intelligence systems play in recognising and valuing the knowledge spillovers that occur in the park, and how they can moderate their use for performance improvement. On the other hand, accessing certain more disruptive and complex knowledge spillovers requires a commitment on the part of the company and their access is subject to collaborative formulas such as strategic alliances. Future research could analyse the most suitable type of strategic alliance. Partnerships are essential in the deployment of sustainability improvement projects such as those proposed under the framework of the circular economy, and therefore represent a line of research of high value and impact.

In future lines of research, it is also worth asking about the relationship between the sustainability performance of organisations hosted in a science and technology park and their level of disclosure of non-financial information to their stakeholders. It is true that some of the organisations hosted in a science and technology park, either because they are public entities or because they belong to a large international parent company, may be compelled to prepare and publish sustainability reports under current legislation. However, it may be very interesting to know and reveal the degree of progress of these disclosure practices in small technology companies, an aspect that has been much less studied in the literature. As stated previously in this doctoral thesis, the importance of reporting cannot be overlooked when it comes to assessing the performance of a company from the perspective of sustainability, as they are two sides of the same coin (Camisón et al., 2021).

ANNEXES

ANNEX I

A) Alpha tests

SUSTAINABILITY

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Average interitem correlation	alpha
objet1recd~o	47870	-	0.5846	0.5156	0.3880	0.9049
objet2recd~o	47870	+	0.5687	0.4980	0.3896	0.9054
objet3recd~o	47870	+	0.6313	0.5678	0.3834	0.9032
objet4recd~o	47870	+	0.6553	0.5948	0.3810	0.9023
objet5recd~o	47870	+	0.6546	0.5940	0.3811	0.9023
objet6recd~o	47870	+	0.6214	0.5566	0.3844	0.9035
objet7recd~o	47870	+	0.6282	0.5642	0.3837	0.9033
objet8recd~o	47870	+	0.6636	0.6041	0.3802	0.9020
objet9recd~o	47870	+	0.6550	0.5945	0.3811	0.9023
objet10rec~o	47870	+	0.6675	0.6086	0.3798	0.9018
objet11rec~o	47870	+	0.6856	0.6291	0.3780	0.9012
objet12rec~o	47870	+	0.7148	0.6624	0.3752	0.9001
objet13rec~o	47870	+	0.7111	0.6582	0.3755	0.9002
objet14rec~o	47870	+	0.6066	0.5401	0.3858	0.9041
objet15rec~o	47870	+	0.6559	0.5954	0.3810	0.9023
objet16rec~o	47870	+	0.6695	0.6108	0.3796	0.9018
Test scale					0.3817	0.9081

KNOWLEDGE SPILLOVERS

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Average interitem correlation	alpha
fuentetota~d	47870	+	0.4799	0.3510	0.3160	0.8221
fuentetot~d2	47870	+	0.5106	0.3857	0.3115	0.8190
fuentetot~d3	47870	+	0.5796	0.4654	0.3014	0.8118
fuentetot~d4	47870	+	0.5853	0.4721	0.3005	0.8112
fuentetot~d5	47870	+	0.6020	0.4917	0.2981	0.8094
fuentetot~d6	47870	+	0.6300	0.5248	0.2940	0.8063
fuentetot~d7	47870	+	0.6412	0.5382	0.2923	0.8051
fuentetot~d8	47870	+	0.6411	0.5381	0.2923	0.8051
fuentetot~d9	47870	+	0.6597	0.5605	0.2896	0.8030
fuenteto~d10	47870	+	0.6573	0.5576	0.2900	0.8033
fuenteto~d11	47870	+	0.6311	0.5262	0.2938	0.8062
Test scale					0.2981	0.8237

ACAP

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Average interitem correlation	alpha
idinrec	71571	+	0.6278	0.3513	0.1778	0.4638
idexrec	71571	+	0.6264	0.3495	0.1785	0.4650
maquirec	71571	+	0.5856	0.2947	0.1987	0.4980
tecnorec	71571	+	0.4896	0.1738	0.2464	0.5667
formrec	71571	+	0.6495	0.3815	0.1671	0.4451
Test scale					0.1937	0.5457

B) Hausman (1978) specification test

	Coef.
Chi-square test value	293.474
P-value	0

C) Bootstrapping tests for the mediating effects

Partially-mediating effect of ACAP on the relationship between SPILL and SUSTAIN: Hypothesis 3

Bootstrap replications (50)

Bootstrap results Number of obs = 47,870

	Observed	Bootstrap			Normal-based	
	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
_bs_2	0.038	0.002	16.020	0.000	0.033	0.042

Observed		Bootstrap		
Coef.	Bias	Std.Err.	[95%Conf.	Interval]
0.038	-0.002	0.002	0.032	0.041(P)
			0.035	0.043(BC)

(P) percentile confidence interval
(BC) bias-corrected confidence interval

Fully-mediating effect of SPILL on the relationship between STP and SUSTAIN: Hypothesis 5

Bootstrap replications (50)
Bootstrap results Number of obs = 47,870

	Observed			Bootstrap	Normal-based	
	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
_bs_1	0.317	0.111	2.870	0.004	0.100	0.534

Observed		Bootstrap		
Coef.	Bias	Std.Err.	[95%Conf.	Interval]
0.317	-0.004	0.111	0.096	0.507(P)
			0.096	0.507(BC)

(P) percentile confidence interval
(BC) bias-corrected confidence interval

Fully-mediating effect of SPILL on the relationship between STP and ACAP: Hypothesis 6

(Bootstrap replications (50)

Bootstrap results Number of obs = 47,870

	Observed		Bootstrap		Normal-based	
	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
_bs_3	0.027	0.008	3.440	0.001	0.012	0.043

Observed		Bootstrap		
Coef.	Bias	Std.Err.	[95%Conf.	Interval]
0.027	0.001	0.008	0.010	0.040(P)
			0.010	0.039(BC)

(P) percentile confidence interval
(BC) bias-corrected confidence interval

Mediating effect of SPILL and ACAP on the relationship between STP and SUSTAIN: Hypothesis 7

(running modelofinalsosbea on estimation sample)
Bootstrap replications (50)
Bootstrap results Number of obs = 47,870

	Observed	Bootstrap			Normal-based	
	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
_bs_4	0.015	0.006	2.760	0.006	0.004	0.026

		Bootstrap		
Observed				
Coef.	Bias	Std.Err.	[95%Conf.	Interval]
0.015	-0.000	0.006	0.005	0.026(P)
			0.005	0.025(BC)

(P) percentile confidence interval
(BC) bias-corrected confidence interval

ANNEX II. Robustness analysis

A) Fit Indexes SEM

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(1)	117.245	model vs. saturated
p > chi2	0.000	
chi2_bs(6)	32025.747	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.040	Root mean squared error of approximation
90% CI, lower bound	0.034	
upper bound	0.047	
pclose	0.995	Probability RMSEA <= 0.05
Information criteria		
AIC	693836.749	Akaike's information criterion
BIC	693937.712	Bayesian information criterion
Baseline comparison		
CFI	0.996	Comparative fit index
TLI	0.978	Tucker-Lewis index
Size of residuals		
CD	0.025	Coefficient of determination

B) Testing indirect effects with SEM: Monte Carlo tests

Partially-mediating effect of ACAP on the relationship between SPILL and SUSTAIN: Hypothesis 3

Significance testing of indirect effect (unstandardised)

Estimates	Delta	Sobel	Monte Carlo*
Indirect effect	0.318	0.318	0.318
Std. Err.	0.013	0.013	0.013
z-value	25.413	25.413	25.351
p-value	0.000	0.000	0.000
Conf. Interval	0.293 , 0.342	0.293 , 0.342	0.294 , 0.343

Fully-mediating effect of SPILL on the relationship between STP and SUSTAIN: Hypothesis 5

Significance testing of indirect effect (unstandardised)

Estimates	Delta	Sobel	Monte Carlo*
Indirect effect	1.494	1.494	1.494
Std. Err.	0.048	0.048	0.048
z-value	31.398	31.398	31.381
p-value	0.000	0.000	0.000
Conf. Interval	1.401 , 1.587	1.401 , 1.587	1.401 , 1.587

Partially-mediating effect of SPILL on the relationship between STP and ACAP: Hypothesis 6

Significance testing of indirect effect (unstandardised)

Estimates	Delta	Sobel	Monte Carlo*
Indirect effect	0.663	0.663	0.663
Std. Err.	0.020	0.032	0.032
z-value	33.857	21.040	20.979
p-value	0.000	0.000	0.000
Conf. Interval	0.625 , 0.701	0.601 , 0.725	0.602 , 0.726

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