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COMPARATIVE ANALYSIS OF THE TRANSFER OF TECHNOLOGICAL INNOVATION IN ITALY AND ARGENTINA

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ABSTRACT (ENGLISH)

Technology transfer is a fundamental engine for economic growth. The objective of this paper is to compare the process of technological innovation transfer in a country like Italy, one of the major world economies and a member of the European Union, with Argentina, a developing country and non-member of the European Union. To provide context for the analysis, the first chapter theoretically defines technological innovation and the mechanisms through which it is disseminated, also outlining what is meant by the innovation system. In the second chapter, after analyzing the state of innovation in Europe, an examination is conducted on the actors of technological innovation in Italy and how the transfer process takes place. In the third chapter, once the state of innovation in Latin America and the Caribbean is examined, the innovation system in Argentina is analyzed, along with how the process of technological innovation transfer occurs in the country. In the concluding phase, the strengths and weaknesses of the two innovation systems are highlighted through comparison, identifying opportunities for technological transfer between Italy and Argentina.

ABSTRACT (ESPAÑOL)

La transferencia tecnológica representa un motor fundamental para el crecimiento económico. El objetivo de este trabajo es comparar el proceso de transferencia de innovación tecnológica entre Italia, una de las principales economías mundiales y miembro de la Unión Europea, y Argentina, un país en desarrollo y no miembro de la Unión Europea. Para proporcionar contexto al análisis, en el primer capítulo se define desde un punto de vista teórico la innovación tecnológica y los mecanismos a través de los cuales se difunde, definiendo también qué se entiende por sistema de innovación. En el segundo capítulo, después de analizar el estado de la innovación en Europa, se lleva a cabo un análisis sobre los actores de la innovación tecnológica en Italia y cómo se lleva a cabo el proceso de transferencia. En el tercer capítulo, una vez analizado el estado de la innovación en América Latina y el Caribe, se analiza el sistema de innovación en Argentina y cómo se lleva a cabo el proceso de transferencia de la innovación tecnológica en el país, a través de la comparación. En la fase conclusiva, se destacan los puntos fuertes y débiles de los dos sistemas innovadores, identificando oportunidades de transferencia tecnológica entre Italia y Argentina.

INTRODUCTION

Innovation is an inherent aspect of human nature, having played a crucial role in survival and subsequently improving living conditions since the Earth's creation. The industrial revolutions from the late 19th century onward have notably accelerated this process, introducing technologies to enhance national productivity. Simultaneously, a revolution within universities transformed them from elitist enclaves into more inclusive institutions, fostering the use of technological innovation for societal benefit and giving rise to the concept of technology transfer in academia. The contemporary modes of this transfer are significantly influenced by the national system, the institutions within it, their evolution, and a nation's relationships with others. Therefore, understanding this process in countries with diverse geographic regions, economic development conditions, and historical backgrounds becomes crucial.

This paper compares an economically advanced European Union country, Italy, with a developing non-union nation, Argentina. Literature on the comparison of technological innovation transfer between developed and developing countries is limited, Thus, this analysis contributes to a better understanding of the topic, elucidating strengths and weaknesses in these innovative systems. Additionally, Italy and Argentina, despite their apparent differences, share deep cultural ties, particularly through post-World War II migration. This comparative study aims to

shed light on the technological innovation transfer processes in both countries, providing insights into their unique characteristics.

Delving into specifics, Chapter 1 aims to establish a theoretical foundation through overviews of various definitions and classifications of innovation. It defines technological innovation and introduces the Triple Helix Model as the framework for subsequent analyses. The chapter examines diverse sources of innovation and their interactions within an innovation system, analyzing how the transfer of technological innovation takes shape nationally and internationally. Chapter 2 focuses on the analysis of technological innovation transfer in Italy. It provides context by analyzing major European innovation clusters, followed by a macroeconomic and productive analysis of Italy. The chapter then scrutinizes key indicators of Italian innovation, exploring the role of universities, public research institutes, businesses, and hybrid organizations in technology transfer. The final section analyzes European Union policies supporting innovation growth in Italy. In Chapter 3, attention shifts to Argentina. After offering a brief overview of innovation in Latin America and the Caribbean, the chapter analyzes Argentina's macroeconomic situation and production structure. It then examines the country's innovation level and the technology transfer process by universities, public research institutes, businesses, and hybrid organizations. The chapter concludes with an analysis of supranational policies supporting innovation growth in Argentina. Chapter 4 focuses on the comparison, beginning with a comparison of

innovation variables between Europe and Latin America and the Caribbean. It then compares the innovation levels between Italy and Argentina, analyzing similarities and differences in the ways technology transfer occurs among universities, public research institutes, businesses, and organizations. The chapter concludes by identifying international tools for technological innovation transfer between Italy and Argentina.

To conclude, it is necessary to make a clarification: the data included in the analysis are the latest available, up to 2023. The rationale behind this choice lies in the need to represent as accurately as possible the current state of technological innovation and its transfer in Italy and Argentina. Furthermore, the work does not aim to be predictive for the future and does not consider the impact that changes in government may have on the phenomenon.

CHAPTER 1. INNOVATION AND TECHNOLOGICAL TRANSFER: LITERATURE REVIEW

This chapter provides a literature review on the topics of innovation and technology transfer. Initially, it gives an overview of various definitions of innovation proposed over the last 60 years. Subsequently, it's explored different types of innovation, with a specific emphasis on technological innovation. Various models of technological innovation creation are then examined in-depth, with a particular focus on the Triple Helix Model. The analysis follows then on the actors involved in innovation creation and the concept of an innovation system. Finally, the chapter addresses technology transfer, both at the national and international levels.

1.1 DEFINING INNOVATION: FROM SCHUMPETER TO THE OSLO MANUAL

In the context of economic science, the concept of innovation is used to describe a complex phenomenon that involves various actors of the society who are involved in processes of creating new knowledge; finding a unique definition to explain that intricate system of actors is quite challenging. The number and diversity of notion of innovation are extensive and, as identified by Baregheh, Rowley, & Sambrook in " Towards a multidisciplinary definition of innovation", it lead to a situation in which there is no clear and authoritative definition of that.

Nevertheless, in the next few pages is proposed a review of the main and the most recognized definitions of innovation following a categorization as proposed by Baregheh, Rowley, & Sambrook in the same article mentioned before. The chosen definitions were curated to present a wide-ranging and thorough examination of the diverse viewpoints associated with innovation based on a classification of the term built on a disciplinary orientation. Those disciplinary orientation are: economy, innovation and entrepreneurship, business and management, strategy, technology, science and engineering, organization study.

1.1.1 Towards a multidisciplinary definition of innovation

Related to the discipline of ”economy”, deserve to the be mentioned the contribution of Schumpeter, a pioneer in the study of economic innovation who introduced the influential concept of “ creative destruction”. This notion, presented in the book “Capitalism, Socialism, and Democracy” of 1954, emphasize the relation between innovation and economic development and express the concept of innovation as a phenomenon of changing that “revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one” (Schumpeter, 1954). From that is possible to comes out with a first definition of innovation which is understood as a process of destruction of the old to create something new. Is necessary to points out that the term “destruction” should not be understood in a literary sense but in a broader

sense where more than demolition of the past, it refers to a process of evolution where the new state of things comes out from a process of progress from the *status quo*. That precess of modification is defined by the author as the essence of a capitalist economic system and the field where the actors of the capitalist system are operating. Schumpeter also comes out with a definition of two characteristics of innovation; on one side innovation is define as a long-term process that took many years before to produce some tangible results (Schumpeter, 1954). On the other side, innovation is seen as an organic process where "the whole is different from the sum of the parts" (Ravenna, 2013); it means that to understand a specific entrepreneurial innovation choice is necessary to view it in relation to the process of creative destruction that is set in the field of the industry. According to the author, innovation is seen mainly in the entrepreneurial prospective and as a product of the capitalism. To broaden the concept, Schumpeter express a close link between innovation and capitalism: "the fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates " (Schumpeter, 1954). It shows how the economic grow in this kind of economic system is linked to the creation of something different from what is in the current state of things or was in the past.

Related to the disciplinary orientation of “innovation and entrepreneurship” is mentioned the work of Drucker that in his book of 1985 define innovation as the specific instrument of entrepreneurship and as the “the act that endows resources with a new capacity to create wealth” (Drucker, 1985). Therefrom emerge that innovation arise from the capacity of the businessman to give a new economic meaning to something available in nature and give it the power to satisfy people's needs and, from that, create wealth. Also, from the work of the author emerge the idea that innovation doesn’t have to be linked only with technology because innovation “did not grow out of technology at all but out of a new perception “(Drucker, 1985). From that emerge an expansion of the vision of Shumpeter that link innovation mainly to technology; Drucker introduce the possibility of include as innovation the modification of the conditions of use of an object. The ideas of Drucker are different from the ideas of Shumpeter also related to the concept of “social innovations” and for the definition of a sort of hierarchy in the difficulty of implementation of those innovation. Social innovation refers to new ideas that has an impact on the society as, for example, the development of new institution that are defined as “more difficult to achieve than building locomotives and telegraphs “(Drucker, 1985); thanks to that last concept, for the author was possible to introduce a new concept of innovation focus on an economic and social dimension rather than only on a technological one. Development of the concert of innovation is the notion of “systematic innovation” introduced by the same Drucker that

consist in the “organized search for changes, and in the systematic analysis of the opportunities such changes might offer for economic or social innovation” (Drucker,1985); entrepreneur and politicians have to watch at the society and at the market, in a constant and organized manner, in order to anticipate the changes and the challenges that are coming in.

Related to the disciplinary orientation of “business and management” deserve to be mentioned the contribution of Van de Ven (1986) that define “innovation as new idea, which may be a recombination of old ideas, a scheme that challenges the present order, a formula, or a unique approach which is perceived as new by the individuals involved” (Zaltman *et al*, 1973; Rogers, 1982; Van de Ven, 1986). An innovation is something different from the current state of things and it’s a concept closely linked to people's perception; as long as an idea is perceived new from the people involved, as long it will be considered an innovation (Van de Ven, 1986). The author also, mencioning the work of Kimberly (1981), points out the positive bias that pervade the study of innovation; indeed, innovation is often viewed as a good thing because the new idea is something that must be useful as that profitable, constructive, or solve a problem; on the other hand, new ideas that are not perceived as useful are not normally called innovations but mistakes. From that emerge a concept of innovative ideas that are strictly related to a perception of utility from the users.

Regarding the disciplinary orientation of "strategy" is mentioned the writing of Porter of 1990 where is presented the concept of innovation as a source of competitive advantage for a firm. For the author innovation refer to "both improvements in technology and better methods or ways of doing things" (Porter, 1990). Those improvements contribute to the establishment of a competitive advantage for a firm and in order to maintain that business are constantly searching for a new and better way to compete in an industry by bringing those novelty in the market; this last action is in itself an act of innovation for the author. More specifically, innovation can be manifested in product changes, process changes, new approaches to marketing, new forms of distribution, and new conceptions of scope (Porter, 1990). Is given also importance to the causes that force a firm to innovate by distinguish between external and internal forces. Related to the external forces, the novelty arises from a state of "pressure, necessity, or even adversity" that comes from the industry or/and from the market conditions. On relation to the internal forces, on one side is recognized a central role of the innovator that is defined as what force the changes to precede faster; on the other side, innovation arise not necessarily from a formal R&D but can emerge also from a process of development of skills, knowledge, physical assets, and marketing effort (Porter, 1990).

Regarding the disciplinary orientation of "technology, science and engineering" is presented a definition proposed by Dunphy in 1996 where innovation refer to "the

first commercially feasible version of the invention" and an "invention is the first working model of the technology" (Dunphy *et al*, 1996). This definition is strictly related to an engineering and to a commercial prospective where an invention become innovation in case of commercial success. Innovation is driven by demand forces as that from a state of necessity whose intensity influences the speed of the innovation process. Become necessary to mention the role political and socio-cultural driven in the process of innovation: the authors point out that there is a positive relation between the degree of freedom of the individuals of a society to express freely their opinions, and the likelihood of the individuals to develop new ideas. From a political perspective, Dunphy express as the government bureaucracy "acts as an inhibitor to innovation" (Dunphy *et al*, 1996); country with a low level of state interventionism is more likely to be innovative than in countries with high level of regulation.

Regarding the disciplinary orientation of "organization study" is proposed the contribution of García-Morales of 2008. Innovation is defined as new idea, method, or device, the act of creating a new product or process and the act includes invention as well as the work required to bring an idea or concept into final form (García-Morales *et al*, 2008). This definition points out the prospective of innovation as an evolutionary process aimed to create something new. The authors also point out the idea of close relation between innovation in a firm and

its leadership style; collaborative and participative leadership style is more likely to encourage innovation.

1.1.2 Innovation according to the Olso Manual

Finally, is proposed a definitions of innovation as presented by the Organization for Economic Co-operation and Development (OECD) in the Oslo Manual of 2018; this definition represents the international standard of reference for conceptualizing and measuring innovation. Innovation is defined as a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the actor responsible for innovation (process). An innovation requires implementation, either by being put into active use or by being made available for use by other parties, firms, individuals or organizations. Innovation is defined also as a dynamic and pervasive activity that occurs in all sectors of an economy (OECD/Eurostat, 2018). These dynamic and complex activities and relationships pose significant, but not insurmountable, challenges for measurement. Despite this, the Oslo Manual proposed a measurement of innovation in the business enterprise sector; a measurement strategy for innovation must address several issues, such as the choice between a subject- or object-oriented approach, the collection of

qualitative and quantitative data, data sources, and data collection responsibility (OECD/Eurostat, 2018).

1.2 TYPES OF INNOVATION

As emerge from the vast body of literature, innovation have a strong impact on economic growth and socioeconomic development and plays a crucial role in technological, social, and cultural changes. Innovation is configured as a multidimensional concept, characterized by variable meanings and definitions depending on disciplinary perspectives. Based on that, proposing a real taxonomy of the different typologies of innovation is a utopian undertaking even considering the changing that the new industrial revolution[1] are putting in place.

Nevertheless, it's proposed an attempt of classification of the main types of innovation according to the paper of Edwards-Schachter of 2018. The author proposes an overview of the most salient types of innovation in recent decades and distinguished between technological, product, process, service, business model, disruptive, radical, design-driven, and social innovation. A brief explanation of that types is proposed below (Edwards-Schachter, 2018).

The "technological innovation" is defined as the implementation of a new or a significantly improved product (good or service), or a new process, a new marketing method, or a new organizational method in business practices,

[1] With the term new industrial revolution, I am referring at the advent of the so-called Industry 4.0

workplace organization or external relations (Oslo Manual, 2005; Edwards-Schachter, 2018).

The “process innovation” refers to the introduction of new elements into an organization's production or service operations input materials, task specifications, work and information flow mechanisms, and equipment used to produce a product or render a serviced; the aim of this process is achieving lower costs and/or higher product quality (Reichstein and Salter, 2006; Edwards-Schachter, 2018).

A “product innovation” is a product, made available to potential users, that is new or significantly changed with respect to its characteristics or intended uses (Gault, 2018; Edwards-Schachter, 2018). That type of innovation also include significant changes in inputs, infrastructure within the institutional units and techniques.

“Service innovation” refers to the innovation in the service’s industries. More in the details “service innovation comprises both innovation in specific services and service systems, which embodies the structure of the system that generates the service, namely the organization and the environment” (Edwards-Schachter, 2018).

“Business model innovation” is defined by many authors as a new dimension of innovation. Is defined by Edwards-Schachter (2018) as a conscious change of an existing business model or the creation of a new business model that improves its functions and satisfies customer needs better than the existing business models.

The “disruptive innovation” is outline as a disruptive technology that produce a market disruption; this occurs when a new product, despite its inferior performance on focal attributes valued by existing customers, displaces the mainstream product in the mainstream market (Christensen, 1997; Edwards-Schachter, 2018).

A “radical innovation” refers to “changes the rules of the game” and represent a broken in relation at the current state of things; this type of innovation operates with higher levels of uncertainties and represent a “change that sweeps away much of a firm's existing investments in technical skills and knowledge, designs, production technique, plant and equipment” (Utterback,1994-1996; Edwards-Schachter, 2018).

“Design-driven innovation” is a concept that emphasize the design practice as a driver of innovation where the “innovation concerns the skill to understand, anticipate, and influence the emergence of new product and service meanings” (Edwards-Schachter, 2018).

The “social innovation” refers to the orientation to “solve societal needs through changes in social practices that contribute to broader changes in socio-technical systems, and the development of non-technological innovations” (Edwards-Schachter, 2018).

Last type of innovation is the “responsible innovation” that represent a “meta-category” of innovation that has emerged in the past decade. Is defined as “a

transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability, and societal desirability of the innovation process and its marketable products" (Von Schomber 2011; Edwards-Schachter, 2018).

To conclude this section, is necessary to remark that a general characteristic that link together all the different types of innovation is the thing that an innovation is something that is a novelty and changed related to the current state of things.

1.3 FOCUS ON THE CONCEPT OF TECHNOLOGICAL INNOVATION

The concept of technological innovation deserves further study since it will be the main theme on this paper; for this reason, an in-depth exploration of the concept of technology is first proposed.

Technology has a dynamic nature, and it has contributed to the existence of various and a non-unique definition of technological innovation (Wahab *et al,* 2012). Technology consists of two primary components: 1) a physical component which comprises of items such as products, tooling, equipment, blueprints, techniques, and processes; and 2) the informational component which consists of know-how in management, marketing, production, quality control, reliability, skilled labor, and functional areas (Kumar *et al*, 1999; Wahab *et al,* 2012). From that emerge a concept of tecnology made by a tangible and untangible component. Technology can also be seen from a systems perspective that "defines technology

as encompassing: 1) the basic knowledge sub-system; 2) the technical support system (software); and 3) the capital-embodied technology (hardware) "(Afriyie, 1988; Wahab *et al,* 2012). From that emerge a view of technology not just as standalone entity but rather a composite of various components, some of which may be uniquely tied to a particular nation.

Combining the concept of technology with that of innovation is possible to create a synergistic understanding that goes beyond individuals' definitions with the aim to have a comprehensive and interconnected perspective. Technological innovation is about to make changes that will modify the quality of life of the users, is about to jump to something more. It's something that must be consider as a "co-evolutionary patterns" with the economic and social contexts that are deeply interrelated (Dosi *et al,* 2002). The process of "technological learning involves many more elements than simply inventive discovery and patenting: equally important activities are imitation, reverse engineering, adoption of capital-embodied innovations, learning by doing and learning by using " (Freeman 1982; Dosi 1988; Pavitt 1999; Dosi *et al*, 2002). From that emerge a broader view from the ones presented by the OSLO manual that give to the concept of technological innovation a social dimension that extends the point of view on the theme.

1.4 REVIEW OF THE THEORETICAL MODELS ON THE CAUSES OF TECHNOLOGICAL INNOVATION

Technological innovation is of central importance in the international academic panorama due to its impact on phenomena such as the economic growth and social and institutional changes. For this reason, over the years, multiple theories have emerged aimed to try to explain the causes of technological change and the logics behind the process of creation of that. The models that have been created are numerous and refer to the most varied disciplinary orientation where some of them also propose a multidisciplinary perspective by combining science, economics, sociology, management, politics and even geography.

1.4.1 The six generations of innovation models

Proposing a real taxonomy of the models that explain how technological innovation arise is difficult due to the vastness and heterogeneity of the phenomenon. Despite this, it is proposed an historical examination of the most recognized models used to explain how innovation occurs made by Marinova and Phillimore (2003). The authors presented a categorization of the model by using a chronological criterion; are identified six generations of models and below is proposed a table to summarize the main elements of those models.

N. OF GENERA-TION	NAME OF THE MODEL	MAIN AUTHOR AND YEAR OF PUBLICATION	MODEL DESCRIPTION	STRENGTHS	WEAKNESS

First generation	The black box model	S. J. Kline and N. Rosenberg, 1986	The model describes the innovation process as a black box where the only things that count are the inputs and the outputs.	-Innovation as fundamental economic activity for a firm -Management as who made possible the transformation of input into innovative output	- Doesn't explain how the innovation took place in the firm - Doesn't mention the innovation that appends outside of a firm - Consider only the R&D activity of a firm
Second generation	The linear models	-V. Bush and others, 1950s and 1960s. -J. Schmook-er, 1966; S. J. Kline and N. Rosenberg 1986	-First version: technology push model. Discoveries in basic science led to technological developments with result in a flow of new product and process to the marketplace. -Second version: market driven. Innovation rise from existing demands in the marketplace that impulse the development of new technologies.	-Useful to explain success and failure of a wide range of new technologies. -Clear message and economic rationality.	-Technological innovation is linked only to the R&D activities. -Too simplistic.
Third generation	The interactive model	Rothwell and Zegveld, 1985.	The innovation process is a complex web of communication paths within and beyond an organization, connecting internal functions to the broader scientific and technological community and the marketplace.	-Innovation is seen as an interactive model -Explain the variety of interactions necessary for the success of innovation.	- Do not explain what drive the engine of innovation. -Do not express how the organization learn.
Fourth generation	The system models	Does not came from a single author	Innovation as a system; firm that do not have enough resources to develop innovation in-house can benefit from	Reduction of innovation time and cost by cooperation within a network of a	-Rather than be a formal theory, is more a conceptual framework. -Innovation is based on

			establishing relationship with a network of other firms and organizations	small group of small firm.	relations of trust between firms that is characterize by excessive instability.
Fifth generation	The evolutionary model	Saviotti, 1996	Innovation influenced by generation of variety, selection, production and inheritance, fitness and adaptation, variation of population, elementary interaction, socioeconomic environment.	-Shedding light on how decisions are made and how the various participant interact to produce innovation.	-Less normative power -Less focused on the implications for innovation strategy. -Because it is not based on fixed parameters, the model loses the ability to predict reality.
Sixth generation	Milieux explanatory model	Bramanti & Ratti, 1997	Innovation stems from a creative combination of generic know-how and specific component where territorial organization is an essential component of the process of techno-economic creation.	-Help to explain the success of small and medium size enterprise. -Explain why certain localities give birth to many small innovative firms.	-Doesn't address the links between innovation and ecology. -Keep an approach to much anthropocentric.

Table 1.1 - "The six generations of innovation models". Source: original formulation from Marinova & Phillimore, 2003.

This overview highlights the evolution in the research on innovation sources over the past forty years. Scholars have shifted from a company-centric approach to an environmental-centric one. Initially, innovation was viewed solely as a "product of a firm," lacking emphasis on the process. Subsequent models focused on understanding the causes and mechanisms of innovation, progressing from a linear process to a network model, where innovation emerges from exchanges

between firms. The latest models accentuates the environmental factor as the primary influencer of innovation within firms.

1.4.2 Three Triple Helix models

In order to have a wider overview on the theoretical model on the sources of technological innovation, is necessary to incorporate new models that highlight the role of institutions in that process. For that deserve to be mentioned the revolutionary Tripe Helix Model of innovation formulated by Etzkowitz and Leydesdorff in 1995. The model contribute to this field of study by heightened the role of the universities for the innovation process and in the transition to a knowledge-based society (Cai & Etzkowitz, 2020); this focus contrast to previous innovation approach that were focused only on firm or government-firm interaction.

The model shape innovation as a system made by the interaction between three institutions: university, industry, and government. Therefore, emerge firstly the concept of "innovation system" that emphasizes how the innovative process lies in the smooth interrelation (flow of information and technology) among individuals, companies, and institutions, all involved in the generation, dissemination, and utilization of knowledge (Quiroga, 2023).

With regard to the model, is based on the concept of production of technological innovation as the product of the interrelation between university that is dedicated

to basic research, industry that produce commercial goods and government that regulate the markets. The model is proposed by the authors in three configurations (Figure 1).

a) A “statist configuration” where the government controls both academia and industry and is expected to take the lead in developing projects and providing the resources for new initiatives (Cai & Etzkowitz, 2020).
b) The “laissez-faire configuration” is characterized by limited state intervention in the economy with industry as a driving force and the other two entities as limited roles on innovation (Ranga & Etzkowitz , 2013); university act mainly as providers of skilled human capital and the government as regulator of social and economical mechanisms. To sum up, industry, academia, and government are separate and independent of each other and interact only modestly across strong boundaries (Cai & Etzkowitz, 2020).
c) The “balanced configuration” is characterized by the idea that university and other knowledge institutions act in partnership with industry and government and even take the lead in joint venture (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz , 2013).

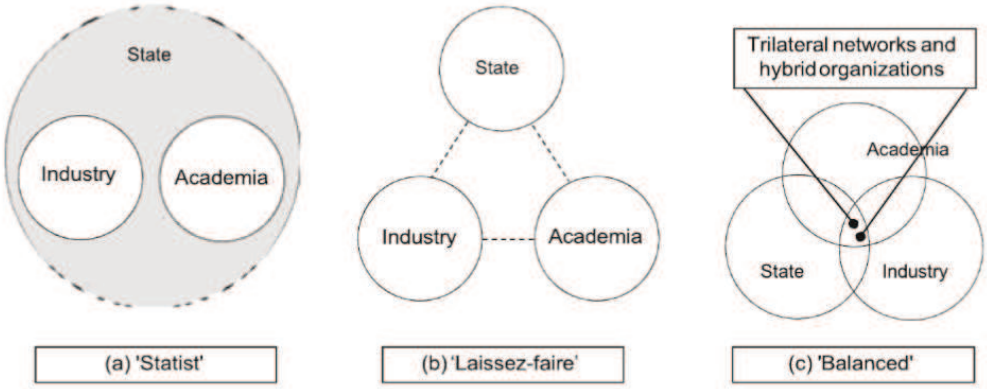

Figure 1.1 - Three Triple Helix models. Source: Etzkowitz & Leydesdorff, 2000.

As can be seen from the Figure 1 – c, the balanced tripe helix model includes the intersection between the different actors of the innovation system that shows as exists a set of contacts between state, industry and university and it may also give rise to new "hybrid institutions" (Quiroga, 2023).

More in the details, is possible to define the following interactions:

- university-industry interactions; universities play a crucial role in providing education and conducting basic research that is transfer throw the movement of individuals between them (Quiroga, 2023).
- university-government interactions; the intensity of the interaction depends on the government's higher education policy and on the nature of the academia; in case of a public university that depend by public

founds the relations are stronger that in the case of the private university that are more independent (Quiroga, 2023).

- industry-government interactions. It depends on government's stance on market involvement (Quiroga, 2023).

Related to the intersection of the spheres, it represents the most favorable environments for innovation becouse represent the place where the three actors of innovation coexist and collaborate (Ranga & Etzkowitz, 2013).
To sum up, the tripe helix model was fundamental because points out the idea of innovation as a product of a system and as a product of the interaction between different players.

Deserve to be noted that innovation theories doesn't have to be seen as something static that have the purpose to "look and draw" the reality; indeed, "what qualifies as a good theory of innovation is not carved in stone but has to evolve as a result of changes in society" (Fagerberg *et al*, 2013; Cai & Etzkowitz, 2020).

Based on that, over the last twenty years were proposed two new configurations of the Triple Helix Model that are briefly presented:

- The Quadruple Helix innovation model bring civil society into the analysis of dynamics in regional innovation (Carayannis & Campbell, 2009; Cai & Etzkowitz, 2020). In this model the civil society is reputed too important to be considered as a parallel helix in addition to the ones presented in the traditional formulation but is considered as

the necessary condition for the existence and functioning of the model itself (Etzkowitz, 2014; Cai & Etzkowitz, 2020).

- The Quintuple Helix innovation model aggregate to the quadruple helix on the concept of "natural environments of society" where, together with the economy, should be seen as drivers for knowledge production and innovation, therefore defining opportunities for the establishment of the knowledge economy (Carayannis, Barth, & Campbell , 2012).

However, one interpretation argues that the Triple Helix emphasizes knowledge production and innovation in the economy, aligning with the knowledge economy. The Quadruple Helix extends this by promoting the perspective of the knowledge society and knowledge democracy in knowledge production and innovation. According to the Quadruple Helix, sustainable development in a knowledge economy requires coevolution with the knowledge society. The Quintuple Helix underscores the imperative socioecological transition of society and the economy in the twenty-first century, making it ecologically sensitive (Carayannis *et al*, 2012).

1.5 THE DEVELOPMENT OF INNOVATION

Where the innovation come from? As emerge from the Triple Elix Model the fundamental actors in an innovation system are universities, industries, and

government; their central position in the technological ecosystem is related to their function as creator of innovation. Innovation is the product of human creativity that is defined as the “ability to generate new and useful ideas” where the individual’s creative ability is a function of his/her intellectual abilities, knowledge, personality, motivation, and environment (Schilling, 2023). The process of generation of a creative idea is not the same in the case of the single inventor or in case of an organization; as that for organization is defined the concept of “organizational creativity” that describe the creativity of an organization as a function of creativity of the individuals within the organization and a variety of social processes and contextual factors that shape the way those individuals interact and behave (Schilling, 2023).

Talking about innovation only in terms of creative ideas can be reductive; innovation does not arise only from a creative idea but those ideas before to become innovation must go throw a process of development (that in many cases may not be successful). Bytheway “innovation requires combining a creative idea with resources and expertise that make it possible to embody the creative idea in a useful form” (Schilling, 2023). The result of that process must be some new devices or processes that must bring an economic utility.

Innovation may arise from various sources. It can originate with individuals, as in the case of lone inventor or users who design solutions for their own needs. Innovation also arises from the research efforts of universities, government

laboratories and incubators, or private nonprofit organizations. Firms also face strong incentives to develop differentiating new products and services to better compete in the market (Schilling, 2023). “An even more important source of innovation, however, does not arise from any one of these sources, but rather the linkages between them” (Schilling, 2023); the network of innovators is a powerful agent of tecnologic advance.

Below is proposed a deepening of the role of these actors in the creation of innovation.

The inventor

It’s a common stereotype to imagine an inventor as “an eccentric and doggedly persistent scientist” (Schilling, 2023) conducting their research in often isolated laboratories. This view is supported by studies in cognitive psychology that analyze the personality traits of inventors and suggests that them are individuals that are likely to be interested in theoretical and abstract thinking and have an unusual enthusiasm for problem solving. The innovation often originates with those who create solutions for their own needs without have a first idea to profit from them; it’s the case of the so called “innovation by users”. Users may alter the features of existing products or approach existing manufacturers with product design suggestions, or develop new products them-selves (Schilling, 2023). Innovation can also arise to solve a problem for someone included in the

inventor's network or it can arise externally to the network, for example from the desire to question the work done by others.

Research and Development by Firms

Without any doubt, companies play a vital role in the creation of innovation. On a general point of view, innovation in firms arise from the activity of research and development; those two terms are “often lumped together “but “they actually represent different kinds of investment in innovation-related activities “ (Schilling, 2023). Research refers both to basic and applied research. The “basic research” is the effort directed to increase the understanding of a topic or field without a specific immediate commercial application objective; this research advances scientific knowledge, which may (or may not) end up having long-run commercial implications. “Applied research” is directed at increasing understanding of a topic to meet a specific need that, in industry, has a specific commercial objective (Schilling, 2023). The intensity of the type of research made by a firm depends mainly on the purpose of the organization and on the market where the organization is making activities. In the case of for-profit companies, the resources allocated to applied research will be greater than those for basic research; by the contrary, in non-profit entities the opposite will tend to happen. The” development” refers to activities that apply knowledge to produce devices, materials, or processes with the aim of being useful and therefore being able to be

marketed. Hence, the term research and development refer to a range of activities that extend from early exploration to specific commercial implementations (Schilling, 2023).

To widen the concept of sources of innovation, most current research suggests that firms that are successful innovators utilize multiple sources of information and ideas that include: in-house research and development, including basic research; linkages to customers[2] or other potential users of innovations; linkages to an external network of firms that may include competitors, complementors[3], and suppliers; linkages to other external sources of scientific and technical information, such as universities and government laboratories. Collaboration might occur in different forms as alliances, participation in research consortia, licensing arrangements, contract research and development, joint ventures, and other arrangements, or even by using external sources of technological innovation (Schilling, 2023).

Universities

Universities are par excellence the source of knowledge, the place where it born and it is spread. In the late 19th century, the institution of university went through

[2] "Several studies indicate that firms consider users their most valuable source of new product ideas ", Schilling, 2023.

[3] Complementors are organizations (or individuals) that produce complementary goods, such as light bulbs for lamps, chargers for electric vehicles, or applications for smartphone (Schilling, 2023).

a revolutionary transition: from being largely a higher-education institute, the universities increasingly came to have social functions in both research and teaching (Etzkowitz & Leydesdorff, 1995).

The activities institutionally consolidated by universities are teaching and research activities. With respect to the manner of conducting research activities, one can first note a substantial difference from research carried out in companies: the freedom of research. In fact, as indicated in Article 8 of the ethical code of Marche Polytechnic University: "The University is committed to promoting freedom and the free exchange of ideas as essential for the achievement of its institutional and academic mission "(2011). Due to the non-essential link between research activities and the need to immediately introduce a product or service into the market, universities are the primary places for the realization of basic research. However, over the last few years “many universities encourage their faculty to engage in research that may lead to useful innovations” (Schilling, 2023), indeed, to concentrate the research more on the direction of applied research.

To sum up, the creation of innovation in the universities is made by favoring a basic type of research animated by the spirit of the progress of scientific.

Government

The governments are actively investing in research through their own laboratories, the formation of science parks and incubators, and by financing public or private

research entities. Also, in many countries, the governments are implementing programs that enable innovative small businesses to receive financed by federal agencies (Schilling, 2023) in order to boost their growth.

In more detail, there are proper state policy instruments to support innovation through its financing. "Basic Research Funding" is one of those and can follow two approaches: "diffusion-oriented" policies that aim to stimulate research and innovation broadly, without selecting specific areas or sectors (known as “science policy”); or "mission-oriented" policies that involve selective interventions aimed at creating new technical-scientific skills in promising areas (known as “technology policy”) (Rossi, 2016).

Depending on each government's decisions, policies can be implemented through:

- Subsidies and tax incentives for companies, such as tax credits, R&D subsidies, tax exemptions for depreciation/accelerated depreciation, reduced social security charges for personnel engaged in R&D, tax incentives for collaboration between companies, tax incentives for equity and venture capital investment, tax exemptions on patent royalties.
- Intellectual property protection such as patents and copyright.
- Direct public funding for universities and research institutes.
- Prizes such as targeted prizes and blue-sky prizes[4].

[4] Targeted prizes are a specific type of award given following a competition where the innovative problem and the prize amount are predetermined by the sponsor. In the case of Blue-sky prizes,

- Support for venture capital through direct state participation in the fund or by increasing the attractiveness of equity investment.

There are also instruments through which the state can promote innovation by directly intervening in the market structure, such as antitrust policies, support policies for specific sectors/industries (large or small), subsidies/tax credits for large/small businesses, reducing barriers to entry in certain sectors (e.g., liberalizations), facilitations for access to the patent system for SMEs, etc. Additionally, the public sector is a 'major buyer' that can offer incentives for innovation in various ways: by directly purchasing innovative goods and services, facilitating the adoption of a standard, expanding the market size for innovative goods, or modifying market structure (through the impact on competition) (Rossi, 2016).

Hybrid entities

The term “hybrid entities” is used to refers to organization that can arise by following an agreement between universities and companies, between universities and government or between government and companies; since they cannot be remembered directly to a specific actor among those mentioned above, they are defined as hybrid. Are examples of these entities: publicly held companies and innovative private startups with university participation, the technological and

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such as Google prizes, the innovative problem is not identified beforehand by the sponsor, and the prize amount is determined post-competition based on the value of the innovation (Rossi, 2016).

science parks, research and development centers, business incubators and accelerator. The ways in which innovation arises in these organizations depends on multiple factors such as the internal characteristics of the organizations themselves and the type of technology on which they work.

In some cases, private nonprofit organizations can be included in the category of hybrid entities and they play a significant role in fostering innovation through a variety of mechanisms. These organizations engage in research and development activities directly, provide funding for external research, or pursue a combination of both approaches. Are included among these organization: private research institutes, nonprofit hospitals, private foundations, professional or technical societies, academic and industrial consortia, and trade associations (Schilling, 2023).

Furthermore, deserves to be highlighted the “importance of collaborative research and development networks for successful innovation “, especially in high-technology sectors (Schilling, 2023). Interfirm networks offer to the members firms access to a broader spectrum of information and resources compared to what individual firms possess; this enhanced connectivity allows firms to achieve outcomes that go beyond what they could accomplish independently.

Following a summary table of how innovation can arise among those actors.

CREATOR OF INNOVATION	SOURCE OF INNOVATION
The inventor	• Create solutions for their own needs. • To solve a problem for someone included in the inventor's network. • Questioning the work done by others.
The Firms	• In-house research and development, including basic research. • Collaboration with customers or other potential users of innovations. • Collaboration with an external network of firms that may include competitors, complementors, and suppliers. • Collaboration with other external sources of scientific and technical information, such as universities and government laboratories.
Universities	• R&D • Collaboration with startup.
Government	• Subsidies and tax incentives for companies. • Intellectual property protection. • Direct public funding for universities and research institutes. • Prizes. • Support for venture capital.
Hybrid Entities	• Technological and science parks. • Research and development centers. • Business incubators. • Start-ups.

Table 1.2 - "The creators and the sources of innovation". Source: original formulation.

1.6 THE INNOVATION SYSTEM

Referring once again to the Triple Helix Model, it is essential in the analysis to focus on the central section of the model, which represents the intersection of the three actors involved in technological innovation and its transfer. It is precisely at this point of intersection that the concept of innovation system can be introduced. More in the details, from the mid of 1970s, "system approaches in innovation research gained considerable importance" (Warnke *et al*, 2016). A definition of innovation system that summarized the most important characteristics of that is the one presented by Edquist that describe an innovation system as "all important

economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovation" (Edquist, 2005; Warnke *et al*, 2016). According to Nelson (1993) and Patel and Pavitt (1994), an innovation systems are constituted by four main elements:

1) The institutional structures of a country, region, or sector. They are formed by companies, universities, research and training organizations, norms, routines, networks, financial organizations, and the policy of promoting and regulating of technical change.
2) The incentive system of a country, region, or sector. These include, among others, incentive systems for innovation, technology transfer, learning and qualification for business formation and job mobility within and between organizations.
3) The skills and creativity of innovation and economic actors in a country, region, or sector.
4) The cultural peculiarities of a country, region or within a sector, which are reflected, for example, in different acceptances and user understandings of technologies (Warnke *et al*, 2016).

Innovation systems have been defined among the literature at different levels for several purposes of analysis; the “national systems of innovation” were the first concept elaborated in the literature on this topic (Markard & Truffer, 2008). The first articulation of that concept was made by Freeman that define a national

system of innovation as a system of institutions, policies, and actors that affect the creation of knowledge, the innovation processes that translate research into applications and the processes that influence the adoption of innovations (Freeman , 1987; Mowery, 2008). The configuration of a nation's innovation system is shaped by policy decisions and intricate historical processes of institutional development. Furthermore, the effectiveness of these systems relies on the actions and decisions of private enterprises, which can either enhance or counterbalance the impacts of public policies (Mowery, 2008).

Hence, the factors that shape a national innovation system are severlas and several studies are focusing on understanding the factors that determine and modify these characteristics of the system. Among these, the contribution of Mowery analyse the relationship between "defense-related R&D, procurement, and national innovative performance". More in the details, the author define that "there are at least three channels through which public investments in defense-related R&D and procurement affect the innovative performance of sectors or the overall economy" (Mowery, 2008). Those channels are: 1) generating new scientific knowledge based on the defense-related R&D investments, 2) creation of spinoffs based on technologies "that have applications in both civilian and defense-related uses" and 3) purchases of new technologies in the society (Mowery, 2008).

Another factor that is seen as an element influencing a national innovation system is culture. As that, the willingness of a country to adopt a new technology is

affected by the willingness of people to adopt something new. For that "innovation requires

specific conditions and culture are considered to be an important determinant of innovation" (Kaasa & Vadi, 2008). Cultural impact on a national innovation system arises from the interplay between tradition and innovation. Different cultures exhibit varying degrees of openness to new experiences, and culturally rooted beliefs, such as perceptions of the roles of individuals and organizations, play a crucial role in determining the acceptance of fundamentally new ideas or objects when confronted with perplexing situations in life (Kaasa & Vadi, 2008).

1.7 THE DIFFUSION OF TECHNOLOGICAL INNOVATION

Due to the absence of a single definition for the concept of technological innovation, it is also difficult to find a single definition of the concept of technological innovation transfer; the literature on this last theme is indeed very extensive and the definitions vary depending on the disciplines of research.

The technology transfer is often view as a chaotic and disorderly process that involve individuals and groups of individuals that may hold different views about the value and potential use of technology (Gibson & Smilor, 1991; Wahab *et al*, 2012). The process of transferring can include the "transmission of know-how (knowledge) which enable the recipient enterprise to manufacture a particular product or provide a specific service" (Baranson, 1970; Wahab *et al*, 2012). From

that emerge a view of transfer of innovation as a learning process where is configurated, on one side, as a transmission of technical machine or process, and on the other side, as a process of learning for the organizations. But the transfer of technology can take place also inside of the process of creation of innovation; it's the case, for example, of transfer of innovation from a university to a firm, where the goal of the agreement is to collaborate in the research process itself, for example by sharing knowledge. By consequence, adopting an organizational prospective, technological transfer may refer to ''the movement of know-how, technical knowledge, or technology from one organizational setting to another" (Roessner, in press; Bozeman, 2000). Therefore, the term has been used to describe and analyze a wide range of organizational and institutional interactions involving some form of technology-related exchange (Roessner, in press; Bozeman, 2000). Referring to another dimension of the concept, technology transfer may also concern to "the process by which ideas and concepts are moved from the laboratory to marketplace" (Williams & Gibson, 1990; Phillips, 2002; Wahab *et al*, 2012). It represents a user-oriented dimension where the process of transfer is going from the creator of the innovation to the final user, as that to the marketplace.

To summarize, in the process of technology transfer is possible to distinguish between those who create innovation and those who use it. Among the sources of technology are included private firms, government agencies, government

laboratories, universities, nonprofit research organizations, and even entire nations; regarding the users, is referred to the target of the transfer process as for instance products consumers, small businesses, MNCs, legislatures, cities, nations, as so on. It is precisely among these actors that the transfer takes place.

Going deeply into the process of transfer of technological innovation, it's a process that involves different actors who collaborate by various means and the effectiveness of the process depend by the type of interaction between them. As already mentioned, the literature on this topic is extensive; with the aim to organize the literature, Bozeman propodes a " Contingent Effectiveness Model of technology transfer" as presented in the figure 1.2.

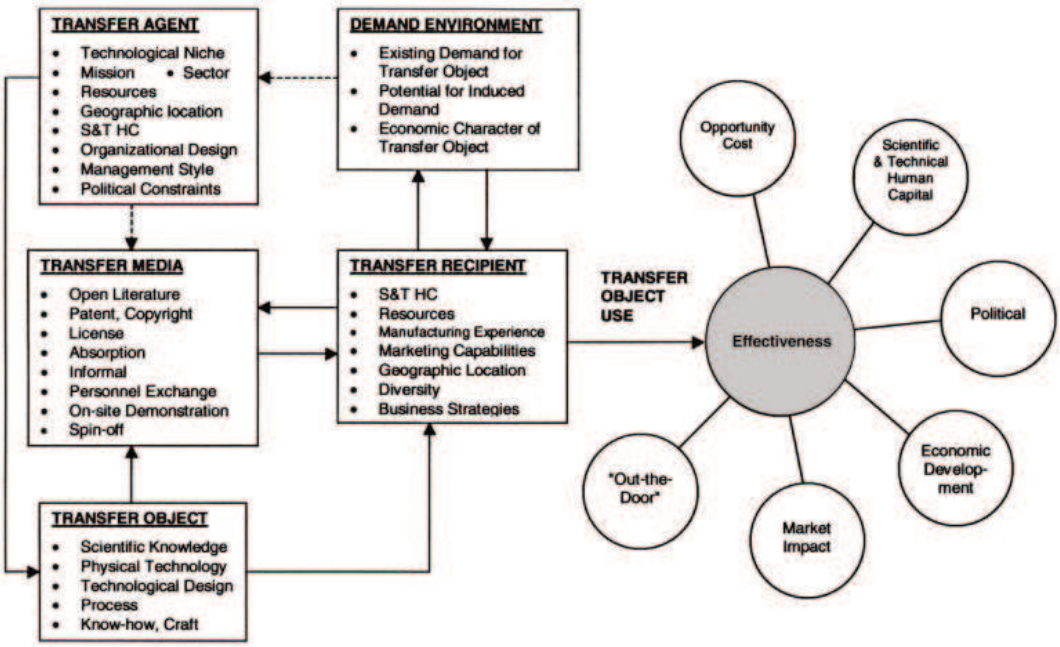

Figure 1.2 – "Contingent Effectiveness Model of technology transfer". Source: Bozeman, 2000.

The Model draws its name from its assumption that parties to technology transfer have multiple goals and effectiveness criteria. The model includes five broad dimensions that determine the effectiveness of the transfer process: characteristics of the transfer agent, of the transfer media, of the transfer object, of the transfer recipient and, the demand environment. These dimensions are not entirely exhaustive but are broad enough to include most of the variables examined in studies of university and government technology transfer activities; the arrows in the model indicate relations among the dimensions (Bozeman, 2000). “The model says that the impacts of technology transfer can be understood in terms of who is doing the transfer, how they are doing it, what is being transferred and to whom” (Bozeman, 2000). Going into detail about the characteristics of the dimensions of effectiveness, the characteristics of the “transfer agent” are dependent on the nature of the institution, its history and culture. Regarding to the “transfer object”, it refers to the content and form of what is transferred, and it consist of: scientific knowledge, technological device, process, know-how, and specific characteristics of each. The “transfer recipient” refers to the organization or institution receiving the transfer object and are example: firm, agency, organization, consumer, informal group and institution. As concerns the “demand environment”, the author refers to the factors (market and non-market) pertaining to the need for the transferred object as for example: “price for technology, substitutability, relation

to technologies now used subsidy and market shelters". Last dimension is the "transfer medium" that refers to the vehicle, formal or informal by which the technology is transferred; are example of them: license, copyright, person-to-person, formal literature (Bozeman, 2000).

In order to increase the level of detail of the current analysis, the following section provides an in-depth examination of various technology transfer means; the organization of the analysis is structured based on the interactions between the actors of innovation as proposed in the Triple Helix Model.

Transfer of technological innovation by universities

As mentioned before, the innovation created in the university can be transferred or directly to the final user, or to another organizations, as for example a private company, to move forward in the process of technological innovation or to collaborate in the phase of commercializing of the innovative idea.

However, it is necessary to primarily explain the concept of the "third mission" of universities. This term refers to the opening of the university towards the socio-economic context through the enhancement and transfer of knowledge, in a conception that includes not only activities for the economic valorization of research but also initiatives with socio-cultural and educational value (Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca). Throw those

activities the knowledge (that is transmitted to students with teaching activities and generated by scientific research) is transferred to the users. In order to make this mission operational, universities have established a technology transfer office (TTO) which is responsible to shaping the university's technology transfer activities by configuring a broad range of mechanisms that are responsible to do that "universities become more entrepreneurial, devoting their organizational efforts to patenting activities, enlarging their business network, and more generally enriching technology transfer channels, including startup formation "(Baglieri *et al*, 2018). More in the details, the creation of startup represents for the university an opportunity to go directly to the market and to exploit the intellectual property that they are generating by theirs own or by collaborating with other organizations.

Transfer of technological innovation between universities and companies. In the academic field, the relation of knowledge exchange between businesses and universities have been among the most studied forms of technology transfer; the importance of this topic is related to the contribution of this kind of collaboration to "business competitiveness and economic growth" (Hitt *et al*, 2000; Hermans & Castiaux , 2007).

Regarding the transfer of knowledge within organizations, it can occur in multiple manner. Hermans & Castiaux "distinguish between two broad perspectives to

approach University-Industry knowledge flow as a research object". In details, the authors distinguish between 1) Untargeted knowledge transfer and 2) Targeted knowledge transfer[5]. In the case of "Untargeted knowledge transfer", the diffusion of knowledge is understood as the dissemination of codified knowledge from the university to a general audience; between the university and the industry it occurs as one way relationship. From a practical standpoint, this transfer process takes place through the "traditional instruments of open science" as for example:

- publication;
- conference proceedings;
- patent.

Regarding to the patents, they represent an ambiguous role because on one side contributes to the "public knowledge stock through its mandatory publication" (Hermans & Castiaux , 2007) but on the other side, is also a direct and excludable source of knowledge. More in the details, when a "license is set up between the university and a private firm, the piece of knowledge encapsuled in the patent loses its non-excludable nature" (Hermans & Castiaux , 2007). Indeed, the patent confers upon its owner the complete and exclusive right to utilize, produce, and sell the innovation. This exclusive right provides the owner to regulate and capitalize on the innovation without facing competition. Therefore, the patented

[5] Is necessary to point out that "studies do not draw a clear line between knowledge and technology transfer because most of the studies have regularly applied the term interchangeably in both technology transfer and knowledge transfer literatures" (Wahab *et al*, 2012).

asset relinquishes, to some extent, its characteristic of potential unrestricted accessibility to a broad audience, evolving into a resource utilizable exclusively by its acquirers (Hermans & Castiaux , 2007). This shift reflects a nuanced dynamic in which the once broadly available patented good now caters exclusively to those who possess it.

Regarding the "Targeted knowledge transfer", it refers to transfer between a university and one (or more) specific private partner(s) when "the knowledge interaction gives the private partner the opportunity to access some level of knowledge appropriation" (Hermans & Castiaux , 2007). The appropriation can be set up in different ways as for example:

- licensing;
- consulting;
- collaborative research project[6].

The contractual agreement between those organizations and the particular nature of the knowledge which is transferred gives to this knowledge the characteristic of the partial exclusion from a third-party perspective on their utilization (Hermans & Castiaux , 2007).

Transfer of technological innovation by companies.

[6] The "Collaborative Research Project" are defining as "exchange relationship in formal research projects undertaken by university researchers and other research partners" (Landry and Amara , 1998; Hermans & Castiaux , 2007)

The main actors in the technology transfer process are companies that initiate research and development processes specifically aimed by introducing a product or service to the market. The market knowledge possessed by entrepreneurs characterizing these organizations accelerates the innovation-to-market process, thanks to the presence of personnel with marketing and commercialization experience already within the organization.

Despite many companies choosing to internally adopt strategies for developing new products, others opt for collaboration agreements with other organizations to make the process more efficient or even faster. This collaborative approach allows for leveraging external expertise and resources, facilitating a faster and potentially more effective introduction of innovation to the market.

Transfer of technological innovation between government entities and companies.

Unlike in the context of relationships between universities and businesses, studies on the transfer between government entities and companies have not been the subject of extensive research. In a general context concerning government innovations protected by legal intellectual property rights, the mechanisms of collaboration between government entities and businesses are regulated by the prevailing national laws regarding the exploitation of intellectual properties. It includes patenting and licensing agreement or research collaborations and partnerships. Collaboration agreements play a crucial role in technology transfer

as “partnerships facilitate the transfer of scientific knowledge to real products” (Wessner, 2003).

Transfer of technological innovation by government entities.

The creation of technological innovation in the government organization can took place in different manners and by consequence also the transfer from government owned R&D institutions to private sector can occurs in different ways. The importance of that process is emphasized by the fact that “governments throughout the world are spending more and more national budget in R&D with the goal to enhance national competitiveness and develop their economies” (Tran & Kocaoglu, 2009). From a general standpoint “ federal technology transfer is a highly legislation dependent area and still evolving along with the introduction of new legislation” (Tran & Kocaoglu, 2009) and is higly influenced by the activities of policy makers.

Similar to what was observed in the case of universities, innovations generated within public research centers can be transferred to society either directly or through collaboration agreements.

In terms of direct transfer, this can occur for example through the establishment of government-backed *spin-off ventures* made by the researchers at these institutions; a spin-off is define as “a new company that is formed (1) by individuals who were former employees of a parent organization, and (2) around a core technology that

originated at a parent organization and that was then transferred to the new company" (Carayannis *et al*, 1998). It is necessary to specify that these types of companies can emerge both as a product of government institutions and from universities themselves.

On the other hand, technological innovation produced within government entities can be transferred to other organizations with the aim, for example, to initiating shared collaboration projects or by giving to private company the possibility to use and commercialize those innovations.

Transfer of technological innovation between universities and government entities.

In a general perspective, technology transfer between universities and government entities can take place through joint research projects. These projects enable the knowledge produced within both organizations to synergize and collaborate in making innovation accessible to society.

1.8 THE NATIONAL AND INTERNATIONAL TECHNOLOGICAL TRANSFER

Technology transfer can occur both domestically and internationally. Regarding the domestic one, it refers to the process of flow of innovation that takes place within the geographical borders of a particular nation.

Before delving into the analysis of how the process occurs, it is necessary to make a clarification. Indeed, by definition, with the concept of globalization, the borders between states have undergone a process of "thinning." This phenomenon, besides influencing the economic and social structures of a nation, has also altered the path innovation are created and disseminated making the international flow of knowledge faster and more common.

Nevertheless, on a domestic level is possible to distinguish between:

- transfer of technological innovation to the final user;
- transfer of technological innovation within organizations.

Regarding to the transfer of technological innovation to the final user, it occurs following the completion of the innovation process and materializes with the commercialization of the product. The commercialization process can be complex and time-consuming. It involves several steps, such as market research, product development, marketing, and sales. However, it can happen that in certain circumstances the market responds particularly poorly to the introduction of a new product or services and it can leads to the reintroduction of the product into the research and development process. In this case, the market, rather than represent the final stage of the innovation process, is the input for a further research phase.

Regarding to the international technology transfer (ITT), as the term itself suggests, refers to the process of transferring technology across the borders of the

nation in which it is generated. The importance of this process for the economic growth of developing countries is immeasurable because “the acquisition of technology and its diffusion foster productivity growth” (Hoekman *et al*,2005) and economic growth.

About the type of resources subject to international flow, is necessary to point out that “transfer process essentially involves flows of different types of technological resources over international boundaries” (Hoffman & Girvan, 1990). The authors, based on Bell's (1982) work, define two types of resources involved in this international flow: 1) resources that expand the production capacity as for example new production facilities, operating manuals, construction specifications and so on; 2) technological resources that expand the technological capacity as technical knowledge, skills, and experience (Hoffman & Girvan, 1990). Given the distinct nature of these two resource types, the outcome of the process will be strongly influenced by the specific and environmental characteristics that accompany it.

The ITT is a phenomenon of national dimensions and can occur through various mechanisms. As discuss by Hoekman , Maskus and Saggi, the ITT may occurs through four channels:

1) *Trade in goods.* Trade plays a crucial role in fostering ITT by facilitating local reverse engineering and providing access to new machinery and

equipment; new products embody novel ideas and international trade is a way to transmit knowledge across borders.

2) *Foreign direct investment and licensing.* Investment by multinational enterprises and licensing may provide developing countries with more efficient foreign technologies and result in technological spillovers.
3) *Labor turnover and movement of people.* The international movement of people, associated with nationals studying or working abroad for a limited period, or the inward movement of foreign citizens represent another potential channel for ITT through the movement of knowledge owned by these people.
4) *Market failures and the need for policy.* When referring to market failure as an impediment to the ITT process, it involves high transaction costs, underinvestment in technology, and inefficient diffusion of technology. These market failures support the potential for policies to enhance welfare by changing the incentives of private agents to participate in ITT as by boost local access to global knowledge and improve technology signaling, lower costs of acquiring existing technologies and increase domestic innovation incentives (Hoekman *et al*, 2005).

Host developing countries face a crucial challenge in improving the local environment for encourage ITT process and its diffusion. Both foreign direct investment and licensing respond to factors like effective infrastructure,

transparent governance, an open trade regime and an entrepreneurial environment attracting skilled workers is also vital for that process. To facilitate the process, governments play a key role by reducing entry barriers in upstream industries, encouraging R&D, bridging technological gaps, and recognizing the risks involved in adopting foreign technologies by recognize subsidies (Hoekman *et al*, 2005).

To conclude, the polity that a government can implement to increase the size of the process of international technology transfer are several and be impacted also positively by the creation of cooperation agreements with other nations.

CHAPTER 2. INNOVATION AND TECHNOLOGY TRANSFER IN ITALY

The chapter analyze the state of technological innovation and the various ways in which it is transferred in Italy. In order to contextualize the phenomenon, is analyzed firstly the "state of innovation" in Europe by highlight the "main players" in the European innovation system and the community policies supporting it. In the second part of the chapter, is analyzed the innovation system in Italy, with an in-depth look at the ways in which technological innovation originates and spreads within the national territory. The chapter concludes by highlighting the role of the European community as a booster for the technological innovation of Italy.

2.1 THE STATE OF INNOVATION IN EUROPE

2.1.1 European innovation clusters

To discuss the state of innovation in Europe, it is significant to identify the so-called "European innovation system" which refers, in general, to the combination of the set of innovation systems of the member states of the union and those members of the European continent, in addition to a set of supranational institutions that constitutes a standalone system. In relation to the member states, the establishment of a European innovation system—an integrated framework among all member countries—has been a focal point since its inception. The primary goal is to foster innovation creation within the member states and facilitate its transfer among them (Archibugi, 2001). However, the fact that Europe is composed of many member states which have substantial autonomy clearly poses a problem for the development of an effective common innovation strategy accentuated even more by the fact that “Europe is characterized by a lack of cohesion in its innovation system” (Archibugi, 2001). There are certain regions within the Union that are well-integrated in terms of knowledge transmission, others remain peripheral or excluded from significant technology transfer flows; these latter regions, specifically labeled as marginal in terms of innovation, have been particularly addressed within the context of community policies to foster the innovation phenomenon within them. In order to provide member states with useful insights to formulating policies to booster innovation, the European

Commission develop a set of indicators to measure the state of innovation in European countries and, among many, the most widely recognized indicators are synthesized in The European Innovation Scoreboard (EIS). This annual report provides a comparative assessment of the research and innovation performance of EU Member States and selected third countries, and the relative strengths and weaknesses of their research and innovation systems. “It helps Member States assess areas in which they need to concentrate their efforts to boost their innovation performance” (European Commission, 2023) and provide tools that helps policy makers to understand the state of innovation in their countries and to develop policies to improve it. The performance of EU national innovation systems is measured by the Summary Innovation Index (SII), which is a composite indicator obtained by taking an unweighted average of the 32 indicators as for example: new doctorate graduates (in STEM[7] disciplines), R&D expenditure in the public sector, employed ICT[8] specialists, trademark applications, small and medium enterprises (SME) with product innovations, development of environment-related technologies, medium and high-tech product exports, and so on[9] .

[7] The STEM disciplines are an acronym representing four main areas of study: Science, Technology, Engineering, and Mathematics.
[8] "ICT" stands for Information and Communication Technology.
[9] For further details on the indicators, please refer to page 8 of European Innovation Scoreboard,2023.

The 2023 European Innovation Scoreboard (EIS) has ranked[10] EU Member States into four groups based on their innovation performance measured by the SII:

- The *Innovation Leaders* which include five Member States where the performance of the SII is above 125% of the EU average. This group includes Belgium, Denmark, Finland, the Netherlands, and Sweden.
- The *Strong Innovators* which include six Member States with a performance between 100% and 125% of the EU average. This group includes Austria, Cyprus, France, Germany, Ireland, and Luxembourg.
- The *Moderate Innovators* includes 10 Member States where performance is between 70% and 100% of the EU average. This group includes Czechia, Estonia, Greece, Hungary, Italy, Lithuania, Malta, Portugal, Slovenia, and Spain.
- The *Emerging Innovators* that include six Member States that show a performance level below 70% of the EU average. This group includes Bulgaria, Croatia, Latvia, Poland, Romania, and Slovakia.

A polarization of innovation is emerging in Europe where the Innovation Leaders and most of the Strong Innovators are located in Northern and Western Europe,

[10] Based on the data provided by Eurostat of 2016 and the most recent of 2023.

and most of the Moderate and Emerging Innovators in Southern and Eastern Europe (European Commission, 2023).

Furthermore, the concentration of innovation in specific geographic areas of Europe also emerges by integrating into the above analysis 11 European countries which are not members of the European Union. Iceland, Norway, and the United Kingdom are Strong Innovators; Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia, Türkiye, Ukraine are Emerging Innovators. Switzerland is the overall best performing country in Europe, outperforming all EU Member States and for this it represents the first among the Innovation Leaders.

Below is proposed a map that sums up the performance of the European countries' innovation systems.

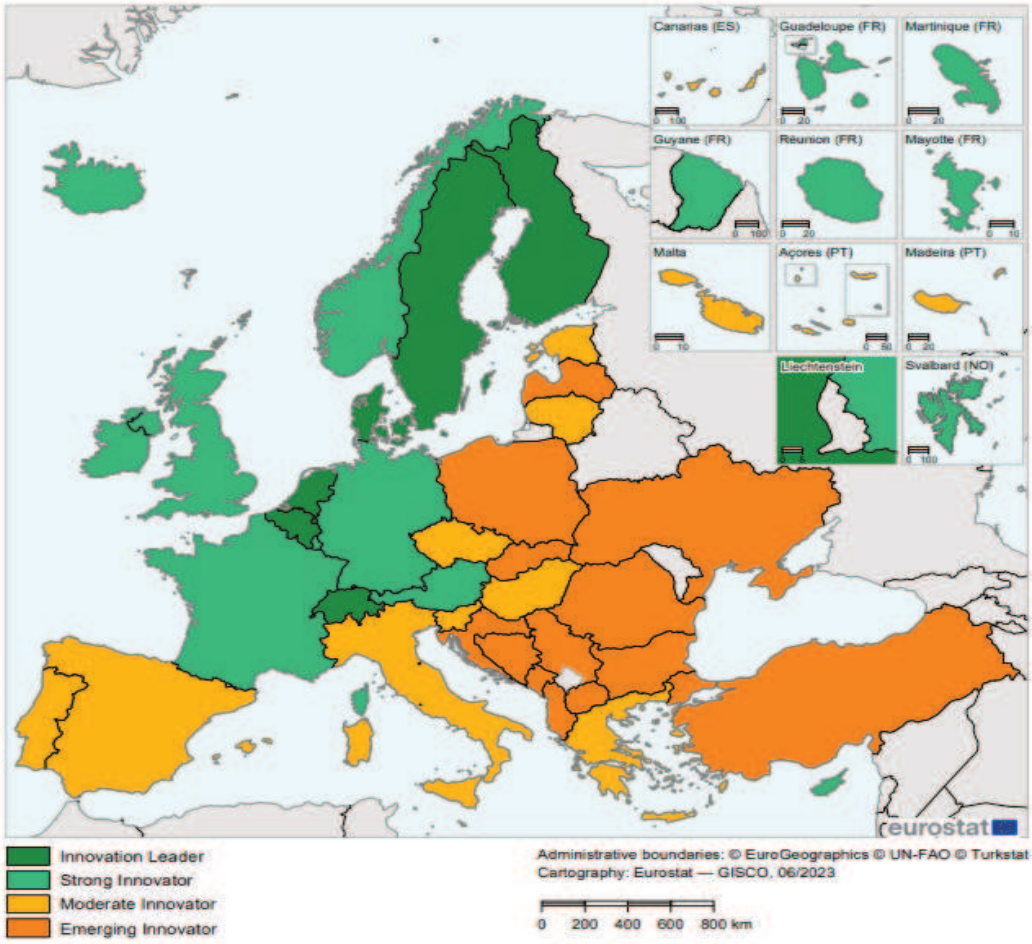

Figure 2.1: "European countries' innovation systems". Source: European Commission, 2023.

To understand how the innovation phenomenon has changed in Europe in recent years, the EIS 2023 proposes a comparative analysis of the period 2016-2023. In general, performance of the EU innovation system has improved by 8.5 percentage in the period. From a purely qualitative point of view, the causes of this result can be linked, for example, to increases in government support for business R&D, SMEs with product innovations and business process innovations,

sales of innovative products, job-to-job mobility in human resources in S&T, foreign doctorate students, and so on. Also, between 2016 and 2023, there has been a convergence of innovation performance between Member States as measured by a decreasing coefficient of variation. The most significant narrowing of performance differences occurred within the groups of Strong Innovators and Moderate Innovators who have been affected by a reduction on performance differences within those groups of countries driven by substantial performance increase for Cyprus. However, within the group of Emerging Innovators, performance differences have not decreased, and these countries are not catching up to the next group of Moderate Innovators[11]. About the 11 European countries which are not EU Member States, compared to 2016 the performance of Norway, Macedonia and Serbia has improved faster than the EU with a positive variation higher that the 8.5 percent points; Switzerland instead passed throw a performance decreased.

To conclude it is necessary to specify that the overall innovation performance differences between countries reflect the differences in the performance for most indicators but not all; it highlights once again the profound relationship between innovative performances and the innovation system of each country.

[11] For further details on the indicators, please refer to page 15 of European Innovation Scoreboard,2023.

2.1.2 The "New Deal" of innovation for the European Community

Since its inception, the European Community has recognized the crucial role of technological innovation in driving economic growth, enhancing competitiveness, and addressing societal challenges; over the years, the European Commission has implemented various initiatives and programs to foster innovation across EU counties. Currently, the funding for the implementation of the "new and reinforced priorities" of the Union, among which the digital transition is a key component, amounts to approximately 2020 billion euros and the division of these resources is regulated through the EU's Multiannual Financial Framework 2021-2027 and the Next Generation EU (EU long term budget, 2023). Below are some examples of new and reinforced programs to increase the level of innovation developed under these budgets.

The *Horizon Europe* is the EU's framework program for research and innovation purpose, among many things, the support to the creation and widespread dissemination of outstanding knowledge and technologies, fostering collaboration, and enhancing the impact of research and innovation to develop, support, and implement EU policies while addressing global challenges (Publications Office of the European Union, 2021). This program also provides significant funding to European Institute of Innovation and Technology (EIT) that has the role to promote innovation in EU countries.

The *European Research Area* (ERA) is a single and borderless market for research and innovation encoraging the free movement of researchers, scientific knowledge and innovation, and encouraging a more competitive European industry (European Research Area, 2021). In the 2020 the European Commission lanched a new ERA based on four strategic objectives: prioritize investments and reforms in research and innovation, improve access to excellent facilities and infrastructures for researchers across the EU, transfer results to the economy to boost business investments and market uptake of research output, strengthen mobility of researchers and free flow of knowledge and technology (Bahrke, 2020).

The *InvestEU* program supports projects that have a high added value as projects of a highly innovative nature. This guarantee fund operates through four windows: sustainable infrastructures, research, innovation and digitisation, SMEs and social investment and skills.

The *Digital Europe Programme* is a new EU funding programme focused on bringing digital technology to businesses, citizens and public administrations. The program support projects in five key areas: in supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring a wide use of digital technologies across the economy and society, including through Digital Innovation Hubs (The Digital Europe Programme).

To conclude, "the Old Continent" is going through a period of change caused by both the effects of the Covid 19 pandemic and the new challenge of fighting

climate change. For this reason, never before has been so significant the funding for the creation of innovation and its transfer, both national and international.

2.2 THE STATE OF INNOVATION IN ITALY

Italy has long been celebrated for its cultural heritage, artistic excellence, and artisanship; however, its innovation performance has frequently fallen behind that of other developed nations. As mentioned before, according to the European Innovation Scoreboard, Italy is categorized as a 'moderate innovator,' ranking 15th out of 27 EU member states in 2023. This evaluation underscores the importance of gaining a thorough understanding of the primary drivers of innovation in Italy and the methods by which knowledge and technologies are transferred within the country.

2.2.1 Italian Macroeconomic Scenario

In 2021, Italy's economy saw a robust 7.0% GDP growth post-pandemic related to the previous year; in 2022, growth continued at a moderated rate (3.7%). The conservative 2023 projection is a 0.9% GDP increase, with stronger expansion expected in 2024 (1.4%), followed by 1.3% and 1.1% in 2025 and 2026 (Ministero dell'Economia e delle Finanze, 2023). Going into more detail about the structure of the Italian GDP, it reflects a developed economy with a small agricultural sector (2.2% of GDP in 2021), a growing services sector (73% of

GDP in 2021), and a significant industrial sector (25% of GDP in 2021). The agricultural sector employs 3.9% of the workforce and has been experiencing a negative trend in recent years, with a 3.2% contraction in production volume in 2020. Most agricultural areas in Italy are small (averaging 11 hectares) and are concentrated in the northern part of the country, where cereals, meat, and dairy products are the primary crops. In the south, fruits, vegetables, olive oil, wine, and wheat are the main agricultural products. Puglia, Veneto, and Sicily are the regions with the highest number of agricultural enterprises in the country. The industrial sector employs 26.1% of the active population and contributes 25% to the economy. The northern part of Italy is home to the majority of industrial activity, particularly in the machinery and fashion industries. In 2019, there were 883,621 registered industrial companies in Italy, a slight decrease from the previous year. The services sector is the most important economic sector for the country employing around the 70% of the active population. In 2019, there were 3,493,758 registered services companies, representing 79.8% of the total number of registered companies (Oficina Economica y Comercial de España en Roma , 2022).

Going into more detail about the composition of the Italian economic system, is presented the "Multipurpose Survey" conducted by the Italian National Institute of Statistics (2023) on a sample representing approximately 22.5% of Italian enterprises. Below is a summary table presenting the data of 2021.

SETTORE DI ATTIVITÀ ECONOMICA	2021			
	Imprese		Addetti	
	Numero	%	Numero	%
INDUSTRIA	**310.470**	**30,4**	**4.815.614**	**36,6**
INDUSTRIA IN S.S.	188.255	18,4	3.792.121	28,8
C - Attività manifatturiere	179.557	17,6	3.483.490	26,5
COSTRUZIONI	122.215	12,0	1.023.493	7,8
SERVIZI	**711.149**	**69,6**	**8.344.924**	**63,4**
COMMERCIO	247.732	24,2	2.445.977	18,6
ALTRI SERVIZI	463.417	45,4	5.898.947	44,8
H - Trasporto e magazzinaggio	40.072	3,9	1.050.066	8,0
I - Alloggio e ristorazione	160.664	15,7	1.195.247	9,1
J - Servizi ICT	26.910	2,6	511.383	3,9
K - Attività finan. e assicurative	13.814	1,4	435.692	3,3
L – Attività immobiliari	23.595	2,3	102.379	0,8
M - Attività professionali, scient.	64.605	6,3	593.198	4,5
N - Noleggio, ag.viaggio, serv.imprese	39.500	3,9	1.271.610	9,7
P – Istruzione	7.163	0,7	69.278	0,5
Q - Sanità e assistenza sociale	31.218	3,1	322.504	2,5
R - Attività artis., sportive, intratten.	12.338	1,2	107.408	0,8
S - Altre attività di servizi	43.538	4,3	240.182	1,8
TOTALE	1.021.618	100,0	13.160.538	100,0

Table 2.1: "Enterprises and employees belonging to the scope of the multipurpose survey". Source: ISTAT, Istituto nazionale di statistica, 2023.

From the table emerges as the manufacturing activity holds significant importance in the Italian economic system, occupying approximately 26.5% of the analyzed sample. The construction sector also plays a substantial role in the economy, representing 12% of the enterprises in the used sample. As mentioned earlier, services are the economic sector with the greatest weight in the Italian economy, where the most important activity sectors are represented by trade (24.2% of the analyzed sample) and hotels and restaurants, employing around 160,000 workers in 2021. Education has the lowest impact on the economy occupying only 0.5% of the population analyzed. One notable data is related to the rental, travel agencies, and business services which, despite representing 3.9% of the enterprises, employ

almost 10% of the total workers in the reference sample (ISTAT, Istituto nazionale di statistica , 2023).

It is necessary to highlight a relevant feature of the Italian economy: the sharp gap between the northern and southern parts of the country. The distribution of value added by geographical region highlights that 37.0 percent is produced in the northwestern regions, and 25.5 percent in the northeastern ones based on data of 2019. Overall, the Northern regions of Italy contribute to 62.5 percent of the national value added, while the remaining share is produced for 20.7 percent by the Central regions and 16.8 percent by the Southern regions and Islands. At an employment level, the role of businesses in the northern area is evident, with employees concentrated at 32.1 percent in the Northwest and 24.1 percent in the Northeast, compared to 20.8 percent of employees in Central region businesses and a combined 23.0 percent in Southern and Island businesses (Istituto nazionale di statistica, 2022). This underscores a developing, but at the same time, old challenge for the country: the structural problem of dual-speed Italy where the north appears more industrialized, while the south tends towards less development and a greater reliance on agriculture. This structural problem is also reinforced by the analysis of the regional labor productivity where the companies with higher productivity that are in Bolzano e Trento, Lombardia and Lazio. In fact, Italy has faced stagnant productivity over the past two decades, marked by notable variations across sectors, firms, and regions; the manufacturing sector

outperformed services, while less-developed regions, especially in the south, lagged (European Commission , 2022).

Another structural aspect of the Italian economy is the predominance in the productive fabric of micro and small and medium-sized enterprises. In detail, in 2019, micro-enterprises (with fewer than 10 employees) are just under 4.0 million, representing 94.8 percent of active enterprises and 43.2 percent of employees. Small and medium-sized enterprises (those with 10-249 employees) number almost 214 thousand, employing 33.5 percent of the workforce (Istituto nazionale di statistica, 2022). Also, the Italian entrepreneurial landscape is led by family-owned businesses, which play a fundamental role in the Italian economic and social system. In fact, they contribute to generating 17% of the GDP and constitute approximately 85 percent of the currently active businesses in the country (AIDAF, Italian Family Business).

At the macroeconomic level the inflation, in 2022, surged to 8.7%, up from 1.9% in 2021, driven initially by energy-related goods and later affecting food, transportation, and hospitality. Related to the employment rate, it reached 60.1% in 2022, the highest since 2004, with a 1.7% increase in employed individuals compared to 2021; the unemployment rate stands at 8.1%, down by 1.4 points from 2021 (Ministero dell'Economia e delle Finanze, 2023).

Regarding the current scenario for the country, it is important to emphasize that the Covid-19 pandemic has significantly impacted Italy's economy, prompting the

European Union's response with the unprecedented Next Generation EU (NGEU) program. This initiative aims to accelerate ecological and digital transitions, enhance workforce training, and address inequalities. Italy's key priorities include modernizing public administration, strengthening the production system, and combating poverty. The NGEU, with a focus on Italy, provides a substantial €191.5 billion through instruments like the Recovery and Resilience Facility and the Recovery Assistance Package for Cohesion and Territories in Europe (Italia Domani).

2.2.2 The Italian innovation ecosystem

The capacity for innovation is vital for business growth, national competitiveness, and overall societal development. Research and innovation, as integral elements, contribute significantly to well-being and sustainable development. Due to its intricate and widespread nature, a comprehensive understanding across various domains is essential to fully appreciate its scope (The European House - Ambrosetti , 2023).

The static and dynamic analysis of the indicators composing the Summary Innovation Index (SII) within the framework of the EIS represents a manner to understand the Italian innovative ecosystem. As already mentioned, the SII is engineered by identifying four main activities that drive innovation in a country that are: framework conditions, investments, innovation activities, and impacts

(European Commission , 2023); below is presented a specific analysis of some of those indicators using the most recent data specifically related to Italy.

About the “framework conditions”, captures the main drivers of innovation performance external to the firm and differentiates between three innovation dimensions: human resources, attractive research systems and digitalisation measures (European Commission , 2023).

- “Human resources” measures the availability of a high-skilled and educated workforce through the combination of three sub-indicators: doctorate graduates in STEM, population with tertiary education and lifelong learning. In the Italian context, the level of human resources in 2023 is below the European average, and between 2016 and 2023, there has been a negative trend with a decline of 4%. This negative trend has been primarily driven by an 11.4% reduction in the indicator "new doctorate graduates in STEM per 1000 population aged 25-34." In fact, in Italy in 2021, there were fewer than one person (0.7) with a doctorate in these disciplines for-every 1000 people aged 25-34 (European Commission, 2023; Eurostat).
- “Attractive research systems” measures the international competitiveness of the science base by focusing on: international scientific co-publications, most cited publications, and foreign doctorate students. The Italian research system has shown a highly positive performance, surpassing the European average; over the past years (from 2016 to 2023), it has demonstrated a growth of

25.9%. The main driver behind this growth is the indicator "International scientific co-publications," representing the number of scientific publications with at least one co-author based abroad; this indicator has experienced a notable increase of 46.5% (European Commission , 2023).

- “Digitalisation” measures the level of digital technologies by measuring the broadband penetration among enterprises and (the supply of) individuals with above basic overall digital skills. Italy is positioned below the European average, although it has shown a growth of 19.5% during 2016-2023 (European Commission , 2023).

Going into more detail on this last dimension, the digitalization of the Union Countries is a priority on the agenda of the European Commission, as the absence of digital infrastructure in a country can serve as a barrier to the adoption and creation of new technologies (Bugamelli *et al*, 2018). The Digital Economy and Society Index (DESI), which summarizes relevant indicators on Europe’s digital performance, shows that Italy ranks in 18th place among the 27 EU member states (European Commission, 2022). In more detail, concerning human capital, Italy ranks 25th out of 27 EU countries; only 46% of the population possesses at least basic digital skills, a figure below the EU average of 54%. The country exhibits a very low percentage of graduates in the ICT sector, with only 1.4% of Italian graduates choosing ICT disciplines, the lowest in the EU. Italy ranks 19th in the EU for digital public services, indicating poor performance in this area. However,

there are more positive outcomes in sectors like connectivity, where Italy ranks 7th in the EU, and 60% of Italian SMEs have at least a basic level of digital intensity (European Commission , 2023).

Regarding the activity “Investments”, captures investments made in both the public and business sector and differentiates between: finance and support, firm investments and use of information technologies.

- “Finance and support" encompasses private funding (venture capital investments), R&D expenditures in universities and government research organizations, as well as direct government funding and tax support for business R&D. Despite Italy experiencing a 20.9% growth in this indicator over the last 7 years, its performance remains among the lowest, trailing only "human capital." The presence of venture capital is crucial for supporting innovative startups, and Italy ranks among the lowest with a normalized score of 56.6; however, there is a positive change of 5.9% in the period from 2016 to 2023 (European Commission , 2023).
- “Firm investments" include three indicators related to R&D and non-R&D investments made by firms to generate innovations: business R&D expenditures, non-R&D innovation expenditures, and innovation expenditures per person employed. Italy's performance in this indicator in 2023 falls between 70% and 100% of the EU's performance, signaling a score below the European average. The "R&D expenditure in the business sector" in Italy

reveals a notably low value, with Gross Domestic Expenditure on R&D (GERD) in 2021 accounting for 1.43% of the GDP. Nevertheless, there has been a positive change of 6.2% from 2016 to 2023 (European Commission , 2023).

- “Use of information technologies" assesses the adoption of information technologies by measuring two factors: enterprises providing ICT training and employed ICT specialists. Regarding Italy, enterprises offering training to develop ICT-related skills for their personnel fall below the European average, despite showing a growth of 44.6% from 2016 to 2023 (European Commission, 2023).

The activity of "Innovation" encompasses various aspects within the business sector, distinguishing among three dimensions: innovators, linkages, and intellectual assets.

- The "Innovators" dimension measures the proportion of SMEs that have introduced innovations in the market or within their organizations, encompassing both product and business process innovations. Italy outperforms the European average for both indicators, experiencing an overall increase of 47.2%. Notably, the indicator "Business process innovators (SMEs)" has witnessed the highest incremental change (62.8%). Into details, this indicator represents the number of SMEs that introduced at least one process, marketing, and organizational innovation; according to Eurostat, in

2020, approximately 43,897 Italian SMEs underwent a business process innovation; considering the Italian SME population in 2020 was around 99,601 enterprises, this implies that nearly one in two businesses embraced innovation (European Commission , 2023; EUROSTAT).

- The dimension of "Linkages" assesses innovation capabilities by examining innovative SMEs engaged in collaboration with others, public-private co-publications, and job-to-job mobility of Human Resources in Science & Technology (HRST). Italy excels in the "number of SMEs with innovation cooperation activities," surpassing the European average with a remarkable 79.2% growth from 2016 to 2023. However, the indicator "job-to-job mobility of HRST" within this category records the lowest value, indicating a potential lack of dynamism in Italy's Science & Technology labor market (European Commission , 2023).
- “Intellectual assets” captures different forms of intellectual property rights (IPR) generated by the innovation process, including PCT patent applications, trademark applications, and design applications. In Italy, this aggregated indicator showed a trend in 2023 that is higher than the European average. A distinctive characteristic of Italian culture is highlighted – a high number of "design applications," even though it has decreased compared to the data from 2016 (European Commission , 2023).

The last activity identified by the EIS is "Impacts," which assesses the effects of enterprises' innovation activities and differentiates between the following innovation dimensions: employment impacts, sales impacts, and environmental sustainability.

- “Employment impacts" measures the influence of innovation on employment by examining the rate of employment in knowledge-intensive activities and in innovative enterprises. In 2023, Italy recorded an indicator value above the European average, showing also a positive change of 10% compared to 2016 (European Commission , 2023).
- "Sales impacts" assess the economic consequences of innovation, considering indicators such as exports of medium and high-tech products, exports of knowledge-intensive services, and sales resulting from innovative products. For Italy, the performance of these indicators falls below the European average, except for the sales of innovative products, which experienced a 30% increase from 2016 to 2023 (European Commission , 2023).
- “ Environmental sustainability" focuses on advancements aimed at reducing the negative impact on the environment, encompassing three indicators: resource productivity, exposure to air pollution by fine particulate matter, and the development of environment-related technologies. In the case of Italy, it emerges as this aggregated indicator has outperformed the European average. Moreover, a specific indicator within this category, resource productivity,

attained the highest value among the 32 indicators comprising the SII in 2023. Resource productivity is a measure of the total amount of materials directly used by an economy (measured as domestic material consumption) in relation to GDP. This measurement provides insights into whether there is a decoupling between the use of natural resources and economic growth (European Commission , 2023).

To summarize, Italy excels in resource productivity, design applications, public-private co-publications, most cited publications, and business process innovation. Challenges remain in areas such as education levels, job mobility, venture capital, R&D spending in the business sector, and environmental technology development. Addressing these challenges is crucial for enhancing Italy's innovation ecosystem (European Commission , 2023).

Moreover, as previously mentioned, a structural characteristic of Italy is the gap between the northern and southern regions, which becomes even more apparent in the analysis of innovation at the regional level. The Regional Innovation Scoreboard (RIS) serves as a regional extension of the European Innovation Scoreboard (EIS), evaluating the innovation performance of European regions based on a limited number of indicators (European Commission , s.d.). Below is a summary figure.

NUTS	Region	RII	Rank	Group	Change
IT	[illegible]	90.3	--	Moderate	15.6
ITC1	[illegible]	95.4	118	Moderate +	17.6
ITC2	[illegible]	72.8	169	Moderate -	7.8
ITC3	[illegible]	89.1	136	Moderate	17.4
ITC4	[illegible]	97.4	113	Moderate +	15.0
ITH1	[illegible]	88.5	139	Moderate	13.4
ITH2	[illegible]	100.8	104	Strong -	13.3
ITH3	[illegible]	97.9	111	Moderate +	14.7
ITH4	[illegible]	101.0	102	Strong -	13.5
ITH5	[illegible]	101.2	101	Strong -	15.8
ITI1	[illegible]	93.1	124	Moderate +	12.3
ITI2	[illegible]	98.0	110	Moderate +	17.9
ITI3	[illegible]	98.7	108	Moderate +	27.8
ITI4	[illegible]	97.6	112	Moderate +	17.9
ITF1	[illegible]	89.2	135	Moderate	26.0
ITF2	[illegible]	76.9	159	Moderate -	16.8
ITF3	[illegible]	81.0	152	Moderate	23.3
ITF4	[illegible]	76.5	163	Moderate -	19.2
ITF5	[illegible]	74.4	166	Moderate -	19.8
ITF6	[illegible]	74.2	167	Moderate -	20.4
ITG1	[illegible]	67.3	183	Emerging +	15.5
ITG2	[illegible]	69.4	176	Emerging +	12.3

Figure 2.2 - "Innovation in Italian regions". Source: European Commission, 2023.

As can be seen from the figure, the most innovative regions in Italy are Emilia Romagna, the autonomous province of Trento, and Veneto. These regions exhibit a level of innovation higher than the Italian average. Conversely, islands and southern regions perform significantly negatively, along with three northern regions: Liguria, Valle d'Aosta, and the autonomous province of Bolzano (European Commission, 2023).

2.3 THE TRANSFER OF TECHNOLOGICAL INNOVATION IN ITALY

The transfer of technological innovation is an highly intricate process that engages multiple actors within a country's innovation ecosystem. To exemplify the

involved entities in Italy, we reference the national innovation structure as outlined in the Triple Helix model. Delving deeper, the following section offers an illustration of how the transfer of technological innovation is executed by businesses, corporations, public entities, and hybrid entities.

2.3.1 The transfer of technological innovation by Italian universities

As mentioned in Chapter 1, the third mission of universities establishes that, in addition to teaching and research, promoting the transfer of knowledge to the community is among their tasks. In Italian universities, the responsibility for implementing this mission is entrusted to the Technology Transfer Office (TTO). The XIV NETVAL Report reveals that while the first TTOs in Italian universities emerged in the 1990s, a significant proliferation occurred between 2001 and 2008. This growth was particularly pronounced from 2004 to 2006 due to new laws permitting ministerial funding for spin-offs and TTOs in public universities, as well as new rules for intellectual property protection. This period coincided with the activation of the National Evaluation Agency of the University System and Research, initiating accreditation procedures for universities by implementing clear rules to ensure quality and encompassing the fulfillment of the universities' third mission (Ramanciotti & Daniele , 2018).

In Italy the TTOs play a multifaceted role in supporting innovation and research commercialization. Their functions encompass aiding the establishment of spin-

off companies, overseeing intellectual property management and licensing activities, offering information and consultancy services, contributing to the formation of university placement structures, managing research contracts and collaborations with industry, and administering scientific parks and incubators. Beyond these operational aspects, TTOs have broader objectives, including fostering an entrepreneurial mindset in research, promoting the economic utilization of scientific and technological research outputs, and strengthening the university's and individual departments' capabilities to engage in research agreements with businesses and other entities at local and regional levels (Ramanciotti & Daniele , 2018).

As for the personnel active in the TTOs in 2021 (across the 78 universities that participated in the XVII NETVAL Survey) a total of 437 full-time equivalent staff members are employed, averaging 5.6 employees per TTO; this number has nearly doubled from 2004. In detail, a significant portion of the time (just over 35%) spent by these office employees was dedicated to intellectual property protection activities and supporting spin-off and start-up companies; this highlights the key activities carried out by those offices (Daniele , Piccaluga, & Tolin , 2023).

Specifically concerning the financial resources, according ones again to the XIV NETVAL Report, the annual budget for TTOs in 2016 amounted to approximately

8 million euros[12] (+62.1% compared to 2006 and -41% compared to 2015); this averaged around 240.6 thousand euros per responding university. Regarding funding sources, 81.1% comes from the university's allocation, while 9.9% is self-financed through projects and third-party accounts (Ramanciotti & Daniele , 2018).

A more pronounced trend in recent years, aiming to generate economic returns for the university through knowledge creation, is the commercialization of the product of the activity of research of the universities. However, before an invention can be commercialized, it must be recognized as such, and this recognition occurs within the realm of intellectual property management; this involves the handling of inventions and patents, as well as licenses and options. Regarding the patent applications, among the universities analyzed in the XIV NETVAL Report, in 2016, a total of 344 priority applications were submitted, averaging 6.3 applications per university, with 82.6% of the total number of applications filed in Italy, an additional 7.5% in Europe, 4.9% in the USA, and the remaining 4.9% in other countries. Specifically, in 2016 a total of 278 patents were granted, with an average of 5.1 patents granted per university (+218.7% compared to 2004 and -5.5% compared to 2015). This contributed to ensuring that in the universities considered in the sample by the end of 2016, the total number

[12] This value is calculated based on a sample of 33 Italian universities reported in XIV NETVAL report.

of patents (applications and grants) held in the portfolio amounted to 3,917 units, reflecting a 229.4% increase since 2005 and a 12.3% increase from 2015. Regarding costs, in 2016, each active title in the portfolio incurred intellectual property protection costs of 769.2 euros for the universities included in the considered panel, costs that are decreasing in years (Ramanciotti & Daniele , 2018). Once a patent is obtained, it actual exploitation to generate economic returns for the university occurs through "license and option" contracts which represents also the main form of knowledge transfer between organizations. Granting patent licenses (which may involve the transfer of know-how or the provision of consulting services by the inventors themselves) is a particularly complex and resource-intensive activity on multiple fronts; nevertheless, in recent years, such activities have been increasing in Italian universities. In 2016, among the universities of the XIV NETVAL Report, a total of 103 license and/or option contracts were signed by 50 responding Italian universities, averaging 2.1 agreements per university; this value represents an increase compared to 2015 when 1.8 agreements were recorded. Focusing on the subject matter of the agreements concluded in 2016, it is observed that 52.7% of the license and/or option contracts signed during the year pertained to patents, with 25.9% of the licenses having an exclusive character. Regarding the geographical origin of industrial partners with whom license and/or option contracts were concluded each year, it shows that in 2016, there was a decrease in the share of Italian

companies, accounting for approximately 61.9%, and an increase in the share of European companies, reaching 20.2% (Ramanciotti & Daniele , 2018).

Therefore, a license agreement represents a means of transferring knowledge to another organization and may occur, for example, when the university does not wish to directly commercialize an invention or when additional studies are needed before the product or service is market-ready, and the promoting university does not intend to undertake this process. However, there are cases in which the university itself chooses to bring its invention to the market; this is the case with university start-ups or spin-off. Spin-offs are specialized start-ups with the purpose of employing, in an entrepreneurial context, the outcomes of university research to develop innovative products or services. Decree no. 168/2011 from the Italian Ministry of Education, University, and Research establishes that spin-offs must be established either by universities or by university personnel, or include mechanisms for the university's entry into the corporate structure (Quarta, 2018). From a purely numerical standpoint, among the 69 universities that participated in the Netval survey, the total number of new spin-offs initiated in 2016 was 100, averaging 1.7 companies per university, with values slightly lower than those in 2015 (Ramanciotti & Daniele , 2018). Moreover, out of the 1,373 active research-based spin-off companies in Italy in 2016 , 90.4% have been generated by universities (Ramanciotti & Daniele , 2018) showing the Italian tendency to see these types of companies born from universities rather than from public research

entities. In terms of geographical distribution, the creation of research-based spin-off companies still appears concentrated and consolidated mainly in the Central-Northern regions, with Tuscany hosting the highest number of spin-offs, followed by Lombardy and Piedmont. Regarding the sectors of activity, as of 31 October 2017, 22.1% of spin-off companies operate in the field of ICT; slightly lower percentages are observed in the energy and environment sectors (16.7%), biomedical (6.3%), electronics (5.0%), industrial automation (3.9%), and nanotechnology (2.5%). Notable Italian universities specialize in the creation of spin-off companies, such as the Polytechnic University of Turin (whose spin-offs represent about 6% of the national total) and the University of Genoa (3.7%) (Ramanciotti & Daniele , 2018).

2.3.2 The transfer of technological innovation by Italian government entities

The role played by government entities in the development and enhancement of innovations is indisputable; in Italy, there are numerous public bodies engaged in research activities on diverse themes. Over the past 10 years, these entities have undergone a progressive process of reorganizing their internal statutes to give greater emphasis to technology transfer activities.

Following are propodes some examples of how the technology transfer process is implemented in some of the most important Italian public research institutions: the National Research Council, the Council for Agricultural Research and

Economics Analysis, the National Agency for New Technologies, Energy and Sustainable Economic Development, and the National Institute of Nuclear Physics.

The National Research Council (CNR, *Consiglio Nazionale delle Ricerche*) is the largest Italian public research institution, with a network of over 100 institutes and nearly 12,000 personnel dedicated to research across various fields as biomedical sciences, physical sciences and materials technologies, humanities and social sciences, as well as cultural heritage. In addition to its research activities, CNR is responsible for safeguarding, promoting, and enhancing the results of research, as well as everything related to technology transfer. Numerically, as of December 31, 2016, CNR holds a portfolio of 367 industrial property rights concentrated primarily in physical sciences and materials technologies, and biological sciences. The CNR has an internal structure dedicated to valorizing its portfolio through licenses, options, and transfers and has been actively involved in creating spin-off companies to commercialize innovations and develop new products and services aimed at strengthening technology transfer to the industrial sector. Also, to facilitate technology transfer, CNR promotes interactions with the productive system and collaborations with financial institutions, venture capital organizations, as well as entities that act as facilitators of transfer, such as incubators and national and international technology transfer networks. As of December 31, 2016, CNR has supported the establishment of 61 new companies

(including 8 liquidated) in technological sectors such as nanotechnologies and new materials, biomedical and life sciences, environment, ICT and telecommunications, electronics, and agri-food, concentrated mainly in Tuscany, Campania, Emilia Romagna, and Puglia. Practically, support has been provided through direct participation in the share capital, licensing of intellectual property rights, mentoring, provision of logistical and instrumental resources during start-up phases, collaboration on R&D projects, and authorization for CNR personnel to engage in activities in support of spin-off initiatives (Ramanciotti & Daniele , 2018).

The Council for Agricultural Research and Analysis of Agricultural Economics (CREA, *Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria*) is a research institute that focuses on improving the competitiveness, sustainability, and quality of the Italian agricultural sector. It conducts research on a variety of topics, including product and process innovations, safety and quality standards, sustainable agricultural practices, and knowledge dissemination. CREA also works to transfer its research findings to the agricultural sector through collaboration with industry, training programs, and demonstration projects. In practical terms, technology transfer at CREA is implemented through the so-called "Transfer Initiatives of each Research Center " that have the goal to disseminate the knowledge generated by each center across various territorial production contexts. This involves coordinating initiatives, as meetings of "mutual

learning", with stakeholders who, in various capacities, contribute to territorial development as businesses, technicians, and researchers. These initiatives are complemented by knowledge dissemination efforts from the CREA to businesses, such as pomological exhibitions, open house events, workshops, publications, archives of transferable results, community of practice facilitation, interactive forums between researchers and stakeholders, online courses, territorial testing activities, and live demonstrations (Ramanciotti & Daniele , 2018).

The National Agency for New Technologies, Energy, and Sustainable Economic Development (ENEA, *Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile*) is the primary Italian institution in the fields of energy and the environment, employing over 2500 personnel. It operates in the areas of energy efficiency, renewable sources, and is a leader in fusion research and nuclear safety technologies. ENEA's knowledge and research findings are made available to businesses, public administrations, and citizens through a variety of channels as for example training activities, knowledge transfer, and information dissemination. In more detail, the services offered by ENEA include: "the technological innovation atlas" that provides businesses with access to over 500 ENEA technologies online, specific roadshows organized for businesses to learn about ENEA's technologies, support in the creation of specific agreements with business in order to use the ENEA's patents and sharing scientific knowledge, establishing laboratories, and implementing technological innovation

projects, protects knowledge and innovation through intellectual property legal institutes, support in the creation of high-tech companies such as spin-offs[13], participation in national and international networks and manage relationships with industry and associations to promote joint research projects. For small and medium-sized enterprises, additional services are offered, including expert meetings, analysis and evaluation of technological needs, assistance in finding partnerships, and audits aimed at corporate innovation plans. ENEA holds over 210 valid industrial property rights, and the promotion of these rights involves licensing activities, seeking potential industrial partners interested in exploiting inventions, and overseeing the transfer of usage rights. In 2016, there were also 10 active spin-offs focused on measurement tools, hydromechanics, and process technologies (Ramanciotti & Daniele , 2018).

The National Institute of Nuclear Physics (*Istituto Nazionale di Fisica Nucleare*, INFN) research in the fields of subnuclear, nuclear, and astroparticle physics. Mostly of those physics research relies on cutting-edge technologies and tools developed in its own laboratories and in collaboration with the industrial sector; these technologies, often beyond conventional industrial know-how, provide opportunities for technology transfer to the industrial and societal fabric. Over the last few years, the INFN invest many resources in order to strengthening

[13] The agency provides technical and administrative assistance for the establishment of spin-offs, which are companies that bring technologies, products, processes, and services generated by ENEA's scientific and technological research to the market. (Ramanciotti & Daniele , 2018).

cooperation and interaction with industrial sector; this is noticeable by the establishment of a National Technology Transfer Committee tasked with coordinating technology transfer activities across all sections and laboratories nationwide. Furthermore, the INFN has championed the creation of an assessment tool for evaluating technology transfer activities and their impact on the Italian industrial landscape by the development, for example, of a surveying local company through a questionnaire to gauge the effectiveness and relevance of technology transfer initiatives (Ramanciotti & Daniele , 2018).

2.3.3 The transfer of technological innovation by Italian companies

Italian companies, driven by a profit-oriented mindset, play a significant role in the immediate transfer of technological innovations to the market. Recent facilitative measures in Italy, including regulations for innovative startups, innovative SMEs, and certified incubators, aim to enhance the complexity of the national system and boost innovation in the productive sector.

In 2012, Italy introduced the "Italian Startup Act" which consists of a set of measures designed to facilitate the establishment and growth of high-tech innovative enterprises. This legislation introduces the new concept of "innovative startup," defining it as a company with specific characteristics as dedicating 15% of the higher of production cost or total value to research and development, having a team with two-thirds holding a master's degree or one-third consisting of

PhD candidates, doctoral graduates, or individuals with three years of experience, and being the holder, depositor, or licensee of a registered patent (industrial property) or holder of an original registered computer program. Attaining this status provides significant benefits to the new innovative enterprise, both in terms of taxation and access to financing resources. Notably, from 2013 to 2014, the number of innovative startups in Italy more than doubled (an increase of 107.3%), and positive growth trends continued in subsequent years. As of October 1, 2022, there are 14,708 active innovative startups, an increase of 4.5% compared to 2021. In terms of geographical distribution, 26.7% are located in Lombardy, 12.2% in Lazio, and 9.5% in Campania. From a sectoral perspective, the "information and communication services" sector is the most representative, accounting for 7,435 innovative startups (50.6%) as of October 1, 2022, with a 0.6% increase from the end of 2021. The "professional, scientific, and technical activities" sector ranks second, comprising 23.1% of the total active startups, followed by the "manufacturing activities" sector with 14.5% of active innovative startups (Direzione Generale per la Politica Industriale, l'Innovazione e le Piccole e Medie Imprese del Ministero delle Imprese e del Made in Italy, 2022).

The "innovative SMEs" are companies operating in the field of technological innovation, representing a natural evolution from startups, although they exhibit distinct accounting requirements. As of October 1, 2022, innovative SMEs numbered 2388, marking a 9.1% increase compared to 2021. Geographically,

29.8% of these innovative SMEs are located in Lombardy, 11.5% in Lazio, and 9.1% in Emilia-Romagna. Moving to sectoral analysis, it is noted that 38.2% of innovative SMEs operated in the information and communication services sector in 2021, representing 31.4% at the total national level; those companies are involved in software production, IT consulting, and related activities, experiencing a notable increase (+25.1%) compared to 2020. Manufacturing activities, with 460 enterprises, make a significant contribution at the national level, accounting for 21%; among the industries in this sector, computer and electronic product manufacturing is the most active, followed by the mechanical industry. In 2021, the 2,152 innovative SMEs collectively generated a turnover exceeding 6.4 billion euros in 2020, with an average value per company of 3 million euros (Direzione Generale per la Politica Industriale, l'Innovazione e le Piccole e Medie Imprese del Ministero delle Imprese e del Made in Italy, 2022).

According to the Italian legal system, a "certified incubator" is a company that provides services to support the birth and development of innovative startups. It must meet specific requirements, such as having facilities, including real estate, suitable for hosting innovative startups; these facilities should include dedicated spaces for installing trial equipment, testing, verification, or research purposes. Additionally, the certified incubator must maintain regular collaborative relationships with universities, research centers, public institutions, and financial partners engaged in activities and projects related to innovative startups

(Ministero dello Sviluppo Economico, s.d.). As of October 3, 2022, there were 56 certified incubators registered, an increase of 19.1% from 2021. In terms of location, at the end of 2021, 31.9% of certified incubators were in Northern Italy, of which more than half located in Lombardy, followed by Lazio and Piedmont. Of the certified incubators, 76.6% operate in the field of professional, scientific, and technical activities, where business management and management consulting activities play a primary role; a small part also deals with research and development (Direzione Generale per la Politica Industriale, l'Innovazione e le Piccole e Medie Imprese del Ministero delle Imprese e del Made in Italy, 2022).

To conclude this section, it is necessary to mention the technology transfer activities carried out by the so called "traditional"[14] companies. According to an ISTAT report covering the innovation of Italian companies from 2018 to 2020, 50.9% of respondent companies are engaged in innovation activities, marking a 5% decline from the 2016-2018 period, largely attributed to the impact of the pandemic (Istat, Istituto Nazionale di Statistica , 2022).

A table with the main innovation indicators referring to the period considered is proposed below.

[14] Not falling into any special category of innovative companies according to Italian legal regulations

MACRO-SECTORS AND EMPLOYEE CLASSES	Businesses with innovative activities*	Innovative enterprises**	Enterprises introducing new products	Enterprises implementing new processes	Innovative enterprises collaborating externally***	Innovation expenditure per employee (thousand euros) **, year 2020
Industry in the narrow sense	58,5	50,9	**32,2**	**48,1**	24,5	8,3
Construction	38,2	35,3	18,1	33,8	8,5	4,4
Services	47,2	44,0	**24,1**	**42,0**	20,7	5,6
10-49 employees	48,4	43,5	**25,0**	41,2	18,7	6,9
50-249 employees	65,7	59,8	37,4	57,6	31,8	5,9
250 employees and above	76,0	70,2	**49,5**	**67,7**	**48,0**	7,4
Total	50,9	**45,9**	**26,8**	**43,6**	**21,4**	6,9

(*) Innovative activities completed, ongoing, or abandoned by the end of 2020.
(**) Refers to companies that have successfully introduced, in the market or within the company, product or process innovations in the 2018-2020 three-year period.
(***) Percentage of the total companies with innovative activities.

Table 2.2-"Principal innovation indicators of companies in the years 2018-2020, percentage values as a share of total companies (unless otherwise indicated)". Source: Istat, Istituto Nazionale di Statistica, 2022.

As indicated by the table, innovative companies—those successfully introducing innovations in product or process either to the market or internally—constituted 45.9% of the surveyed Italian companies during the 2018-2020 period. Within this group, the industrial sector played a pivotal role in technology transfer, with 32.2% of companies introducing new products and 48.1% implementing new processes. The prevailing trend among Italian companies continues to be a preference for innovating internal business processes rather than developing new products for the market (43.6% versus 26.8%); however, compared to the 2016-2018 period, there is a decrease in the percentage of companies realizing product innovations (-4.3 points) and those investing in new processes (-3.8 points).

Across sectors, industrial enterprises are more inclined toward developing new processes or products compared to those in the Services sector (42.0% new processes and 24.1% new products). Regardless of the economic sector, major players in these innovations are large enterprises, with 49.5 % introducing new products to the market compared to the 25% of the new product introduced by small enterprises. Furthermore, there is a trend towards individual innovation efforts, with only 21.4% of innovators collaborating with other entities (companies or public and private entities such as universities, research centers, and the non-profit sector) also carried out mainly by large companies (Istat, Istituto Nazionale di Statistica , 2022).

2.3.4 The transfer of technological innovation by Italian hybrid entities

As mentioned in Chapter 1, the term hybrid entities refers to organizations that arise from collaborations between universities, businesses, and government entities. Their importance in Italy's technological innovation transfer ecosystem is indisputable. The following analysis provides insights on technology transfer activities of several of these entities as: the Science Park, Foundations, Centers of High Specialization and Expertise, and the Technology Transfer Centers.

In broad terms, a “Science Park (SP)” is a geographic area where firms, R&D laboratories, universities, and research centers co-locate to leverage proximity advantages, encourage knowledge spillovers, and benefit from agglomeration

economies. In 2012, Italy had 39 technology parks distributed across the national territory. These Italian Science Parks exhibit considerable heterogeneity in terms of size, performance, strategy, and specialization. Each park has a primary partnering university in the same region, often within the same province, indicating substantial collaborative activities with local knowledge institutions; when it comes to collaboration with universities and other public research institutions, SPs engage in joint research projects, particularly on a national scale. Additionally, they foster cooperation by allowing reciprocal use of facilities, such as laboratories and machinery. Going into more detail regarding the technology transfer activities specifically, it is evident that as of 2012, 17 technology parks have their own technology transfer office (Liberati, Marinucci, & Tanzi, 2014) .

In Italy, there are also foundations actively involved in technology transfer, and one notable example is the "*Fondazione Idis–Città della Scienza*". Established through the collaboration of scientists, intellectuals, and both public and private institutions, the foundation is dedicated to fostering scientific culture and contributing to the economic and social development of Southern Italy, Italy as a whole, and Europe. The foundation's initiatives include the International Technology Transfer Center which supports internationalization efforts by offering specialized services for business matching; this facilitates technology transfer, collaborative research and innovation projects, the establishment of new enterprises, and the exploration of business opportunities and investments

between Italy and other countries. Furthermore, the foundation is engaged in educational activities for children to promote scientific and technological knowledge (Ramanciotti & Daniele , 2018).

The "Centers of High Specialization and Expertise" are public-private partnerships tasked with providing guidance and training to businesses on Industry 4.0 topics. This centers also also support the implementation of innovation projects, helping companies, especially SMEs, develop new products, processes, or services using advanced technologies. Currently, there are eight such centers in Italy (Ministro delle Imprese e del Made in Italy , 2023); the “MADE - Competence Center Industry 4.0” is one of them. Specifically focused on supporting companies in implementing innovation projects for products and related production processes, it’s technology transfer activities are structured into several projects. Those projects involves rigorous analysis, technological scouting through a consortium of companies, universities, and public entities, technological consulting for the implementation of specific solutions, collaborative innovation projects, demo and prototyping, and validation of Industry 4.0 projects. Moreover, the MADE Center leverages its demonstrative space and available technologies to demonstrate the feasibility of solutions through the replication of industrial scenarios (MADE).

The “Technology Transfer Centers of the Industry 4.0 Plan” provide training, technological consulting, and technology transfer services to businesses in

operational areas as additive manufacturing, augmented reality, the internet of things, cloud computing, cybersecurity, and big data analytics (Unioncamere). Among these centers is the REI Foundation which provides services to businesses, particularly in innovation processes, technology transfer, and industrial and technological research services (Fondazione REI , s.d.). Of particular interest is the 'Demonstration Laboratory of Advanced Manufacturing Technologies,' a facility where companies experiment with automation, robotics, vision systems, digital twins, and virtual simulation models, supported by specialized technicians (Digital Automation LAB , s.d.).

2.4 INTERNATIONAL TECHNOLOGY TRANSFER FROM EUROPE TO ITALY

When discussing international technology transfer, it is essential to highlight the role that the European community plays in relation to Italy as a significant driver of this process. Italy's membership in the European community provides the country with important tools to support the growth of its innovation level. One of the latest initiatives is the Next Generation EU, a project created by the European Union in response to the pandemic crisis, aiming to foster unprecedented investments and reforms to accelerate ecological and digital transition. Within this framework, Italy has access to various resources, including €68.9 billion allocated for the period 2021-2026. In Italy, this investment project is known as the

National Recovery and Resilience Plan (PNRR), organized into missions such as innovation, education and research, green revolution, and ecological transition. Specifically focusing on the "Education and Research" mission, €11.44 billion is earmarked for "from research to business" initiatives. These funds are intended to address structural and organizational challenges hindering technology transfer, such as obstacles to transferring research, even in numerous areas of excellence, and leveraging it in terms of patents, commercial agreements, and the creation of new businesses. To address these issues, €2.05 billion is allocated to "support innovation and technology transfer processes," maintaining an open perspective on European collaborations (Italia Domani , 2021). This support is divided into:

- IPCEI (Important Projects of Common European Interest). Additional resources to fund new projects developed on European platforms within the strategic European value chains. This approach brings together knowledge, skills, financial resources, and economic actors from across the Union, promoting collaboration between the public and private sectors (Italia Domani , 2021).
- Partnerships – Horizon Europe: The objective of this measure is to support research, development, and innovation projects identified through specific calls for participation in research and innovation partnerships (European Partnerships) under the Horizon Europe program (Italia Domani , 2021).

Moreover, the role played by the network in the technology transfer process is also acknowledged at the European level through numerous organizations such as:

- Enterprise Europe Network. This network plays a crucial role in assisting businesses in innovating and expanding internationally. It stands as the world's largest support network for small and medium-sized enterprises (SMEs) with global ambitions, actively operating worldwide, and bringed together experts from member organizations recognized for their excellence in providing business support. Support activities range from tailoring digital solutions to the specific needs of SMEs, fostering businesses' potential for innovation, growth, and the development of disruptive products; additionally, it helps companies find the right business partners and promotes the global adoption of new technologies (Advice and Support).
- European Digital Innovation Hubs (EDIHs). Assist companies in improving business processes through digital technologies by offer access to technical expertise for testing digital solutions before investment. EDIHs also provide crucial innovation services, including financial advice and training for successful digital transformation. Addressing environmental concerns, particularly sustainability and circularity, is another focus. EDIHs leverage regional presence for localized support and language-specific services, while the European network facilitates sharing

best practices and offering specialized services across regions (European Commission).

In conclusion, the role of the European Commission in shaping the present and future of technology transfer in Italy is pivotal.

CHAPTER 3. INNOVATION AND TECHNOLOGY TRANSFER IN ARGENTINA

The present chapter focuses on the analysis of the state of technological innovation and its transfer in Argentina. To provide setting to the analysis, a brief overview on the Latin American and Caribbean context in terms of science and technology is presented. In the second part of the chapter, ample space is given to Argentina, starting with its production profile, and then moving on to the actors that generate innovation. The third part of the chapter emphasizes how the process of technological innovation transfer occurs focusing on the main actors that carry out this process. In the concluding section, an overview is provided of some projects implemented in Argentina by major supranational organizations that operate in Latin America and the Caribbean region.

3.1 THE STATE OF INNOVATION IN LATIN AMERICA AND THE CARIBBEAN

3.1.1 Economic outlook of Latin America and the Caribbean region

The regional bloc of Latin America and the Caribbean (LAC) comprise around 42

countries[15] with a population in 2022 of 659310,56 (thousands) people that represent approximately the 8.3% of the world and contribution to the 2022 world GDP (at current US$) of the 6.73%. In more detail, the GDP of Latin America and the Caribbean grew by 21% overall between 2012 and 2020, with a negative contraction of 2020 caused by the pandemic; however, this growth was below the levels of other regions, such as Europe, Oceania, and Asia (UNESCO , 2023). In general, this region is characterized by various complexities, such as challenging socioeconomic conditions, with an overall poverty rate of 29% and an extreme poverty rate of 11.2%. There is a high incidence of labor informality, with an average of 42.8% of the population living in households dependent solely on informal employment, leading to lower wages and a lack of access to social protection networks, additionally with an increased inflation rate and a general low productivity of the production system (OECD *et al*, 2023). On the other hand, LAC counties holds significant potential to pursue a more robust and sustainable development path. Those territories are extremely rich in terms of minerals, such

[15] Referring to World Bank data, the following countries fall under the categorization of "Latin America & Caribbean": Antigua and Barbuda, Argentina, Aruba, The Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Curacao, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Sint Maarten (Dutch part), St. Kitts and Nevis, St. Lucia, St. Martin (French part), St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela, and Virgin Islands.

as lithium with Argentina, Chile, and Bolivia that are defined as the “lithium triangle” hosting nearly 75 % of the world's lithium resources (Ahmad, 2020). Another characteristic of this region is the presence of vast and highly fertile land expanses; for instance, post-World War II, Argentina was referred to as the "breadbasket of the world" due to covering 32% of the global grain market with its cereal exports (Rosti, 2008). To address recent challenges, the LAC region requires a more ambitious investment agenda. Despite low domestic investment, it attracted substantial foreign direct investment in 2022, ranking as the top recipient globally at 4% of the region's GDP. Foreign companies in LAC offer higher wages, employing a significant number of unskilled workers and providing training opportunities for skill enhancement. Strategic investments in research and development and emerging sectors have the potential to reshape the production structure, especially in the context of the green transition (OECD *et al*, 2023).

3.1.2 Science and technology in Latin America and the Caribbean region

Science and technology play a crucial role in driving the growth of a country and a region, serving as a means for social well-being. Generally, the level of innovation in LAC countries is positioned below that of other world regions, such as Europe and Asia. Concerning the distribution of global investment in R&D by geographic blocks, the R&D investment in the LAC countries represented 2.32% (a decrease from the 3.4% recorded in 2012) of the total world investment in

2021. By contrast, countries like the United States and Canada represented 30.5% of the world R&D investment, and the European Union represented 23.8% of the world R&D investment, while Asian countries led with 41.6% (UNESCO, 2023). In more details, the LAC region has been interested by a growth of 19% in the R&D investment between 2012 and 2021; despite a contraction in 2020, R&D investment rebounded in 2021, accounting for approximately 0.6% to 0.7% of the region's GDP. A distinctive feature of LAC is the strong concentration of R&D investment in a few countries: Brazil alone represents 62% of the regional effort and is the only country in this region to exceed 1% of GDP in R&D investments (in contrast to countries like Israel with a 5.56% GDP allocation for R&D). Mexico contributes 13% to the regional effort, while Argentina contributes 9%; Colombia and Chile represent 3% of the regional investment each. Although this concentration correlates with the size of their economies, the significant gap in R&D investment between these countries and the rest of Latin America and Caribbean is noteworthy (UNESCO , 2023). Thus, it emerges that in addition to the low relative intensity of R&D investment in this region compared to other regions, there is also a concentration in a few countries of the process, namely Brazil, Mexico, and Argentina, accounting for 84% of the total investment in the region. An additional feature of the region is the substantial contribution of the government sector to the financing of R&D, covering 56% of the total R&D investment in 2021; companies, both private and public, contribute 36% of the

financing, higher education contributes 5%, and external funding makes up 3%. The limited investment in innovation in this region can be attributed, in part, to the public nature of knowledge, leading to a low level of appropriability of innovation results for those investing in it. This is compounded by the uncertainty and intangibility inherent in innovation processes (UNESCO , 2023). Regarding human resources dedicated to R&D activities, the LAC region constitutes 4% of the global distribution of researchers although from 2012 to 2021 this figure showed a growth of 60%. Despite that, the level is significantly lower than in other regions of the word, such as the Asian countries (49.4%) and Europe (27%). In terms of distribution of human resources by sector, the higher education sector is the most significant for LAC countries, with 62% of researchers conducting their activities in universities in 2021, while those employed in businesses constituted 26%, and 11% worked in public-sector R&D institutions. The same applies to financial resources allocated to R&D activities, Asian countries have the highest representation of human resources dedicated to research, reaching 49.4% of the total worldwide, with Europe at 27% (a decrease of almost 3% from 2012). In terms of specific indicators, the number of international patent applications filed through the Patent Cooperation Treaty experienced a 19% decline in LAC region from 2012 to 2021, with notable drops in Mexico and Brazil during 2021. However, Chile showed opposite trends, with growth rates of 55% over the decade. Analyzing patent applications at the intellectual property

offices of the region's countries in 2021, 83% of the patent applications in LAC countries were from non-residents, primarily foreign companies protecting products in the region's markets. Mexico had the highest proportion, with 93% of total applications, while Chile and Argentina had values of 93% and 89%, respectively. Brazil had one of the lowest with 73% of applications coming from non-residents (UNESCO , 2023).

To conclude, the Latin America and Caribbean region faces challenges in R&D investment, human resources, and international patents while the public sector is a major contributor. Increased private sector investment, increase productivity, and develop new sustainable use of natural resources is crucial to enhance innovation and global competitiveness.

3.2 THE STATE OF INNOVATION IN ARGENTINA

In the context of the countries belonging to the Latin American and Caribbean region, Argentina stands out in importance, both due to its territorial extension and its contribution to the overall GDP of this region. Beginning with a brief analysis of the Argentine productive system, an examination of the state of innovation in the country is proposed.

3.2.1 Argentina productive system: general overview

Argentina is one of the most developed economies in Latin America, ranking third

in South America behind Brazil and Colombia. It has a total population of 46.04 million as of 2022, with an estimated growth rate of around 0.9%. According to the latest measurement of the official poverty index published by the National Institute of Statistics (INDEC), in the second semester of 2022, 39.2% of the population was living below the poverty threshold. Argentina is often described as a macrocephalic country due to the enormous influence of its capital, Buenos Aires, in almost every aspect of national life, encompassing 31% of the population and contributing to 40% of the GDP. (Oficina Economica y Comercial de España en Buenos Aires, 2023). Regarding current and future trends, GDP is projected to contract by 1.8% in 2023 and by 1.3% in 2024, before rising by 1.9% in 2025 (OECD , 2023). The economic contractions are influenced by various factors, including the still-resilient labor market, where unemployment stood at 6.2% in the second quarter of 2023, and the informality of the labor market, which approaches 40% of the total labor force. Another contributing factor to the economic challenges is the headline inflation, which surged to 143% in the year leading up to October 2023(OECD , 2023). Regarding the main sectors of the economy, Argentina's geographical and climatic endowments have provided a clear advantage for the production of cereals, oilseeds, fruits, and vegetables, as well as fostering the development of forestry. The country benefits from natural conditions that rank it as the fourth country with the most arable land. Despite this, the primary sector represented only the 12% of the GDP in 2022. More

specifically, agriculture accounted for 8% of the GDP, 22% of private employment, and 67% of exports. In more details, Argentina is the third-largest global producer of soybeans, surpassed only by Brazil and the United States, and the third-largest exporter of soybean oil after China and the United States. Furthermore, it is necessary to also highlight that Argentina has traditionally been one of the major global producers and exporters of beef (Oficina Económica y Comercial de España en Buenos Aires, 2023). As for the secondary sector in 2022, it accounted for 23.94% of the GDP; this represents a 77% increase compared to the 2021 figure. Within the sector, manufacturing is the largest segment, contributing 18.56% of the GDP, followed by the construction sector (4.41%) and the electricity, gas, and water sector (0.95%) (Oficina Económica y Comercial de España en Buenos Aires, 2023). Regarding the tertiary sector, it represented 63.98% of the GDP in 2022; within this aggregate, the wholesale and retail trade, repair of vehicles, and real estate activities had the most significant weight in that year (Oficina Económica y Comercial de España en Buenos Aires, 2023).

Argentina is characterized by a significant presence of micro-enterprises (0-9 employees) in its economic landscape, accounting for 79.6% of the total businesses in the territory. However, despite their large number, these micro-enterprises only employ 10% of the workforce as of 2019. Small enterprises (10 to 59 employees) represent 15.5% of the businesses and occupy 21.7% of the active population; medium-sized enterprises (50 to 199 employees) make up 3.9% of the

businesses and employ 24.3% of the active population. It's the large enterprises that have the highest share of the active population (44%), even though they represent only 1% of the active businesses in the territory. As mentioned previously, a peculiar characteristic of the Argentine economic system is the concentration of economic activity in a specific area; in fact, also in relation to the concentration of companies, the 35.3% of the companies are located in the Autonomous City of Buenos Aires, 28% in the province of Buenos Aires, and 8.6% in the province of Santa Fe. On the other hand, businesses located in the other 20 provinces of the country represent only the 27.9% of the total enterprises expressing a strong regional economic heterogeneity (Instituto Nacional de Estadística y Censos, 2022).

Before concluding, it is necessary to highlight another structural aspect of the Argentine economy: the significant presence of family businesses. In fact, according to 2017 data, these family enterprises constitute 99% of the total businesses in the territory (Lucero Bringas *et al*).

3.2.2 The Argentine innovation ecosystem

Innovation plays a crucial role in enhancing productivity and driving substantial growth. Strengthening innovation capabilities in Argentina holds the potential for achieving sustained, long-term economic growth and fostering shared prosperity (Gurcanlar *et al*, 2021). According to the World Intellectual Property Organization

(2023), Argentina ranked 73th (over 132 economies) in the Global Innovation Index 2023. The examination of Argentina's innovation ecosystem involves analyzing performance across various innovation inputs, including human capital, public and private research and development (R&D) activities, managerial practices, and innovation outputs such as patents and new businesses, products, and processes (Gurcanlar *et al*, 2021). The "Research and development (R&D) activity" play a pivotal role in fostering innovation, yet Argentina faces challenges in this area. Argentina's gross expenditure on R&D is similar to its regional peers but is relatively low compared to other counties, amounting to 0.53 percent of its GDP in 2015; it represents the second highest gross expenditure in Latin America after Brazil (which invests 1.2 percent of GDP). Between 2007 and 2015, Argentina witnessed a 78 percent increase in total R&D expenditures (measured in current purchasing power parity US dollars) and a 15 percent rise in the ratio of R&D to GDP (from 0.46 percent to 0.53 percent) (Gurcanlar *et al*, 2021). This growth was mainly driven by public investments framed within the Argentina Innovadora 2020 plan, which among its main investment strategies includes increasing the base of scientists to strengthen basic and priority socio-productive research capacities, and increasing funding for scientific and technological projects. However, the change of government during the period 2015-2019 downsized the scope of action of this project. Instead, regarding the private R&D spending, the country faces challenges with the business sector contributing only

17 percent of the gross expenditure in R&D; moreover, this value experienced a negative trend, declining by 21 percent between 2007 and 2016. Examining the share of firms investing in R&D, data from the World Bank in 2017 reveals that most investments come from large firms[16] (51.1%). Limited private sector involvement in R&D is also evident in the percentage of researchers employed by the private sector. Despite Argentina generate more researchers per capita than its regional peers, a significant majority are employed by public agencies. Only 13 percent of manufacturing firms have an R&D department, indicating a mere 9 percent of all researchers are employed by businesses. These challenges highlight the need for policies to encourage increased private sector participation in R&D to strengthen Argentina's innovation landscape (Gurcanlar *et al*, 2021). As regards to the category "Technology Absorption and Equipment", in Argentina only 44 percent of firms report having invested in fixed assets[17]; this marks a significant difference from other countries such as Turkey where more than 75 percent of firms indicate to acquire knowledge mostly through the purchase of machinery and equipment, as opposed to other possible sources of knowledge. Argentina's total spending on computer software is 0.2 percent of GDP, a figure similar to the one of its regional peers; additionally, only 7.5 percent of firms report using technology licensed from foreign companies (Gurcanlar *et al*, 2021). As regards to

[16] According to World Bank, Large firms refers to firms with more than 100 employees.
[17] Which include land and buildings in addition to equipment and machinery (Gurcanlar *et al*, 2021).

"Human Capital and Research", Argentina possesses valuable assets in the form of researchers and excellent research institutes that contribute to innovation. From 2004 to 2016, the country expanded its research base by 36 percent, reaching 3.006 researchers per 1,000 employees, the highest regional increase, and the highest number of researchers per capita in Latin America. The country also excels in the quality of its research centers, ranking 27th globally in 2019. While Argentina performs well in academic collaboration with the global research community, with international co-invention and coauthorship representing substantial percentages of total outputs, there are gaps in human capital inputs, particularly in STEM; the percentage of the population aged 25–34 with less than a secondary school education was 32 percent in 2014. Argentina's share of tertiary graduates in STEM disciplines averaged 16.1% between 2012 and 2017, lagging behind its structural peers and ranking second lowest among OECD countries (23%). Early entrepreneurship in Argentina has been declining, dropping from 20 percent in 2011 to 6 percent in 2017, which is lower than its regional and structural peers; considering recent demographics, approximately 1.2 million individuals in Argentina are currently engaged in early-stage entrepreneurial activity, sharply decreasing value compared to 2011 (Gurcanlar *et al*, 2021). About the "Innovation Output", according to the 2019 Global Innovation Index (GII), Argentina's performance in innovation outputs[18] falls behind both regional

[18] According to Gurcanlar *et al* (2021) "Innovation Output" encompased knowledge, technology,

and structural comparators ranking of 75th standing below even lower-income economies such as Jamaica and Kenya. The country exhibits the lowest rate of patent applications per capita among its peers counting in the 2017 with only 393 thousand applications, unlike Brazil that, in the same year, recorded 5480 thousand application and Turkey, which counted 8175 thousand applications. Furthermore, the Argentine annual number of granted patents in proportion to research and development expenditure is notably low (Gurcanlar *et al*, 2021). In addition, Argentina's international trademark applications per person lag behind Chile and Costa Rica, while the share of high-tech exports in total exports stands at a mere 2 percent. Despite leading in the issuance of ISO 9001, Argentina significantly lags in the density and growth of new businesses (measured as a share of GDP per worker). The country also faces challenges in firm-level innovation, with over 50 percent of manufacturing firms not introducing new products or services and over 60 percent failing to implement process innovation in 2017 (Word Bank, 2017; Gurcanlar *et al*, 2021). About the "Innovation Impacts", from a general perspective, Argentina falls behind all of its structural and regional peers across the levels of innovation impact[19]; among these, particularly low data were recorded in terms of firm growth. The majority of Argentine enterprises displaying a "stunted growth" maintaining the same size

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and creative achievements like patents and ISO 9001 certificates.

[19] According to Gurcanlar *et al* "Innovation Impact" encompased firm growth, productivity growth, and economic diversification (2021).

even after five years of activities; this lack of firm growth results in a small proportion of fast-growing firms, which play a crucial role in generating new private employment. Despite significant entrepreneurial potential, the density of new businesses (new business registrations per 1,000 people ages 15–65) has historically been low and has slightly declined since 2008. As of the data available for 2014, there were only 0.43 new businesses for every 1,000 people, contrasting with figures of 0.86, 1.00, and 3.20 for Brazil, Turkey, and OECD members, respectively (World Bank 2019; Gurcanlar *et al*, 2021). Consequently, due to the limited firm growth and private sector dynamism, productivity-led growth in Argentina has been limited (Gurcanlar *et al*, 2021).

When examining the causes behind Argentina's performance in innovation indicators, it is crucial to highlight the impact of limited financial markets, which hampers the country's ability to finance technology, innovation, and entrepreneurship. Factors such as credit constraints and the destabilizing effects of uncertainty contribute to the underinvestment in innovation. Argentina's credit to the private sector stands at a low 14 percent, notably below the Latin America and Caribbean average of 44 percent. Moreover, the historical average interest rates exceed 30 percent, reaching as high as 73 percent in 2019 and stressing even higher values for the small and medium enterprises. According to the Global Entrepreneurship Monitor, the availability of financing for entrepreneurs in Argentina is lower than in any of its regional and structural peers, receiving a

score of 1.93[20] (Chile had a score of 1.93 while Brazil scored 2.92). Regarding venture capital funding, rough estimates of US$100 million to US$200 million in commitments or funds raised in 2017–18 indicate a nascent but growing venture capital investment scene. At the high end of the estimate, total venture capital funding amounts to 0.03 percent of Argentina's 2017 GDP; by contrast, the average OECD country allocated 4.16 percent of GDP to venture capital in 2016 (Gurcanlar *et al*, 2021).

In conclusion, Argentina's innovation ecosystem poses challenges, marked by deficiencies in R&D and minimal private sector engagement. The country also grapples with gaps in STEM education, hindering its potential for growth. Additionally, limited firm growth and productivity, primarily due to the dominance of small enterprises, negatively impact productivity-led growth. Argentina faces also financial hurdles due to limited markets, featuring low private sector credit, historically high interest rates, and low venture capital commitments. Despite these challenges, Argentina boasts an extensive research base and high-quality research, representing positive aspects within the innovation ecosystem.

[20] The value is calculated on a scale of 1 to 9 where 1 represent a very inadequate insufficient status and 9 a very adequate sufficient status.

3.3 THE TRANSFER OF TECHNOLOGICAL INNOVATION IN ARGENTINA

The transfer of technological innovation is an important driver for the economic growth, and in the case of Argentina, it's particularly a resource for overcoming complex economic situations. For this reason, and analogously to what has been seen in the case of the transfer of technological innovation in Italy, an analysis of the practices in which the transfer mechanism takes shape in Argentina is proposed. As in the case study of Chapter 2, the analysis is organized by referring to the classification of the actors of the innovative ecosystem proposed by the Triple Helix Model namely businesses, universities and government, and with an integration on so-called hybrid entities.

3.3.1 The transfer of technological innovation by Argentine universities

In Argentina the university plays a prominent role in the field of technological innovation transfer. However, before delving into the specifics of the topic, it is essential to highlight a peculiarity of the Argentine university system: the concentration of the majority of higher education institutions in a limited part of the country, namely the province and the city of Buenos Aires. As one can imagine, this unique aspect has an impact on the diffusion of innovation within these institutions across the territory. In detail, the Argentine Higher Education System is regionally organized to facilitate planning and coordination with 7

identified regions (Consejos Regionales de Planificación de la Educación Superior (CPRES)). Two of these regions are associated with universities located in the city and province of Buenos Aires, once again emphasizing the significant influence of this region on the entirety of the territory. This phenomenon becomes even more pronounced when analyzing the growth rate of higher education institutions and their locations in recent years. In fact, from an analysis of data between 2000 and 2015 related to the expansion of the university system (including both the creation of new universities and the establishment of new higher education institutes), the most striking case is that of the Metropolitan Region[21], that sow an increase of 111%, and Buenos Aires Regions, that experiment a 60% increase. Furthermore, in 2015, the Metropolitan Region accounted for 40.9% of the country's university courses, followed by the Central Region[22] at 15.4% and the Buenos Aires Region at 13.2%. Examining specific educational offerings, the Northwest[23], Buenos Aires, and Central Regions led in applied and technological sciences although these disciplines have a reduced weight in the total national academic supply.

[21] The Metropolitan Region (*CPRES Metropolitano)* refers to the area of the city of Buenos Aires and some municipalities of the Province of Buenos Aires (Consejos Regionales de Planificación de la Educación Superior (CPRES), s.d.).
[22] The Central West Region (*CPRES Centro)* refers to the provinces of Cordoba, Entre Rios y Santa Fe(Consejos Regionales de Planificación de la Educación Superior (CPRES), s.d.).
[23] The Northwest Region (*CPRES Noroeste)* refers to the provinces of Catamarca, Jujuy, Salta, Santiago del Estero and Tucumán. (Consejos Regionales de Planificación de la Educación Superior (CPRES), s.d.).

Returning specifically to the transfer of technological innovation in the university context, it is necessary to highlight the concept of the third mission of universities, (defined in Spanish as) the *extension universitaria* (university extension). The concept of university extension first appeared in Argentina in 1905 when it was incorporated into the statute of the National University of La Plata, alongside research and teaching activities. In contemporary times, the legitimacy of this function is grounded in the *Ley de Educación Superior* (Higher Education Law) number 24.521 of 1995, which defines, among other things, that within the basic functions of Argentine university institutions there is "Create and disseminate knowledge and culture in all its forms" and also to "Extend their action and services to the community, contributing to its development and transformation, studying in particular national and regional problems, and providing scientific and technical assistance to the State and the community" (Ley Nacional de Educacion Superior No. 24.521,1995; Herrera Albrieu, 2012). This law also stipulates that the organization of extension activities must be specifically regulated by individual universities which identify internal mechanisms for evaluating extension activities. However, the same law also provides for the establishment of a National Interuniversity Council aimed at coordinating plans and activities in academic, scientific research, and extension matters among university institutions within their respective areas (Ley Nacional de Educacion Superior No. 24.521 , 1995). Therefore, is revealed on one side the need to maintain a profound

relationship between university and society, while, on the other hand, the need to develop a control system for the activities carried out in this area; also for this reason emerge a dual dimension of planning and evaluation of university extension activities: one conducted by individual universities and another carried out by a national-level entity.

The operationalization of the third mission is entrusted to technology transfer offices present in most universities across the territory. However, it is essential to highlight a distinctive aspect of Argentine universities: the concept of the fourth mission, materialized through the so called *Vinculación Tecnológica* (Technological Linkage). More specifically, following the profound crisis experienced by the country in 2001, universities explored channels to rethink their role, confirming or redefining their founding missions. They created and recreated spaces to play a leading role in the reconstruction of the social fabric, democratic continuity, and economic recovery that followed the crisis. This social function will no longer be channeled solely through the historical university extension but will be expanded to other areas, actors, and institutions, leading to a transition from technological transfer, a predominant unilateral link in the 1989-2001 period, to a more comprehensive bilateral concept of greater scope and complexity: Technological Linkage (Tamaño and Eciolaza, 2009; Erreguerena , 2021). This specialization involved an implicit division of tasks, topics, and prioritized actors in the interaction, where technological linkage is primarily oriented towards

solvent demand (mainly companies and the government). By contrast, extension will be directed primarily towards the cultural sphere and interaction with actors, organizations, and social movements without the capacity for remuneration (Erreguerena , 2021). Therefore, university extension refers more to the implementation of projects in the community, for example with citizens, while technological linkage refers more to the management of relationships with other organizations aimed at, for example, the realization of joint research projects. From a purely conceptual point of view, university linkage should not be understood as an expansion of the concept of university extension but as a new function. From an empirical standpoint, based on a study of the statutes of 58 Argentine universities, it emerges that in 62% of the analyzed statutes, the classic triad of teaching, research, and extension is defined as the substantive function of universities. Meanwhile, in 38% of cases, the recognition of a fourth function is also acknowledged (Erreguerena, 2021). Going into more detail about the extension projects, from a strictly funding perspective, these projects can find space within the budget of universities or in the so-called *Convocatoria a Proyectos de Extensión* (Call for Projects of Extension) which is a call for interdisciplinary teams from institutions aimed at developing specific solutions for various issues in the social, cultural, and productive environment of the territories where are located. Analyzing the data, over the years, funding from the university policy secretary for extension projects has been substantial, experiencing a

positive trend; the number of funded projects increased from 36 in 2008 to 266 in 2011 (Herrera Albrieu, 2012).

Therefore, the third and fourth missions of Argentine universities represent a significant source of knowledge dissemination in the territory, encompassing both technological and non-technological aspects. However, as previewed in Chapter 1, the exploitation of intellectual properties also plays a predominant role in the technology transfer process. For this reason, the analysis of the patenting activity within the university system is of particular interest. According to an analysis carried out by *Universidad Nacional del Litoral* (National University of the Litoral, UNL) on patent applications filed in Argentina over the last 20 years by 70 institutions belonging to the *Consejo Interuniversitario Nacional* (CIN, National Interuniversity Council), it emerges as 34 of these institutions have submitted at least one patent application at the national or international level (Serrano *et al*, 2023). A total of 647 patent families were identified, with the majority (57%) being developed in collaboration with National Scientific and Technical Research Council (CONICET), mainly due to the presence of researchers employed by both the university and CONICET or those conducting research activities in multiple research institutes. Out of the 647 patent families, comprising 1129 patent applications filed in 41 territories, 49.1% include at least one granted patent application. Notably, the analysis reveals that the National University of the Litoral (UNL), the University of Buenos Aires (UBA), and the

National University of Rio Cuarto concentrate the majority of patent families globally, accounting for 17.9%, 16.5%, and 9.3%, respectively. Regarding the filed and granted patents, the UNL recorded a total of 229 patent applications and 95 granted applications, the UBA reported 170 total patent applications and 65 granted applications, while the University of Quilmes had 98 total patent applications and 54 granted applications (Serrano *et al*, 2023). In the analysis of patent holders, collaborations with companies and science and technology institutions were identified, particularly with InisBiotech (4.6%), the National Atomic Energy Commission (2.5%), and the National Institute of Agricultural Technology (1.9%). In terms of technological fields, the biotechnological sector presented the highest number of applications (144), followed by pharmaceutical products (98) and metrology (76). UNL filed the highest number of patents related to the biotechnological industry (40%), followed by UBA (25%) and UNLP[24] (13%).Concerning the geographical distribution of patent families, the majority (608) are for Argentina, with only 1 in Italy (Serrano *et al*, 2023). Therefore, in recent years, there has been an increase in the number of patents granted by universities across the territory, with a predominance of collaborative agreements with CONICET and the national maintenance of such patents.

[24] *Universidad Nacional de La Plata*, National University of La Plata.

3.3.2 The transfer of technological innovation by Argentine government entities

The role of government organizations as drivers of technological innovation transfer is undeniable. Similarly to the Italian case, the following is an analysis of the technological innovation transfer activities carried out in Argentina's most important public research centers: the National Council for Scientific and Technical Research, the National Institute of Agricultural Technology, the National Institute of Industrial Technology and the National Atomic Energy Commission.

The National Council for Scientific and Technical Research (CONICET, *Consejo Nacional de Investigaciones Científicas y Técnicas*) is the main entity dedicated to promoting science and technology in Argentina. The institute count over 11,800 researchers, more than 11,800 doctoral and postdoctoral fellows, over 2,900 technical professionals supporting research, and approximately 1,500 administrative staff. They operate across the country in 16 scientific and technological centers, 8 research and transfer centers, a multidisciplinary research center, and over 300 exclusive CONICET institutes and centers in collaboration with national universities and other institutions. In terms of technology transfer activities, as of 2023, CONICET has founded 52 technology-based companies, offered 15,200 high-level technical services by 2022, and conducted 3,800 consultations and agreements in the same year (CONICET). Delving into the

specifics of the binding activities, these are divided in relation to the beneficiary entity.

- “Organizations”. CONICET provides advice to institutions and civil society on the implementation of public policies related to innovation, social inclusion, and environmental sustainability. Specific activities include technical assistance (such as diagnostics, studies, and tests related to public policies), research and development projects, technology licensing (both for previously protected technologies and knowledge developed by researchers), high-level technical services (the use of specific machinery), and local government programs (training programs for local communities) (CONICET).
- “Companies”. CONICET's activities focus on improving the technological and competitive capacity of SMEs, cooperatives, and large companies with cutting-edge technology for innovation. Detailed services include technical assistance (addressing complex technical or scientific issues for companies, SMEs, or cooperatives), commercial technology licensing (allowing both the licensing of pre0viously protected technologies or knowledge developed by researchers), creation of technology-based companies (formed through the participation of CONICET researchers and professionals as entrepreneurs, and institutional and private investors supporting these initiatives), confidentiality agreements (regulating the exchange of information between CONICET and companies), high-level technical services, specialized personnel incorporation

(allowing CONICET researchers and fellows to work in the business environment through researchers in companies and co-financed scholarships), and research and development projects in companies (research groups can collaborate with companies, SMEs, or cooperatives for innovation, generating new knowledge, developments, and/or improvements to products or processes) (CONICET).

- "CONICET Community". CONICET supports researchers, support staff, and fellows in project development, knowledge transfer, and tools for technological linkage. This is achieved through agreements, intellectual property contracts, confidentiality agreements, material transfer agreements, technological and social development projects (projects aimed at solving market needs and having an adopter and/or demander, whether public or private, for the developed technology), incorporation of specialized personnel (through researchers in companies and co-financed scholarships), as well as technology-based companies and high-level technological services (CONICET).

The National Institute of Agricultural Technology (INTA, *Instituto Nacional de Tecnología Agropecuaria*) is the largest institute in Argentina for research and extension in the agro-bioindustry sector, conducting also research related to human and animal health. Fundamental to its institutional mission are innovation projects developed in the territory, facilitated by over 400 INTA units nationwide

and 6 international field research centers. The organization plays a crucial role in rural extension and development through information and knowledge exchange processes, fostering innovation capacities within rural, urban, and peri-urban communities (INTA). The system comprises over 330 extension units located throughout the country focused on agricultural, agri-food, and agro-industrial sectors, social inclusion, food security, and sustainable management of natural resources (INTA). Below are examples of recent extension projects active in the territory.

- A.E.R. Justiniano Posse. This extension unit, located in Justiniano Posse, Cordoba province, provides technical advice for the development of agricultural machinery, strengthens agro-industry at its origin, and promotes exports throughout the central region of the country (INTA).
- A.E.R. Concarán. Located in the province of San Luis, this unit addresses topics such as production systems in breeding and feedlots, forage, soils, water resources, irrigation, cereals, and crops under irrigation (INTA).
- Campo Anexo Los Cerrillos. Located in the city of Chamical (La Rioja), the extension unit covering an area of 8,000 hectares where are conducted experiments on breeding herd management, natural and introduced pastures, among other activities (INTA).

Additionally, other actions are carried out in the territory, including training courses, consulting activities, and product and service trials.

The National Institute of Industrial Technology (INTI, *Instituto Nacional de Tecnología Industrial*) is the main institute in Argentina for industrial technology and metrology. It provides, among other things, assistance and training to SMEs enhancing their growth by promoting optimization and innovation processes, ensuring better quality and a broader range of services. With 52 technological centers distributed nationwide, INTI offers over 5000 services for industries and is involved in approximately 200 research and development projects. The services provided range from technical assistance, analytical services, tests, and knowledge transfer specifically designed for SMEs. INTI offers technical assistance in current regulations, documentation, and certification in regulated services that require technical approval. The institute also provides a wide range of seminars, courses, and programs to transfer its capabilities to the community. Additionally, INTI promotes innovation and technological transfer to address current and future challenges faced by businesses (INTI, Instituto Nacional de Tecnologia Industrial, 2023). In the strategic area of technological transfer, INTI has developed various flexible models to cater to different industrial sectors, ensuring implementation according to their needs and possibilities (shared risk). These services include cooperation agreements, contracts (generic, specific, exclusivity, or with shared risk through royalties), patents, licensing, among others. The institute boasts a vast team of specialists with industrial experience in various sectors, supported by specialized service areas in design, marketing, communication, and marketing.

Utilizing state-of-the-art equipment, pilot plants, and advanced laboratories, INTI conducts multidisciplinary analyses of problems, challenges, and opportunities in the sector. It diagnoses products, processes, and services comprehensively, proposing alternatives to generate greater value, development, and sustainability. From its origins, INTI has actively involved the private sector and established connections with peer institutions worldwide, fostering the transfer of design, prototypes, development, formulation, construction, and/or technologies. This collaboration extends to companies in food, energy, mobility, and other industries, as well as various areas of knowledge. Additionally, INTI promotes technological development and innovation in productive ecosystems to contribute to sustainability through collaborative management models; the institute strengthens the value chain by developing with local natural materials, promoting clean energy, and encouraging collaborative production in harmony with the environment (INTI).

The National Atomic Energy Commission (CNEA, *Comision Nacional de Energia Atomica*) is an Argentine governmental agency with a mission to develop and regulate nuclear energy for peaceful purposes in the country. Currently, CNEA operates three main research centers and various smaller units throughout the country conducting research in both nuclear and non-nuclear fields. CNEA has a longstanding tradition of transferring knowledge generated from its research and development activities in both nuclear and non-nuclear domains. In this context, it

fosters collaborations with national organizations and companies, both in the public and private sectors, aiming to enhance national socio-productive development through technological innovation. The agency's scientific research, spanning basic and applied sciences, and technological developments across various disciplines, enable CNEA to provide a wide range of technological assistance in areas such as energy, health, environment, industry, agriculture, among others. CNEA has a portal listing available services with descriptions, laboratory or department details, locations, and links for processing requests (Comisión Nacional de Energía Atómica, s.d.).

To conclude, Argentine government organizations, including CONICET, INTA, INTI, and CNEA, actively drive technological innovation and knowledge transfer in diverse sectors, ranging from agriculture and industry to nuclear energy, contributing significantly to national development.

3.3.3 The transfer of technological innovation by Argentine companies

The entrepreneurial world plays a crucial role in transmitting technological innovation to the market and in Argentina, startups play a leading role in this process. In recent years, there has been a surge in technology companies whose funding has been boosted by investors with excess liquidity faced with the significant market growth potential, high monetary emission from central banks in the context of the pandemic, and the availability of talent in the Latin American

region. Despite facing challenges such as administrative complexity, legal, labor, and financial bureaucracy, and a volatile economic, political, and social scenario, Argentina has positioned itself as one of the most valued startup ecosystems in Latin America. The country boasts talented professionals on a global level and a unique competitiveness within its environment (González Gozalo, 2022). Geographically, entrepreneurial activity is concentrated in the capital (Ciudad Autónoma de Buenos Aires or CABA) and other cities in the province of Buenos Aires, accounting for 67.5% of the national total startup. This is followed by the province of Cordoba that account for 22.5% and Tucuman at 5% (González Gozalo, 2022). Regarding sectoral distribution, notable verticals include biological technology (BioTech), financial technology (FinTech), agricultural technology (AgroTech), software services (SaaS), and commerce. Argentina has a special and differential potential in biotechnology, with a solid tradition in science and an excellent human capital. The agriculture and food industry technology (AgriFoodTech) sector are also highly relevant both nationally and globally (González Gozalo, 2022). Internationally, Buenos Aires stands out as the true focus of the Argentine entrepreneurial system, receiving recognition worldwide; in fact, according to the Global Cities Competitiveness Index, contained in the Global Talent Competitiveness Index (2021), positions the Argentine capital as the most competitive city in Latin America, ranking 103rd globally (INSEAD, 2021). As for unicorn companies (which are startups with a valuation exceeding 1 billion

dollars) Argentina currently boasts 12 unicorns, making it the second country with the most unicorns in all Latin America, behind only Brazil. These unicorns exemplify the success of the Argentine entrepreneurial system, serving as significant employers of high-quality resources and contributing to the development of local SMEs playing also a crucial role in talent development in the technology sector. Despite Latin America accounting for only 1.5% of global Venture Capital, Argentina represents 10% within this percentage. Despite these figures indicating a relatively small ecosystem, the high number of unicorns, among other factors, demonstrates its significant relevance (González Gozalo, 2022).

In order to analyze the transfer of technological innovation carried out by the so called traditional companies, reference is made to a survey on the use and dissemination of ICT conducted in 2010 and involving around 1,100 companies in the main urban centers of Argentina, carried out by the Division of Productive Development and Entrepreneurship of CEPAL. Specifically, the innovative capabilities of the firms can be measured in terms of efforts and results. In terms of efforts, it is worth noting the limited presence of teams engaged in upgrading activities within the company, as that activities of improvement, adaptation and development of new products and processes or changes in strategic function as marketing or logistics. In fact, 86% of the companies do not have any formal or informal teams dedicated to improvements and, by consequence, only 14% of

companies allocate resources to groups of improvement and development. These types of activities are mainly carried out by multinational companies where 38.5% of foreign companies have declared to have such a team unlike national companies where only 13% said they had one. On the size of companies, it emerges as a research and development area is present in 32.5% of the large companies analyzed, while only in 9% of the small companies. At the sectoral level, the differences are not as noticeable, although there is a greater presence of improvement groups in the industry and services compared to commerce activities (Novick & Rotondo , 2013).

In terms of the results of innovation processes, analyzing the importance of new products introduced by companies in the billing of 2009 since 2003, is showed as only 19% of companies show a high impact of new products on the 2009 billing (weighing more than 50% of sales). A significant impart is registered mainly for multinational companies where new products introduced since 2003 had a significant impact on 2009 sales, as that of the 46%, compared to 18% in national companies. The highest impact is evident in large companies (29%), mainly in the in the economic sector of trade (24.2%) (Novick & Rotondo , 2013).

Before to conclude this section, it is necessary to analyze the innovative activity of SMEs. To do this, reference is made to the study conducted by Borello (2016) based on the data of the Mapa Pyme (2008) where is analyzed the innovative activity carried out by SMEs (defined as companies with more than 4 employees

and a maximum of 250) between 2006 and 2008 in the manufacturing and services industries. In general, out of a total of 39,975 industrial and service establishments, approximately 23% (9,167 cases) engage in innovation activities. Going into detail on the analysis of the distribution of innovation carried out by these companies, the following chart illustrates the orientation of investment in innovation.

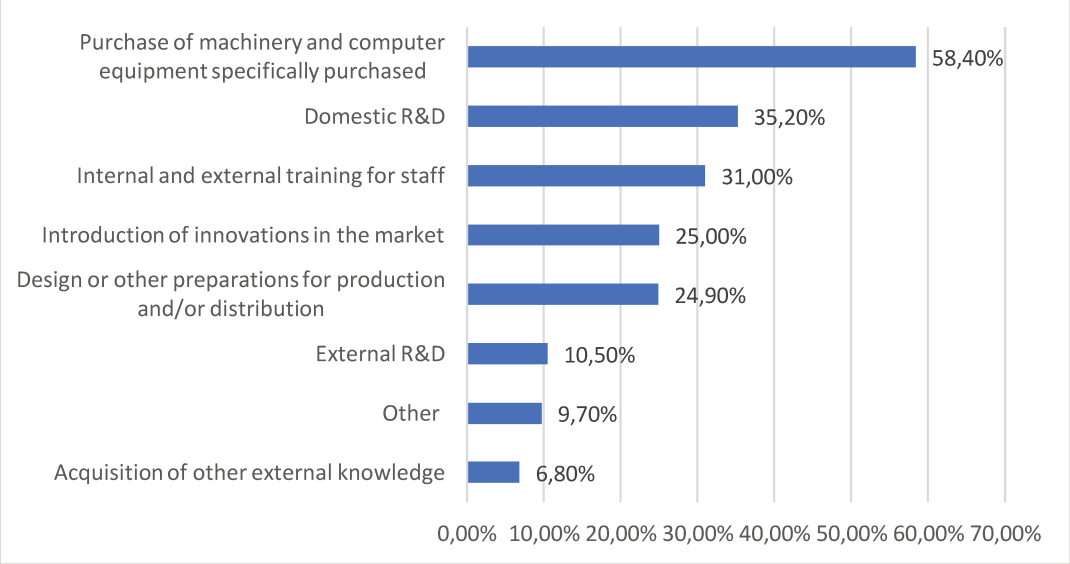

Table 3.1 – "Percentage of mentions regarding the orientation of investment in innovation (industry and services)". Source: Borello, 2016.

It emerges that the majority (58.4%) of the establishments that carried out innovations did so through the acquisition of machinery and computer equipment, as that through an incorporated innovation. However, it is noteworthy the importance of activities related to design or other preparations for production and/or distribution, mentioned by a quarter (24.9% of respondent companies) of

the firms engaged in innovation activities. In terms of geographical distribution, a significant portion of these establishments was concentrated in the main jurisdictions of the country: the province of Buenos Aires and the Autonomous City, Santa Fe, and Córdoba; these jurisdictions accounted for just over 76% of the innovations carried out by manufacturing and service companies of this size (Borello, 2016).

To conclude, Argentina's thriving startup ecosystem, especially in Buenos Aires, drives technological innovation globally. Traditional companies face challenges, and SMEs show a noteworthy focus on innovation, particularly in machinery acquisition and design-related activities.

3.3.4 The transfer of technological innovation by Argentine hybrid entities

Analogously to what has been observed in the Italian case study, in Argentina, it is also possible to identify hybrid organizations that play a significant role in the process of transferring technological innovation to the market or between other organizations. Below is an analysis of some institutions present in the Argentine territory: the Technological Park of Litoral Centro, Leloir Institute Foundation, INICIA Community of Entrepreneurs and, CEDyAT Argentine Technological Linkage Center.

The technological parks are spaces dedicated to the establishment of scientific and technological-based industries with a focus on innovation (Ministerio de

Economia , 2019). In Argentina, there are very interesting experiences in this regard and one of the most prominent is the *Parque Tecnológico del Litoral Centro* (Technological Park of Litoral Centro), located in the city of Santa Fe and promoted in the 1990s by the Province of Santa Fe, the Municipalities of Santa Fe and Paraná, the National University of Litoral, and CONICET. Currently, the park counts 23 companies operating in various stages of development, providing 500 jobs, and contributing to 42% of the city's exports. Specifically, companies that want to settle in the park are offered the opportunity to participate in the "entrepreneurial development model" structured in four phases:

- Pre-incubation. For incipient projects, the pre-incubation area has trained personnel who assist in formulating the business plan until the completion of the prototype, providing basic infrastructure.
- Incubation. The Incubation space is ideal for the company's formation and market entry period. They promote the development of ventures over a period of 24 months with the possibility of extension.
- Pre-location. Are offered company containers where entrepreneurs can build facilities related to economic activity and functional project needs. For ICT, there is a business condominium that houses ventures requiring small office spaces.

- Location. Established companies have spaces with tax benefits, consulting services, and the advantages of the scientific-technological, educational, and business environment.

The Technology Park Litoral Centro forms an urban ecosystem where the scientific-technological, governmental, academic, and business sectors coexist. In fact, the proximity and connection to CONICET and UNL represent additional significant sources of technological acquisition for the businesses located within it (Parque Tecnológico Litoral Centro S.A.P.E.M.).

The *Fundación Instituto Leloir* (Leloir Institute Foundation) is a public-interest with private management institute that is dedicated in research and the training of young scientists. The institute operate mainly in the production of knowledge in life sciences, with work undertaken in areas such as neuroscience, microbiology and infectious diseases, cancer, cellular, molecular, and developmental biology, as well as plant biology. Furthermore, in 2006, in order to reaffirm the commitment of the institute with the society, has been created the INIS Biotech, a technological transfer arm (Instituto LeLoir Fundacion). In detail, the technological transfer activity is articulated in the following functions:

- Technological services: research and development activities for testing and/or improvement of drugs, therapies, diagnostic tests in the health field, and/or food and agricultural inputs.

- Business consulting in the life sciences field, in the formulation of high-tech innovation projects, and in the management of technological businesses, including public-private consortia between companies and researchers, as well as scientific entrepreneurs.
- Research and development agreements with interested parties may be established, or technologies may be transferred under licenses for use and exploitation, enabling companies and/or entrepreneurs to progress in the innovation process in the health and agricultural input sectors.
- Linkage between researchers (Inis Biotech).

The business incubators play a predominant role in Argentina's economic system, similarly to Italy, and can have public, private, or mixed nature. As of 2018, approximately 498 startup incubators were active and registered with the Ministry of Production (Murúa, 2018). Among them, INICIA *Comunidad de Emprendedores* (Community of Entrepreneurs), based in Buenos Aires, holds a prominent position. It is the largest community of entrepreneurs in the country, having supported over 30,000 entrepreneurs in its 15 years of existence with training programs, development initiatives, networking opportunities, mentoring, coaching, and more. The primary goal is to promote the creation and development of sustainable ventures that contribute to economic, social, civic, or environmental value for society. The community comprises over 18,000 members with over 400 volunteers providing training, support, and assistance to entrepreneurs (INICIA).

Among the various services offered, the concept of open innovation stands out, aiming to connect organizations and entrepreneurs to address the challenges posed by innovation. In more details, the innovation model that is used has the objective of invigorating organizational innovation processes by directly connecting with entrepreneurs and startups, enabling them to capture talent, technology, and new business models, among other aspects. This is achieved through the implementation of a three-stage program (INICIA):

1) Hackathons: Defining company challenges presented to entrepreneurs, students, developers, designers, etc., seeking innovative and disruptive solutions. Duration: 4 months.
2) Contests: Generating an open call through which the company attracts entrepreneurs presenting ideas contributing to more efficient processes in their value chain. Duration: 9 months.
3) Incubation: Working with groups of entrepreneurs over periods of 6 to 9 months, providing coworking spaces, mentorship, and facilitating access to investment. Total duration: 12 months.

The CEDyAT *Centro de Vinculación Tecnológica Argentino* (Argentine Technological Linkage Center) is driven by scientists, educators, computer scientists, researchers, professionals, and technologists who collaborate to assist in management and promote technological innovation in the country. Its objective is to facilitate organizations' access to systematic work for deepening technological

knowledge derived from research and/or practical experience. This work is aimed at optimizing organizational processes, improving service delivery, producing new materials, products, or devices, and establishing new processes, platforms, or computer devices, systems, or services, including the prototype construction phase, pilot plants, or demonstrative units, concluding with their homologation. The activities carried out by the organization range from collaboration agreements for technical assistance or the use of licenses. Additionally, specialized technological services are offered in sectors such as robotics and data analysis for companies (CEDyAT).

To conclude, in Argentina the hybrid organizations play a central role to booster innovation by promoting open innovation, research in life sciences and technological transfer, facilitates collaboration, technical assistance, and specialized services in areas like robotics and data analysis.

3.4 INTERNATIONAL TECHNOLOGY TRANSFER: FROM ORGANISATIONS OF LATIN AMERICA AND THE CARIBBEAN COUNTRIES TO ARGENTINA

The development of technological innovation in a country depends largely, but not exclusively, on its own resources. Especially in the face of current environmental and technological challenges, funding for the development of technological innovations from international organizations has been diverse, and Argentina has

not been exempt from this process. The impetus that such funding provides for economic growth is substantial and esse0ntial for understanding the potential future trends for a country. In detail, in this section are analyzed some programs of the Inter-American Development Bank and the World Bank Group developed in Argentina.

The Inter-American Development Bank (IDB) is a major source of long-term financing for economic, social, and institutional projects in Latin America and the Caribbean. The group comprises the IDB, which has collaborated with governments for 60 years, the IDB Invest, which works with the private sector, and the IDB Lab, which explores innovative ways to promote more inclusive growth (Chicola *et al*, 2021). In the specific case of Argentina, that is one of the founding member, the IDB's country strategy for the period 2021-2023 underscores key priorities such as poverty reduction, macroeconomic stability, and the integration of digital technologies. In this strategic framework, the IDB has identified four pillars to guide its operational activities: (i) poverty reduction and social protection for the most vulnerable, (ii) economic recovery and productive development 4.0, (iii) macroeconomic stability and public policy effectiveness, and (iv) digital transformation as a crosscutting contributor to development. Each pillar also places emphasis on environmental sustainability, diversity, and gender. The projected financial commitments for the 2021-2023 period amount to an average annual approval of $1.479 billion, with disbursements averaging around

$1.394 billion; additionally, net loan flows are anticipated to be approximately $458 million per year. Furthermore, the IDB's commitment extends beyond traditional financing, encompassing technical cooperation operations and knowledge products. In the realm of business services and public goods development, the IDB has supported innovative programs aimed at enhancing the technological innovation capabilities of companies and strengthening the country's scientific and technological research capacities. This includes providing financial assistance to Micro, Small, and Medium Enterprises (MSMEs) to boost competitiveness and value-added activities. Notably, technical assistance has been extended to numerous MSMEs, and support has been provided to improve the competitiveness of production clusters, as well as nurturing 467 start-ups (Inter-America Development Bank , 2021). One example of a project specifically dedicated to technology transfer is the "Transition towards Regenerative Agriculture for Environmental Impact Reduction", aproved in november 2023. The project aims to promote the transition to regenerative agriculture among small agricultural producers in Argentina through a systemic approach addressing the main limitations hindering its adoption: awareness, training, incentives, and financing. The project is allocated a funding of approximately $ 500,000 (Inter-America Development Bank , 2023). Another program in this field is the "Strengthening Technical, Environmental, and Social Capacities for the Governance of Lithium Resources in the Province of Jujuy" aproved in june 2019.

The objective of this technical cooperation is to support the responsible and sustainable development of the lithium sector in the province of Jujuy (in the north of Argentina), from exploration to extraction and sector governance. The technical cooperation has three main objectives: (i) strengthen the evaluation and technical and environmental control of lithium projects; (ii) support awareness efforts regarding the technical, environmental, and social dimensions of lithium mining and the adoption of effective multi-stakeholder relationship practices; and (iii) promote the exchange and dissemination of knowledge among lithium-producing regions. The funding for this project amounts to USD 1,350,000 (Inter-America Development Bank , 2023).

The World Bank Group operates across various developmental domains, offering a diverse range of financial products and technical assistance to help countries address their challenges through innovative knowledge and solutions. Since 1947, the World Bank has financed more than 12,000 development projects through traditional loans, interest-free credits, and grants. Taking a closer look at projects implemented in Argentina, an example is the "Unleashing Productive Innovation Project," which concluded in 2019. The primary goal of this project was to enhance Argentina's capacity for generating productive innovation in knowledge-based sectors by: (i) facilitating the establishment of new knowledge-based companies; (ii) upgrading research infrastructure in science, technology, and productive innovation; and (iii) reinforcing the policy framework governing

science, technology, and productive innovation. The project received a total funding of $230 million. In terms of impact achieved by this initiative, notable outcomes include the registration of 63 technology-based start-ups as formal companies (as of august 30, 2019), and an increase in the number of graduates in technology brokerage and technology management by 375 individuals (covering the period from december 31, 2008, to august 30, 2019) (The World Bank , 2023).

CHAPTER 4. COMPARISON OF TECHNOLOGICAL INNOVATION TRANSFER BETWEEN ITALY AND ARGENTINA

The purpose of this chapter is to highlight the similarities and differences in the manners technological innovation transfer occurs in Italy and Argentina. To provide a broader context for the analysis, the first part of the chapter offers a brief comparison of the innovation levels in Europe and Latin America and the Caribbean. Subsequently, the focus shifts to a more detailed examination of the Italian and Argentine cases. Following a comparison of the production systems in these countries, the innovation levels are compared, referencing key innovation variables. The third part of the chapter presents a comparison of the various modes of technological innovation transfer, referring to the four main actors identified in this process: universities, governmental entities, businesses, and hybrid entities. In the final section of the chapter, an analysis of international technological transfer opportunities between Italy and Argentina is proposed.

4.1 COMPARISON OF THE STATE OF INNOVATION BETWEEN EUROPE AND LATIN AMERICA AND THE CARIBBEAN

The Europe and Latin America-Caribbean regions are extremely diverse in various aspects, including economic, social, cultural, and geographic factors. These regions consist of countries with significantly different histories, yet they share certain points of contact, with the most recent being the substantial wave of

migration from Europe to Latin America after the Second World War. From an innovation perspective, Europe demonstrates a much higher level compared to Latin America and the Caribbean. The reasons behind this diversity are manifold. However, before delving into a detailed comparison of specific variables influencing innovation levels, some macroeconomic data are analyzed. Starting with GDP, according to World Bank data (GDP in current US$) for the European Union in 2022, it amounted to $16,746,223.63, whereas that of Latin America and the Caribbean (LAC) was $6,820,032.32 in the same year with a percentage change in the period 2012-2022 of 14.4% for the EU and 9.82% for LAC (World Bank, 2022). Regarding population data, the EU had a population of approximately 447 million people in 2022, while LAC had 659 million people. The percentage change in the period 2012-2022 was 1.3% for the EU and 9.46% for LAC (World Bank , 2022). Consequently, the GDP per capita (current US$) in Europe in 2022 was $37,432.6, with a growth of approximately 12.86% since 2012. In LAC, the GDP per capita (current US$) was $10,344.2, with a growth of 0.3% since 2012 (World Bank , 2022). From this brief analysis of some macroeconomic variables, it becomes apparent that despite a significant population growth in LAC countries, it has not been accompanied by a proportional increase in GDP. In contrast, over the past decade in Europe, the GDP increase and a limited population growth have resulted in a substantial per

capita GDP growth, unlike LAC, where the population growth has absorbed the GDP increase on a per capita basis.

Among the level of innovation in EU and LAC, following is proposed the analysis of some of the main indicators to understand the effort to innovate in a region. Starting with the analysis of gross domestic spending of research and development in terms of percentage, below a summary graph[25].

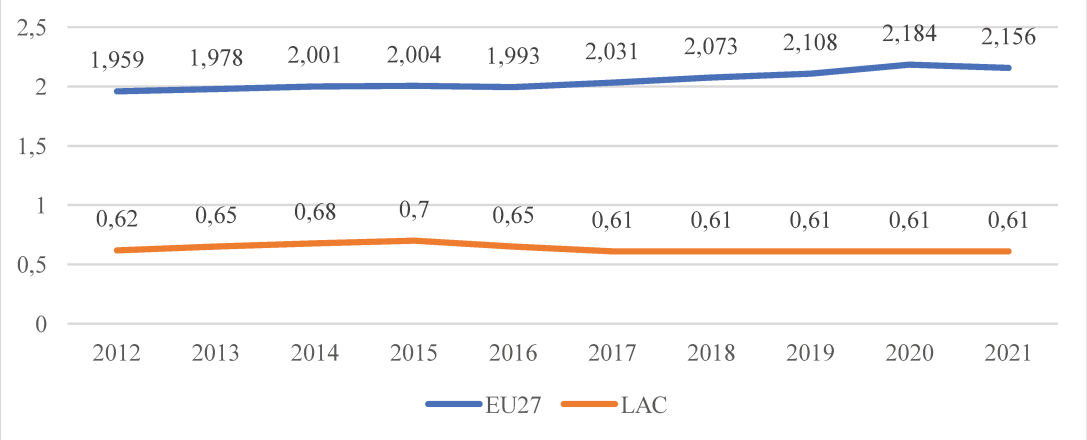

Figure 4.1: "Gross domestic spending on R&D UE27 – LAC, % of GDP, 2012 – 2021". Source: Own elaboration based on based on information from the Network of Science and Technology Indicators, RICYT (2024) and Organization for Economic Cooperation and Development, OECD (2024).

From the graph, it is evident that the percentage of GDP invested in the European Union is significantly higher than the same parameter for Latin America and the Caribbean, by an amount of 253.44%. Going into further detail, during the period from 2012 to 2021, the trend of this parameter is diverse in the two regions: increasing in the case of the EU (a positive variation of 10%), while a

[25] As for the data concerning the European Union, reference is made to the 27 member states.

predominantly stagnant situation is observed in the case of the Latin American and Caribbean countries, with a decrease of 0.62% during the considered period. Investigating the causes of these trends is not the subject of this paper; however, a more comprehensive understanding of the phenomenon can be provided by analyzing the distribution of funding for R&D activities, referring to the following funding sources: business enterprise sector, government sector, higher education sector, private non-profit sector, and the rest of the world.

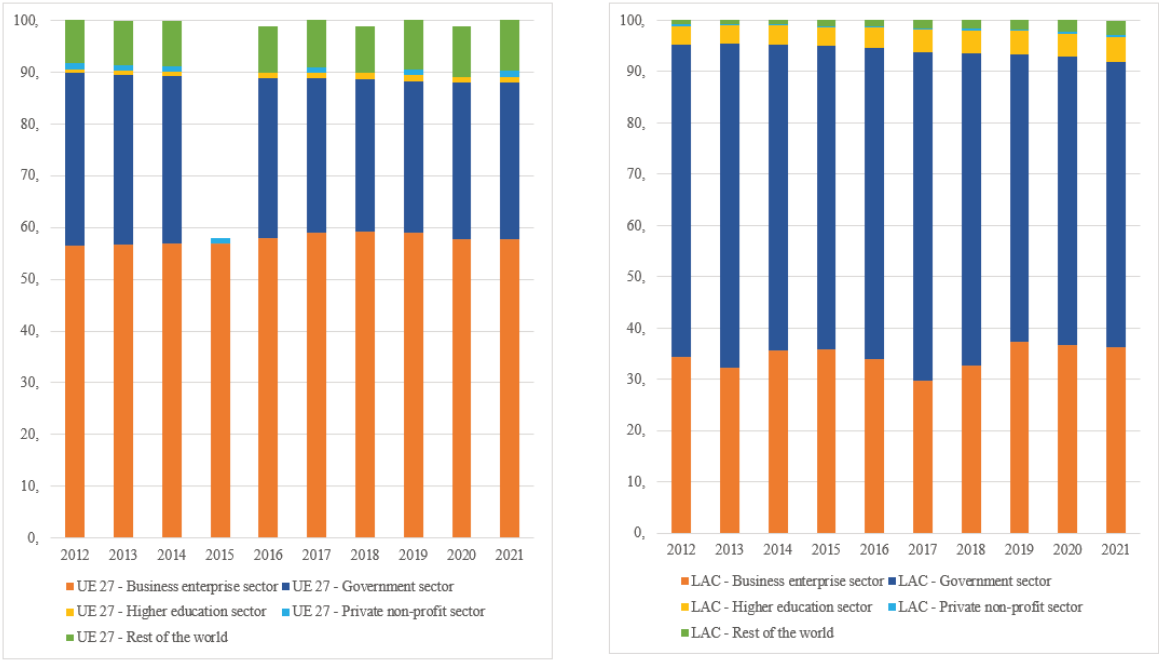

Figure 4.2: "R&D expenditure by source of funds – UE and LAC, % of the total, 2012 – 2021". Source: Own elaboration-based on data from EUROSTAT (2024) and Network of Science and Technology Indicators, RICYT (2024).

The graph reveals a substantial difference in the modes of financing research and development activities between these two regions. Europe is characterized by a prevalence of funding originating from both public and private enterprises, in

contrast to Latin America, where government funding prevails. In more detail, in 2021, concerning the "business enterprises sector" in the EU, it amounted to 57.65%, while in LAC, it was 36.22%. Regarding government funding in the same year, in the EU, it was 30.29%, while in LAC, it was 55.67%. Concerning other funding sectors, it emerges that in the EU, greater relevance is represented by the "rest of the world," accounting for 3.7% of the total in 2021. This variable, however, holds a smaller weight in LAC countries, where it represents 2.79%. However, a distinctive factor in Latin America is the significant weight of the higher education sector in R&D, representing 4.93% of the total, compared to 1.19% in Europe. The only similarity between these two regions is the limited weight of R&D financing from the private non-profit sector. In terms of trends, it is evident that both in the EU and LAC, higher education R&D activities increased by 56.58% and 37.32%, respectively, between 2012 and 2021. Another similarity is observed in the negative trend of government funding, with a reduction of 9.12% in the EU and 8.53% in LAC during the considered period. Thus, a contrasting situation emerges: the EU with a predominant weight represented by business financing and LAC with government funding. Additionally, among the "minor" financiers, sources from non-EU countries stand out in the EU, while in LAC, this role is predominantly attributed to higher education institutions. Nevertheless, trends between the two blocs of countries during the period 2012-2021 are similar in terms of positive trends by higher

education institutions and negative trends for the public sector. Another indicator of the state of innovation that can be considered is the number of patent applications filed and granted. According to data from the World Intellectual Property Organization, the share of world total patent applications in the EU in 2021 was 10.5%, while granted patents were at 11.8%. In contrast, for the Latin American and Caribbean region, these values were 1.6% and 2.6% of the global total, respectively. This highlights a substantial difference in the number of patent grants, with European grants being 22.06% higher than those in LAC in 2021 (WIPO, 2024). However, analyzing the historical evolution of LAC reveals that from 2011 to 2021, despite a reduction in the number of patent applications, there was a remarkable increase of 137.8% in the number of patent grants. In comparison, the EU experienced a 35.92% increase in the same period. Furthermore, during the 2011-2021 period, it is noteworthy that the share of world total patent grants decreased for Europe (22.48%) and increased for LAC (36.62%). Therefore, it emerges that there may have been an improvement in terms of the quality of the innovations in LAC countries, as it has resulted in an increase in granted patents despite a reduction in patent applications. In contrast, the EU's increase in the number of patents obtained was accompanied by a simultaneous increase in the number of applications. A significant distinction arises in the resident share of the total worldwide, with a rapid increase in LAC of patents obtained by non-resident companies and a reduction in the EU.

To conclude, Europe outpaces Latin America and the Caribbean in innovation, with higher GDP per capita and greater investment in research and development (R&D). Europe relies on a mix of public and private sector funding, while LAC leans heavily on government funding, especially in higher education. In spite of a declining trend in patenting rates when compared to European nations, countries in the Latin America and Caribbean region are exhibiting positive developments in terms of patent quality, specifically in the granting process.

4.2 CONFRONTATION OF THE STATE OF INNOVATION BETWEEN ITALY AND ARGENTINA

Moving now into the details of the two proposed case studies, namely Italy and Argentina, a comparison is presented on the state of innovation in these countries. Once again, an overview is provided to give context to the differences and peculiarities of the productive systems of these countries, and then the focus shifts to the comparison of certain variables that determine the level of innovation.

4.2.1 Bried comparison between the Italian and Argentine economic systems

From a general perspective, Italy and Argentina are two extremely diverse countries, and summarizing such diversities comprehensively is a complex task due to the multidisciplinary nature of the analysis. Nevertheless, the table below, relying on World Bank data, provides a summary by organizing key variables into

four themes (social, economic, environment, and institutions) to grasp these diversities.

	ITALY	ARGENTINA	Year
SOCIAL			
Poverty headcount ratio at $2.15 a day (2017 PPP) (% of population)	0.8	1	2020
Life expectancy at birth, total (years)	83	75	2021
Population, total	**58,940,425**	**46,234,830**	2022
Population growth (annual %)	**-0.3**	**0.9**	2022
Net migration	28,021	2,344	2021
Human Capital Index (HCI) (scale 0-1)	0.7	0.6	2020
ECONOMIC			
GDP (current US$)	**2,049.74**	**631.13**	2022 billion
GDP per capita (current US$)	**34,776.4**	**13,650.6**	2022
GDP growth (annual %)	**3.7**	**5**	2022
Unemployment, total (% of total labor force) (modeled ILO estimate)	**8.1**	**6.5**	2022
Inflation, consumer prices (annual %)	8.2%	50.9%	2022
Personal remittances, received (% of GDP)	0.5	0.2	2022
ENVIRONMENT			
CO2 emissions (metric tons per capita)	4.7	3.4	2020
Forest area (% of land area)	32.5	10.4	2021
Access to electricity (% of population)	100	100	2021
Annual freshwater withdrawals, total (% of internal resources)	18	13	2020
Electricity production from renewable sources, excluding hydroelectric (% of total)	22.5	1.9	2015
People using safely managed sanitation services (% of population)	79	46	2022
Territorial extension	**302.073 km²**	**3.761.274 km2**	2024
INSTITUTIONS			
Intentional homicides (per 100,000 people)	1	5	2021
Statistical performance indicators (SPI): Overall score (scale 0-100)	89.8	64.6	2019
Individuals using the Internet (% of population)	85	88	2022
Proportion of seats held by women in national parliaments (%)	32	45	2022
Foreign direct investment, net inflows (% of GDP)	**1.5**	**2.4**	2022

Table 4.1 "Italy and Argentina country overview based on the 4 main topics". Source: The World Bank (2024).

A primary significant difference between the two countries lies in their territorial nature: Argentina is a large country with a sparse population, whereas Italy is a smaller country with a denser population. Indeed, Argentina ranks as the eighth-largest country globally, with a land area approximately 12.5 times larger than that of Italy. However, its population is 27.48% smaller than Italy's as of 2022. The Italian population is currently in decline (-0.3% as of 2022), in line with the European trend, whereas Argentina is experiencing population growth (0.9% as of 2022). Turning to institutional data, another trend consistent with Latin America emerges: the attractiveness to foreign capital, where foreign direct investments amount to 2.4% of the GDP, compared to 1.5% in Italy as of 2022. Moving to economic data analysis, it becomes apparent that as of 2022, Italy's GDP was approximately 3.4 times higher than Argentina's, a figure mirrored in per capita GDP. Despite this, the Italian GDP exhibited a weaker growth compared to Argentina, with growth rates of 3.7% and 5%, respectively, in 2022. Additionally, Argentina recorded a lower unemployment rate than Italy in 2022, standing at 6.5% and 8.1%, respectively.

Delving into the productive profiles of both countries, a similarity emerges: the prevalence of the services sector in both Italian and Argentine economic ecosystem. As already mentioned in Chapter 2 and 3, in Italy the tertiary sector contributed to 73% of the GDP in 2021, while in Argentina, it represented 63.98%

in 2022. Regarding the secondary sector, it accounted for 25% of Italy's GDP in 2019 and 23.94% of Argentina's. The agricultural sector, however, is more developed in Argentina, mainly due to its territorial characteristics; it represents 12% of the 2022 GDP in Argentina, whereas in Italy, it constitutes only 2.2% (Oficina Economica y Comercial de España en Roma , 2022; Oficina Económica y Comercial de España en Buenos Aires, 2023). Furthermore, both the Argentine and Italian productive system exhibit the strong presence of small and medium-sized enterprises (SMEs). In Italy, in 2019, they represented 94.8% of active businesses, employing 43.2% of the active population (Istituto nazionale di statistica, 2022); in Argentina, in 2019, they constituted 79.6% of active businesses but employed only 10% of the active population (Instituto Nacional de Estadística y Censos, 2022). Therefore, it can be asserted that these enterprises have a greater economic impact in Italy than in Argentina. Another similar aspect between the two countries is the prevalence of family-owned businesses; in Argentina they represent approximately 99% of active businesses in 2017 (Lucero Bringas *et al*), while in Italy, they account for around 85% of active businesses (AIDAF, Italian Family Business). The last aspect that requires attention is the concentration of productive activity in specific areas of the country. In Italy, the central-northern regions contribute to approximately 62.5% of the national GDP (Istituto nazionale di statistica, 2022); in Argentina, the focus is not on a "North-South divide" but on the concentration of economic activity in the city and

province of Buenos Aires, contributing to 40% of the GDP (Oficina Economica y Comercial de España en Buenos Aires, 2023).

4.2.2 Comparison on the level of innovation between the Italian and Argentine

The analysis of the innovation level is a complex phenomenon since, as mentioned multiple times, there is no single parameter that allows for its identification. Globally, various organizations propose their composite indicators to classify the innovation level of different economies based on their innovation performance. In this case, to compare the state of innovation between Argentina and Italy, reference is made to the WIPO's Global Innovation Index (GII) of 2018 and 2023.

From a general perspective, the Global Innovation Index (GII) is calculated by the World Intellectual Property Organization (WIPO) to reveal the innovative performance of 132 countries by combing sub indicator of innovation inputs and output[26]. Argentina ranked 73rd in the GII 2023, whereas Italy ranked 26th in the same year. Comparing this with the ranking reported in the 2018 edition of the same WIPO, there is a general improvement in the state of innovation in both Italy and Argentina. In 2018, Italy held the 31st position, while Argentina was in the 80th position. Below is a comparative table.

[26] The Innovation Input Sub-Index is defined by the combination of the following composite indicators: Institutions, Human capital and research, Infrastructure, Market and Business sophistication. Instead the Innovation Output Sub-Index refers to the combination of Knowledge and technology outputs and Creative outputs (World Intellectual Property Organization, 2023).

	ITA 2023 score (*)	ITA % variation from 2018	ARG 2023 score (**)	ARG % variation from 2018		ITA 2023 score (*)	ITA % variation from 2018	ARG 2023 score (**)	ARG % variation from 2018
Institutions	**55.4**	**-0,26%**	**30.9**	**-0,43%**	**Business sophistication**	**41.3**	**0,04%**	**30.3**	**-0,03%**
Institutional environment	51.1	-0,19%	36	-0,36%	Knowledge workers	37.9	-0,21%	34.3	-0,18%
Regulatory environment	76	-0,03%	40.9	-0,17%	Innovation linkages	45.6	0,22%	15.4	-0,17%
Business environment	39.2	-0,53%	15.8	-0,79%	Knowledge absorption	40.5	0,21%	41.1	0,22%
Human capital and research	**43.7**	**-0,03%**	**30**	**-0,15%**	**Knowledge and technology outputs**	**44.3**	**0,17%**	**19.2**	**0,07%**
Education	57.2	0,12%	43.7	-0,23%	Knowledge creation	41.2	0,24%	13	0,18%
Tertiary education	30.5	-0,2%	29.6	-0,03%	Knowledge impact	40.5	-0,27%	23.8	-0,08%
Research and development (R&D)	43.4	-0,04%	16.5	-0,13%	Knowledge diffusion	51.2	1,15%	20.9	0,24%
Infrastructure	**57.2**	**-0,07%**	**39.9**	**-0,08%**	**Creative outputs**	**45.3**	**0,16%**	**30.3**	**0,28%**
ICTs	81.1	0,03%	74.8	0,14%	Intangible assets	60.1	0,15%	39.7	0,04%
General infrastructure	37.9	-0,04%	21.1	-0,26%	Creative goods and services	26.5	-0,09%	18.2	0,62%
Ecological sustainability	52.8	-0,2%	23.6	-0,34%	Online creativity	34.5	0,59%	23.4	2,20%
Market sophistication	**44.3**	**-0,13%**	**25.2**	**-0,33%**	(*) ITA is the abbreviation of Italy				
Credit	41.4	0,02%	14.7	-0,25%	(**) ARG is the abbreviation of Argentina				
Investment	6.7	-0,8%	4.2	-0,87%					
Trade, diversification and market scale	84.9	0,08%	56.8	-0,06%					

Table 4.2 "Italy and Argentina comparison of main innovation indicators". Source: Own elaboration-based World Intellectual Property Organization, 2023 and Cornell University, INSEAD, and WIPO, 2018.

According to the table, Italy generally outperforms Argentina in all indicators in 2023. However, upon closer examination of sub-indicator data, it becomes apparent that Argentina's performance is superior in terms of the percentage of

GDP spent on education, tertiary enrollment percentage, and access to ICT. Analyzing the percentage change in the period 2018-2023, it emerges that despite both Italy and Argentina experiencing an improvement in the overall ranking, this improvement is not solely attributed to better performance in innovation inputs but primarily stems from the outputs. In the case of Italy, there is a growth of 17% in the indicator Knowledge and Technology Outputs and 0.16% in Creative Outputs. For Argentina, the increases are 0.07% in Knowledge and Technology Outputs and 0.28% in Creative Outputs. In detail, for Italy, the most significant negative variation occurred in investments, as well as in the case of Argentina. On the positive side, Italy recorded growth in Knowledge Diffusion by 1.15%, while Argentina experienced an increase of 2.2% in Online Creativity.

4.3 COMPARISON OF TECHNOLOGICAL INNOVATION TRANSFER BETWEEN ITALY AND ARGENTINA

For the economic growth of a country, the creation of technological innovation is essential. However, in order that the innovation contributes to the economic growth, it is essential it's subsequent transferred to the territory. Therefore, the process of technological innovation transfer plays a crucial role as its creation. Following what has been discussed in Chapters 2 and 3, this section proceeds to compare the ways in which technological transfer takes shape in Italy and

Argentina based on the four organizations creating innovation: universities, governmental entities, businesses, and hybrid organizations.

4.3.1 Comparing the transfer of technological innovation between the Italian and Argentine universities

As seen before, the public funding of research and development activities in LAC countries carries more weight than in European countries. The higher education system in Italy and Argentina is characterized by the presence of both public and private universities. In Argentina, the public universities are entirely free, while in Italy, there are fees to support exams and obtain a university degree. Nevertheless, both countries recognize the right to education. Before analyzing aspects of the university technology transfer system, it is essential to highlight a parallelism between a peculiarity of the Italian and Argentine productive systems and universities. In Argentina, Buenos Aires not only concentrates the country's main economic activity but also hosts the highest number of higher education institutions. In Italy, economic activity is concentrated in the northern part of the country, and most Italian university spin-offs are also concentrated in this area. Both Italian and Argentine universities recognize the three missions of the university: teaching, research, and technology transfer. The regulation of the latter is outlined in the university statutes. Additionally, in both cases, the management of this third mission is entrusted to technology transfer offices. Over the years,

both countries have established specific performance control systems for these offices—ANVUR (National Evaluation Agency of the University System and Research) in Italy and CONEAU (National Commission for University Evaluation and Accreditation) in Argentina. An important difference between the two university systems is the identification of the concept of the fourth university mission in Argentina, absent in Italian universities. This concept focuses on strengthening and managing links between universities and businesses and government entities, with the aim of commercially managing research outputs. This distinction is more pronounced in relatively newly formed Argentine universities. The presence of this distinction highlights the importance of this function for Argentine universities, which I believe is of lesser significance in Italian universities. The concept of the fourth mission arises in Argentina in response to the 2001 crisis, attributing a more significant role to universities as a key for social development, especially for those in economically disadvantaged situations. Economic stability in Italy may have contributed to the lesser emphasis on the third and fourth missions in Italian universities. Despite the official recognition of the third (and fourth) mission as a basic function of the university, funds and personnel allocated to technology transfer are extremely limited in both Italy and Argentina. Personally, I attribute this limitation to a historically rooted cause. The concept of the third mission emerged relatively recently (early 1900s) compared to older universities, and over the years, it is expected to undergo an

evolutionary process, gaining a more prominent role in both Italian and Argentine universities. While I lack data to support this hypothesis for Argentina, according to the XVII NETVAL Report, the 78 units analyzed generally doubled the number of employees in TTOs from 2004 to 2021 (Ramanciotti & Daniele , 2018). Moreover, the strong emphasis on extension projects by Argentine universities is evident from the availability of data on the number of government-co-financed extension projects, amounting to 266 in 2011 (Herrera Albrieu, 2012); unfortunately, I couldn't find similar data for Italy.

Moving on to an analysis of intellectual property held by universities, it emerges that patenting activity in collaboration with CONICET is predominant in Argentina; in more details, of the universities belonging to the CIN, 57% of patent applications have been carried out in collaboration with CONICET (Serrano *et al*, 2023). In contrast, there is a lack of data on collaborative agreements in the Italian universities. Analyzing the patent activity, by the end of 2016, Italian NETVAL universities included 3,917 units in their portfolio, reflecting a 229.4% increase since 2005 and a 12.3% increase from 2015 (Ramanciotti & Daniele, 2018); instead, in the analysis conducted by the *Universidad Nacional del Litoral* in 2023 recorded 1,129 patent applications from Argentine universities (Serrano *et al*, 2023). From a personal standpoint, I believe that university licensing and spin-off activities are more widespread in Italy than in Argentina for two reasons. First, there is more available analysis on this type of activity in Italy, while specific

information on the number of spin-offs in Argentina is challenging to find. Secondly, a peculiar aspect of Argentine patents is the prevalence of patents in collaboration with CONICET, potentially resulting in a higher number of spin-offs born from collaborations with government entities rather than being strictly university spin-offs.

4.3.2 Comparing the transfer of technological innovation between the Italian and Argentine government entities

Regarding the transfer of technological innovation produced within government research centers, an analysis has been conducted on the public institutions that fulfill the same institutional mission in both Italy and Argentina. Therefore, the comparative analysis will be specifically articulated in relation to these organizations.

The Italian National Research Council (CNR, *Consiglio Nazionale delle Ricerche*) and the Argentine National Council for Scientific and Technical Research (CONICET, *Consejo Nacional de Investigaciones Científicas y Técnicas*) are the most important research institutes in their respective countries. The CNR conducts research in science and technology, while CONICET regulates its own internal technology transfer office, and the activities performed are substantially similar between the two centers. These activities include collaboration on R&D projects, logistical and instrumental resources during start-up phases, local training

programs, licensing contracts for the exploitation of intellectual property, and research and development projects in companies. Additionally, both CNR and CONICET develop joint research projects and engage in joint patenting activities with local businesses (Ramanciotti & Daniele, 2018; CONICET).

The Italian Council for Agricultural Research and Analysis of Agricultural Economics (CREA, *Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria*) and the Argentine National Institute of Agricultural Technology (INTA, *Instituto Nacional de Tecnología Agropecuaria*) are the most important institutes in the field of agricultural research. Both attribute a prominent role to technology transfer activities. In terms of organizing such activities, INTA provides an online database listing technologies developed by the organization to enhance community awareness, while CREA has a section indicating ongoing research activities. Both CREA and INTA engage in knowledge dissemination activities through courses, workshops, talks, and training programs for various audiences, as well as consultancy activities. An important difference is the presence of extension units in INTA, which are not identified in the case of CREA. In Argentina, approximately 330 projects are active, addressing issues such as the development of new agricultural machinery or solving specific production problems. In the case of CREA, research activities are primarily carried out in specific areas of the country (Ramanciotti & Daniele, 2018;INTA).

The Italian National Institute of Nuclear Physics (*Istituto Nazionale di Fisica Nucleare*, INFN) and the Argentine National Atomic Energy Commission (CNEA, *Comisión Nacional de Energía Atómica*) are government agencies with a mission to develop and regulate nuclear energy for peaceful purposes in their respective countries. The research conducted by these organizations on "cutting-edge technologies" makes them important laboratories where companies develop solutions with high technological content. There is substantial similarity in technology transfer activities, ranging from technological assistance to collaborative research projects with companies. One difference between INFN and CNEA is that the Italian institute has implemented a service evaluation system for the assistance provided to companies, including the use of questionnaires; I did not find this mechanism for CNEA (Ramanciotti & Daniele, 2018; Comisión Nacional de Energía Atómica).

Therefore, I do not find substantial differences in the methods of implementing technology transfer by these government organizations, which essentially involve providing various services to other research entities and companies, as well as, in some cases, engaging with the community. The projects of extension carried out by CREA and the evaluation system for technology transfer services implemented by INFN stand out.

4.3.3 Comparing the transfer of technological innovation between the Italian and Argentine companies

Companies undoubtedly play a crucial role in the technology transfer process, with innovative startups being particularly important. In Italy, this type of enterprise has experienced significant growth (a 107.3% increase from 2013 to 2014) due to a 2012 law that provided funding and tax incentives for such businesses. Related to Argentina, I didn't find specific data among a specific law on startups, but a broader category of high-tech potential businesses falls under the umbrella of startups. In terms of the concentration of innovative startups, Italy exhibits a more even distribution across the country (26.7% in Lombardy, 12.2% in Lazio, and 9.5% in Campania) ((Direzione Generale per la Politica Industriale, l'Innovazione e le Piccole e Medie Imprese del Ministero delle Imprese e del Made in Italy, 2022), while in Argentina, the majority are concentrated in the Buenos Aires area (67.5%) (González Gozalo, 2022). In the legal framework of Italy, there is also recognition of innovative SMEs that enjoy privileged access to funding sources and favorable taxation conditions (Direzione Generale per la Politica Industriale, l'Innovazione e le Piccole e Medie Imprese del Ministero delle Imprese e del Made in Italy, 2022); from the analysis conducted, I did not identify a similar legal category in Argentina. Comparing technology transfer

activities in industrial and service sector companies[27], reveals interesting insights. In Argentina, 23% of companies reported engaging in innovative activities. In Italy, 58.5% of industrial companies and 47.2% of service sector companies declared involvement in such activities. Among Argentine companies, the primary innovative activity reported was the acquisition of new computers and specific machinery (58.4% of respondents). In Italy, the acquisition of new processes was reported by 48.1% of industrial companies, exceeding the percentage in the services sector (42%). Regarding the introduction of innovation into the market through new products, this was reported by 25% of Argentine companies, while in Italy, 32% of industrial companies and 24.1% of service sector companies reported introducing new products. Therefore, despite the profound differences in the samples of companies considered, it appears that innovative activities were more prevalent among Italian companies. Additionally, interorganizational technology transfer, particularly in the form of acquiring new machinery, was a prevalent trend. Concerning direct technology transfer to the market, this process was more pronounced in Italy than in Argentina.

[27] In the specific case of Italy is consider an ISTAT analysis based on a sample of companies between 2016 and 2018. In the case of Argentina the analysis is conducted based on a survey on innovation activities by a sample of Argentine companies conducted between 2006 and 2008, specifically small and medium-sized enterprises with more than 4 employees and less than 250.

4.3.4 Comparing the transfer of technological innovation between the Italian and Argentine hybrid entities

Hybrid entities in both Italy and Argentina are diverse and depending on the actors involved and the attributed purposes, they conduct technology transfer activities in different ways. To facilitate a comparison, similar organizations in the two countries are analyzed.

The Italian Science Park (SP) and the Argentine technological parks are spaces dedicated to the establishment of scientific and technological-based industries with a focus on innovation. The functions performed by these parks are generally the same in both Italy and Argentina, such as supporting the creation of companies and providing specific technological consultations. The ecosystem created by the coexistence of startups, universities, and incubators in the same location facilitates the informal technology transfer process. Both in Italy and Argentina, specific technology transfer offices regulate these activities within the science parks.

The Italian foundation "Fondazione Idis–Città della Scienza" and the Argentine Fundación Instituto Leloir are foundations, i.e., nonprofit organizations, which can perform various functions, including technology transfer. In both foundations, there is a dedicated office regulating technology transfer activities, encompassing collaborative research and innovation projects, the establishment of new enterprises, linkage between researchers, and so on.

4.4 OPPORTUNITIES FOR INTERNATIONAL TECHNOLOGICAL INNOVATION TRANSFER BETWEEN ITALY AND ARGENTINA

International technological transfer is an important source of growth for a country; therefore, strengthening this process between Italy and Argentina can represent a significant growth opportunity for both nations.

From a general perspective, the European Union's relations with Latin America and the Caribbean are multifaceted and conducted at various levels. In this context, the EU-MERCOSUR agreement signed in 2019 is noteworthy, as it envisaged the reduction of a series of trade barriers between these two regions where Argentina represent the second most important commercial partner for Italy after Brazil (Pensa & Gallo , 2024). Looking at current and future prospects, the EU-LAC Global Gateway Investment Agenda (GGIA) is relevant. This agenda focuses on a fair green transition, an inclusive digital transformation, human development, and health resilience, including vaccines. To achieve these goals, the Team Europe has committed over €45 billion to support the strengthened partnership with Latin America and the Caribbean until 2027 (Eupean Commission , 2023). The management of these funds takes shape through the implementation of a series of projects, particularly in the case of Argentina. These projects are either directly managed by the European Commission or in collaboration with other European nations and international organizations; examples of such projects include the creation of renewable energies, expansion

and modernization of the electricity transmission network, waste management improvement, and support to small and medium-sized enterprises (SMEs) leading investments in energy efficiency, renewable energy, and bioeconomy (European Commission , 2023).

Descending into the analyzed case study of technological transfer between Italy and Argentina, it is crucial to highlight how commercial exchanges play a significant role in this process. In fact, Italy is a great partner of Argentina in terms of providing machineries. In more details, the imports comprised 37% of the category "Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof," 13% of "Pharmaceutical products," and 6% of "Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television and so on" (International Trade Centre , 2024). Concerning Italy, in 2021, 46% of imports from Argentina consisted of "Residues and waste from the food industries and prepared animal fodder," 22% of "Fish and crustaceans, molluscs and other aquatic invertebrates" and 7% of "Edible fruit and nuts; peel of citrus fruit or melons" (International trade centre , 2024). Therefore, it emerges that Argentina tends to purchase technological products from Italy, making trade an important source of international technological transfer. On the other hand, Italy appears to prefer importing products from Argentina in the primary sector, with a generally limited technological contribution. Consequently, it can be

affirmed that, from the Italian perspective, this channel of technological transfer is not considered crucial.

Within the framework of bilateral relations between Italy and Argentina aimed at the transfer of innovation, universities play a predominant role. In fact, both Italian and Argentine universities have entered into various agreements that allow students enrolled in specific Italian universities to undertake a study period, including the possibility of dual-degree programs, in Argentina and vice versa. The strengthening of ties between these universities was underscored by the establishment in 2022 of CUIA, the Italian University Consortium for Argentina, currently comprising 27 affiliated universities. CUIA operates in both Italy and Argentina, actively supporting joint research projects as well as the mobility of students, faculty, and researchers, particularly doctoral candidates. The consortium specifically funds scientific initiatives of interuniversity cooperation between Italy and Argentina, workshops, and laboratories focusing on, for example, sciences, technologies, knowledge transfer, and territorial development (CUIA , 2024). Through the CUIA – CONICET Bilateral Program, projects aimed at promoting the exchange and mobility of researchers between Italian universities and CONICET are financed.

Within the scope of governmental entities, it is evident that the bilateral agreement is the primary instrument used to regulate relationships between major Argentine

and Italian research centers. Specifically, the following agreements can be identified:

- Joint Bilateral Agreement CNR/National Scientific and Technical Research Council (Argentina). This collaboration involves the implementation of research projects, with open calls every two years. Members of these two research centers have the opportunity to propose joint scientific cooperation in areas such as Engineering and Applied Mathematics, Nanotechnology, and Advanced Materials, as well as Energy. The winning projects from the call will be financed by both contracting parties under the agreement (Virginia, 2022).
- Joint Bilateral Agreement CREA / INTA. Upon analysis of active international agreements by CREA, no agreements with Argentina were found.
- Agreement CNEA/INFN. There are several active agreements between these two public entities, with one specifically related to experimental projects developed in Argentina, where INFN is a partner. This project is part of a broader framework of agreements aimed at advancing the development of joint projects and facilitating the exchange of information and researchers (Istituto Nazionale di Fisica Nucleare, 2023).

An interesting factor for understanding an organization's intent to disseminate its patented innovation is the acknowledgment of that patent in the designated country. Upon analyzing patents from Argentine companies filed in Italy, a total of 5 such patents were identified (based on the conducted analysis) (UIBM , 2024). In the Argentine context, there are a total of 20 Italian companies that have filed patents in Argentina, predominantly in the telecommunications sector (INPI, 2024). This information highlights the reciprocal engagement of companies from both countries in seeking patent protection and recognition in each other's territories, providing insights into their interest in sharing and protecting innovative technologies.

Italy and Argentina have substantial growth opportunities through technological transfer, emphasized by the EU-MERCOSUR agreement and the EU-LAC Global Gateway Investment Agenda. Commercial exchanges, university collaborations, and governmental agreements contribute to this transfer, with mutual interest in patent protection evident through reciprocal filings between companies from both countries.

CONCLUSION

The comparative analysis between Europe and Latin America-Caribbean reveals significant disparities in various aspects, such as economic, social, and innovation-related factors. Europe, characterized by a higher GDP per capita, demonstrates a more robust innovation landscape, with substantial investments in research and development (R&D). The innovation dynamics differ significantly between the two regions, with Europe relying on a balanced mix of public and private sector funding, while Latin America and the Caribbean heavily lean towards government funding, particularly in higher education. The examination of R&D spending as a percentage of GDP further accentuates the innovation gap, with Europe investing significantly more than LAC. The funding sources for R&D activities also diverge, with Europe featuring a predominant role of business enterprise funding, while LAC relies more on government funding, especially in higher education. Examining patent applications and grants adds another dimension to the innovation landscape. Europe outpaces LAC in both the number and share of global patent applications and grants. However, a noteworthy development in LAC is the improvement in patent quality, reflected in a considerable increase in granted patents despite a reduction in applications. This contrasts with the EU's simultaneous increase in both patent applications and grants. The findings suggest that while Europe maintains its innovation

leadership, Latin America and the Caribbean exhibit positive developments, particularly in enhancing the quality of innovation.

In the exploration of Italy and Argentina's diversities across social, economic, environmental, and institutional dimensions, a nuanced understanding of their complexities emerges. Italy, characterized by a smaller territorial expanse and higher population density, stands in contrast to Argentina, a vast country with a sparse population. This divergence is reflected in demographic trends, with Italy experiencing a population decline while Argentina sees growth. Notably, Argentina's appeal to foreign capital, with higher foreign direct investments as a percentage of GDP, aligns with broader Latin American patterns. Economically, Italy's substantial GDP and per capita GDP overshadow Argentina's, but the latter exhibits a higher GDP growth rate and lower unemployment in 2022. Both nations share a predominant reliance on the services sector, but Argentina's agricultural sector plays a more significant role due to its territorial characteristics. Small and medium-sized enterprises (SMEs) feature prominently in both economies, with Italy showcasing a more substantial economic impact from these enterprises.

Moving to the innovation landscape, the Global Innovation Index (GII) positions Italy ahead of Argentina in 2023, reflecting superior performance across various indicators. However, a closer examination reveals Argentina's strengths in the percentage of GDP spent on education, tertiary enrollment, and access to ICT. Both countries have improved their innovation rankings from 2018 to 2023, with

Italy showcasing notable growth in knowledge and technology outputs, and Argentina excelling in online creativity. As both countries navigate their distinct paths, this comparative study contributes to a nuanced comprehension of their trajectories and potential areas for future collaboration and growth.

In the exploration of technology transfer and innovation ecosystems in Italy and Argentina, a rich tapestry of similarities and distinctions emerges. Both countries boast a higher education system marked by a blend of public and private institutions, recognizing the three university missions: teaching, research, and technology transfer. However, Argentina introduces a unique dimension, the "fourth mission," emphasizing university collaboration with businesses and government entities, a concept absents in Italian universities. While the acknowledgment of technology transfer as a fundamental university mission is evident, limitations in funding and personnel allocation pose challenges in both nations. However, a gradual evolution is anticipated, fostering a more prominent role for technology transfer in the future. An examination of intellectual property reveals notable collaboration in patenting in Argentina, particularly with CONICET, potentially influencing a higher prevalence of spin-offs born from government collaborations rather than strictly university-driven initiatives. In Italy, the emphasis on university licensing and spin-offs appears more widespread, possibly due to the availability of more comprehensive data and analysis. A comparative analysis of technology transfer in government entities highlights

substantial similarities between Italy's CNR and Argentina's CONICET, CREA and INTA, as well as INFN and CNEA. Both nations engage in collaborative research projects, knowledge dissemination, and assistance to companies. Notable differences include Argentina's focus on extension projects and Italy's implementation of an evaluation system for technology transfer services. Turning to technology transfer within companies, Italy demonstrates a more even distribution of innovative startups across regions, benefiting from legal recognition and privileges for innovative SMEs. Argentina, while lacking a similar legal category, concentrates a majority of startups in the Buenos Aires area. Innovative activities among Italian companies appear more prevalent, covering the acquisition of new processes and products, surpassing reported activities in Argentine companies. Hybrid entities, exemplified by science parks and foundations, contribute to technology transfer activities in both countries. The Science Park in Italy and its Argentine counterparts share similar functions, providing support for new enterprises and fostering collaboration. Foundations, like Fondazione Idis–Città della Scienza in Italy and Fundación Instituto Leloir in Argentina, play diverse roles, including technology transfer regulation.

Also, international technological transfer between Italy and Argentina presents significant growth opportunities for both nations. The EU-MERCOSUR agreement and the EU-LAC Global Gateway Investment Agenda underscore the importance of bilateral ties. Commercial exchanges, particularly in machinery,

highlight trade as a vital source of technological transfer. Universities play a key role through agreements, exemplified by the Italian University Consortium for Argentina (CUIA). Governmental entities strengthen innovation transfer via bilateral agreements between major research centers. Reciprocal patent filings between Italian and Argentine companies reflect a mutual interest in protecting and sharing innovative technologies. Overall, these initiatives create a conducive framework for sustained growth and collaboration between Italy and Argentina.

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