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Innovation Performance of Portuguese Research Innovation Centers

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Master in Business Economics and Competition

Supervisor:
Assistant Professor Vítor Hugo dos Santos Ferreira
ISCTE Lisbon University Institute

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BUSINESS SCHOOL

Department of Economics

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“Pelo sonho é que vamos,
Comovidos e mudos.
Chegamos? Não chegamos?
Haja ou não frutos,
Pelo Sonho é que vamos.

Basta a fé no que temos.
Basta a esperança naquilo
Que talvez não teremos.
Basta que a alma demos,
Com a mesma alegria,
Ao que desconhecemos
E ao que é do dia-a-dia.

Chegamos? Não chegamos?
-Partimos. Vamos. Somos”

Sebastião da Gama.

Agradecimentos

Frequentemente dizemos que a limitação do conhecimento humano reside na forma como nos expressamos e reflete-se na linguagem que usamos. Para além disso, com o passar do tempo, palavras proferidas num determinado momento, podem desvanecer aquilo que pretendíamos transmitir. Para que fique um registo que não seja efémero e para que o agradecimento que hoje expresso perdure no tempo, escrevo estas palavras no sentido de agradecer profundamente aos meus pais, Filomena e Carlos e aos meus avós, Alice e Silvino por me terem acompanhado em todo o meu trajeto, por todos os ensinamentos que recebi, por toda a prontidão instantânea e por todas as oportunidades proporcionadas.

São Tomás de Aquino, sugere que a gratidão humana, tal como a linguagem que frequentemente usamos é fragmentária e representa uma realidade complexa. Assim a gratidão compõe três distintos graus. O primeiro grau que comporta o reconhecimento do benefício obtido (*ut recognoscat*), o segundo grau que louva e que dá graças (*ut gratias agat*) e o terceiro grau, que gera o vínculo e o comprometimento (*ut retribuat*). É neste terceiro nível que me sinto perante os meus pais e avós dadas todas as circunstâncias vividas quer em tempo quer em lugar.

Por fim, quero agradecer ao Professor Vítor Hugo dos Santos Ferreira por me ter feito sempre querer superar as expectativas e por ter sido um verdadeiro suporte ao longo de todo este percurso. Professor, muito obrigado.

Resumo

Os Centros de Interface Tecnológico estabelecem um papel fundamental entre as instituições ligadas à produção de conhecimento científico e tecnológico. São definidos como "entidades de ligação entre as instituições de ensino superior e as empresas, que se dedicam à valorização de produtos e serviços e à transferência de tecnologia".

Neste sentido, procuram identificar e valorizar tecnologias úteis para os problemas das empresas, alavancando atividades de inovação e reforçando o dinamismo económico e o investimento empresarial.

A seguinte dissertação propõe uma metodologia de investigação estruturada em duas dimensões sistémicas, focalizada em medir a performance de inovação de cada centro. A primeira dimensão pretende avaliar o potencial de inovação que cada centro geraa. Por sua vez, a segunda dimensão visa compreender o real estado de inovação gerado por esses centros. Para isso, foram estabelecidas duas perguntas de pesquisa: "Qual o pepel dos centros de interface na inovação em Portugal?" e " Qual a performance de inovação destes centros?". Sendo a metodologia baseada nos European Innovation Scoreboards, foi construído um indicador compósito.

Os resultados a que chegámos espelham que os centros de investigação maiores apresentam maior potencial de inovação, no entanto, a medição do potencial de inovação (por empregado) revela um quadro diferente. Combinando o potencial de inovação com o desempenho real de inovação, descobrimos que, contrariamente ao esperado, outros centros têm um melhor desempenho. Estas conclusões mostram que quando o tamanho do centro é retirado do estudo, o desempenho real de inovação é diferente e pode levar a diferentes abordagens de financiamento.

Palavras chave: Centros de Interface; Medição de inovação; Capacitação da indústria; Performance de inovação.

JEL Codes: 021, 032

Abstract

Research innovation centers establishes a fundamental role between institutions linked with scientific production and technological knowledge. They are defined as "liaison bodies between higher education institutions and companies, which are dedicated to the valorisation of products and services and to technology transfer".

In this sense, they seek to identify and value technologies that can be useful for each company problems, leveraging innovation activities, reinforcing economic dynamism and strengthening business investment.

The following dissertation proposes a research methodology structured in two systemic dimensions, focused on measuring innovation performance of each center. First dimension evaluates innovation potential that each entity is capable of generating. In turn, second dimension assesses the real state of innovation generated by them. To this end, two research questions have been established: "What is the role of research innovation centers in Portuguese innovation?” and " What is the performance in terms of innovation of the centers?”. Following a methodology based on European Innovation Scoreboards, a stabilised composite indicator was constructed.

Our results explain that, as expected, bigger research centers seem to have more potential capacity for innovation, nevertheless, measuring innovation potential (per employee) reveals a different picture. Matching innovation potential with real innovation performance we found that, contrary to what was expected from the gatherer project applications data, different centers have a better performance (especially when measured by employee). These findings are interesting since they display that, when size is taken out of the picture, real innovation performance is different and may lead to different funding approaches.

Keywords: Research Innovation Centers; Innovation Measurement; Industry Training; Innovation Performance.

JEL Codes: 021, 032

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List of Acronyms

ANI - National Innovation Agency

EC - European Commission

EU - European Union

FITEC - Fundo de Inovação, Tecnologia e Economia Circular

IAPMEI - Portuguese Agency for Small and Medium Enterprises and Innovation

I&I System Research and Innovation Strategy for Smart Specialisation

IUS - Innovation Union Scoreboard

NIS - National Innovation System

OECD - Organisation for Economic Co-operation and Development

PT2020 - Portugal 2020

R&D - Research and Development

RD&T - Research and Technological Development Incentive System

SI ID&T - Sistema de incentivos à investigação e desenvolvimento tecnológico

SMEs - Small and Medium Enterprises

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Chapter I – Introduction

The study object of this dissertation will focus on how research innovation centers, known in Portugal as "*Centros de Interface*", are characterised and what is their real role in innovation in Portugal.

In a general-to-specific order, it is essential to ensure that a historical framework is apprehended and how the concept of innovation has evolved. As a result, the central topic of this research involves channelling our attention, both to the relationship between production and knowledge, and to the way innovation is interconnected with companies and with business fabric (República Portuguesa, 2014).

Furthermore, the bond between innovation, innovation models, and companies that are arising, raises a number of notions that have become structuring in the evolutionary framework of each country. Topics such as qualified hiring, generation of certified patents, technology transfer or collaborative networks have led many governments in several countries to set programs to support collaborative and open innovation. This is what happens in Portugal.

Interface program, which currently integrates twenty-six research innovation centers in Portugal, through innovation, increased productivity, value creation and technology incorporation in production processes of national companies aims to speed up the evolutionary process in the country. As so, this dissertation purposes to ascertain whether this goal is being successfully fulfilled.

The research questions that will guide our dissertation are: "What is the role of research innovation centers in Portuguese innovation?" and " What is the performance in terms of innovation of the centers?". They should be clearly answered at the end of this dissertation with the intention of adding relevance and empirical content to the study.

As reported by Caraça (2007), innovation results from an unpredictable process that gathers several chain actions deeply related between them. Still in the same follow-up, the interaction between business routines, the signals and responses of the techno-economic environment and the efforts of companies make innovation an idiosyncratic process.

Due to the current economic context, it is important to be conscious how innovation models contribute to the appreciation of knowledge. In this sense, Schumpeter (2000), states that an indispensable factor for this agreement is to apply (in real context) the practical relationship between company's and entrepreneurs.

Several authors, such as, Caraça (2007), Schumpeter (2000) and McNie et al. (2016) realise that there is a variety of hypotheses that make innovation models, technology transfer or even technology incorporation into a production process. Taking into account what is said, both in economic literature and in the practical context, we believe that this subject represents a key point to be addressed in the present and in the coming years. In addition, it is important to compare Portugal and other European countries with an eye to perceive whether research innovation centers do indeed have an active role in Portuguese innovation (República Portuguesa, 2014).

It is certain that in the last decade's innovation has become one of the drivers of economic activity, not only because it adds value, but also, because it creates competitive advantages that become a key to operating in competitive markets (Stoneman, 1983). Thereby, the exponential evolution of technology, the treatment of big data or the mere competitiveness of economy in national and international markets becomes central to follow the strategic dynamics that innovation suffers over time, with the aim of comprehend its financial stability and also its strategic durability for the future (Markides, 1998).

By analysing the relationship between science and industry, we are also identifying potential systemic market failures which lead us to question how companies are operating in their cycles and in the external environment.

Objectively, it is important to ascertain how innovation concept has been subdivided and managed to link between science and companies. Through the above, conducting a review of judicious literature, it is recognised that innovation concept has left itself, surrounding notions suchlike technology transfer, open innovation, collaborative networks or even research innovation centers.

Finally, by examining these issues, we are able to recognise the role of these entities in technology transfer, and, taking into account the empirical segment of this dissertation, measure their real performance.

Chapter II – Literature Review

This chapter provides the theoretical background linked with innovation and research centers. From that perspective, the first idea to be transmitted is that innovation leads to economic growth. This economic growth plays a leading role in transformation of past resources into more efficient goods and services (Gulbranson & Audretsch, 2008).

Focusing on research innovation centers, it is possible to verify that there are many supports from various countries in promoting this type of directed innovation research. These centers are essential to the creation and dissemination of knowledge and are seen as one of the key elements in science globalisation (Altbach, 2009).

According to Altbach (2009), some countries come to the conclusion that such institutions are the connection principal between an innovation economy and knowledge transfusion. Not only do these institutions train key personnel, but also, arrange opportunities to scientific information worldwide by providing breaks for top-level scientific communication.

Research innovation centers also deliver benefits for civil society, these research centers are not only used to investigate methodological issues or market procedures, as stated by Gray et al. (2001), they are significant to create professional networking profits, research relevance or administrative operations. The implications of these findings are vital to public policy, cooperative research management and future research discussions.

Following what is mentioned above, and based on what research innovation centers exist for, it is critical to know how this support is done. As a result, the supply of high-quality R&D is a determining factor in technology transfer. Emphasising the importance of R&D supply, we've come to the conclusion that the most important role that any government can play in technology transfer is in funding and conducting research and development (Davine et al., 1987).

Giving this historical standpoint, the only possible way for innovation and innovation processes to acquire economic significance is through a fundamental stage called diffusion (Fuentelsaz et al., 2016). In such circumstances, research innovation centers fit perfectly in this broadcast, both by ideas and innovation processes adopted. One of its main objectives, is the allowance of quick dissemination of innovations among the population of potential users.

Finally, backing the case of Portugal, we find several connection points between traditional innovation methodologies and the interface program objectives.

In the light of a neoclassical perspective, regarding innovation as an endogenous factor and encompassing the numerous roles of different markets and scientific organisations, it's understandable that there is a monopoly's tendency towards technological production advancements (Schumpeter, 1982). Counterbalancing, Fagerberg et al. (2014) lists that, knowledge production allied to economic markets and innovation technology, engender the following factors: **(i)** introduction of new products or qualitative modifications of existing products; **(ii)** introduction of new production method or improvements of existing processes; **(iii)** opening of new markets; **(iv)** acquiring new sources of supply for inputs; **(v)** changes in the organisational structure (e.g., monopoly position or governmental framework).

In conclusion, innovation concept has become inseparable from notions suchlike knowledge production. That's what research innovation centers intend to accelerate, once they are a way of trying to lead companies (especially SMEs) to promote R&D activities and innovation, enhancing the connection of innovation system entities and facilitating their access to highly qualified human resources, promoting scientific and qualified employment, and increasing knowledge access (República Portuguesa, 2014).

2.1 Science, Technology and Innovation

2.1.1 Innovation in economic literature

The evolutionary process can be nothing but complex. Innovation has, by definition, a main role in evolution. Therefore, innovation is considered as a growing consensus in which there are preponderant factors such as information transfer, development of various methodical disciplines or even overcoming barriers by systematic methods that require expert's intervention (Kostoff, 1999).

As stated by Caraça (2007), innovation results from an unpredictable process that gathers several chain actions deeply related between them. Upholding what is mentioned, the interaction between business routines, the signals and responses of the techno-economic environment and the efforts of companies make innovation an idiosyncratic process.

However, it is important to realise the historical context that involves innovation, knowing how it emerged, from where first theoretical ideas started or even how it reaches the most modern models is preeminent to the elaboration of this dissertation. In agreement with Pavitt (2005), innovation emerges to supply some flaws that exists in the general economic system and in civil society.

As a result, the concept origin is related with the simplest technological changes, altered with different theories that have been emerging over time. Up until the 1950s, technical progress, such as equipment improvements or tacit amendments were used as the only definition of innovation and it certain brought “side effects” suchlike, employment increasing, productivity intensification, competitiveness or costs solutions and services provision. However, Schumpeter signpost that innovation process is not just limited to embedded transformations, but also, to set connections with determinate economic growth aspects and economic performance.

Currently, in the twenty-first century, innovation plays a different function in the binomial knowledge – economy and there are an extensive amount of more accurate definitions covering the subject. Even though, globalising processes are in constant adaptation to various economic environments, the concept of innovation stretched to be the improvement of commercialisation of new business propositions (Caraça, 2007; Schumpeter, 1950;).

It is absolutely essential to produce knowledge, to transform it into products, new processes or services and spread it matching market needs and demands (Pavitt, 2005). However, not everything is linear, in agreement with Fagerberg et al. (2005), there are different types of innovation that can be focused on firms or in innovative processes. Hence, this complex concept could emphasis on **(i)** an introduction of a new product or provide improvements on an existing product **(ii)** an insertion or development on a new method of production, both in production lines or in open market **(iii)** obtaining new bases to afford first-hand inputs **(iv)** vicissitudes in the organisational structure (Fagerberg et al. 2005; Lee et al. 2008; Schumpeter, 1950).

In the last decades of the past century several approaches suggested that science and technology were connected with innovation, allowing discussions that questioned the traditional/mainstream economy and the innovative economy (Castellacci, 2008). Thereby, Crawford (1991) establishes that neither technology nor markets can drive product innovation by themselves, they need each other for achieve an optimum performance. The debate around mainstream and evolutionary assessments do indeed diverge with regard to their theoretical foundations, empirical research and policy implications. From this point of view, innovation is a booster which impels firms in direction of further ruthless long-standing objectives, handgrips, revitalisation of industrial organisations and is reliable for the upsurge of new-fangled economic sectors (Castellacci, 2008; Crawford, 1991; Giannopoulou et al., 2018).

In such way, innovation branched its approach to macro issues (markets) and to micro issues (cost-production organisation).

Figure 1: Different types of innovation indicators approaches

Macro Level Innovation Indicators	Micro Level Innovation Indicators
• Economic processes of applying and spreading scientific advances; • Strategic measurements of competition in high technology industries; • Routine organisation purposes; • Economic development through cumulative complex interactions; • Industrial structures and entrance barriers.	• The average number of employees hired by organisations that enhance innovation as a product-market transaction; • The competition level that innovation engenders in goods and services through the ability to generate patents; • Costs that competitors charge for the same goods and services.

Source: Own design based on Fonseca 2002; Crawford 1991

Macro levels indicators measure knowledge absorption and diffusion, which are concepts that are associated with the quick and comprehensive dissemination of novelties among the population of potential users (Engelbrecht and Darrogh, 1999). Conversely, it crafts a problematic that its arduous to overtake. On that account, an innovation paradox is created. This paradox is categorised as the difficulty that each organisation suffers to get ahead of the competition relishing market advantageous. In doing so, these organisations structure's create immeasurable variability. Currently, being the world seen as a global market, and with the increasing competitiveness and demanding consumers, organisations seem to have no alternative but to keep innovating. As they battle to attain some steadiness, so they keep producing more and more complexity. Ironically, the more they proceed with a sight to ensure their future, the more they compound specific behaviours outcomes which results in complex interrelations that settle a more unpredictable and astonishing future (Fonseca, 2002).

Lastly, it is an erroneously idea to simplify the concept as a linear representation, translated into stages such as investment in scientific investigation, engineering of nurtured ideas, or even manufacturing and blast-off to prolific markets (Kline and Rosenberg, 2010). These are extremely important notions, yet, as stated by Baregheh et al. (2009), overviewing the Schumpeterian vision these concepts extend themselves to an economic discussion level, to activities regarding R&D, to patents or trading issues, forming, in general, a degree of involvedness around the subject.

2.1.2 Innovation models

There are innumerable pathways of innovation, from innovation paradigms to long waves of innovation models (Pohlmann, 2005).

In an era dominated by competition globalisation, to achieve a public policy discussion on how to uphold a strong economic progress it is fundamental to distinguish how innovation undergone its adjustments, integrating competitive environments and assuming strategic positions in organisations development (Tidd, 2006).

In accordance with Senker (1995) innovation advances in an orderly linear-sequential manner which created a habit to run towards the subject. As so, innovation progresses by scientific findings, leading to R&D and manufacturing technology, which achievements ends in marketable new products or processes.

This simplistic succession overlooks the parallel and interactive happenings typifying innovation and disregarding inputs from the external environment, for example, scientific and technological knowledge and market evidences (Pavitt, 2005; Senker, 1995).

A linear sight of innovation process means that science results from technology and transformation procedures that fulfil market needs. In addition, there are an investment on research and development that results in a smooth unidirectional flow starting from rudimentary scientific investigation up to commercial tenders (Arnki et al. 2010; Bernstein and Singh, 2006; Tidd, 2006).

Figure 2: Conventional linear model of innovation

Source: own design based on (Godin, 2015; OECD 2005)

In accordance with OECD (2005) innovation was firstly comprehended as a linear model where R&D ended in marketable inventions, yet, at the same time, this model has recently been under attack. It is undeniable that the model was slightly essential and the idea that innovation followed a rectilinearity that began in the discovery of basic science, went through its application and ended in the development of a new process or products, quickly began to be insufficient to explain economic or tacit phenomes (Freeman, 1996). In such wise, there are some flaws that are arguments against the model, standing out failings suchlike: **(i)** linear models are implicit in the argument around technical push contrasting with market pull **(ii)** to have a push or pull infers a procedure where it is guaranteed that there is a beginning and an end and a certain type of link between them **(iii)** the surpassing prominence assumed by R&D over time, that was escorted by the carelessness of other innovation factors **(iv)** overseeing economic systems as incapable of generating knowledge and creativity of their own, conceiving them only as passive and reactive (Freeman, 1996; Kline, 1985 Kok and Biemans, 2009).

With an eye to supply these flaws along with the necessary to measure the exact return on asset R&D, other innovation models were developed aiming to set actions that leads to actual embracing practices, process, or systems.

In response, Kline and Rosenberg (1986) introduced an enhanced model entitled chain-linked model which defines innovation over progressions of collaborating absorbing that comprises the organisations limits. As so, this model (with all its inputs and unpredictability) is characterised by being a market-pull model.

Therefore, chain-linked model gave countless advances to scientific and technology policies and comprises knowledge management, once it is a cross-generational synthetic framework characterised by market growth (Kameoka et al. 2001).

Chain-linked model can be founded between organisations, assembling two sorts of interactions. Initially it encompasses indispensable internal procedures, known as organisation network, on the other hand, it covers the structured global system of science and technology and the occurred interactions among organisations.

Furthermore, this model stipulates an interaction between common organisations and different nature of activities related with goods suppliers, services and technologies (upstream activities) or, at the same time, activities similar to marketing and distribution, industrial clients or end-users (downstream activities) (Kline and Rosenberg, 1986).

Figure 3: Main differences between linear and chain-linked model

	Form	Starting Point	Market Characteristics		Feature	Applications
			Maturity	Uncertainty		
Linear Model	Linear open loop	Seeds	Low	Low	Core model	Firms at an early stage of industrialisation
Chain-Linked model	Closed loop	Needs	Medium	Medium	Using model	Current firms

Source: own design based on (Kline and Rosenberg, 1986; Kameoka et al. 2001).

Market behaviour is a good needle to understand if innovation processes works well, however, due to the incertitude and the quickness of changes that are verified nowadays, innovation processes can be misjudged by innovation models.

At the same time, due to these properties, market strengthens itself as a complex system, and the principle of "increasing returns" comes to work. It implies that becoming the front-runner is extremely significant. The above, is presented as a market experiment model precisely because, in its genesis, it is implicit that competitive advantages can only be achieved if products are introduced in early stages, even if this means that the learning process are made through trial and error (Åström and Wittenmark, 1990; Kameoka et al. 2001).

There are several main implications of this model. It should fulfil purposes such as **(i)** establishment of value for end-users with proposals that are grounded on technology **(ii)** the innovation process has a responsibility to identify market segments and the income mechanism (i.e., users to whom technology is suitable and for what determination) **(iii)** identify how to create and allocate the balancing assets to generate a value chain prosperous in knowledge production and market flow **(iv)** estimates potential costs and profits (given the value proposal and the value chain structure) **(v)** realise the point of view of firms within the value network, involving suppliers and customers **(vi)** frames the competitive approach by which the innovating firm will advance and hold advantage over rivals, taking into account potential complementors and competitors (Chesbrough and Rosenbloom, 2002).

The fact that there are market peculiarities, in particular, uncertainty or speed of processes, brands compulsory to form a new market rather than waste too much time understanding the uncertainties of existing markets. In this sense, the "market creation model" was born (Kameoka et al. 2000; Lakoff et al.,1981). The strategic approach is dived into two stages. Seeking to sort market identification and control easier, this first phase requests to build an attractive platform such as essential component of products at a low price, as is often exemplified in several markets (i.e., cutting edge technology markets). The second phase looks over to provide profitable products such as technology. Therefore, blending these two phases, it is possible to generate profit increases.

In this sense, this last model is categorised by trying to change the consumer preferred characteristics, whereas the "linear model", "chain-linked model", and "market experiment model" are passive since it adapts to the variable market (Kameoka et al. 2000).

2.1.3 Market failures and how innovation is connected with them

From a very simple standpoint a "market failure" can be seen as a blank idea that covers some vital variables, which helps to determine social exchange conduct (Toumanoff, 1984). In a straighter way, market failures are an economic situation where the allocation of goods and services by a free market does not follow a *pareto* efficient logic causing a net loss of economic value (Zerbe et al., 1999).

Although, this is not a newly explored notion, once it scrounges fundamental influences from Buchanan (1959), Demset (1982) or Dahlma (1979), a few years later, newest investigations began to associate market failures with innovation processes and its respective models. Innovation policies analysis is unswervingly related with innovation systems structure, in this logic, it is implied that government interventions are not sufficient to indorse development and diffusion of new innovation technologies (Freeman, 1987; Nelson, 1993).

It is clear that there is an aggregate complexity that characterises innovation systems, as they are seen as a complex evolutionary procedure spread among a multiplicity of socio-economic agents whose behaviour and interactions are headed by market forces and by greater extent of non-market institutions (Kline and Roseberg, 1986; von Hippel, 1998; Metcalfe and Ramlogan, 2005).

In view of the foregoing, there is no doubt that evolution has followed a sense of a service-driven economy. Economic advances, production massification and consumption demand have shifted away from simple physical objects towards information and services. This phenomenon transformed the endowment of services into a key handler when we approach concepts like competitiveness, employment and economic growth. The problem lies in the interplay between innovation and market failures, as it was difficult to consider all emerging technology services (Rubalcaba et al., 2010).

Owing to Arthur Pigou's famous Economics of Welfare in 1920 conventional economists began to relate market failures with socially efficient production of outcomes either in services or through government intervention.

In this case, market failures are allied with innovation when two major actions occur: Firstly, market incompleteness. In this sense, there is a market failure when markets are unable to produce goods and services due to the insufficient demand in covering costs of provisions, whether they are linked with innovative technology products or mere innovation services. Secondly, market failure ascends by virtue of an absence of complementary markets. In practice this means that there is one market that is dependent of another, which is seen as an innovation barrier, as markets are limited to a narrow choice (Dollery and Wallis, 1997).

Conclusively, reaching the inputs that can spawn resistance and innovation failures it is imperative to highlight that innovation can give rise to market insufficiencies on its own (Gemser et al., 1996). In this sense, combining the way in which an innovation is intended to be developed and the policies with which it is associated is well known that there is a cause-effect situation.

Therefore, the improvement of inputs for expending industries (gotten as a main model of innovation) can engender financial market transactions costs, risk coupled with standards for new technology or even limited appropriability of common technologies, which are sources of sectoral innovation failures. In another sense, the elaboration of complex systems can create extreme costs or limited appropriability (as seen above) predominantly for infrastructure technologies. Lastly, the requests of high-science-content technology can induce the non-recognition of potential applications or effectively communicate new developments to possible users (Baker, 1998; Dosi, 1988; Martin and Scott, 2000; Pavitt, 1984).

2.2 Interface Program

2.2.1 Governance Structure and Framework

Interface Program is an initiative created by the Portuguese government with the purpose of empower Portuguese industry. Therefore, a series of measures are considered to support companies and increase tacit value in innovation in Portugal. This program aims to enhance value to Portuguese products through innovation, increased productivity, and the incorporation of technology into the production processes of national companies (Programa Interface, 2015).

In this sense, interface hastens technology transfer from universities to companies, improving product certification and intensifying competitiveness of the Portuguese economy in national and international markets. As a result, the 21st Constitutional Government Program and the National Reform Program highlight the promotion of innovation in Portuguese economy as a key instrument to upsurge corporate competitiveness (Agência Nacional de Inovação, 2019).

Research innovation centers, encompassed by the interface program, and seen as one of its main mobilisers, partake objectives that support the purpose of the program, focusing on “nuclear” companies. Looking at their main goal, research centers are intended to gain scale in activities that develop international dynamic, employ qualified human resources and allow Portugal to position itself in its value chains so that they can gradually rise in them (Agência Nacional de Inovação, 2019; Compete 2020, 2018).

As specified by Direção - Geral das Atividades Económica (2016) research centers are entities that indorse interactions between higher education institutions and companies, which are dedicated to enhancing products and services and technology transfer. This initiative aims to enable research centers and companies, especially SMEs, in R&D activities and innovation, increasing the linking of innovation system entities and facilitating their access to highly qualified human resources, promoting scientific and qualified employment.

2.2.2 Link between knowledge production and its application

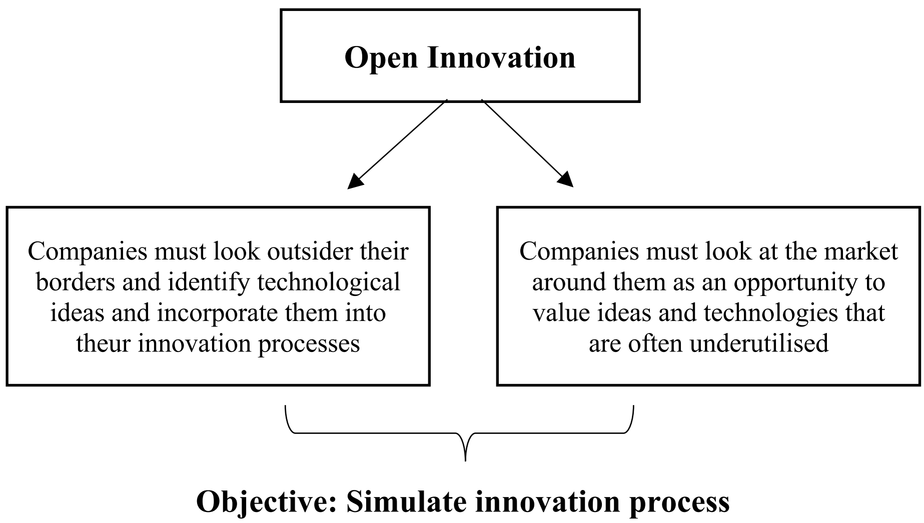
The systemic approach to knowledge production leads to a multiplicity of concepts, therefore, the link that attaches value creation, its application and its end result, is scrupulously associated with the develop of successfully completed R&D activities, greater technology demonstration and new technologies dissemination in form of new products, processes or innovative products highlighting their advantages and boosting knowledge diffusion (Fagerberg, 2017).

Nevertheless, it is obligatory to state that, even though, there is a contemporary necessity in Europe to promote open innovation and knowledge production as a measure of innovation policy, in the early days of the European Economic Community (EEC) (current EU) this was seen as embryonic (Santos, 2016; Fagerberg, 2017). The first framework-program for research actions barely appeared in 1984, and only from then, common settlements began to exist between the European Communities to pursue the target of researching, producing knowledge and designing policies that set out these principles (EU, 2013, 2014, 2016).

Portugal's accession to the EEC guide decision makers to start encompassing R&D within the economic system, leading to the upsurge of new forms of knowledge. As a result, new systems of transferable technologies were developed. This phenom was an accurate strengthened of scientific research and it is undeniable that innovation processes, technology transfer, the creation of research centers and research from the academic point of view were a result of the evolution of community policy (EU, 2013). By virtue, the innovation intensity of companies is directly connected with their results.

In this sense, research centers mediate the gap between production and application of technology transfer, knowledge production or even open innovation and circular economy.

Figure 4: Open Innovation as a key factor



Source: Own desing based upon (Agência Nacional de Inovação, 2019; Santos, 2016)

In a simplistic view, research centers, should promote the integration and participation of Portuguese companies in value chains through cooperation with other relevant companies that can guarantee the best conditions of access to markets, technologies and skills. These projects may constitute a first application of a new technology in the development of an activity in a specific economic sector with prospects of techno-economic viability and replicability conditions aiming to achieve the industrial validation of knowledge related with new technologies that can be applied in national or international level.

However, at the same time that technology transfer and knowledge production were seen as a relevant factor in the economic system, Portugal became more innovative and competitive. Programs like “Sistema de incentivos à investigação e desenvolvimento tecnológico (SI ID&T)” emerged and settled an encouragement of entrepreneurship, by assimilating and matching technology organisations and firms (EU, 2014, 2017).

Figure 5: Innovation inputs and outputs

Measures Taken	Results Obtained
• Growth of a consolidated innovation policy; • Scientific research and encompasses; • Increase of training and qualification human recourses; • Advancement of technological and scientific culture; • Promotion of technology transfer; • European and international cooperation.	• Cumulative scientific construction absorbed towards technology and high added value; • Comprise technology transfer scientific knowledge production into business routines; • Amplify the investment in R&D, firming the relationship amid companies and technology infrastructures; • Aggregate corporate investment in innovative activities.

Source: Own desing based upon (EU, 2013, 2016)

2.3 Innovation Instrumentation

2.3.1 Innovation Evaluation

Innovation investment in is an issue that sparks much interest from organisations, particularly those (like research innovation centers) with a high intensity of innovative practices. It is certain that innovation is increasingly a priority for business, nonetheless, it is extremely important to have a strong support allowing an evolutionary process evaluation.

Innovation can be evaluated in various ways, ranging from performance evaluation, distribution funds evaluation, public policies evaluation or even economic evaluation of engendered values. It is considerable that this assessment is an important tool for improving the efficiency of an evolutionary process which, may be, vague and intangible (Georghiou et al., 2002; Youtie et al.,).

The existence and use of a process for evaluating areas where a company needs to innovate makes it possible to identify the inherent strengths of a company's innovation efforts while, at the same time, defines opportunities for improvement. To evaluate Research Centers, (entities that have a systemic vision of innovation), an increasing factor focused on learning economic and market behaviours is needed.

Therefore, evaluation of innovation aids for much more than just a global assessment of management models or organisational capacities within the framework of innovation production. The following table endorses four strategic points where evaluation of innovation generates outputs to measure the performance of launched products or services.

Figure 6: Strategic ways of assessing innovation

Strategic ways of assessing innovation

Innovation strategic innovation profile	Organisational readiness for innovation	Inherent strengths in company's innovation efforts	Strategic innovation trends
Diagnosing the company's strategic profile of innovation and the critical success factors that must be ensured when implementing it.	Dimension that represents an **"accelerator tool"**. Evaluates issues such as: **1)** Strategic alignment; **2)** Innovation capacity; **3)** Innovation networks **4)** Organisation and processes; **5)** Readiness for digitisation	Company approach to innovation ensures that the ideas generated are substantiated and analysed, allowing them to evolve throughout the innovation process. Dimension addressing the Capacity to effectively and systematically approach the generation of new ideas	Strategic innovation trends with an impact on the business and activity of companies, determining opportunities for improvement that contribute positively to their performance

Source: Own desing based upon (Georghiou et al., 2002; Youtie et al.,).

Evaluation is not easy, as it advances to projects and programs, when considering sub-systems and innovation systems. Tactics to deal with these include the use of methods to reach decisions at each level, the explicit use of theory, and the best practices of reference to evaluate performance.

Finally, the difficulty in establishing a single evaluation criterion for innovation programmes lies on the fact that policy impacts on innovation processes are measured over time and are a social phenomenon. Evaluation is a social process as it involves interactions of individuals, organisational methods, practices and routines (Georghiou & Roessner, 2000; Papaconstantinou & Polt, 1997).

2.3.2 Innovation Measurement

Measuring innovation is a contingent process, not only because it's difficult to understand the details of an innovation process, but also, because its own factors, results and control. Quantifying or measuring innovation is an important goal for any company, since business and profit, in the knowledge era, depend increasingly on innovation (Evans & Johnson, 2013).

Innovation measurement is understood as a process that brings together four essential factors. According to European Innovation Scoreboard (2018), these combining measurement factors, considered that innovation is a specific driving force that fosters company's performance and reinforces their competitive position: **(i)** understanding the current objectives in an innovation process; **(ii)** realise the environment in which it takes place; **(iii)** comprehend its intrinsic factors and the parameters in which its results are circumscribed; **(iv)** recognise that innovation is always in continuous acceleration.

Over the last decades, innovation measurement, has undergone gradual changes and structural improvements. However, there are still difficult problems to overcome. It is necessary to admit that surveys conducted, were preferably aimed at the macrolevel, which represents a barrier to assess small businesses and entities engaged in knowledge production and, consequently, in innovation techniques and processes (e.g. Research Innovation Centers, University departments of innovation or even SME´s) (Mamede, 2017).

Promoting a more uniform innovation measurement between countries, (Mamede, 2017) states that using Innovation Union Scoreboard (IUS) standardises the assessment of innovation capabilities of European countries and oversees a wide variety of economic structures among countries under analysis.

On the other hand, according to Oslo Manual (2005), innovation is a broad concept with an open definition. It is important to establish common indicators that can be seen as global metrics for classifying an extract innovation measurement. In fact, innovation measurement processes have often been associated with research and development statistics and patents, once, organic structures have been continuously disregarded. However, in the last years, the most consensual way of measuring innovation is to focus on criteria for quantifying initial R&D spending's for measurement of tangible projects, product improvements and intangible investments.

Affording these distinct sights, the question that arises is: Which indicators can reflect acceptable levels of innovation measurement?

According to Gupta (2009) the effective measures to assess innovation will have to be based on the early understanding and control of the respective process and the relationship between inputs and outputs, focusing the SIPOC model (Supplier, Input, Process, Output, Customer).

This author, states that measurements based on purely financial and numerical metrics are not necessarily a form of measurement of innovation once, it is fundamental to establish their beforehand objective and purpose. The following steps can be taken as an example to establish measurement procedures in a process or activity:

Step 1) Definition of the organisation innovation objective, based on the assumption that it corresponds to the application and commercialisation of new ideas and products. This means that a significant improvement can be made through acts of creation, collaboration or dissemination;

Step 2) Establishing the expected results and their contribution to business performance in terms of growth and profitability;

Step3) Determination of measurement levels that define success taken into account the achieved results;

Step 4) Identification of challenging opportunities for improvement processes;

Step 5) Listing develop activities to accelerate innovation;

Step 6) Inputs and internal processes identification;

Step 7) Determining the capacity to collect information;

Step 8) Establishing reporting and monitoring communication methods.

In this sense, the great objective is to understand the importance of each founded indicator, aiming to build a methodology that will be able to dictate the position of each company in this classification system.

2.4 Research Innovation Centers as a driver of innovation

2.4.1 Role of Research Innovation Centers in innovation

Research Centers boost innovation through multiple factors. These factors, developed over time, address business needs and affect civil society. However, these innovation factors have emerged due to the methodological study of innovation processes or through current market needs (i.e., competitiveness, tacit value creation or knowledge enhancement) (Agência Nacional de Inovação, 2019; EU, 2014; Portugal2020, 2019). Thereby, the central role of these entities is to achieve key points that act as innovation drivers. It is undeniable to assume that the innovative process has a track record over centuries, yet, this innovation approach is itself innovative (EU, 2017).

Following the directives of the Portuguese government, the role of produced innovation by research centers is characterised as: **(i)** the expansion of technological infrastructures in different regions, **(ii)** the support for co-promotion projects, **(iii)** the support for participation in European networks **(iv)** funding for companies with projects in I&DT, **(v)** the support for industrial research (Agência Nacional de Inovação, 2019, Compete2020, EU, 2014, IAPMEI, 2019, Portugal2020, 2018).

By analysing each of these individual points, it is simple to understand that they all have strong bonds and connections. Regarding the expansion of technological infrastructures of different regions, issues connected to geography and decentralisation are covered, not only by research centers, but also, by higher education institutions. On the other hand, the support for co-promotion projects focuses on incentives for research and technological development, the stimulation of business cooperation and the articulation between companies and research entities, accelerating diffusion, technology transfer and using knowledge and R&D in business fabric.

The support and participation in European networks is built by offering direct encouragement to companies and entities in the I&I System (Research and Innovation Strategy for Smart Specialisation) dedicated to scientific research and participating in Eurostar's European Networks.

Funding for companies with projects in R&DT, embodies the funding opportunities in regions capable to establish projects. Research centers perform a main role in this directive, once they are a vehicle to launch projects or patents in certain regions both at national and international level.

Lastly, the support for industrial research, represents the final part of the cracking application of innovation process. In business incentive context, the way to finance industrial research or development activities, reside in the encouragement provided to companies to unveiling new products or to implement new industrial processes.

As stated by (Cunningham et al., 2017) these transactions are chief enablers and promoters of innovation process, and as supported by (Saiz et al., 2005) nowadays, each company in dissimilar business area, expects to progress their actions and results by collaborating within enterprises networks.

2.4.2 Collaborative Networks

A collaborative network is defined as a network comprising of a multiplicity of entities, people or even companies that are autonomous, geographically distributed, and heterogeneous in relation with their operating environment, culture, social capital and goals. Collaborative networks interact with each another, driven by the pursuit of common objectives, and whose interactions are aligned with the environment around them (Camarinha-Matos, and Afsarmanesh, 2005).

Collaborative networks are present in very diverse and distinct environments (i.e., production or service-oriented organisations, innovative enterprises, industry clusters, research innovation centers, technology communities) (Camarinha-Matos, and Afsarmanesh, 2005; Santos, 2016). However, they cannot be seen as a singular phenomenon. In fact, there are different factors that make up its current definition. In this way, the interlinked concepts of networking, coordination, cooperation and collaboration represent the different "*building blocks*" that constitute the concept (Denise, 1999).

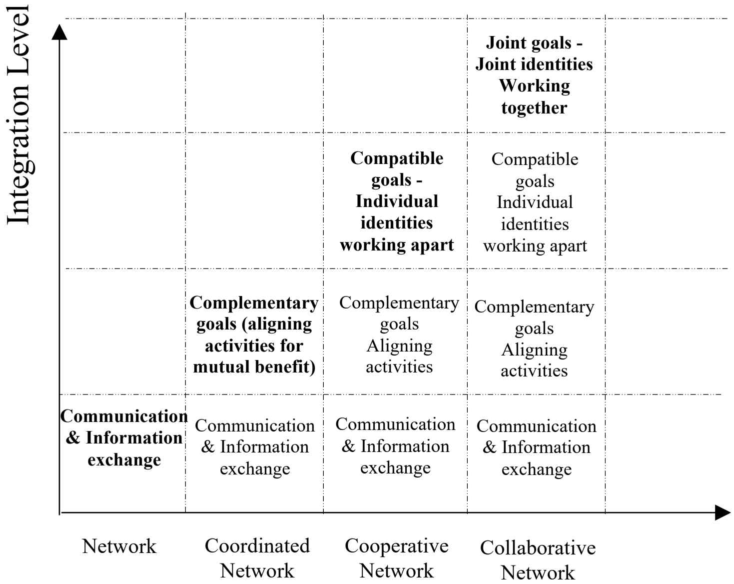
Kolakovic (2003) defines networking as a process that involves communication and information exchange for mutual benefit, based on a sense that it can act alone, without necessarily being embedded in a collaborative network. On the other hand, coordination is a procedure that brings accomplishments to attain more efficient results. In literature coordination is described as the action of working together harmoniously and generating value, usually shaped at individual level (Camarinha- Matos, and Afsarmanesh, 2005; Caraça 2007).

Cooperation which is a more robust notion as it always promotes common plans involving information exchange and adjustments of activities is described as a common plan which in most cases is not defined jointly, but rather meant by a lone entity, and that needs some amount of co-working (Saiz et al., 2005).

At least, as stated by Evans et al., (2004), collaboration is a procedure in which entities assign information, resources and responsibilities to mutually plan, implement, and evaluate a program of activities to achieve a common goal. Caraça (2007) and Santos, (2016) described collaboration as process throughout a group of entities that improve the competences of each other.

As so, figure 7, demonstrates how these concepts are related and what they provide to the innovation and knowledge production system. These principles are fundamental to collaborative networks structure, which means that information is not retained between the different stages of the process (Himmelman, 2001).

Figure 7: Relation between collaborative network principles



Source: (own design based on Camarinha-Matos, and Afsarmanesh, 2005)

2.4.3 Technology Transfer and knowledge valorisation in business context

The prominence of technology transfer arises from the idea that knowledge should be extended continuously and uninterrupted. In such wise, innovation, seen as a robust phenomenon for medium and long-term, had to adapt and develop viewpoints that could be transferable and more than just knowledge produce, once there was a constant involvement factors such as chronological time and the re- adaptation of ideas (Krugman, 1978).

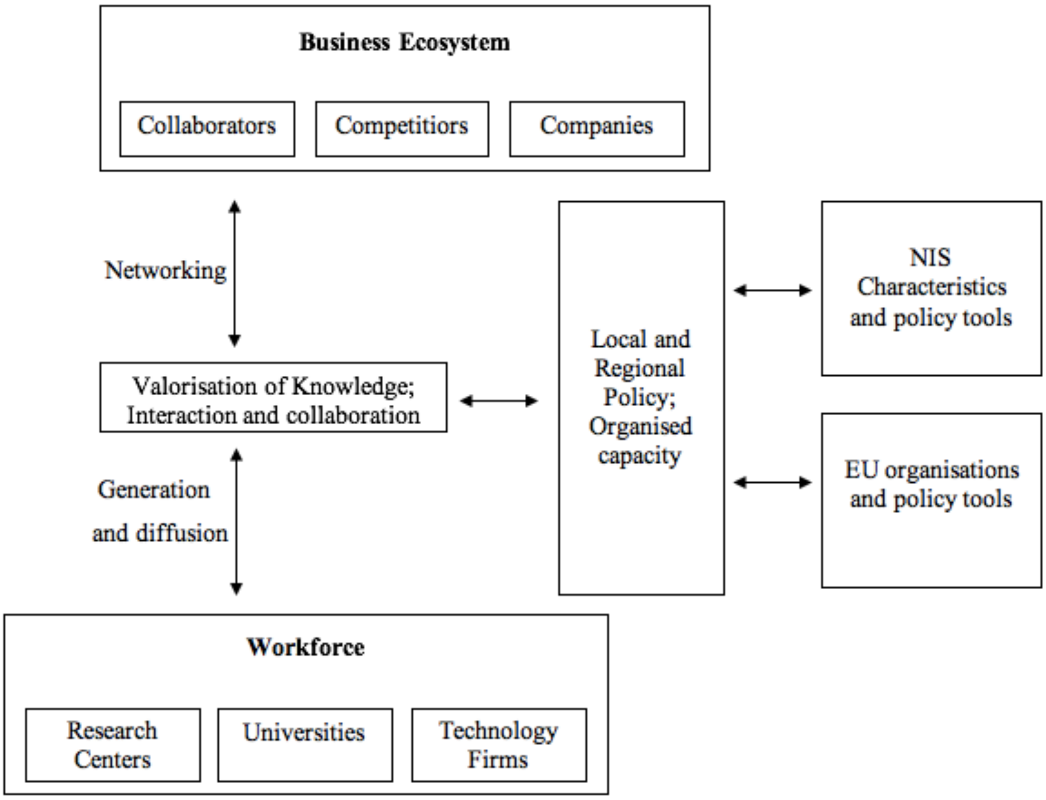
Years later, Potterie and Linchtenberg (2001) reported that technology transfer was a complex occurrence that had become structural in the way innovation was being produced and designed. In this regard, these authors argued that technology transfer was a floating mechanism that was interconnected with entrepreneurs and their ability to pass on knowledge. This gave rise to the idea that this process was linked to key issues clarifying concepts and attracting foreign R&D contributions to productivity growth.

However, the application of technology transfer cannot be limited to its definitions. (Amesse and Cohendet, 2001) mentioned that technology transfer coupled with the interactive and systemic vision of the innovation process and its increasing importance over the last few years was due to factors such as: **(i)** the significance of "technological competence" as a font of competitiveness, both at the level of firms and at the level of nations governments, **(ii)** the expansion of new technology programmes, **(iii)** the fact that commodities are no longer centralised at one supplier and are accessible from multiple sources (multi-dimensional portents), **(iv)** the accumulative request for innovative funding's based on scientific and technological research (Amesse and Cohendet, 2001; Bessant and Rush, 1995; Cunningham et al., 2017).

Technology transfer is influenced by the surrounding system and by interconnections quality. Through these purposes the quality of generating important doles on company's organisational enactment and on economic and social performance is influenced (Bessant and Rush, 1995; Newman et al., 2015).

Following a path that meets the knowledge production subject, and looking at how the innovation system in Portugal is organised, Shane (2004) sums that technology transfer comprehends bonding of new technologies, formation and safeguarding of national patents, trademarks and progress devising.

Figure 8: Research Centers and their environment



Source: Own design based on Geenhuizen (2010); Rathenau Instituut (2009), Shane (2004).

Figure 8 points that business ecosystem dimension and the large group of actors involved seem important, not only for intensifying economies, but also, for devising a critical mass above which progress begins to mature as a self-propelling mechanism. (Rathenau Instituut, 2009), states that knowledge valorisation is also persuaded by regulation of R&D and market access, which is exactly one of the purposes and definitions of transfer technology. It should be emphasised that without the contribution and effort of entrepreneurs and organisations it would not be possible to achieve technology transfer processes as they are the real inputs to value creation (Bathelt et al., 2004).

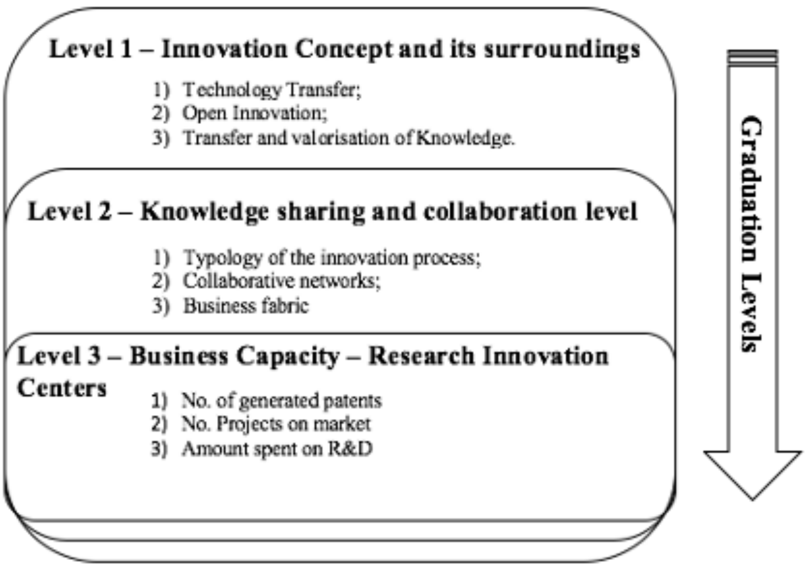
Chapter III – Methodological approach

Following our research questions and research objectives, this chapter introduces the developed methodology used over the study. The adopted research strategy is detailed, the chosen data sources are justified, and the variables selected are identified. Therefore, the current chapter will lay out the leading theoretical and empirical beliefs and techniques which underpin innovation performance in Portugal.

The aim of this stage is to characterise how concrete results are intended to be achieved, clarifying the study objective, research questions and the advantages and disadvantages of each selected model.

Figure 9 represents the three levels of our research. These gradual levels embody the study's surroundings and the way research centers ecosystem aligns to produce results.

Figure 9: Tacit results on how innovation is achieved



Source: Own design based on (Agência Nacional de Inovação, 2019).

3.1 Research Objectives

In a simple way, the assessment object defines the action to be assessed. There are small details that will have to be simplified and addressed before moving on to the empirical approach. Following the logic of the previous chapter, the main research objective is to measure innovation performance of research innovation centers. Thereby, it is essential to describe the tacit number of innovation projects that these entities support and typify how many of these projects have generated innovation indicators, such as, increased scientific employment, creation of new patents or spin-off´s.

Deepening our research, it is essential to understand how these initiatives are supported and especially what is its added value. Through the above, the assessment's target-programme emphasise innovation measurement and the intentions that stem the way of this investigation are:

(i) Firstly, this is the project typology which directly fosters the existence of collaborative R&D and technology transfer, which leads to innovation, technological advancement and product priory. In the end, these combined issues prompt technical and incremental innovation.

(ii) Secondly, support for innovation by national and international organisations creates robustness, sustainability and budgetary predictability for companies wishing to develop innovative projects. Consequently, there is a greater probability that they will position themselves better in responding to needs not covered by services and not available on the market. That is, proposing alternatives to possible "market failures" already identified.

(iii) Thirdly, it is important to mention the internationalisation potential that every research innovation center create for projects developed by "new-born" companies. Being the support for company's dependent of the acquisition and development of border knowledge, it is essential that there is an integration of chains and solid international value. For this reason, it is vital to potentiate participation of Portuguese projects or companies in networks, such as, the European Innovation Network. In addition, participation in international collaborative projects, inter-institutional collaboration, active participation and influential contribution in European technology platforms are strong indicators that characterise innovation of both, research innovation centers and the country itself.

(iv) As a fourth reason, the pillar of competitiveness is presented. Promoting innovation in the area of the circular economy should be a pillar of competitiveness and economic growth, as well as the spread of new business models and integration into new value and strategic development chains. Research Centers should highlight how they support companies in adopting new innovation strategies in line with the principles of the circular economy, as well as, research and development and technology adoption in this area (Fundo de Inovação, Tecnologia e Economia Circular, s.d.).

3.2 Investigation strategies

The investigation will follow a deductive approach. In this type of approach hypotheses are developed and a research strategy is designed to test the hypotheses (Saunders, Lewis, & Thornhill, 2009). Given the nature of the research, this study analyses the relationship between the established variables. Thus, it was established a research by questionnaire.

In this type of methodological approach, given our population, a random and numerous sampling is not privileged, but rather judicious or criterial one. The selection of the sample is restrained to certain criteria that helps our research to create efficiency in the model (Grimshaw, Thomas & MacLennan, 2004).

In this way, surveys are popular because they allow the collection of a large number of data from a considerable population. Usually use, the administration of a questionnaire, enables the standardisation of the sample, allowing easy comparison. The data collected through the survey may suggest possible reasons for particular relationships between variables, producing models of these relationships and generating representative results of the entire population (Saunders, Lewis & Thornhill, 2009).

The investigation strategies focus on finding inputs, that can attend as indicators to analyse the formulated hypotheses. In this way, the collected data acts as a guide to answer the following research questions:

H1: What is the role of research innovation centers in Portuguese innovation?

H2: What is the performance in terms of innovation of the centers?

3.2.1 Data collection method

We can differentiate data in two different ways: **(i)** primary data **(ii)** secondary data (Hallett, 1978).

Primary data, which was collected from first-hand sources, helps to know the "state of the art" of a certain subject. On the other hand, it contrasts with secondary data. These types of data are those that are at our disposal, from other research already finished or from other entities (Hallett, 1978).

In this investigation, mixed sources of information were used. The steps followed in the collection of primary and secondary data are described below. Regardless the type of data, the accuracy in its collection is a determining factor for the quality of information, which we tried to maintain throughout the process (Barañano, 2008).

3.2.2 Primary data

3.2.2.1 Questionnaire

The questionnaire applied represents our primary data source. Through it, it is possible to establish the originality and differentiation of the investigation. In addition, the questionnaire purposes to clarify how the study will be developed (Fincham, 2008). As so, it is intended to: **(i)** Provide a clear definition of research issues **(ii)** identify the parameters and characteristics of collected information **(iii)** identify data gaps **(iv)** identify the target sample and the geographical location of the investigation.

The applied questionnaire is fundamental to validate the previously hypotheses and to draw a description of the target population (Fincham, 2008).

Beholding our research objectives and the size of the population it was established that it would be applied to all research innovation centers in Portugal, attempting to collect and gather primary information on how many innovation projects have been supported, how many patents and new companies were generated, how mature these projects are and also what is the result of this support in the economic context.

In the end, the intention is to build a database that tells us the innovation potential and performance, since their creation until 2019.

3.2.2.2 Advantages and disadvantages

A questionnaire investigation has innumerable advantages that can be beneficial both in the way we collect the data or the way we work the data. Thus, the main advantages are related with time management and travel dislocations. At the same time, it is possible to obtain a large number of data (Scalability) and reach a large number of respondents in dispersed geographically areas. On the other hand, questionnaires have the advantage of comparing other investigations, which is an important tool to measure indicators and determine the degree of reasonableness of the study (Comparability) (Salant & Dillman, 1994).

Notwithstanding, questionnaires also have inconveniences. Problems suchlike the heterogeneity of the sample, the impossibility of knowing if who completed the questionnaire was in fact the person to whom it was addressed and unconscientious responses and lack of accessibility are vigorous threats that might misrepresent the study (Salant & Dillman, 1994).

3.2.2.3 Population and sample

Statistically there are concepts that are essential to characterise an empirical study. Concepts such as population and sampling cannot be studied *per se*, once they are allied among them. According to Barañano (2008), population is defined as a complete set of elements, persons or objects that own around characteristics defined by the sampling standards established by the researcher. In addition, Krejcie & Morgan (1970), claim that this concept is divided into two large groups target population & accessible population. Target population represents the entire group of people or objects to which the researcher wishes to generalize the study findings, conversely, accessible population represents the portion of population to which the researcher has reasonable access. Determining sample size for research activities.

According to Barañano (2008), sample is characterised as the set of selected elements (people or objects) chosen for participation in a study. This concept can also be subdivided into two distinct concepts, although, related to each other. First, sampling is the process of selecting a group of people, behaviours, or other elements with which to conduct a study, and, sampling frame is a list of all the elements in the population from which the sample is drawn.

In the specific case of this study, the population surveyed focuses on all research innovations centers. Particularly, the population concurs with the sample, since the aggregate cases from the statistical universe plotted overlaps with the sampling. Consequently, using the definition of Barañano (2008) and Krejcie & Morgan (1970), research innovations centers represent, not only, the target population, but also the accessible population, while also representing our sample and sampling frame.

Figure 10: Target population and sampling of our study

Research Innovation Centers in Portugal	
Name	**Social Reason**
1. AEMITEQ	Association for Technological Innovation and Quality
2. AIBILI	Investigation and Development of Health for Progress of Biomedical Technologies
3. CATIM	Center for Technological Support to the Metallomechanics Industry
4. CCG	Computer Graphics Center
5. CEIIA	Engineering and Development Center
6. CeNTI	Center for Nanotechnology and Technical, Functional and Intelligent Materials
7. CENTIMFE	Technology Center of the Mold Industry (Special Tools and Plastics
8. CITEVE	Technological Center for Textile and Clothing Industries of Portugal
9. COTR	Sprinkler Operating and Technology Center
10. CTCOR	Cork Technology Center
11. CTCP	Portugal Footwear Technology Center
12. CTCV	Ceramic and Glass Technology Center
13. CTIC	Technological Center of Leather Industries
14. CVR	Waste Recovery Center
15. iBET	Institute of Experimental and Technological Biology
16. INEGI	Institute of Science and Innovation in Mechanical Engineering and Industrial Engineering
17. INESC TEC	Institute of Systems and Computer Engineering, Technology and Science
18. INL	Research and Development in Nanotechnologies
19. INOV	Institute of New Technologies
20. IPN	Association for Innovation and Development in Science and Technology
21. ISQ	Institute of Welding and Quality
22. IT	Telecommunications Institute
23. ITeCons	Institute of Research and Technological Development for Construction, Energy, Environment and Sustainability
24. PIEP	Innovation Institute in Polymer Engineering
25. RAIZ	Institute of Forest and Paper Research
26. WavEC	Competence Center in Maritime Energy

Source: Own design based on (Agência Nacional de Inovação, 2019; Programa Interface, 2015).

3.2.3 Secondary data

3.2.3.1 Advantages and disadvantages

Secondary data are useful to answer the subjects of the study, as they have advantages over primary data. For a large part of research issues, databases sources allow considerable resource savings, in particular, time and money. On the other hand, they enable faster information and guarantee, a better quality of the information (Saunders, Lewis & Thornhill, 2009).

In this particular case these secondary data serve as a complement to primary data, which in itself constitutes an undeniable advantage.

Along with the advantages identified in the literature, secondary data also partake inconveniences. From the outset, the difficulty in finding appropriate data to the research objective, may pose a problem, since this database used was built for another purpose (Saunders, Lewis & Thornhill, 2009).

3.2.3.2 Data Base

Through the used database we can control two essential issues. Firstly, these data are equipped with indicators that are important to characterise the innovation performance of research innovation centers. Secondly, the same database will allow us to compare the data collected through the questionnaire with what each research innovation centers proposed itself to perform in a time universe from 2015 to 2019.

In addition, our database also allows an evaluation of three dimensions that ascertain innovation performance of each center: **(i)** Dimension Consistency and Rationality; **(ii)** Dimension Power and Capability; **(iii)** Dimension Scope - Innovation outputs.

The following table shows how indicators under evaluation are related with the three listed dimensions.

Figure 11: Dimensions to compare between the questionnaire and the data base.

Dimension Consistency and Rationality	Dimension Power and Capability - Degree of Innovation	Dimension Scope - outputs
• Number of research innovation centers; • Sector of activity; • Investment plan; • Type of innovation.	• Team's adequacy; • Reinforcement of R&D capacity regarding new appointments; • Nature of innovation.	• Economic valuation of results; • Contribution to national economy; • Contribution to the national strategy of smart specialisation.

Source: Own design based on (Agência Nacional de Inovação, 2019; EU, 2013, 2016; Programa Interface, 2015)

3.3 Formulating the Model

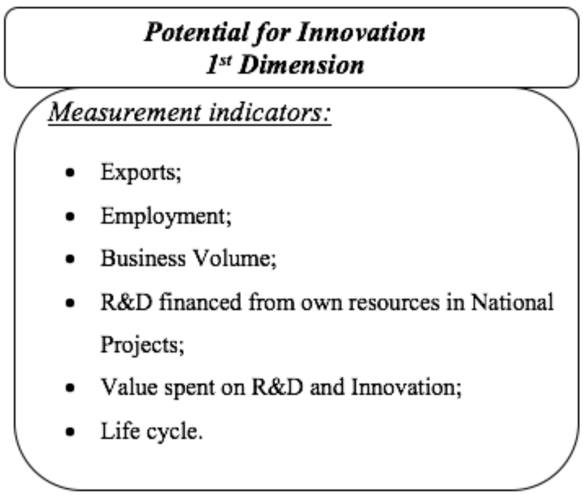
As stated above, the investigation core is to determine the level of innovation performance of each research entity. As such, it is necessary to establish a way of operationalising an aggregate measure of innovation. Therefore, two dimensions of analysis were created. Each dimension has different measurement indicators, which together compile needed information to measure innovation performance. Thus, **first** dimension is characterised as, **the potential for innovation** and **second** dimension is characterised as **the actual-effective production of innovation**.

As so, figure 12 drafts the indicators that compose the first dimension. These indicators represent the potential for innovation, since they embody real data from a time horizon comprehended between 2015 and 2016 and projections for a comprehended time between 2017 and 2019. Although these are more financial indicators than the addressed in the second dimension, fist dimension indicators set out the arrangement of each center and what they hope to achieve in the future.

As a result, the six indicators that frame our research first dimension are: **(i)** Exports **(ii)** Employment **(iii)** Business volume **(iv)** R&D financed from own resources in national projects **(v)** Value spent on R&D and innovation **(vi)** Life cycle.

In accordance with the assessed methodology, this dimension corresponds to the expected advances for each center, bringing together real data and potential data which allows us to perceive the maturation and the *status quo* which leverages technological advances.

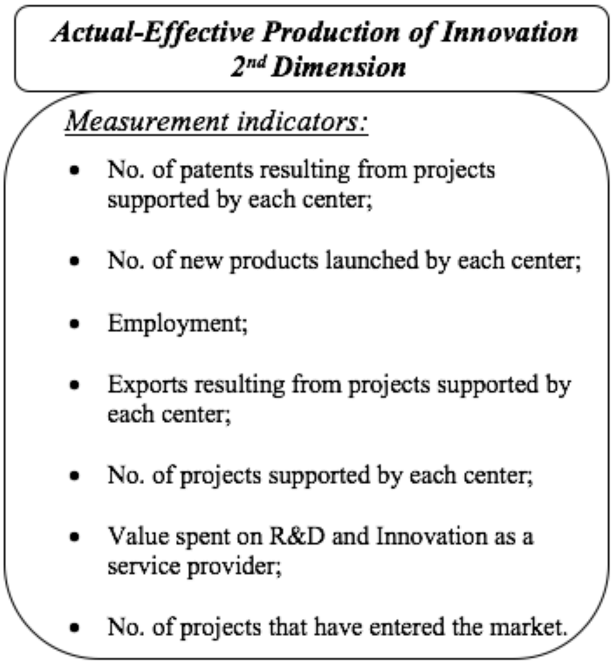
Figure 12: Measurement indicators – First Dimension



Source: Own design

The following table shows the measurement indicators that compose the second dimension.

Figure 13: Measurement indicators – Second Dimension



Source: Own design

Using the European Innovation Scoreboards methodology, each indicator is combined in its respective dimension. Different variables aggregated in a composite indicator allows the evaluation of indicators innovation capacity. The advantage of this capacity is that it is multidimensional, however, it captures characteristics of a complex and non-linear reality (OECD, 2004).

According to the Oslo Manual terminology, firms can alter innovation inputs, such as, R&D, human resources, research infrastructures and knowledge transformation into outputs, like patents, products launched to the market or research projects (OECD, 2015).

In this sense, our created scoreboards are a systematic attempt to provide comparable data on the outputs and outcome dimension of innovation, once they grab structural information such as innovation indicators and leverage an upgrade of innovation novelties (OECD and Eurostat, 2005).

The first step in the aggregation of the two variables was a normalisation process, also known as the *Z-Score* method. It consists in dividing the difference between the value of each indicator in a given indicator and the average of that indicator by the standard deviation of that distribution, thus guaranteeing normalised values with a zero average and a unit standard deviation. This avoids introducing bias into the aggregation of indicators, basically leveraging the scale and unit of measurement and retaining the amplitude of variation.

The basic Z-*Score* formula sample is:

$$Z - Score = \frac{xi - u}{s}$$

Where:

$\boldsymbol{xi}$ represents the aggregate value assumed by indicator x in each dimension;
$\boldsymbol{u}$ represents the sample mean;
$\boldsymbol{s}$ represents the standard division.

After this standardisation, the composite indicator was constructed, which was found by a simple average of values of the two synthetic dimensions.

The basic Max-min method sample is:

$$\mathbf{MNX_i} = \frac{\boldsymbol{x}_i - min\ (\boldsymbol{x})}{max\ (\boldsymbol{x}) - min\ (\boldsymbol{x})}$$

Where:

MNXi represents the normalised value given by indicator i in each dimension;
$\boldsymbol{xi}$ represents the value assumed by indicator i in each dimension;
$\boldsymbol{min}\ (\boldsymbol{x})$ represents the minimum distribution of aggregates in each in all indicators;
$\boldsymbol{max}\ (\boldsymbol{x})$ represents the maximum distribution of aggregates in each in all indicators.

The values are aggregated into a distribution between 0 and 1, being 0 attributed to the lowest value indicator in a given dimension, (representing the relative worst performance) and 1 to the highest value indicator (representing the relative best performance). The value of the final composite indicator remains between 0 and 1 for each indicator.

3.4 Questionnaire development

The questionnaire is part of the primary data. It was designed to create the second dimension study analysis, designated as “Actual-Effective Production of Innovation”.

Following the proposed methodology, this second dimension is divided into seven performance investigation indicators: **(i)** Number of patents resulting from projects supported by each center **(ii)** Number of new products launched by each center **(iii)** Employment **(iv)** Exports resulting from projects supported by each center **(v)** Number of projects supported by each center **(vi)** Value spent on R&D and Innovation as a service provider **(vii)** Number of projects that have entered the market.

These indicators, tested in the questionnaire, serve to make a comparison between first dimension and the actual data presented by each entity. In this way it is possible to understand where innovation generates stands and how Portuguese industry is empowered.

Although there is only one commonly tested indicator with the first dimension (Employment), these essentially aid to measure innovation performance of the centers surrounding ecosystem, either through companies that incubate projects in them or through the application of direct technology transfer from these entities to companies that surround them. In addition, a pre-test was carried out to CENTIMFE which allowed us to shape the answers and adapt them to a context that was easy to understand.

Within the universe of twenty-six research centers, eleven responses were obtained, which admits estimating the real performance of each one.

Finally, the questionnaire also makes it possible to analyse the state of maturity of these centers. In the first dimension, the database includes an indicator that analyses the evolutionary state of these entities (e.g. *introduction, growth, maturity or decline*), so the questionnaire tests, to this day, whether there is progression or not.

Chapter IV – Analysis and Discussion of Results

The following chapter illustrates the analysis data from both dimensions described in the methodology. It is important to stabilise results, develop indicators and create methods that indicate whether each center is evolving, measuring its innovation performance.

This chapter evidences what is described in Chapter II, once it is the empirical confirmation of what is explained, trying to formulate methodologically viable hypotheses and bringing a statistical analysis that seeks to answer the research questions established before. Research entities are characterised, each indicator in each dimension is analysed and results are obtained.

4.1 Characterisation of the innovation potential of Research Innovation Centers in Portugal

For a characterisation of research innovation centers in Portugal, it was decided to develop a description sheet. This description form, inspired by European Scoreboards methodology, aims to aggregate indicators that measure innovation performance of each center, as well as, describing them individually regarding their state of maturity. These characterisation sheets are attached (Appendix D) and they analyse all indicators from first and second dimension of the study[1].

4.2 State of maturity

Maturity is determined from two different perspectives. In a first phase, it is directly assessed by the extraction from the database, however, in a second stage, the questionnaire tests this degree of maturity.

Life cycle is a common indicator between the first and the second dimension, it is possible, through this indicator, to understand how the performance of other indicators influences the evolution of each entity.

Consequently, this indicator, represents the development of each center in the studied time horizon.

Life cycle indicator is subdivided into four phases of evolution:

Phase 1) Introduction;

Phase 2) Growth;

[1] Although the population and sample of the study is composed of 26 interface centers, there are only 11 description forms since we only obtained 11 answers to the questionnaire.

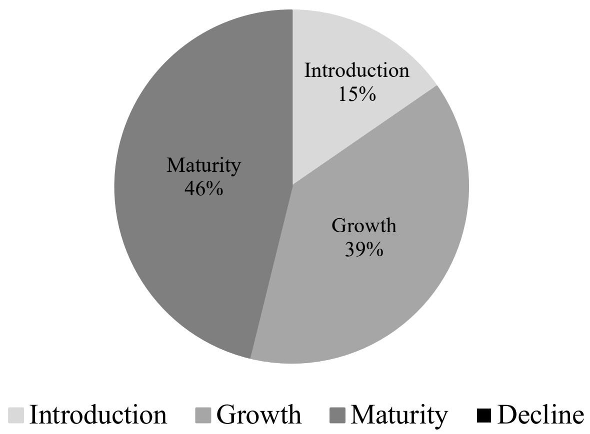
Phase 3) Maturity;

Phase 4) Decline.

Is important to compare their progression with the number of supported projects and with technology transfer generated in knowledge production. As so, the following charts represent the development of all entities which results were obtained from the entire population, acquired through the database.

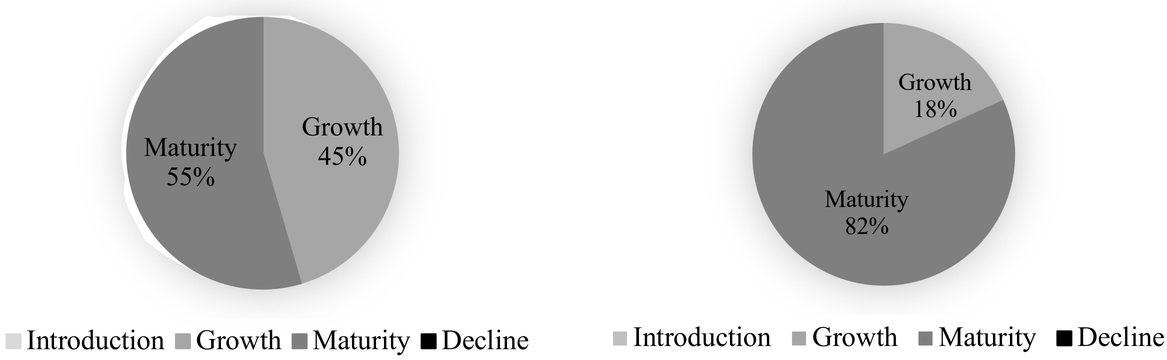
It should be noted that a comparison of progress can only be made for entities which have replied to the questionnaire. Their potential state of innovation is scrutinised (**first dimension** - obtained through the database) and in their actual-effective state of innovation (**second dimension** - obtained through the questionnaire).

Figure 14: Life Cycle



Source: Own design based on data retrieved from ANI.

Figure 15: Life Cycle: Potential   Life Cycle: Actual-Effective



Source: Own design based on data retrieved from ANI & the questionnaire.

The following graphs show that: Firstly, observing the total performance, (figure 14) there are three sub-indicators that characterise these centers: Introduction - 15%; Growth - 39%; Maturity - 46%.

Secondly, restricting the sample to the eleven that responded, it is noticeable that there are only two sub-indicators (figure 15): Growth - 45%; Maturity - 55%.

Separating the potential from the actual data (acquired in 2019) it is noteworthy that, although there are still only two sub-indicators, the percentages change substantially, indicating that there has been a progression: Growth - 18% Maturity - 82%.

State of maturity indicator directly mirrors the evolution of the addressed entities. Its major objective is to measure whether there is any relationship between the evolutionary process and the increase of production and innovation. Since it is not possible to determine it, the main drawn conclusion is that, back in 2015, there were more research centers growing, which may indicate that there was more scope for innovation progress.

4.3 Potential Innovation Index

Following the proposed methodology and targeting to afford the expected innovation potential of each entity, the following tables are based on statistical inference, covering the studied temporal horizon and comparing first dimension performance measurement indicators.

It is important to keep in mind that projections data are enclosed from 2015 to 2019.

4.3.1 Potential Rankings

Innovation performance is determined through several factors. The assembled indicators help to measure innovation performance of each center, however, through the handled methodology (processed through Z-Score and Max-min method) an average of indices was achieved, which was transformed into rankings. These rankings deliver the innovation potential of each entity (**centers with more index average have more innovation potential, center with less index average have less innovation potential**).

Therefore, figure 16 aggregate an average of values such as:

Figure 16: Potential Index Average & Potential Rankings

Center	Index Average
AIBILI	11,12

Center	Ranking	
ISQ	65,36	***High Potential***

CATIM	4,39
CENTIMFE	2,98
CTCOR	0,81
CTCV	2,35
CTIC	1,19
iBET	34,01
INEGI	26,57
ISQ	65,36
RAIZ	13,60
WavEC	1,62

iBET	34,01	
INEGI	26,57	
RAIZ	13,60	
AIBILI	11,12	
CATIM	4,39	
CENTIMFE	2,98	
CTCV	2,35	
WavEC	1,62	
CTIC	1,19	
CTCOR	0,81	***Low Potential***

Source: Own design based on data retrieved from ANI.

After the statistical treatment we came to a conclusion that could, in a certain way, distort what was being studied. According to the table above, innovation potential was conditioned by the number of employees (completely dissimilar) that each center owns. In this sense, as expected, bigger entities, such as ISQ, have a higher innovation potential index, since they have more employees, projects, R&D spending and so on.

It became necessary to study how each entity behaved without the presence of the employment indicator.

4.3.2 Potential Rankings per employee

In order to avoid the common indicator - employment - so as not to draw obvious conclusions such as - greater number of employee's greater potential for innovation - the following topic intends to recognise the degree of innovation regardless the number of employees per center.

Figure 17: Potential Index Average per employee & Potential Rankings per employee

Center	Index Average per employee
AIBILI	52,91
CATIM	22,27
CENTIMFE	16,31
CTCOR	19,26
CTCV	17,56
CTIC	20,87
iBET	38,36

Center	Ranking per employee	
AIBILI	52,91	***High Potential***
iBET	38,36	
ISQ	37,95	
RAIZ	34,53	
WavEC	29,56	
CATIM	22,27	
CTIC	20,87	

INEGI	11,25
ISQ	37,95
RAIZ	34,53
WavEC	29,56

CTCOR	19,26	
CTCV	17,56	
CENTIMFE	16,31	
INEGI	11,25	***Low Potential***

Source: Own design based on data retrieved from ANI.

The conclusions drawn become completely different from those addressed in figure 16.

Descriptively, indices averages are changed as a performance indicator is eliminated, however, the main conclusion is that innovation performance (high or low) is no longer directly dependent with the employees' number. In fact, centers at the top of the table partake different maturity states, different missions and completely dissimilar value spent on R&D and Innovation.

In this particular case, it is possible to see that entities with the highest number of employees are not necessarily those with the greatest potential for innovation. Specifically, INEGI (a center with a high number of human resources) embodies the weakest innovation potential per employee. However, other entities, such as ISQ or IBET (two other centers with a high number of employees) continue to occupy the places with the most innovation potential, since the other indicators analysed display a high performance level.

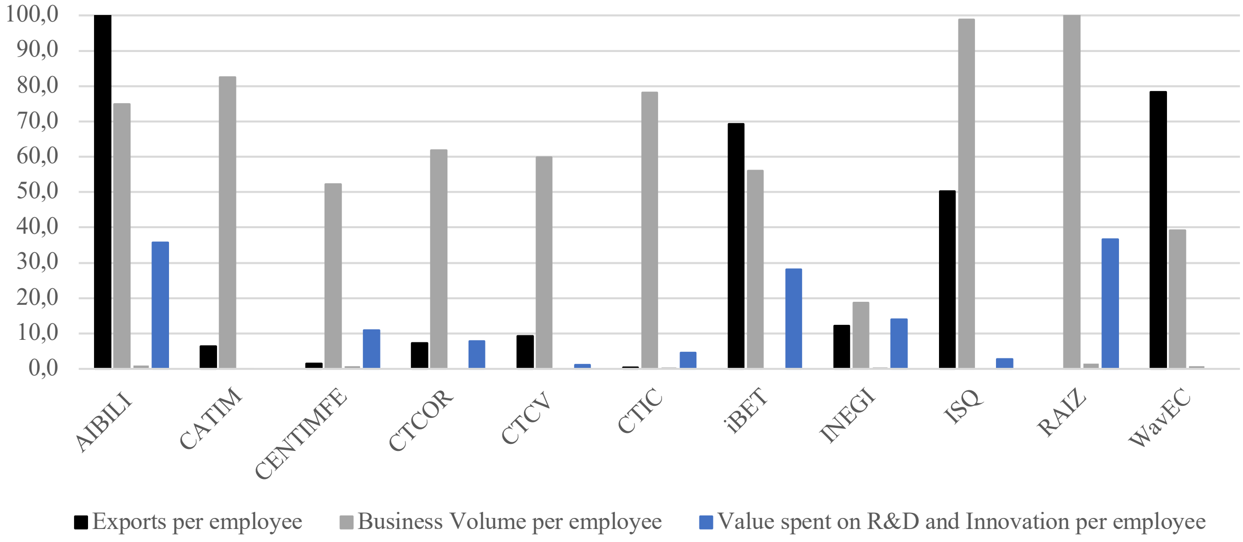
On the other hand, considering all indicators treated for the indices construction, R&D financed from own resources in national projects per employee, seems to be a highly significant indicator for the ranking in which each entity appears.

Conversely, centers with fewer workforce, CTCOR, CTCV and WavEC, yet, with higher export volumes and more transferred value in innovation and technology, manage to position themselves above centers with higher numbers of employees.

4.3.3 Potential innovation performance indicators per employee

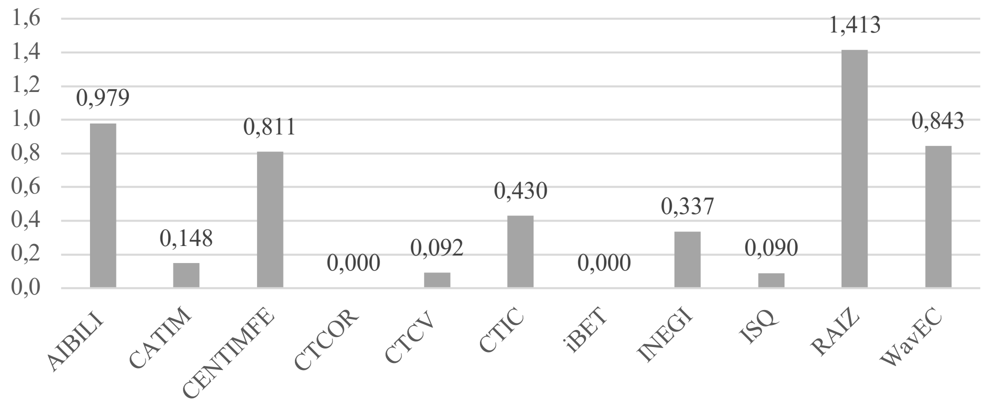
Bar charts are useful to relate the performance of each center with each treated indicator and it is possible to verify how the potential for innovation is influenced.

Figure 18: Exports, Business Volume and Value spent on R&D and Innovation (per employee)



Source: Own design based on data collected from the questionnaire.

Figure 19: R&D financed from own resources in National Projects (per employee)



Source: Own design based on data collected from the questionnaire.

As noted, figure 18 aggregates three of the four indicators obtainable in the first research dimension asserting a direct relation between the spent values per center, exports, business volume and value spent in R&D.

The scale measures standards from 0 to 100 due to the Max-min assembly indices, indicating the lowest potential generated and the highest innovation potential possible to generate. Despite the oscillations, it is achievable to detect which entities are able to remain more uniform and more consistent, influencing the potential for innovation.

At first sight, it is possible to infer that business volume indicator, tends to fix entities with highest performance in ranking top positions, ensuring greater potential for innovation. However, we cannot interpret an isolated indicator, since generated positions in potential rankings and in potential per employee rankings diverge not only in size, but also, in the innovation potential that was estimated and that is actually succeeded.

In this sense, analysing the other two indicators, it is possible to remark two important things: **(i)** not all centers display export values because their mission does not include a "business model" that allows them to export **(ii)** values spent on R&D, which are fundamentally the mission of each center, are influenced by the number of employees that each center afford after the development of its own business.

This is why entities such as CTCV, CTIC or CTOR do not achieve large variabilities from innovation potential to the potential per employee.

On the other hand, figure 19 (which is individualised because it has a different scale), signposts that entities with a larger international dimension do not unveil results as entities committed only to national projects, balancing their ranking position. Entities such as iBET, INEGI or ISQ, which were characterised as the ones with the most potential, are the ones with the least performance in this indicator since their mission is to internationalise and, consequently, export.

4.4 Actual-Effective Innovation Index

Actual-Effective innovation index describes the results obtained in the second dimension of analysis. These data, which result from the questionnaire applied, establish the current state of each research innovation center in Portugal.

The goal of this point is to mirror the differences between first dimension collected data and the statistics that characterise second dimension. Thereby, it is possible to understand the differences between what was expected to reach and what actually accomplished.

4.4.1 Actual-Effective Rankings

Rankings that assemble the second dimension are drawn up by the answers obtained in the questionnaire. Although we can only analyse eleven entities, it is interesting to see how the addressed indicators have contributed to an improvement of innovation performance. Therefore, figure 20 aggregates an average of actual-effective values.

Figure 20: Actual-Effective Index Average & Actual-Effective Rankings

Center	Index Average
AIBILI	5,54
CENTIMFE	20,02
RAIZ	34,71
IBET	8,25
CATIM	18,53
ISQ	34,54
WavEC	1,28
INEGI	54,32
CTCV	7,41
CTIC	17,95
CTCOR	12,17

Center	Ranking	
INEGI	54,32	***High Potential***
RAIZ	34,71	
ISQ	34,54	
CENTIMFE	20,02	
CATIM	18,53	
CTIC	17,95	
CTCOR	12,17	
IBET	8,25	
CTCV	7,41	
AIBILI	5,54	
WavEC	1,28	***Low Potential***

Source: Own design based on data collected from the questionnaire.

Actual-Effective rankings embody the central axis of data comparison, since they collect actual data of each center in all indicators, measuring innovation performance. Through innovation potential measurement, actual-effective rankings can be directly compared with the previous ones established in figure 16, once there is a convergent measurement of what was expected *vs.* what was achieved.

Given this comparative analysis it is possible to understand that, projected results are different from the actual results due to the second dimension indicators under analysis (e.g. number of new products launched by the centers or value spent on R&D and Innovation as a service provider). Research centers ranking positions are influenced by their mission and social reason and by economic indicators generated from them. However, we are still confronted with the problem that entities with more employees, consequently, generate more potential for innovation.

According to figure 20 it is noticeable that two of the three centers with greatest innovation potential match with those appearing in the first three positions in figure 16. From this observation, it is possible to understand that innovation potential of ISQ and INEGI coincides with what is actually being produced. Yet, we cannot consider that the established innovation potential coincides with the current state of the innovation produced, since we are covering the employment indicator.

Nevertheless, it is possible to highlight three entities by their significant rise in ranking position. RAIZ, CTIC and CTCOR, have a positive performance in the second dimension of analysis, not only in indicators such as the number of projects that have entered the market, but also in projects that are "incubated" in the center itself.

Contrariwise, AIBILI, CATIM or CENTIMFE, in their actual-effective stage, acquire less potential for innovation than was expected. The explanation lies on the fact that in the second dimension they have low exports values resulting from supported projects and, as a consequence, a lower significance in provision of R&D and innovation services.

4.4.2 Actual-Effective Rankings per employee

Under the same assumption, removing the employment indicator from this second dimension the results are substantially different. This analysis allows us to recognise how indicators that are directly linked to economic data and allied with technology transfer enhance each center or not.

Through statistical observation, the indicator with the highest level of linearity with the potential for innovation is the spent value on R&D and innovation, translating almost directly that entities that spends the most on R&D and innovation, subsequently, have higher innovation potential.

Figure 21: Actual-Effective Index Average per employee & Actual-Effective Rankings per employee

Center	Index Average per employee
AIBILI	21,00
CENTIMFE	35,07
RAIZ	38,82
IBET	12,16
CATIM	29,28
ISQ	13,20
WavEC	27,50
INEGI	48,01
CTCV	22,38
CTIC	42,44
CTCOR	58,52

Center	Ranking per employee	
CTCOR	58,52	***High Potential***
INEGI	48,01	
CTIC	42,44	
RAIZ	38,82	
CENTIMFE	35,07	
CATIM	29,28	
WavEC	27,50	
CTCV	22,38	
AIBILI	21,00	
ISQ	13,20	
IBET	12,16	***Low Potential***

Source: Own design based on data collected from the questionnaire.

At the same time, considering the other indicators it can be stated that there is a direct correlation between the provision of services through R&D and the potential for innovation, so it is possible to assert that centers with the most value spent on R&D and innovation as a service provider have most potential for innovation.

In addition to this conclusion, the following table can be directly related with figure 17. Although projected data is distinct from real data, it is possible to find a common denominator, with centers that spend more on R&D, tend to have more innovation potential, either from value spent on innovation or value spent on service provision.

The following table shows contradictory results of innovation ranking potential per employee when compared with figure 17. Thus, the first three entities with the greatest innovation potential in the first dimension per employee (AIBILI, IBET and ISQ) are those with the lowest innovation potential per employee in the second dimension.

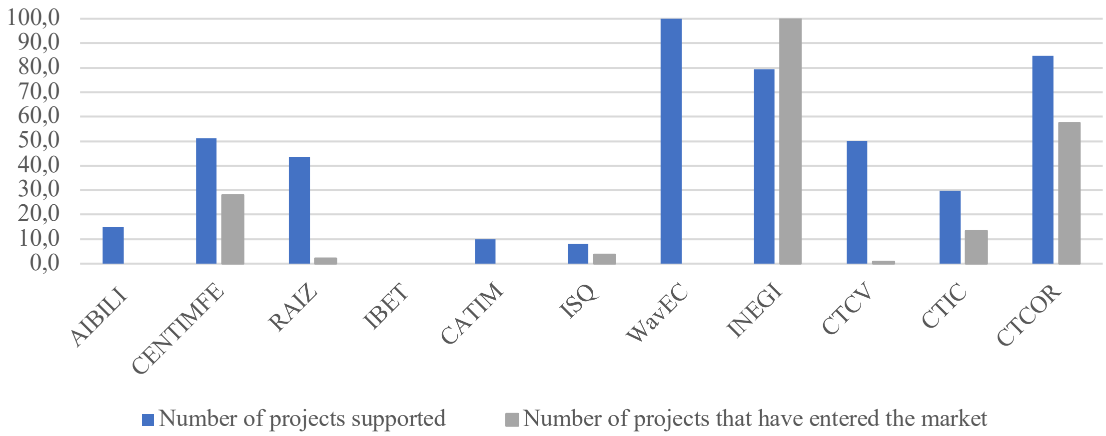
Only one of the entities with the highest number of employees, INEGI, stands out in the current effective production of innovation and technology transfer. Thus, by avoiding the employment factor, it becomes clear that the number of generated patents, the number of projects entering the market and the value of exports are essential indicators to characterise the real innovation potential.

4.4.3 Actual-Effective innovation indicators per employee

The following figures intend to represent the consequences of eliminating the employment indicator in the second dimension by showing the relationship level between the studied indicators. Recognising how performance indicators are related to each entity, three tables that link the obtained data are constructed. Representing real time data, these indicators shows the performance of each entity in knowledge production and in technology transfer. As so, it is possible to conduct a direct comparison between these centers and to distinguish how each indicator contributes to strengthening the innovation system. Once more, the represented scale in each graph encompasses values from 0 to 100, since indicators have been standardised using the Z-score and Max-min method.

Figure 22 aggregates the number of projects supported by the each center, (whether incubated or generally supported), and the number of those projects that have even entered the market.

Figure 22: Number of projects supported and Number of projects that have entered the market (per employee)



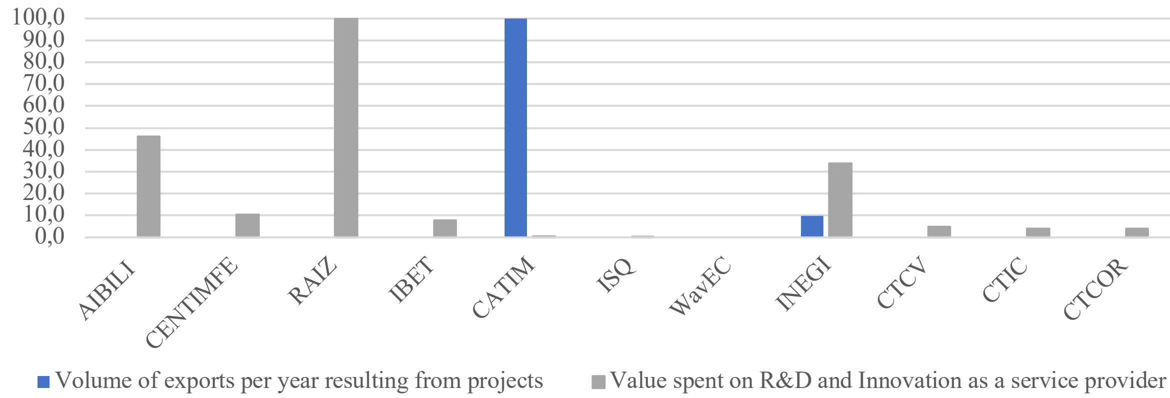
Source: Own design based on data collected from the questionnaire.

As can be seen from the graph analysis, centers with the highest correlation between the two indicators analysed are INEGI and CTOR, which means that there is greater potential for generated innovation per employee. However, it is possible to verify that it is also the "smaller" centers - in terms of employed human resources - that incubate or support more projects.

It is interesting to note that, in iBET´s case (an entity totally focused on internationalisation) there are no development of projects supported or projects that have entered the market, which explains why, despite having numerous employees, is the center with the least potential for innovation per employee.

As understood, there is no linearity in the interaction between the number of projects supported and the number of projects that have entered the market, since many of these entities function as a vehicle for interaction between companies that incubate projects and those that actually launch them into the market.

Figure 23: Volume of exports resulting from projects and Value spent on R&D and Innovation as a service provider (per employee

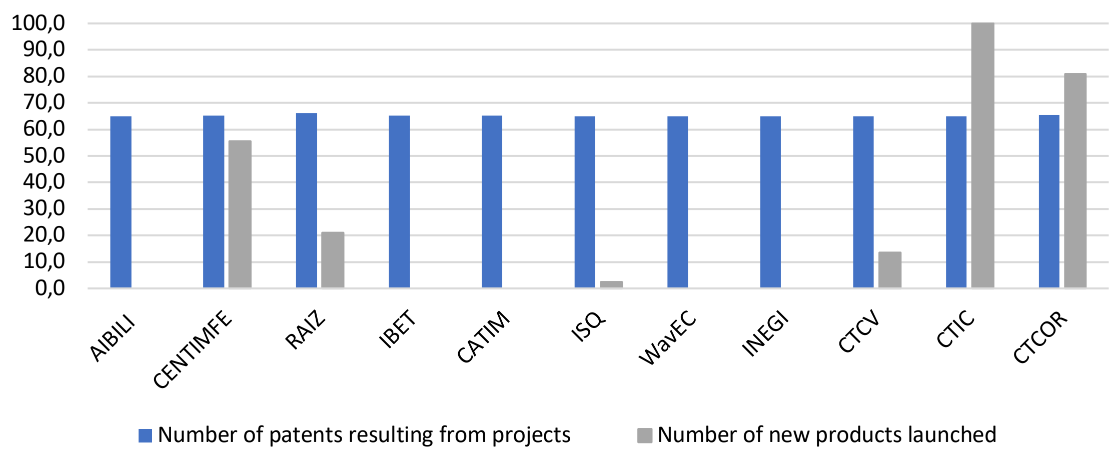


Source: Own design based on data collected from the questionnaire.

The correlation shown in the following graph reflects how value spent on R&D boosts exports by centers. These two indicators are not, relevant for influencing innovation potential, however, they are important for understanding how larger entities devote their innovation potential. By creating the Max-min indices, it is noticeable that only two entities develop significant values (CATIM and INEGI). These conclusions are expected to be drawn since these centers business model is committed to internationalisation.

However, value spent on R&D as a service provider is, otherwise, a profoundly significant study indicator. Although almost all centers display values in this indicator, the real objective of this measurement is to relate the quantities spent with the number of employees.

Figure 24: Number of patents resulting from projects and Number of new products launched (per employee)



Source: Own design based on data collected from the questionnaire.

The indicator that performed most consistently throughout the study was the number of patents resulting from projects This indicator exhibits relatively low amounts in centers and falls even further when we perform the treatment per employee. For this reason, when we transform data into indices, we find a linearity of values that unifies the indicator in question.Nevertheless, the graph presented is interesting to relate patents with the number of launched projects.

In this particular case, entities such as CENTIMFE, RAIZ, CTIC and CTCOR stand out for being able to place generated patents into the market. Due to this consequence, it is possible to observe that in the ranking per employee these centers occupy the positions with the greatest innovation potential.

4.5 Main differences between Potential and Actual-Effective innovation

Following the proposed methodology and presenting the created indicators, it was possible to establish two dimensions of analysis. These dimensions highlight different results due to the empirical study and the performance of each indicator.

In general, it was possible to launch two rankings of potential analysis. These rankings, inspired by the European Innovation Scoreboards methodology, expound different results.

Comparing the projected data in 2015 with what was actually accomplish, it is reasonable to recognise that there are gaps between what was projected and what is accomplished. This statement does not mean that these centers do not generate innovation in Portugal, but rather, there are centers that have surpassed themselves and entities that had not measured up expectations.

Through the innovation potential rankings some differences between the first dimension and the second dimension have been notable. Although were observing different measuring indicators, we only considered indicators that are included in the values and social reason of each entity. These differences reflect the following metric - **Entities with better performance in each indicator have, consequently, a higher innovation potential.**

Nevertheless, there are indicators that, due to their numerical significance, craft obvious results (e.g. employment). In this case, entities with most human resources, naturally, had the highest potential for innovation. It has become a necessity to understand whether this inference was true or not.

In this way, two more rankings of innovation potential were elaborated, however, this time, without the aggregate number of employees per center. The statistical inferences observed are relevant to the study since it is proven that larger entities do not necessarily generate more innovation. In a combination of measurement performance indicators, it is evident that indicators such as **(i)** value spent on R&D **(ii)** number of supported projects **(iii)** number of reached patents became progressively significant assessing the performance of each entity and gaining strength to rank them with more or less innovation potential.

Finally, in this chapter there are two tables that can be compared two by two. Potential Index Average & Potential Rankings (figure 16) and Potential Index Average & Potential Rankings (per employee) (figure 17) and also, Actual-Effective Index Average & Actual-Effective Rankings (figure 20) with the Actual-Effective Index Average & Actual-Effective Rankings (per employee) (figure 21)

However, to be able to compare the evolution of innovation performance of these entities we must behold figure 16 and figure 20, since these tables and rankings aggregates indicators of the first and second dimension. Thereby, it is easy to understand the oscillations of each entity, the way in which indicators condition innovation and how innovation gains are linked with the mission of each center.

Chapter V – Final Remarks

The last chapter summarises the implications of dealing with technology transfer and innovation production. It is important to clarify how the two dimensions impacts the formation of rankings and how they group the statistically treated indices. Furthermore, according to the methodology developed and the literature studied, it is relevant to know whether research questions have received a clear and concrete answer.

Finally, this chapter aims to outline a perspective for future analysis, as well as, to indicate the limitations encountered throughout the study.

5.1 Final remarks and policy implications

As mentioned above, the assessment and analysis of innovation performance embodies the core of our study. In this way, research entities, seen as a central vehicle for technology transformation in Portugal, seek to strengthen the link between entities in the innovation system and enabling their access to highly qualified human resources, promoting scientific and increasing access to knowledge.

The applied methodology, sub-divided into two dimensions, so as to answer the established questions, needs a range of different inquiry indicators, different techniques, and different methods. Accordingly, first dimension focuses on the collection of secondary data from a database and second dimension covers primary data collected through an applied questionnaire. This data was treated in the same way that indices were constructed, using the Z-score and the Max-min method, which allowed us to compare different indicators and assemble standardise indices. Subsequently, the standardised indices were later transformed into rankings

As studied, a competitive economy is defined by a common set of high experiences and sustained productivity growth, still, governments and firms face unpredictability stages of uncertainty as technology and geopolitical strengths reshape the economic and political system (Fundo de Inovação, Tecnologia e Economia Circular, s.d.).

It is also understood that an enterprise competitiveness depends on its ability to bring products to market and to meet the standards required, not only by civil society, but also, by the need to empower industry (Compete2020, EU, 2014).

Considering innovation models that emerged in the last century, up to the most recent procedures of innovation, it is assumed that traditional approaches, that previously ensured growth, no longer correspond to the only expectation of mitigating competition and competitive pressures. Concepts such as open innovation, technology transformation or technological support to enterprises must be fully intertwined with growth notion (Santos, 2016).

With the advent of the digital age and technological transformation, the old traditional phenomena that ruled the "enterprise concept" undergone brutal updates and new research dynamics have emerged. The main consequence felt was that digital innovation idea changed the rules that once dictated business competitiveness and the way they adapted to volatile and flexible concepts (EU, 2014, 2017).

Research centers are part of this modern period as they manage global competitiveness tied with the challenges and solutions that are handled by companies looking for development of technology transfer information, adopting a flexible posture oriented towards creativity and the settlement of social and economic problems.

New technological platforms have made it possible to know how operations taken by different companies are treated, aggregating indicators of local and business needs, empowering the increase of Portuguese industry and adapting the position of each entity according to its economic and social needs.

Therefore, a methodology was designed and applied encompassing indicators that define competition and innovation performance, studying agents that can develop the real effective needs to promote a more sustainable economic impact and strengthening Portuguese business capacity.

Over the obtained results, it is possible to recognise that research innovation centers allowed that: **(i)** there is a link between innovative projects and their market insertion; **(ii)** they empower industry segments through products and patents that are necessarily born out of difficulties experienced by companies linked to centers (e.g. universities, SME´s or collaborative projects) **(iii)** a large number of projects are raised by entities included in the scientific and technological system, since research centers have boundless support from incubators and technology support offices; **(iv)** these entities generate international competitions with a double implication since these competences are used to export to other countries, but also, to attract investment from abroad.

Nevertheless, after the analysed indicators and through the generated outputs it is vital to recognise the innovation performance generated by each entity and how it influences human resources and the creation of products and patents.

In response to the previous paragraph, the assessed methodology enables the recognition of the path that has been followed since 2015, and the conclusions of its application provides an opportunity to identify the innovation “strength” that these entities have.

In view of data standardisation and rankings creation it is clear that **(i)** largest centers, naturally, had the greatest innovation potential **(ii)** after the elimination of the employment indicator, innovation potential was influenced by other performance indicators **(iii)** entities with the greatest innovation potential in 2015 - analysed through the first dimension, are not necessarily those with the greatest potential today **(iv)** mission and values of some research entities do not coincide with the indicators to be analysed, meaning that some centers have less innovation potential **(v)** financial data studied implies that some entities worth the economic dimension, since their business model is based on an idea of internationalisation and development **(vi)** the provision of R&D services is the reason why most centers incubate companies and generate market products.

The following conclusions reflect, as expected, the existence of entities that have higher innovation performance than others. At first sight, innovation performance can be categorised by centers that are best positioned in the established rankings, however, it is necessary to understand that the indicator (per employee) influences how performance is measured.

As they remain more constant, entities such as, INEGI, ISQ or RAIZ tend to be more innovative, nonetheless, we cannot forget centers that exhibit an "increase" comparing the potential and the real innovation. CTCOR, CENTIMFE or CTIC, present an interesting upsurge to be analysed, not only by the number of employees they display, but also, by the uniformity in indicators with a high degree of significance for the study.

As interface programme is a state-led programme it is obliged to follow indications that can often some restrictions to companies, on the other hand, through the obtained results, it is generally concluded that there is a pursuit of innovation in Portugal, encompassing several agents and cementing a more capable and increasingly strong industry.

5.2 Research limitations and future research suggestions

In a perfect scenario, this dissertation aimed to obtain answers from the total surveyed population. However, due to the constraint of the COVID-19 pandemic it was impossible to collect all the contributions from all 26 research innovation centers enabling only 11 responses. Despite this limitation, there is not lose of robustness as it analyses entities with different dimensions, different missions, and different values.

In summary, the study methodology was divided into two dimensions that measured the innovation potential that each entity would expect to have in 2015 and the current effective state of innovation today, encompassing indicators that gage the performance of each center and evaluate the performance of each studied indicator.

At the end of the study, it is important to note that the created indicators may not exactly measure innovation performance, since their choice was somewhat driven by the availability of data. As we discussed, innovation is a complex phenomenon and rather difficult to measure, and, as such, the metrics used are insufficient to capture the multidimensional natura of innovation.

At the same time, we did not assess the economic impact of each entity and how do they facilitate innovation value chains. A performance analysis was made in order to understand which indicators show more strength in performance evaluation, however, due to the simplicity of the methodology, it was impossible to review and study in depth the impact that each of these centers has on the economy. To assess this type of economic impact it was necessary to stare beyond the dimensions created for each indicator in the first and second phases of the analysis.

It is also recommended that with the purpose of reaching all branches of Portuguese industry, empowering them and promoting technology transfer it is important to focus on these entities, making them cooperate with the university education system so that they can accelerate knowledge and innovation potential.

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APPENDICES

Appendix A - Formation of the indices under analysis

The potential for innovation is measured by transforming previously collected data into indices, using the Z-Score method and the Max-min method.

Z-Score method is achieved by the following rational:

$$Z - Score = \frac{xi - u}{s}$$

The Max-min method is achieved by the following rational:

$$\boldsymbol{MNXi} = \frac{\boldsymbol{xi} \ - \ min\ (\boldsymbol{x})}{max\ \ (\boldsymbol{x}) - min\ (\boldsymbol{x})}$$

Exports						Average	Z-Score	Max min
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,000
AIBILI	721 290,000 €	1 750 542,000 €	1 394 472,000 €	950 307,000 €	1 350 000,000 €	1 233 322,20 €	0,23	13,857
CATIM	89 761,020 €	89 015,420 €	68 892,330 €	72 336,950 €	388 620,000 €	141 725,14 €	-0,38	1,592
CCG	35 952,000 €	27 679,000 €	4 780,000 €	4 548,000 €	8 073,000 €	16 206,40 €	-0,45	0,182
CEIIA	2 982 082,660 €	2 617 504,340 €	3 718 176,050 €	2 150 000,000 €	3 150 000,000 €	2 923 552,61 €	1,16	32,848
CeNTI	273 748,310 €	265 600,200 €	105 220,500 €	315 000,000 €	315 000,000 €	254 913,80 €	-0,32	2,864

CENTIMFE	9 592,000 €	21 991,000 €	6 633,000 €	10 000,000 €	20 000,000 €	13 643,20 €	-0,45	0,153
CITEVE	1 171 442,000 €	650 238,000 €	889 779,000 €	876 873,000 €	894 400,000 €	896 546,40 €	0,04	10,073
COTR	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,000
CTCOR	36 464,200 €	18 930,640 €	21 636,950 €	26 000,000 €	27 000,000 €	26 006,36 €	-0,44	0,292
CTCP	173 294,450 €	113 182,390 €	129 613,570 €	138 000,000 €	138 000,000 €	138 418,08 €	-0,38	1,555
CTCV	116 696,000 €	94 959,000 €	112 510,000 €	116 795,000 €	122 634,000 €	112 718,80 €	-0,39	1,266
CTIC	192,800 €	202,300 €	1 656,780 €	3 050,590 €	4 672,000 €	1 954,89 €	-0,46	0,022
CVR	540,000 €	0,000 €	3 400,000 €	0,000 €	0,000 €	1 970,00 €	-0,46	0,022
iBET	2 366 954,000 €	1 784 227,000 €	3 443 221,000 €	3 713 463,000 €	3 750 598,000 €	3 011 692,60 €	1,21	33,839
INEGI	665 890,950 €	749 485,190 €	976 187,670 €	1 049 000,000 €	1 101 000,000 €	908 312,76 €	0,05	10,206
INESC TEC	172 746,730 €	287 426,000 €	355 471,000 €	301 633,000 €	330 000,000 €	289 455,35 €	-0,30	3,252
INL	267 168,000 €	1 380 357,000 €	1 444 614,000 €	2 010 124,000 €	2 412 149,000 €	1 502 882,40 €	0,37	16,886
INOV	35 310,000 €	3 900,000 €	58 054,000 €	48 000,000 €	45 000,000 €	38 052,80 €	-0,44	0,428
IPN	136 033,000 €	168 347,000 €	202 772,000 €	163 336,000 €	181 466,000 €	170 390,80 €	-0,36	1,914
ISQ	10 095 378,000 €	9 250 761,000 €	8 174 611,000 €	8 300 000,000 €	8 680 000,000 €	8 900 150,00 €	4,46	100,000
IT	483 576,780 €	422 919,150 €	214 947,380 €	200 000,000 €	250 000,000 €	314 288,66 €	-0,28	3,531
ITeCons	59 728,300 €	63 235,540 €	85 352,970 €	78 553,190 €	82 480,850 €	73 870,17 €	-0,42	0,830
PIEP	20 861,330 €	59 061,320 €	92 063,310 €	65 000,000 €	90 000,000 €	65 397,19 €	-0,42	0,735
RAIZ	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,000
WavEC	191 560,000 €	189 549,000 €	368 185,000 €	620 250,000 €	793 045,000 €	432 517,80 €	-0,22	4,860
Average of Exports Average							825 691,86 €	
Standard deviation							1808533,81	

Employment						Average	Z-Score	Max min
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	9	8	8	9	9	8,6	-0,63	0,00
AIBILI	52	54	54	54	58	54,4	-0,41	5,47
CATIM	82	84	96	101	106	93,8	-0,22	10,18
CCG	47	51	56	67	79	60	-0,38	6,14
CEIIA	225	242	278	258	284	257,4	0,56	29,73
CeNTI	39	48	66	82	92	65,4	-0,36	6,79
CENTIMFE	39	39	42	44	46	42	-0,47	3,99
CITEVE	109	111	123	132	134	121,8	-0,09	13,53
COTR	10	10	10	10	10	10	-0,62	0,17
CTCOR	15	15	15	16	18	15,8	-0,59	0,86
CTCP	41	41	46	46	51	45	-0,45	4,35
CTCV	50	51	53	56	59	53,8	-0,41	5,40
CTIC	21	23	24	24	27	23,8	-0,56	1,82
CVR	16	26	38	35	30	29	-0,53	2,44
iBET	167	175	192	208	208	190	0,24	21,68
INEGI	289	334	368	283	395	333,8	0,92	38,86
INESC TEC	715	807	890	924	891	845,4	3,36	100,00
INL	85	109	166	181	255	159,2	0,09	18,00
INOV	48	37	38	41	45	41,8	-0,47	3,97

IPN	153	134	136	157	176	151,2	0,05	17,04
ISQ	767	769	812	800	776	784,8	3,08	92,76
IT	31	38	54	73	72	53,6	-0,41	5,38
ITeCons	63	70	72	71	75	70,2	-0,33	7,36
PIEP	34	25	25	28	34	29,2	-0,53	2,46
RAIZ	68	76	77	91	92	80,8	-0,28	8,63
WavEC	19	20	22	26	28	23	-0,56	1,72
Average of EmploymentAverage							140,15 €	
Standard deviation							209,61 €	

Business Volume						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	108 133,000 €	98 815,000 €	119 920,000 €	149 900,000 €	217 400,000 €	138 833,60 €	-0,48	0,00
AIBILI	1 659 688,000 €	3 296 982,000 €	2 120 059,000 €	1 756 307,000 €	2 250 000,000 €	2 216 607,20 €	-0,22	5,08
CATIM	3 952 654,480 €	4 260 810,840 €	4 083 013,840 €	4 125 000,000 €	4 207 500,000 €	4 125 795,83 €	0,03	9,75
CCG	1 744 555,000 €	1 539 878,000 €	1 666 587,000 €	1 585 828,000 €	2 236 936,000 €	1 754 756,80 €	-0,28	3,95
CEIIA	11 878 102,610 €	14 597 675,950 €	17 514 630,820 €	7 717 717,000 €	7 822 167,000 €	11 906 058,68 €	1,02	28,76
CeNTI	947 936,320 €	796 183,690 €	820 554,620 €	1 260 000,000 €	1 260 000,000 €	1 016 934,93 €	-0,37	2,15
CENTIMFE	1 180 026,680 €	1 246 806,090 €	1 161 130,630 €	1 200 000,000 €	1 415 094,600 €	1 240 611,60 €	-0,34	2,69
CITEVE	4 322 500,000 €	4 350 381,000 €	4 712 237,000 €	5 010 700,000 €	5 110 900,000 €	4 701 343,60 €	0,10	11,15
COTR	294 341,000 €	404 554,000 €	399 616,000 €	407 608,000 €	415 760,000 €	384 375,80 €	-0,45	0,60

CTCOR	482 158,750 €	534 187,030 €	532 212,160 €	560 860,000 €	597 475,000 €	541 378,59 €	-0,43	0,98
CTCP	1 773 999,450 €	1 817 191,890 €	1 853 750,520 €	1 890 826,010 €	1 928 642,560 €	1 852 882,09 €	-0,26	4,19
CTCV	1 688 526,000 €	1 854 524,000 €	1 725 090,000 €	1 790 785,000 €	1 880 324,000 €	1 787 849,80 €	-0,27	4,03
CTIC	676 169,410 €	902 736,260 €	1 046 765,490 €	1 271 078,000 €	1 168 000,000 €	1 012 949,83 €	-0,37	2,14
CVR	508 635,000 €	496 365,000 €	450 443,000 €	472 964,940 €	496 613,190 €	485 004,23 €	-0,44	0,85
iBET	3 745 949,000 €	4 494 765,000 €	6 927 765,000 €	7 572 641,000 €	7 648 367,000 €	6 077 897,40 €	0,28	14,52
INEGI	4 453 207,070 €	3 843 738,720 €	4 162 367,470 €	4 454 000,000 €	4 766 000,000 €	4 335 862,65 €	0,05	10,26
INESC TEC	3 503 537,740 €	2 830 037,000 €	3 153 733,000 €	3 690 249,000 €	4 144 150,000 €	3 464 341,35 €	-0,06	8,13
INL	463 834,000 €	1 621 751,000 €	1 597 963,000 €	2 535 494,000 €	3 042 593,000 €	1 852 327,00 €	-0,26	4,19
INOV	1 699 880,000 €	1 213 871,000 €	1 662 709,000 €	1 600 000,000 €	1 500 000,000 €	1 535 292,00 €	-0,30	3,41
IPN	1 810 549,000 €	1 664 583,000 €	1 770 261,000 €	1 887 963,000 €	1 986 427,000 €	1 823 956,60 €	-0,27	4,12
ISQ	39 576 457,000 €	40 552 288,000 €	40 216 720,000 €	41 500 000,000 €	43 400 000,000 €	41 049 093,00 €	4,75	100,00
IT	1 242 087,410 €	996 448,080 €	597 855,180 €	740 000,000 €	850 000,000 €	885 278,13 €	-0,39	1,82
ITeCons	1 557 076,000 €	1 775 186,540 €	1 880 001,180 €	1 974 001,240 €	2 072 701,300 €	1 851 793,25 €	-0,26	4,19
PIEP	1 325 167,180 €	780 208,440 €	782 987,360 €	850 000,000 €	1 010 000,000 €	949 672,60 €	-0,38	1,98
RAIZ	3 805 319,000 €	4 224 600,000 €	4 354 305,000 €	4 397 849,000 €	4 441 827,000 €	4 244 780,00 €	0,04	10,04
WavEC	294 599,000 €	241 839,000 €	415 783,000 €	827 000,000 €	1 057 393,000 €	567 322,80 €	-0,43	1,05
Average of Business Volume Average							3 915 499,97 €	
Standard deviation							7 811 545,28 €	

R&D financed from own resources in National Projects						Average	Z-Score	Max min
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	N/A	N/A	32 328,555 €	39 476,777 €	48 388,470 €	40 064,60 €	-0,33	0,25
AIBILI	259 165,000 €	249 166,000 €	250 000,000 €	260 000,000 €	260 000,000 €	255 666,20 €	-0,27	1,57
CATIM	57 253,580 €	59 222,293 €	59 814,516 €	60 412,661 €	100 000,000 €	67 340,61 €	-0,32	0,41
CCG	0,000 €	15 805,000 €	104 177,000 €	270 250,000 €	36 747 631,000 €	7 427 572,60 €	1,88	45,50
CEIIA	315 506,633 €	239 097,167 €	208 763,623 €	818 618,860 €	996 138,880 €	515 625,03 €	-0,19	3,16
CeNTI	150 433,970 €	118 760,950 €	257 324,210 €	499 528,580 €	1 108 327,180 €	426 874,98 €	-0,22	2,61
CENTIMFE	43 566,210 €	22 851,100 €	194 735,790 €	293 272,727 €	298 170,517 €	170 519,27 €	-0,29	1,04
CITEVE	159 386,853 €	169 244,445 €	169 156,728 €	397 270,000 €	548 579,500 €	288 727,51 €	-0,26	1,77
COTR	28 552,255 €	18 251,000 €	4 010,000 €	28 000,000 €	30 000,000 €	21 762,65 €	-0,34	0,13
CTCOR	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,34	0,00
CTCP	25 009,000 €	98 632,700 €	113 816,000 €	93 802,960 €	78 801,650 €	82 012,46 €	-0,32	0,50
CTCV	20 000,000 €	25 000,000 €	28 000,000 €	30 000,000 €	15 000,000 €	23 600,00 €	-0,34	0,14
CTIC	48 400,000 €	49 300,000 €	50 200,000 €	50 300,000 €	45 800,000 €	48 800,00 €	-0,33	0,30
CVR	397 500,000 €	2 011 800,000 €	5 466 200,000 €	63 197 191,000 €	10 555 274,000 €	16 325 593,00 €	4,54	100,00
iBET	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,34	0,00
INEGI	407 879,520 €	368 796,560 €	846 080,350 €	520 000,000 €	568 000,000 €	542 151,29 €	-0,18	3,32
INESC TEC	366 938,200 €	575 645,000 €	1 234 838,330 €	1 100 776,330 €	1 403 333,330 €	936 306,24 €	-0,06	5,74
INL	22 994,000 €	23 105,000 €	293 835,000 €	765 728,000 €	1 134 394,000 €	448 011,20 €	-0,21	2,74
INOV	90 699,000 €	68 706,000 €	74 846,000 €	297 609,000 €	389 902,000 €	184 352,40 €	-0,29	1,13
IPN	224 360,400 €	70 794,478 €	376 378,211 €	681 813,015 €	301 964,928 €	331 062,21 €	-0,24	2,03

ISQ	665 122,000 €	81 333,000 €	128 656,000 €	371 825,000 €	439 162,000 €	337 219,60 €	-0,24	2,07
IT	267 000,000 €	164 000,000 €	346 600,000 €	300 000,000 €	300 000,000 €	275 520,00 €	-0,26	1,69
ITeCons	157 271,836 €	122 078,390 €	142 903,884 €	153 601,064 €	234 951,092 €	162 161,25 €	-0,29	0,99
PIEP	139 770,000 €	33 600,630 €	96 739,250 €	353 094,460 €	620 471,110 €	248 735,09 €	-0,27	1,52
RAIZ	104 109,333 €	45 230,000 €	239 835,000 €	1 601 309,000 €	1 023 425,000 €	602 781,67 €	-0,16	3,69
WavEC	89 004,000 €	68 367,000 €	N/A	N/A	N/A	78 685,50 €	-0,32	0,48
Average of R&D financed from own esources in National Projects Average							1 147 736,36 €	
Standard deviation							3 341 167,80 €	

Value Spent on R&D and Innovation						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,83	0,00
AIBILI	2 725 670,000 €	2 397 727,000 €	2 534 629,000 €	3 102 103,729 €	2 901 318,000 €	2 732 289,55 €	0,31	29,62
CATIM	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,83	0,00
CCG	1 169 546,000 €	893 456,000 €	797 177,000 €	2 003 444,000 €	2 951 203,000 €	1 562 965,20 €	-0,18	16,94
CEIIA	1 628 341,360 €	1 683 299,810 €	1 611 191,560 €	7 000 665,000 €	8 179 641,260 €	4 020 627,80 €	0,84	43,58
CeNTI	787 469,640 €	718 700,000 €	726 753,000 €	1 144 000,000 €	1 134 000,000 €	902 184,53 €	-0,46	9,78
CENTIMFE	576 048,090 €	328 465,410 €	611 384,980 €	890 545,400 €	834 076,770 €	648 104,13 €	-0,56	7,02
CITEVE	1 251 569,640 €	1 002 064,220 €	1 075 111,770 €	2 110 500,000 €	2 882 000,000 €	1 664 249,13 €	-0,14	18,04
COTR	26 609,000 €	16 986,000 €	36 158,000 €	36 881,000 €	37 619,000 €	30 850,60 €	-0,82	0,33
CTCOR	138 022,500 €	214 566,750 €	88 232,850 €	214 296,000 €	230 000,000 €	177 023,62 €	-0,76	1,92

CTCP	19 017,000 €	83 185,000 €	146 178,000 €	216 748,000 €	265 079,000 €	146 041,40 €	-0,77	1,58
CTCV	87 492,000 €	86 361,000 €	27 754,000 €	65 000,000 €	150 425,940 €	83 406,59 €	-0,80	0,90
CTIC	84 849,000 €	240 931,000 €	197 413,000 €	105 160,000 €	136 500,000 €	152 970,60 €	-0,77	1,66
CVR	376 571,560 €	339 917,020 €	528 566,050 €	378 154,074 €	479 635,157 €	420 568,77 €	-0,66	4,56
iBET	7 661 841,000 €	8 259 017,000 €	10 611 126,000 €	10 371 087,000 €		9 225 767,75 €	3,02	100,00
INEGI	5 498 574,000 €		6 285 998,000 €	6 571 000,000 €	7 554 000,000 €	6 477 393,00 €	1,87	70,21
INESC TEC	3 265 783,000 €	2 525 318,690 €	2 748 132,250 €	3 446 629,000 €	3 891 014,730 €	3 175 375,53 €	0,49	34,42
INL	437 803,000 €	1 127 510,000 €	1 167 278,000 €	2 463 494,000 €	2 956 193,000 €	1 630 455,60 €	-0,15	17,67
INOV	1 899 982,911 €	1 641 615,439 €	1 962 271,195 €	2 153 978,005 €	2 345 755,504 €	2 000 720,61 €	0,00	21,69
IPN	414 500,000 €	232 909,000 €	184 866,000 €	297 849,000 €	342 697,000 €	294 564,20 €	-0,71	3,19
ISQ	2 194 489,000 €	2 070 453,000 €	3 030 493,000 €	3 854 607,000 €	3 599 162,000 €	2 949 840,80 €	0,40	31,97
IT	5 965 326,800 €	5 892 875,000 €	7 376 922,390 €	7 320 000,000 €	8 545 000,000 €	7 020 024,84 €	2,10	76,09
ITeCons	912 005,650 €	925 775,610 €	1 059 894,850 €	1 251 067,590 €	1 564 302,910 €	1 142 609,32 €	-0,36	12,38
PIEP	1 652 789,000 €	759 202,000 €	857 210,000 €	1 420 000,000 €	1 795 182,690 €	1 296 876,74 €	-0,29	14,06
RAIZ	3 338 683,333 €	3 211 494,000 €	3 919 267,000 €	5 662 718,000 €	4 927 192,000 €	4 211 870,87 €	0,92	45,65
WavEC	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,83	0,00
Average of Value Spent on R&D and Innovation Average						1 998 722,35 €		
Standard deviation						2 394 570,53 €		

Number of patentes resulting from projects						Average	Z-Score	Max min
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	0	0	0	0	0	0,00	-0,66	0,00
CENTIMFE	1	0	1	2	1	1,00	-0,06	16,67
RAIZ	N/A	N/A	N/A	3	9	6,00	2,98	100,00
IBET	3	1	1	0	3	1,60	0,31	26,67
CATIM	1	1	1	1	1	1,00	-0,06	16,67
ISQ	0	0	0	0	0	0,00	-0,66	0,00
WavEC	0	0	0	0	0	0,00	-0,66	0,00
INEGI	1	1	0	0	5	1,40	0,19	23,33
CTCV	1	0	0	0	0	0,20	-0,54	3,33
CTIC	0	0	0	0	1	0,20	-0,54	3,33
CTCOR	1	2	0	0	0	0,60	-0,30	10,00
Average of No. of Patentes resulting from projects Average							1,09	
Standard deviation							1,65	

Number of new products lauched						Average	Z-Score	Max min
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	0	0	0	0	0	0,00	-0,95	0,00

CENTIMFE	2	2	5	10	5	4,80	1,58	100,00
RAIZ	N/A	N/A	N/A	1	4	2,50	0,36	52,08
IBET	0	0	0	0	0	0,00	-0,95	0,00
CATIM	0	0	0	0	0	0,00	-0,95	0,00
ISQ	2	3	2	4	8	3,80	1,05	79,17
WavEC	0	0	0	0	0	0,00	-0,95	0,00
INEGI	0	0	0	0	0	0,00	-0,95	0,00
CTCV	1	1	2	1	2	1,40	-0,22	29,17
CTIC	3	1	1	12	7	4,80	1,58	100,00
CTCOR	1	2	3	3	4	2,60	0,42	54,17
Average of No. of new products lauched Average							1,81	
Standard deviation							1,89	

Employment						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	50	55	54	52	57	53,60	-0,39	4,89
CENTIMFE	39	39	42	44	46	42,00	-0,44	3,38
RAIZ	N/A	N/A	N/A	52	62	57,00	-0,37	5,33
IBET	129	139	127	145	154	138,80	0,01	15,96
CATIM	82	66	96	93	94	86,20	-0,24	9,12
ISQ	764	779	791	793	801	785,60	3,04	100,00
WavEC	19	20	22	22	23	21,20	-0,54	0,68

INEGI	181	209	226	255	271	228,40	0,43	27,60
CTCV	51	51	53	49	53	51,40	-0,40	4,60
CTIC	24	23	23	23	26	23,80	-0,53	1,01
CTCOR	16	16	16	16	16	16,00	-0,57	0,00
Average of Employment Average							136,73	
Standard deviation							213,67	

Volume of exports per year resulting from projects						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,00
CENTIMFE	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,00
RAIZ	N/A	N/A	N/A	0,000 €	0,000 €	0,00 €	-0,46	0,00
IBET	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,00
CATIM	3 952 654,480 €	4 260 810,840 €	4 083 013,840 €	4 556 446,760 €	4 626 231,190 €	4 295 831,42 €	2,71	100,00
ISQ	19 641,000 €	10 882,000 €	10 185,000 €	11 056,000 €	9 264,000 €	12 205,60 €	-0,45	0,28
WavEC	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,00
INEGI	0,000 €	0,000 €	1 900 000,000 €	2 000 000,000 €	2 400 000,000 €	1 260 000,00 €	0,47	29,33
CTCV	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,46	0,00
CTIC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CTCOR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average of Volume of exports per year resulting from projects Average							618 670,78 €	
Standard deviation							1 357 986,04 €	

Number of projects supported						Average	Z-Score	Max min
Center	2015	2016	2017	2018	2019			
AIBILI	11	7	6	6	5	7,00	-0,56	1,87
CENTIMFE	7	10	18	23	24	16,40	-0,31	9,19
RAIZ	N/A	N/A	N/A	15	23	19,00	-0,24	11,21
IBET	0	0	0	0	23	4,60	-0,62	0,00
CATIM	1	5	10	14	14	8,80	-0,51	3,27
ISQ	69	51	74	76	65	67,00	1,06	48,60
WavEC	15	14	13	14	20	15,20	-0,34	8,26
INEGI	94	94	149	164	164	133,00	2,83	100,00
CTCV	8	18	22	25	23	19,20	-0,23	11,37
CTIC	4	3	5	8	8	5,60	-0,60	0,78
CTCOR	10	0	12	13	14	9,80	-0,48	4,05
Average of No. of projects supported Average							27,78	
Standard deviation							37,16	

Value Spent on R&D and Innovation as a service provider						Average	Z-Score	Max min
Center	2015	2016	2017	2018	2019			
AIBILI	2 936 347,000 €	3 546 542,000 €	2 469 082,000 €	2 459 551,000 €	2 675 544,000 €	2 817 413,20 €	0,33	32,02
CENTIMFE	400 000,000 €	150 000,000 €	455 000,000 €	806 000,000 €	735 000,000 €	509 200,00 €	-0,47	5,79

RAIZ	N/A	N/A	N/A	6 000 000,000 €	7 000 000,000 €	6 500 000,00 €	1,61	73,86
IBET	0,000 €	0,000 €	0,000 €	3 750 402,000 €	2 910 445,000 €	1 332 169,40 €	-0,19	15,14
CATIM	57 253,580 €	51 671,200 €	53 406,800 €	62 693,890 €	66 985,160 €	58 402,13 €	-0,63	0,66
ISQ	319 000,000 €	193 000,000 €	97 000,000 €	77 000,000 €	64 000,000 €	150 000,00 €	-0,60	1,70
WavEC	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,65	0,00
INEGI	7 700 000,000 €	7 100 000,000 €	8 200 000,000 €	9 900 000,000 €	11 100 000,000 €	8 800 000,00 €	2,41	100,00
CTCV	102 000,000 €	120 000,000 €	130 000,000 €	460 000,000 €	604 000,000 €	283 200,00 €	-0,55	3,22
CTIC	9 621,000 €	185 603,000 €	208 616,000 €	56 779,000 €	70 656,000 €	106 255,00 €	-0,61	1,21
CTCOR	60 000,000 €	70 000,000 €	75 000,000 €	80 000,000 €	85 000,000 €	74 000,00 €	-0,63	0,84
Average of Value Spent on R&D and Innovation as a service provider Average							1 875 512,70 €	
Standard deviation							2 877 682,61 €	

Number of projects that have enteres the market						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	0	0	0	0	0	0,00	-0,40	0,00
CENTIMFE	4	4	4	5	9	5,20	-0,21	5,14
RAIZ	N/A	N/A	N/A	1	0	0,50	-0,38	0,49
IBET	0	0	0	0	0	0,00	-0,40	0,00
CATIM	0	0	0	0	0	0,00	-0,40	0,00
ISQ	8	7	16	14	16	12,20	0,03	12,06
WavEC	0	0	0	0	0	0,00	-0,40	0,00
INEGI	57	77	130	119	123	101,20	3,14	100,00

CTCV	1	0	0	0	0	0,20	-0,39	0,20
CTIC	1	3	0	1	2	1,40	-0,35	1,38
CTCOR	3	3	4	5	5	4,00	-0,26	3,95
Average of N. of projects that have enteres the market Average							11,34	
Standard deviation							28,64	

Appendix B - Formation of the indices (per employee) under analysis

Exports per employee						Average	Z-Score	Max min
Center	2015	2016	2017	2018	2019			
AEMITEQ	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,78	0,00
AIBILI	13 870,962 €	32 417,444 €	25 823,556 €	17 598,278 €	23 275,862 €	22 597,22 €	2,91	100,00
CATIM	1 094,647 €	1 059,707 €	717,628 €	716,207 €	3 666,226 €	1 450,88 €	-0,54	6,42
CCG	764,936 €	542,725 €	85,357 €	67,881 €	102,190 €	312,62 €	-0,73	1,38
CEIIA	13 253,701 €	10 816,134 €	13 374,734 €	8 333,333 €	11 091,549 €	11 373,89 €	1,08	50,33
CeNTI	7 019,187 €	5 533,338 €	1 594,250 €	3 841,463 €	3 423,913 €	4 282,43 €	-0,08	18,95
CENTIMFE	245,949 €	563,872 €	157,929 €	227,273 €	434,783 €	325,96 €	-0,73	1,44
CITEVE	10 747,174 €	5 858,000 €	7 233,976 €	6 642,977 €	6 674,627 €	7 431,35 €	0,43	32,89
COTR	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,78	0,00
CTCOR	2 430,947 €	1 262,043 €	1 442,463 €	1 625,000 €	1 500,000 €	1 652,09 €	-0,51	7,31
CTCP	4 226,694 €	2 760,546 €	2 817,686 €	3 000,000 €	2 705,882 €	3 102,16 €	-0,27	13,73
CTCV	2 333,920 €	1 861,941 €	2 122,830 €	2 085,625 €	2 078,542 €	2 096,57 €	-0,44	9,28
CTIC	9,181 €	8,796 €	69,033 €	127,108 €	173,037 €	77,43 €	-0,77	0,34
CVR	33,750 €	0,000 €	89,474 €	0,000 €	0,000 €	24,64 €	-0,78	0,11
iBET	14 173,377 €	10 195,583 €	17 933,443 €	17 853,188 €	18 031,721 €	15 637,46 €	1,77	69,20
INEGI	2 304,121 €	2 243,968 €	2 652,684 €	3 706,714 €	2 787,342 €	2 738,97 €	-0,33	12,12
INESC TEC	241,604 €	356,166 €	399,406 €	326,443 €	370,370 €	338,80 €	-0,72	1,50
INL	3 143,153 €	12 663,826 €	8 702,494 €	11 105,657 €	9 459,408 €	9 014,91 €	0,69	39,89

INOV	735,625 €	105,405 €	1 527,737 €	1 170,732 €	1 000,000 €	907,90 €	-0,63	4,02
IPN	889,105 €	1 256,321 €	1 490,971 €	1 040,357 €	1 031,057 €	1 141,56 €	-0,59	5,05
ISQ	13 162,162 €	12 029,598 €	10 067,255 €	10 375,000 €	11 185,567 €	11 363,92 €	1,07	50,29
IT	15 599,251 €	11 129,451 €	3 980,507 €	2 739,726 €	3 472,222 €	7 384,23 €	0,42	32,68
ITeCons	948,068 €	903,365 €	1 185,458 €	1 106,383 €	1 099,745 €	1 048,60 €	-0,61	4,64
PIEP	613,569 €	2 362,453 €	3 682,532 €	2 321,429 €	2 647,059 €	2 325,41 €	-0,40	10,29
RAIZ	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,78	0,00
WavEC	10 082,105 €	9 477,450 €	16 735,682 €	23 855,769 €	28 323,036 €	17 694,81 €	2,11	78,31
Average of Exports per employee Average							4 781,69 €	
Standard deviation							6 129,92 €	

Business Volume per employee						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	12 014,778 €	12 351,875 €	14 990,000 €	16 655,556 €	24 155,556 €	16 033,55 €	-1,09	24,40
AIBILI	31 917,077 €	61 055,222 €	39 260,352 €	32 524,204 €	38 793,103 €	40 709,99 €	0,80	74,95
CATIM	48 203,103 €	50 723,939 €	42 531,394 €	40 841,584 €	39 693,396 €	44 398,68 €	1,08	82,50
CCG	37 118,191 €	30 193,686 €	29 760,482 €	23 669,075 €	28 315,646 €	29 811,42 €	-0,03	52,62
CEIIA	52 791,567 €	60 320,975 €	63 002,269 €	29 913,632 €	27 542,842 €	46 714,26 €	1,26	87,25
CeNTI	24 306,059 €	16 587,160 €	12 432,646 €	15 365,854 €	13 695,652 €	16 477,47 €	-1,06	25,31
CENTIMFE	30 257,094 €	31 969,387 €	27 645,967 €	27 272,727 €	30 762,926 €	29 581,62 €	-0,05	52,15
CITEVE	39 655,963 €	39 192,622 €	38 310,870 €	37 959,848 €	38 141,045 €	38 652,07 €	0,64	70,73

COTR	29 434,100 €	40 455,400 €	39 961,600 €	40 760,800 €	41 576,000 €	38 437,58 €	0,63	70,29
CTCOR	32 143,917 €	35 612,469 €	35 480,811 €	35 053,750 €	33 193,056 €	34 296,80 €	0,31	61,81
CTCP	43 268,279 €	44 321,753 €	40 298,924 €	41 104,913 €	37 816,521 €	41 362,08 €	0,85	76,28
CTCV	33 770,520 €	36 363,216 €	32 548,868 €	31 978,304 €	31 869,898 €	33 306,16 €	0,23	59,78
CTIC	32 198,543 €	39 249,403 €	43 615,229 €	52 961,583 €	43 259,259 €	42 256,80 €	0,92	78,12
CVR	31 789,688 €	19 090,962 €	11 853,763 €	13 513,284 €	16 553,773 €	18 560,29 €	-0,90	29,58
iBET	22 430,832 €	25 684,371 €	36 082,109 €	36 406,928 €	36 770,995 €	31 475,05 €	0,09	56,03
INEGI	15 409,021 €	11 508,200 €	11 310,781 €	15 738,516 €	12 065,823 €	13 206,47 €	-1,31	18,61
INESC TEC	4 900,053 €	3 506,861 €	3 543,520 €	3 993,776 €	4 651,122 €	4 119,07 €	-2,00	0,00
INL	5 456,871 €	14 878,450 €	9 626,283 €	14 008,254 €	11 931,737 €	11 180,32 €	-1,46	14,46
INOV	35 414,167 €	32 807,324 €	43 755,500 €	39 024,390 €	33 333,333 €	36 866,94 €	0,51	67,08
IPN	11 833,654 €	12 422,261 €	13 016,625 €	12 025,242 €	11 286,517 €	12 116,86 €	-1,39	16,38
ISQ	51 599,031 €	52 733,795 €	49 527,980 €	51 875,000 €	55 927,835 €	52 332,73 €	1,69	98,75
IT	40 067,336 €	26 222,318 €	11 071,392 €	10 136,986 €	11 805,556 €	19 860,72 €	-0,80	32,24
ITeCons	24 715,492 €	25 359,808 €	26 111,128 €	27 802,834 €	27 636,017 €	26 325,06 €	-0,30	45,48
PIEP	38 975,505 €	31 208,338 €	31 319,494 €	30 357,143 €	29 705,882 €	32 313,27 €	0,16	57,75
RAIZ	55 960,574 €	55 586,842 €	56 549,416 €	48 328,011 €	48 280,728 €	52 941,11 €	1,74	100,00
WavEC	15 505,211 €	12 091,950 €	18 899,227 €	31 807,692 €	37 764,036 €	23 213,62 €	-0,54	39,11
Average of Business Volume per employee Average							30 251,92 €	
Standard deviation							13 055,26 €	

R&D financed from own esources in National Projects per employee						Average	Z-Score	Max min
Center	2015	2016	2017	2018	2019			
AEMITEQ	N/A	N/A	4 041,069 €	4 386,309 €	5 376,497 €	4 601,29 €	-0,22	0,96
AIBILI	4 983,942 €	4 614,185 €	4 629,630 €	4 814,815 €	4 482,759 €	4 705,07 €	-0,22	0,98
CATIM	698,214 €	705,027 €	623,068 €	598,145 €	943,396 €	713,57 €	-0,26	0,15
CCG	0,000 €	309,902 €	1 860,304 €	4 033,582 €	465 159,886 €	94 272,73 €	0,75	19,61
CEIIA	1 402,252 €	988,005 €	750,948 €	3 172,941 €	3 507,531 €	1 964,34 €	-0,25	0,41
CeNTI	3 857,281 €	2 474,186 €	3 898,852 €	6 091,812 €	12 047,035 €	5 673,83 €	-0,21	1,18
CENTIMFE	1 117,082 €	585,926 €	4 636,566 €	6 665,289 €	6 481,968 €	3 897,37 €	-0,22	0,81
CITEVE	1 462,265 €	1 524,725 €	1 375,258 €	3 009,621 €	4 093,877 €	2 293,15 €	-0,24	0,48
COTR	2 855,226 €	1 825,100 €	401,000 €	2 800,000 €	3 000,000 €	2 176,27 €	-0,24	0,45
CTCOR	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,27	0,00
CTCP	609,976 €	2 405,676 €	2 474,261 €	2 039,195 €	1 545,130 €	1 814,85 €	-0,25	0,38
CTCV	400,000 €	490,196 €	528,302 €	535,714 €	254,237 €	441,69 €	-0,26	0,09
CTIC	2 304,762 €	2 143,478 €	2 091,667 €	2 095,833 €	1 696,296 €	2 066,41 €	-0,24	0,43
CVR	24 843,750 €	77 376,923 €	143 847,368 €	1 805 634,029 €	351 842,467 €	480 708,91 €	4,91	100,00
iBET	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,27	0,00
INEGI	1 411,348 €	1 104,181 €	2 299,131 €	1 837,456 €	1 437,975 €	1 618,02 €	-0,25	0,34
INESC TEC	513,200 €	713,315 €	1 387,459 €	1 191,316 €	1 575,009 €	1 076,06 €	-0,26	0,22
INL	270,518 €	211,972 €	1 770,090 €	4 230,541 €	4 448,604 €	2 186,35 €	-0,24	0,45
INOV	1 889,563 €	1 856,919 €	1 969,632 €	7 258,756 €	8 664,489 €	4 327,87 €	-0,22	0,90
IPN	1 466,408 €	528,317 €	2 767,487 €	4 342,758 €	1 715,710 €	2 164,14 €	-0,24	0,45

ISQ	867,173 €	105,765 €	158,443 €	464,781 €	565,930 €	432,42 €	-0,26	0,09
IT	8 612,903 €	4 315,789 €	6 418,519 €	4 109,589 €	4 166,667 €	5 524,69 €	-0,21	1,15
ITeCons	2 496,378 €	1 743,977 €	1 984,776 €	2 163,395 €	3 132,681 €	2 304,24 €	-0,24	0,48
PIEP	4 110,882 €	1 344,025 €	3 869,570 €	12 610,516 €	18 249,150 €	8 036,83 €	-0,18	1,67
RAIZ	1 531,020 €	595,132 €	3 114,740 €	17 596,802 €	11 124,185 €	6 792,38 €	-0,19	1,41
WavEC	4 684,421 €	3 418,350 €	N/A	N/A	N/A	4 051,39 €	-0,22	0,84
Average of R&D financed from own resources in National Projects per employee Average							24 763,22 €	
Standard deviation							92 888,00 €	

Value spent on innovation and R&D per employee						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AEMITEQ	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,74	0,00
AIBILI	52 416,731 €	44 402,352 €	46 937,574 €	57 446,365 €	50 022,724 €	50 245,15 €	1,01	35,73
CATIM	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,74	0,00
CCG	24 883,957 €	17 518,745 €	14 235,304 €	29 902,149 €	37 357,000 €	24 779,43 €	0,12	17,62
CEIIA	7 237,073 €	6 955,784 €	5 795,653 €	27 134,360 €	28 801,554 €	15 184,88 €	-0,21	10,80
CeNTI	20 191,529 €	14 972,917 €	11 011,409 €	13 951,220 €	12 326,087 €	14 490,63 €	-0,23	10,31
CENTIMFE	14 770,464 €	8 422,190 €	14 556,785 €	20 239,668 €	18 132,104 €	15 224,24 €	-0,21	10,83
CITEVE	11 482,290 €	9 027,606 €	8 740,746 €	15 988,636 €	21 507,463 €	13 349,35 €	-0,27	9,49
COTR	2 660,900 €	1 698,600 €	3 615,800 €	3 688,100 €	3 761,900 €	3 085,06 €	-0,63	2,19
CTCOR	9 201,500 €	14 304,450 €	5 882,190 €	13 393,500 €	12 777,778 €	11 111,88 €	-0,35	7,90
CTCP	463,829 €	2 028,902 €	3 177,783 €	4 711,913 €	5 197,627 €	3 116,01 €	-0,63	2,22

CTCV	1 749,840 €	1 693,353 €	523,660 €	1 160,714 €	2 549,592 €	1 535,43 €	-0,68	1,09
CTIC	4 040,429 €	10 475,261 €	8 225,542 €	4 381,667 €	5 055,556 €	6 435,69 €	-0,51	4,58
CVR	23 535,723 €	13 073,732 €	13 909,633 €	10 804,402 €	15 987,839 €	15 462,27 €	-0,20	11,00
iBET	45 879,287 €	47 194,383 €	55 266,281 €	49 860,995 €	0,000 €	39 640,19 €	0,64	28,19
INEGI	19 026,208 €	0,000 €	17 081,516 €	23 219,081 €	19 124,051 €	19 612,71 €	-0,06	13,95
INESC TEC	4 567,529 €	3 129,267 €	3 087,789 €	3 730,118 €	4 367,020 €	3 776,34 €	-0,60	2,69
INL	5 150,624 €	10 344,128 €	7 031,795 €	13 610,464 €	11 592,914 €	9 545,98 €	-0,40	6,79
INOV	39 582,977 €	44 367,985 €	51 638,716 €	52 536,049 €	52 127,900 €	48 050,73 €	0,93	34,17
IPN	2 709,150 €	1 738,127 €	1 359,309 €	1 897,127 €	1 947,142 €	1 930,17 €	-0,67	1,37
ISQ	2 861,133 €	2 692,397 €	3 732,134 €	4 818,259 €	4 638,095 €	3 748,40 €	-0,61	2,67
IT	192 429,897 €	155 075,658 €	136 609,674 €	100 273,973 €	118 680,556 €	140 613,95 €	4,14	100,00
ITeCons	14 476,280 €	13 225,366 €	14 720,762 €	17 620,670 €	20 857,372 €	16 180,09 €	-0,18	11,51
PIEP	48 611,441 €	30 368,080 €	34 288,400 €	50 714,286 €	52 799,491 €	43 356,34 €	0,77	30,83
RAIZ	49 098,284 €	42 256,500 €	50 899,571 €	62 227,670 €	53 556,435 €	51 607,69 €	1,05	36,70
WavEC	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,74	0,00
Average of Value spent on innovation and R&D per employee Average							21 233,95 €	
Standard deviation							28 861,10 €	

Number of patents resulting from projects per employee						Average	Z-Score	Max min
Center	2015	2016	2017	2018	2019			
AIBILI	0	0	0	0	0	0,00	-0,65	64,98
CENTIMFE	0	0	0	0	0	0,02	0,17	65,27
RAIZ	N/A	N/A	N/A	0	0	0,10	2,92	66,21
IBET	0	0	0	0	0	0,01	-0,24	65,12
CATIM	0	0	0	0	0	0,01	-0,23	65,13
ISQ	0	0	0	0	0	0,00	-0,65	64,98
WavEC	0	0	0	0	0	0,00	-0,65	64,98
INEGI	0	0	0	0	0	0,01	-0,45	65,05
CTCV	0	0	0	0	0	0,00	-0,51	65,03
CTIC	0	0	0	0	0	0,01	-0,38	65,08
CTCOR	0	0	0	0	0	0,04	0,67	65,44
Average of No. of Patentes resulting from projects per employeeAverage							0,02	
Standard deviation							0,03	

Number of new projects lauched per employee						Average	Z-Score	Max min
Center	2015	2016	2017	2018	2019			
AIBILI	0	0	0	0	0	0,00	-0,71	0,00

CENTIMFE	0	0	0	0	0	0,11	0,88	55,60
RAIZ	N/A	N/A	N/A	0	0	0,04	-0,11	20,88
IBET	0	0	0	0	0	0,00	-0,71	0,00
CATIM	0	0	0	0	0	0,00	-0,71	0,00
ISQ	0	0	0	0	0	0,00	-0,64	2,40
WavEC	0	0	0	0	0	0,00	-0,71	0,00
INEGI	0	0	0	0	0	0,00	-0,71	0,00
CTCV	0	0	0	0	0	0,03	-0,33	13,47
CTIC	0	0	0	1	0	0,20	2,15	100,00
CTCOR	0	0	0	0	0	0,16	1,60	81,01
Average of No. of new projects lauched per employee Average							0,05	
Standard deviation							0,07	

Volume of exports per year resulting from projects per employee						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,39	0,000
CENTIMFE	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,39 €	0,00 €
RAIZ	N/A	N/A	N/A	0,000 €	0,000 €	0,00 €	-0,39 €	0,00 €
IBET	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,39 €	0,00 €
CATIM	48 203,103 €	64 557,740 €	42 531,394 €	48 994,051 €	49 215,225 €	50 700,30 €	2,81 €	100,00 €
ISQ	25,708 €	13,969 €	12,876 €	13,942 €	11,566 €	15,61 €	-0,39 €	0,03 €

WavEC	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,39 €	0,00 €
INEGI	0,000 €	0,000 €	8 407,080 €	7 843,137 €	8 856,089 €	5 021,26 €	-0,07 €	9,90 €
CTCV	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,39 €	0,00 €
CTIC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CTCOR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average of Volume of exports per year resulting from projects per employee Average							6 193,02 €	
Standard deviation							15 813,33 €	

Number of projects supported per employee						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	0	0	0	0	0	0,13	-0,86	14,90
CENTIMFE	0	0	0	1	1	0,38	0,26	51,20
RAIZ	N/A	N/A	N/A	0	0	0,33	0,02	43,62
IBET	0	0	0	0	0	0,03	-1,32	0,00
CATIM	0	0	0	0	0	0,10	-1,02	9,96
ISQ	0	0	0	0	0	0,09	-1,07	8,06
WavEC	1	1	1	1	1	0,72	1,76	100,00
INEGI	1	0	1	1	1	0,58	1,13	79,35
CTCV	0	0	0	1	0	0,37	0,22	50,04
CTIC	0	0	0	0	0	0,23	-0,41	29,70
CTCOR	1	0	1	1	1	0,61	1,29	84,76

Average of No. of projects supported per employee Average	0,32	
Standard deviation	0,22	

Value Spent on R&D and Innovation as a service provider per employee						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			
AIBILI	58 726,940 €	64 482,582 €	45 723,741 €	47 299,058 €	46 939,368 €	52 634,34 €	0,92	46,112
CENTIMFE	10 256,410 €	3 846,154 €	10 833,333 €	18 318,182 €	15 978,261 €	11 846,47 €	-0,30 €	10,38 €
RAIZ	N/A	N/A	N/A	115 384,615 €	112 903,226 €	114 143,92 €	2,76 €	100,00 €
IBET	0,000 €	0,000 €	0,000 €	25 864,841 €	18 898,994 €	8 952,77 €	-0,39 €	7,84 €
CATIM	698,214 €	782,897 €	556,321 €	674,128 €	712,608 €	684,83 €	-0,64 €	0,60 €
ISQ	417,539 €	247,754 €	122,630 €	97,100 €	79,900 €	192,98 €	-0,65 €	0,17 €
WavEC	0,000 €	0,000 €	0,000 €	0,000 €	0,000 €	0,00 €	-0,66 €	0,00 €
INEGI	42 541,436 €	33 971,292 €	36 283,186 €	38 823,529 €	40 959,410 €	38 515,77 €	0,50 €	33,74 €
CTCV	2 000,000 €	2 352,941 €	2 452,830 €	9 387,755 €	11 396,226 €	5 517,95 €	-0,49 €	4,83 €
CTIC	400,875 €	8 069,696 €	9 070,261 €	2 468,652 €	2 717,538 €	4 545,40 €	-0,52 €	3,98 €
CTCOR	3 750,000 €	4 375,000 €	4 687,500 €	5 000,000 €	5 312,500 €	4 625,00 €	-0,52 €	4,05 €
Average of Value Spent on R&D and Innovation as a service provider per employee Average							21 969,04 €	
Standard deviation							33 394,53 €	

Number of projects that have enteres the market per employee						**Average**	**Z-Score**	**Max min**
Center	**2015**	**2016**	**2017**	**2018**	**2019**			

AIBILI	0	0	0	0	0	0,00	-0,61	0,00
CENTIMFE	0	0	0	0	0	0,12	0,30	27,98
RAIZ	N/A	N/A	N/A	0	0	0,01	-0,53	2,21
IBET	0	0	0	0	0	0,00	-0,61	0,00
CATIM	0	0	0	0	0	0,00	-0,61	0,00
ISQ	0	0	0	0	0	0,02	-0,49	3,55
WavEC	0	0	0	0	0	0,00	-0,61	0,00
INEGI	0	0	1	0	0	0,44	2,64	100,00
CTCV	0	0	0	0	0	0,00	-0,58	0,90
CTIC	0	0	0	0	0	0,06	-0,17	13,42
CTCOR	0	0	0	0	0	0,25	1,26	57,36
Average of N. of projects that have enteres the market per employeeAverage							0,08	
Standard deviation							0,13	

Appendix C – Innovation Performance questionnaire

1) **Name:**
2) **Represented entity:**
3) **Position held:**

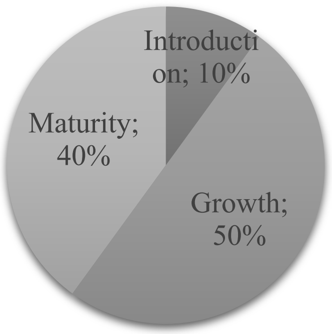
4) **Data for the year 2015:**
   a) Number of patents resulting from projects supported by each Research Center
   b) Number of Research centers employees in the reporting year
   c) Number of projects supported by each Research Center
   d) Number of projects that have entered the market
   e) Number of new products launched by each Research Center
   f) Volume of exports per year resulting from projects supported by each Research Center
   g) Value spent on R&D and Innovation as a service provider
5) **Data for the year 2016:**
   a) Number of patents resulting from projects supported by each Research Center
   b) Number of Research centers employees in the reporting year
   c) Number of projects supported by each Research Center
   d) Number of projects that have entered the market
   e) Number of new products launched by each Research Center
   f) Volume of exports per year resulting from projects supported by each Research Center
   g) Value spent on R&D and Innovation as a service provider
6) **Data for the year 2017:**
   a) Number of patents resulting from projects supported by each Research Center
   b) Number of Research centers employees in the reporting year
   c) Number of projects supported by each Research Center
   d) Number of projects that have entered the market
   e) Number of new products launched by each Research Center
   f) Volume of exports per year resulting from projects supported by each Research Center
   g) Value spent on R&D and Innovation as a service provider

7) **Data for the year 2018:**
   a) Number of patents resulting from projects supported by each Research Center
   b) Number of Research centers employees in the reporting year
   c) Number of projects supported by each Research Center
   d) Number of projects that have entered the market
   e) Number of new products launched by each Research Center
   f) Volume of exports per year resulting from projects supported by each Research Center
   g) Value spent on R&D and Innovation as a service provider
8) **Data for the year 2019:**
   a) Number of patents resulting from projects supported by each Research Center
   b) Number of Research centers employees in the reporting year
   c) Number of projects supported by each Research Center
   d) Number of projects that have entered the market
   e) Number of new products launched by each Research Center
   f) Volume of exports per year resulting from projects supported by each Research Center
   g) Value spent on R&D and Innovation as a service provider
9) **State of Maturity:**
   a) Introduction
   b) Growth
   c) Maturity
   d) Decline

Appendix D - Description sheet of each entity

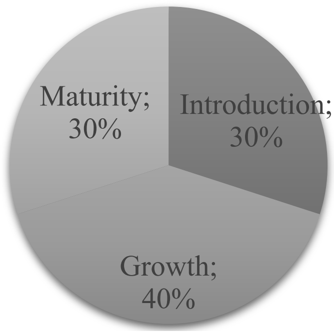
AIBILI

AIBILI - Association for Innovation and Biomedical Research on Light and Image, founded in 1989. The main objective of AIBILI is to promote research in health area dedicated to the development and clinical research of new products for medical therapy and diagnostic imaging.



Maturity in 2017

From → To



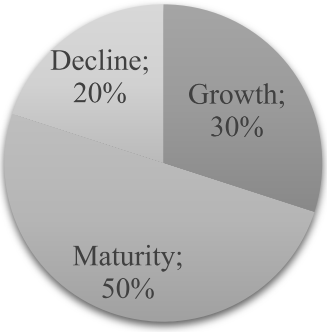
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	13,86
Business volume	5,08
R&D financed from own resources in National Projects	1,57
Value spent on R&D and Innovation	29,62
Employment	5,47

Performance indicators	Actual- Effective Innovation Index
Number of patents resulting from projects	0,00
Number of new products launched	0,00
Employment	4,89
Volume of exports per year resulting from projects	0,00
Number of projects supported	1,87
Value spent on R&D and Innovation as a service provider	32,02
Number of projects that have entered the market	0,00

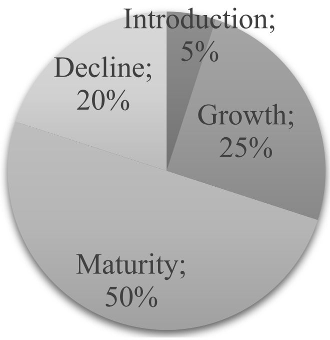
CENTIMFE

CENTIMFE - Technological Center for the Moulds Special Tools and Plastics Industry, founded in 1991. The main objective of CENTIMFE is to develop activities ranging from technical assistance, to R&D and technology transfer, through specialised training, creating important bases for industrial competitiveness.



Maturity in 2017

From → **To**



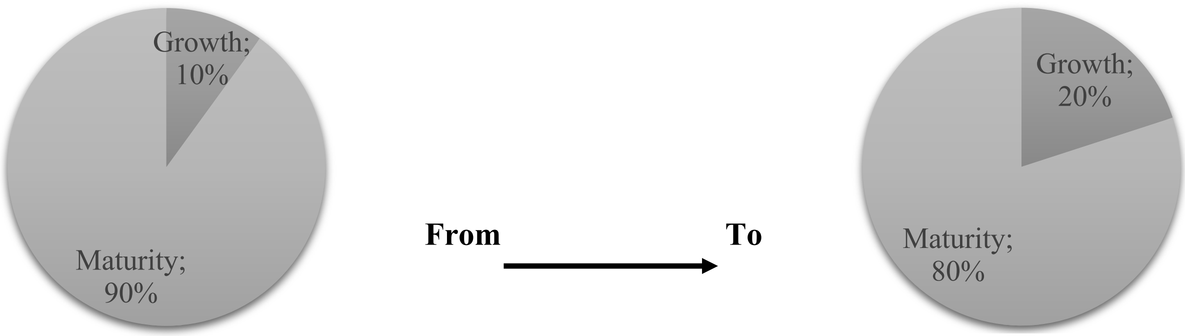
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	0,15
Business volume	2,69
R&D financed from own resources in National Projects	1,04
Value spent on R&D and Innovation	7,02
Employment	3,99

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	16,67
Number of new products launched	100,00
Employment	3,38
Volume of exports per year resulting from projects	0,00
Number of projects supported	9,19
Value spent on R&D and Innovation as a service provider	5,79
Number of projects that have entered the market	5,14

RAIZ

RAIZ - Institute of Forest and Paper Research, founded in 1997. The main objective of RAIZ is to optimize, from a cost/benefit point of view, the competitive advantages of the national silvo-industrial sector, guaranteeing its sustainability.



Maturity in 2017

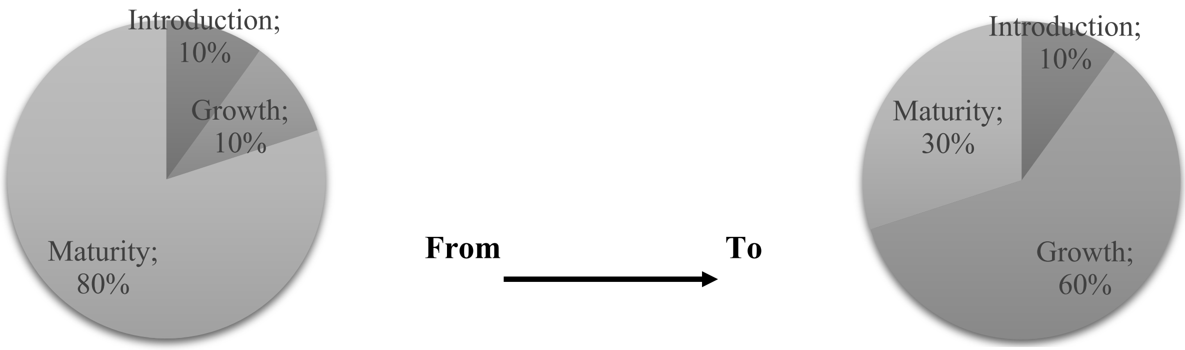
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	0,00
Business volume	10,04
R&D financed from own resources in National Projects	3,69
Value spent on R&D and Innovation	45,65
Employment	8,63

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	100,00
Number of new products launched	52,08
Employment	5,33
Volume of exports per year resulting from projects	0,00
Number of projects supported	11,21
Value spent on R&D and Innovation as a service provider	73,86
Number of projects that have entered the market	0,49

IBET

iBET - Institute of Experimental Biology and Technology, founded in 1989. The main objective of iBET is to create value for our partners leveraging scientific and technological knowledge in biology and chemistry and to provide biotech solutions globally.



Maturity in 2017

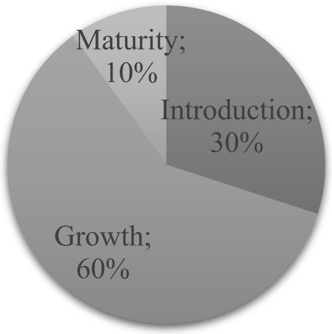
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	33,84
Business volume	14,52
R&D financed from own resources in National Projects	0,00
Value spent on R&D and Innovation	100,00
Employment	21,68

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	26,67
Number of new products launched	0,00
Employment	15,96
Volume of exports per year resulting from projects	0,00
Number of projects supported	0,00
Value spent on R&D and Innovation as a service provider	15,13828864
Number of projects that have entered the market	0,00

CATIM

CATIM - Technological Support Center for the Metalworking Industry, founded in 1980. The main objective of CATIM is to contribute to innovation and competitiveness of national metal industries and similar or complementary sectors.



Maturity in 2017

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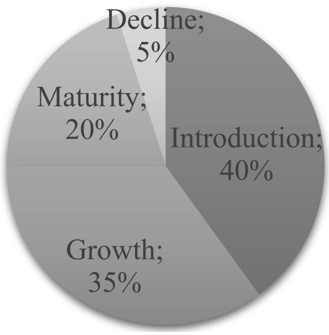


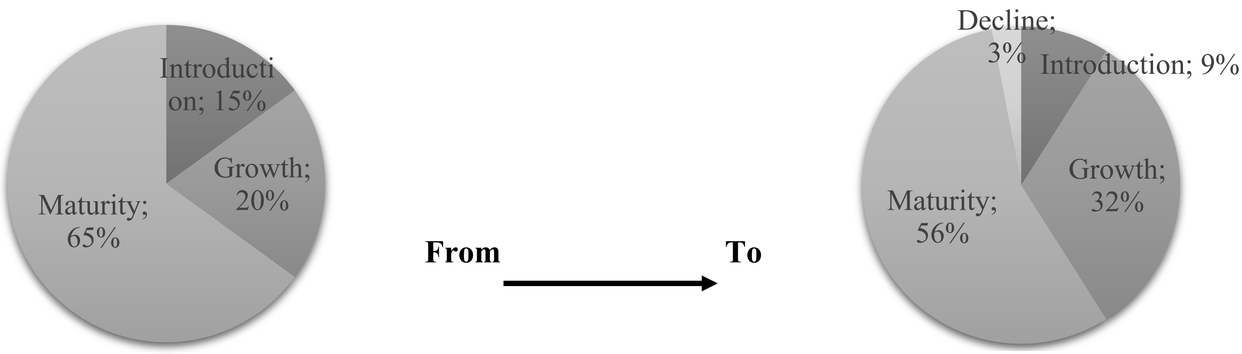
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	1,59
Business volume	9,75
R&D financed from own resources in National Projects	0,41
Value spent on R&D and Innovation	0,00
Employment	10,18

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	16,67
Number of new products launched	0,00
Employment	9,12
Volume of exports per year resulting from projects	100,00
Number of projects supported	3,27
Value spent on R&D and Innovation as a service provider	0,663660523
Number of projects that have entered the market	0,00

ISQ

ISQ - Institute of Welding and Quality, founded in 1965. The main objective of ISQ is to offer services in areas of inspection, training and technical consultancy, supported in research and development activities and accredited laboratories.



Maturity in 2017

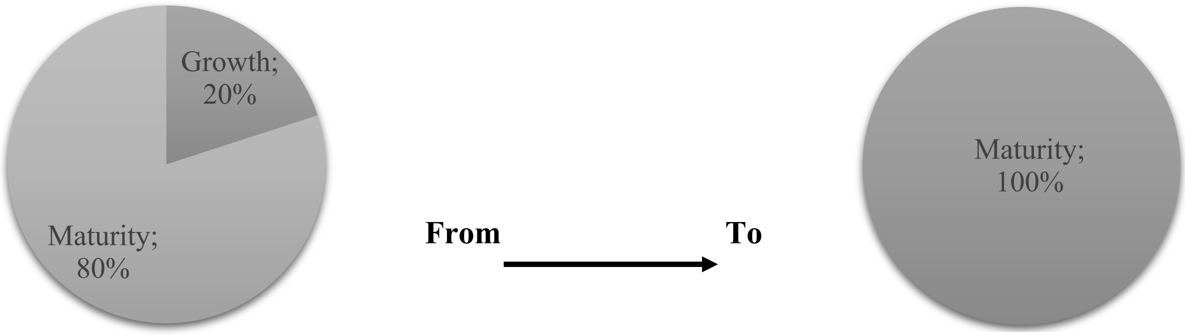
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	100,00
Business volume	100,00
R&D financed from own resources in National Projects	2,07
Value spent on R&D and Innovation	31,97
Employment	92,76

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	0,00
Number of new products launched	79,17
Employment	100,00
Volume of exports per year resulting from projects	0,28
Number of projects supported	48,60
Value spent on R&D and Innovation as a service provider	1,704545455
Number of projects that have entered the market	12,06

WaveEC

WavEC - Offshore Renewables, founded in, 2003. The main objective of WavEC is to provide a professional engineering services and R&D support in the marine renewable energy sector and related areas.



Maturity in 2017

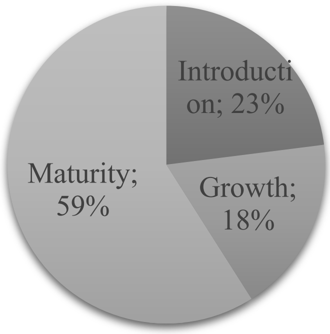
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	4,86
Business volume	1,05
R&D financed from own resources in National Projects	0,48
Value spent on R&D and Innovation	0,00
Employment	1,72

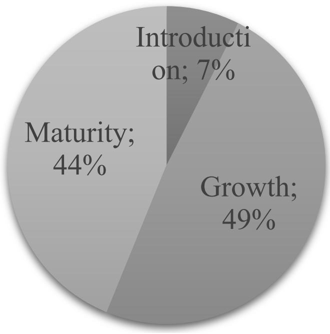
Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	0,00
Number of new products launched	0,00
Employment	0,68
Volume of exports per year resulting from projects	0,00
Number of projects supported	8,26
Value spent on R&D and Innovation as a service provider	0
Number of projects that have entered the market	0,00

INEGI

INEGI - Institute of Science and Innovation in Mechanical Engineering and Industrial Engineering, founded in 1986. The main objective of INEGI is to develop and carry out research and technology based on innovation activities, technology transfer, consulting and technological services.



Maturity in 2017



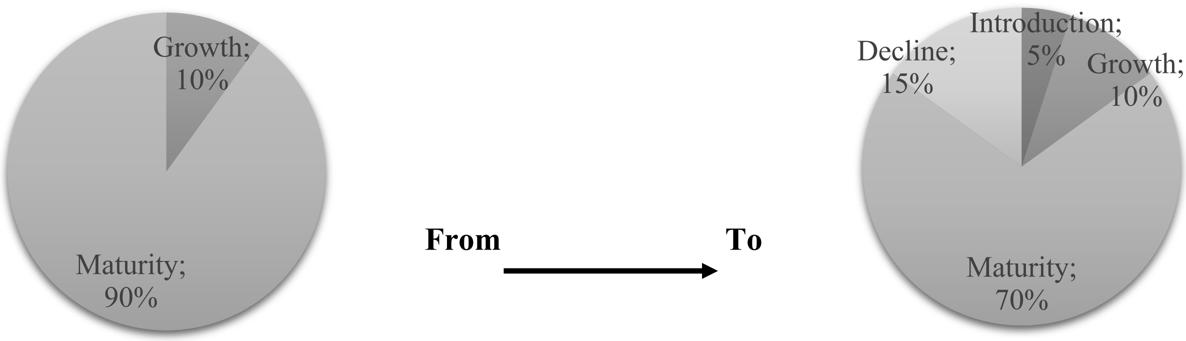
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	10,21
Business volume	10,26
R&D financed from own resources in National Projects	3,32
Value spent on R&D and Innovation	70,21
Employment	38,86

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	23,33
Number of new products launched	0,00
Employment	27,60
Volume of exports per year resulting from projects	29,33
Number of projects supported	100,00
Value spent on R&D and Innovation as a service provider	100
Number of projects that have entered the market	100,00

CTCV

CTCV - Technology Center for Ceramics and Glass, founded in 1997. The main objective of CTCV is to provide technical and technological support to the glass industry, to promote the development and quality of industrial products and processes and to promote highly specialised training.



Maturity in 2017

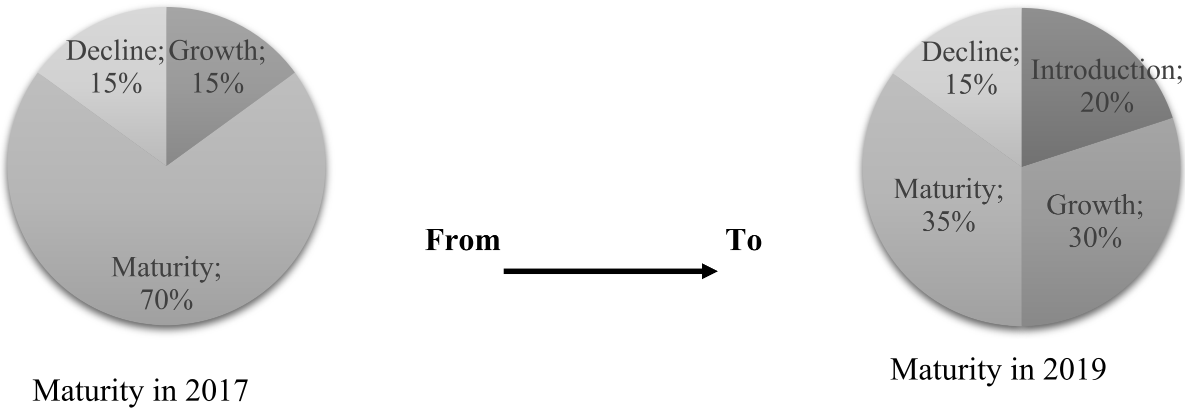
Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	1,27
Business volume	4,03
R&D financed from own resources in National Projects	0,14
Value spent on R&D and Innovation	0,90
Employment	5,40

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	3,33
Number of new products launched	29,17
Employment	4,60
Volume of exports per year resulting from projects	0,00
Number of projects supported	11,37
Value spent on R&D and Innovation as a service provider	3,22
Number of projects that have entered the market	0,20

CTIC

CTIC - Leather Industries Technology Center, founded in 1992.The main objective of CTIC is to intervene on the technological dimension of the tanning sector in Portugal, extending its interests to key areas such as innovation and technological development, environment and energy management systems.

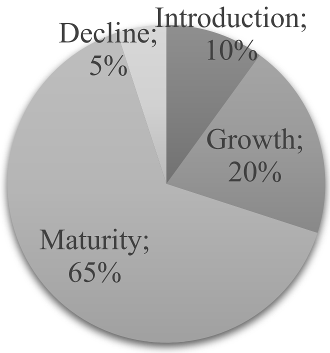


Performance indicators	Potential Innovation Index
Exports	0,02
Business volume	2,14
R&D financed from own resources in National Projects	0,30
Value spent on R&D and Innovation	1,66
Employment	1,82

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	3,33
Number of new products launched	100,00
Employment	1,01
Volume of exports per year resulting from projects	N/A
Number of projects supported	0,78
Value spent on R&D and Innovation as a service provider	1,207443182
Number of projects that have entered the market	1,38

CTCOR

CTCOR - Cork Technology Center, founded in 1987. The main objective of COTR is to promote and support innovation, development, the environment, quality and sustainability in the cork sector.



Maturity in 2017

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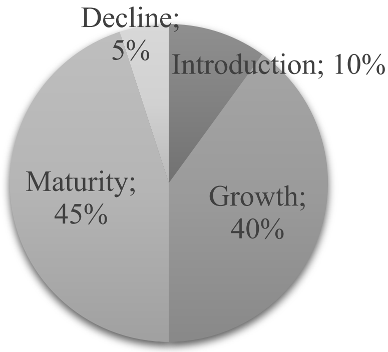

Maturity in 2019

Performance indicators	Potential Innovation Index
Exports	0,29
Business volume	0,98
R&D financed from own resources in National Projects	0,00
Value spent on R&D and Innovation	1,92
Employment	0,86

Performance indicators	Actual-Effective Innovation Index
Number of patents resulting from projects	10,00
Number of new products launched	54,17
Employment	0,00
Volume of exports per year resulting from projects	N/A
Number of projects supported	4,05
Value spent on R&D and Innovation as a service provider	0,840909091
Number of projects that have entered the market	3,95