Lisbon School of Economics & Management
Universidade de Lisboa

MASTER

ECONOMICS AND MANAGEMENT OF SCIENCE, TECHNOLOGY AND INNOVATION

MASTER´S FINAL WORK

DISSERTATION

REGIMES OF COLLABORATIVE INNOVATION: APPLICATION TO THE PORTUGUESE COLLABORATIVE LABORATORIES 2018-2022

ANA ISABEL BELCHIOR GONÇALVES

OCTOBER - 2023

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OCTOBER - 2023

no início – antes da palavra

era o gesto;

antes da sombra

era a árvore.

Ondjaki *in* “Há gente em casa”

GLOSSARY

R&D – Research and Development

S&T – Science and Technology

ANI – Agência Nacional de Inovação/National Innovation Agency

PPP – Public-Private Partnership

ABSTRACT

Recognising collaboration as a privileged innovation strategy for tackling complex problems, public policies aimed at strengthening the institutional basis of the Science and Technology System have contributed to the institutionalisation of new forms of collaboration between the public and private sectors in Portugal. In this context, the emergence of institutions oriented to innovation and markets development, through mechanisms of co-responsibility between partners, sharing of risks and costs, and ownership of objectives and benefits, is particularly relevant. In this framework, this dissertation attempts to provide new evidence on regimes of collaborative innovation, making use of the experience of Collaborative Laboratories implemented in Portugal in the period 2018-2022. Adopting a conceptual model in which three different regimes evolve – Disruptive, Technology Push and Market Pull, analysis shows that the collaborative innovation process depends upon a complex and diversified set of input-output variables, including relative stakeholder relationships, autonomy and the level of capacities required to develop sophisticated products and services to global markets and stimulate the creation of qualified employment and externalities related with the quality of jobs.

KEYWORDS: Collaborative Innovation; Regimes; Collaborative Laboratories; Collaborative governance; Quality of jobs.

JEL CODES: O30; O32; O38; O38; O43.

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Some people say that one of the greatest difficulties in developing a dissertation is that it is a lonely process. Fortunately, this was not my case, and there are several people without whom I would not have been able to complete this stage and to whom I owe deep and sincere thanks.

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REGIMES OF COLLABORATIVE INNOVATION: APPLICATION TO THE PORTUGUESE COLLABORATIVE LABORATORIES 2018-2022

By Ana Gonçalves

CHAPTER 1. INNOVATION AND COLLABORATION: CONCEPTUAL FRAMEWORK

Widely recognized as a crucial element of a knowledge-based society, innovation is nowadays conceptually consolidated as a systemic, dynamic and complex process, that act as promoter of the development of economies, societies and territories. This recognition of innovation as a source of competitiveness is the result of profound transformations occurred in consequence of the globalization of the economy, the diffusion of Information and Communication Technologies and the intensification of the relation between science, technology and economic and social systems (Breznitz, 2021). Along with these transformations, new forms of collaborative innovation between public and private sectors emerged more systematically in recent years, recognizing the centrality that knowledge, science and technology assume as driving forces of the economy and society.

1.1.Framing the research issue

Since the 1980s, public policies on science, technology and innovation in Portugal have been oriented to strengthening the institutional base of the national Scientific and Technological System, along with significant efforts of qualification of the population and promotion of R&D activities, increasing the levels of R&D expenditure. Recognising collaboration as a privileged innovation strategy for tackling complex problems, through mechanisms of co-responsibility between partners, sharing of risks and costs, and ownership of objectives and benefits, public policies aimed at institutional strengthening have contributed to the institutionalisation of new forms of collaboration between the public sector, the private sector and the third sector, namely the creation of institutions oriented to innovation and markets development.

In this framework, this work attempt to provide new evidence on collaborative innovation, making use of the experience of Portugal in collaborative innovation. A specific analysis is considered for a set of Collaborative Laboratories created since 2018 in terms of mobilizing actors across the productive, social and cultural sectors, stimulating

qualified employment and attracting foreign direct investment for activities with greater added value and gradually promoting private investments in R&D. This work considers that the establishment and reinforcement of Collaborative Laboratories in Portugal represented a new phase of evolution and development of the research and innovation system in a way that has fostered the institutionalization of the collaboration between different actors, promoting inter-institutional co-responsibility of knowledge-based strategies, as well encouraging new forms of collaboration and risk sharing between public and private sectors to create value and, above all, qualified employment. Analysis shows that the process depends upon a complex and diversified set of input-output variables, including institutional autonomy and relative stakeholder relationships, and the capacities required to develop sophisticated products and services to global markets and to stimulate the generation of good jobs externalities.

1.2. Main theoretical foundations

At the beginning of the 20th century, innovation was understood mainly as an economic event of application/introduction of inventions in the market, resulting in technological changes as a mechanism of economic growth. This perspective was made famous by Joseph Schumpeter[1] who laid the first foundations for understanding innovation as a process of "*creative destruction*" resulting from continuous improvements or "*new combinations*" of existing competencies and resources, highlighting the discontinuities of the innovation process and the role of the "entrepreneur" (and not the scientist) as the main actor in the innovation process (Fagerberg, 2009).

Evidencing the growing economic interest that the application of scientific knowledge aroused, from the 1950s, important theoretical contributions to this discussion emerged in the field of neoclassical economics. Examples of this are the reference works of Abramovitz (1956) and Solow (1957) that focused on the introduction of "*technical progress as a factor of economic growth*" and Gilliches (1957), pioneer in the empirical study of the technological diffusion process (Fagerberg, 2009). Assuming innovation as a linear, sequential and hierarchical process, in which fundamental research moves successively to applied research and from there to the development, production and

[1] Firstly in 1912 with the introduction of the concept of innovation in "The Theory of Economic Development", and later in 1934 and 1947 with the introduction of the concept of "creative destruction".

commercialisation of products, the neoclassical approach confined innovation to companies and attributed to knowledge a marginal role in economic growth. Ignoring aspects such as uncertainty, risk and feedback effects associated with the innovation process, the linear model of innovation advocated by neoclassical economists proved insufficient to address the complexity of the phenomenon (Chaminade & Edquist, 2010).

The following decades were thus marked by a strong questioning of neoclassical assumptions. In fact, the contributions of Arrow (1962) on how competition favours innovation; Freeman[2] (1974) on innovation processes in companies and their interaction with the environment (social, institutional and economic) surrounding; Nelson and Winter[3] (1977) on the ineffectiveness of the neoclassical assumptions of profit maximization and market equilibrium in the analysis of technological innovation and the dynamics of competition between companies; and, Rosenberg[4] (1984) on how technological innovation influences and is influenced by science, industry and economy, were decisive for the emergence of a new school of thinking. Considered an "evolutionary" approach, the study of the dimensions of technological progress and the prominent role of science and technology in economic development assumed a prominent position among innovation studies scholars. As stated by Kline and Rosenberg (1986):

> "Models that depict innovation as a smooth, well-behaved linear process badly misspecify the nature and direction of the causal factors at work. Innovation is complex, uncertain, somewhat disorderly, and subject to changes of many sorts. (…) The process of innovation must be viewed as a series of changes in a complete system not only of hardware, but also of market environment, production facilities and knowledge, and the social contexts of the innovation organization".
>
> Kline and Rosenberg in Rosenberg, 2010: 275.

This approach has contributed significantly to the transition from a linear model of innovation to a model that considers the innovation process as complex and interactive. This model, entitled "*chain-linked model",* became famous with the work of Kline and Rosenberg (1986) and assumes innovation as a process of continuous and systemic transformation, recognizing "*not only that innovation draws on science, but also that the*

[2] The Economics of Industrial Innovation (1974)
[3] In Search of a Useful Theory of Innovation (1977)
[4] Inside the Black Box: Technology and Economics (1984)

demands of innovation often force the creation of science" (Caraça et al., 2009: 863). This approach argues that innovation activities determine and are determined by the market, resulting from processes of interaction, feedback and learning in the various stages of the process, where various stakeholders (among these universities, laboratories and companies) play an important role. Contrary to what occurs in the neoclassical approach, institutions, the cumulativeness of knowledge, tacit knowledge, the interactive process of learning and the diffusion of knowledge are now considered as fundamental in the innovation process (Rosenberg, 2010). For this perspective, also contributed greatly to the work of Lundvall & Johnson (1994) on the "*learning economy*", emphasizing the importance of learning processes, the organizational dimension, the institutional context and the environment in which companies are inserted as determinants of the innovation process. This systemic perspective embraces a broader vision of the innovation process, placing this process within the framework of an innovation system composed of a set of interdependent actors and a precise institutional context, that shapes the behaviour of actors and determines the functioning of the system in which public policies play an important role (Lundvall, 2022; Freman, 1995).

1.3. Understanding collaborative innovation in the context of markets development

Collaboration is gaining prominence as a favoured innovation strategy for addressing complex problems, evolving from the "individualistic" view according to which innovations are developed by actors acting in isolation, to an innovation-oriented collaborative view (Ketchen et al., 2007). Perceived as the mutual commitment between two or more actors to work together towards a common goal, through the sharing of knowledge, competencies, ideas and resources, collaboration is understood as the "*constructive management of stakeholder differences*" to find joint solutions to shared problems (Hartley et al., 2013; Sørensen & Torfing, 2017; Stojčić, 2021; Torfing, 2019). In this context, collaborative innovation can be defined as:

> "innovation activities or innovation processes involving multiple actors, organisations or individuals that transcend borders (within or between organisations) for the purpose of creating and developing new products, services, policies, processes or business solutions."
>
> Ystrom and Agogué, 2020: 1.

In addition, highlighting the role of collaborative networks and learning, collaborative innovation also involves "*collective learning actions to improve the joint creation of innovative ideas, products, services, processes or business models, through the combination of competences, capabilities and resources of the organisations and individuals participating in the process*" (Brown et al., 2021: 2).

Not benefiting from a single and stable theoretical framework, collaborative innovation has been widely explored from two main points of view. On the one hand, taking the company as the unit of analysis, several authors have focused their attention on providing a greater understanding of the determinants, effects and patterns that characterise collaborative innovation (Audretsch & Guenther, 2023; Stojčić, 2021). From this perspective, contributions derived from resource-based theory and economic geography have been useful in conceptualising collaborative innovation as a complex phenomenon of vertical and horizontal mechanisms involving multiple actors (including competitors, suppliers, customers, knowledge producers and/or public sector entities) through which companies have equip themselves with relevant competences and capabilities for developing different types of innovations (marginal, incremental or radical) (Stojčić, 2021). Studying collaborative innovation in emerging innovation systems in Central and Eastern Europe, Stojčić (2021: 537-538) notes that as well as in the short-term collaborative innovation is a "*mechanism for complementing non-existent organisational resources*", minimising the time and costs associated with the innovation process, in the medium-and long term "*it also enables the development of internal resources through demonstration effects, the accumulation of knowledge and skills and vertical spillovers from buyers and customers*". Using the work of Boschma (2005), the author complements the analysis by stating that the success of this process depends on inter-organisational proximities, in particular non-spatial proximities such as social, institutional, organisational and, above all, cognitive proximities between the actors.

A second perspective focuses on the role of the public sector in promoting innovation by analysing the different forms of government participation/intervention in the development of (emergent) markets (OECD, 2004, 2008, 2012). In fact, the discussion about the role of public policy in promoting and regulating innovation activities has also accompanied the conceptual evolution of innovation, giving rise to new narratives that go beyond the idea that innovation is exclusively a matter of the private sector (Chaminade

& Edquist, 2010; Laranja, 2007; Lundvall, 2022; Mazzucato, 2021). In this regard, Dan Rodrik (2007) offers a new view for industrial policy advocating that the industrial policy model should be centred on the process of discovery and strategic collaboration between the public and private sectors:

> "Market forces and private entrepreneurship are at the helm of this agenda, but governments also play a strategic and coordinating role in the productive sphere, beyond simply ensuring property rights, contract enforcement and macroeconomic stability".
>
> Rodrik, 2007: 100.

In this context, the author argues that industrial policy should be based less on traditional top-down mechanisms (such as subsidies or tax incentives for companies/sectors) and more on collaborative and iterative interaction as a strategy for responding to concrete problems (Juhász et al., 2023; Rodrik, 2007, 2022). This view is shared by several academics who argue that a new understanding of the role of innovation-orientated public policies is needed to address the complexity of the economic, social and political challenges facing society today (Breznitz, 2021; Goldsmith & Coleman, 2021; Lacerda et al., 2023; Lundvall, 2022; Mazzucato, 2021).

One example of the recognised importance that different governments have assumed in the development of emerging markets is the space sector (Kim, 2023; Mazzucato, 2021; OECD, 2021). As the OECD (2021) points out, in this particular sector, the government has been performing three main roles: a "chief developer" role in which the public sector assumes the responsibility, costs and risks associated with financing and developing specific technologies and applications; a "customer" role in which the public sector buys products and services available on mature markets to fulfil its needs, transferring some risks as development costs and operating costs to the private sector; and, a "partner" role in which the public and the private sector engage jointly in different types of formal agreements, sharing risks, costs and responsibilities. As Kim (2023) points out when trying to identify and characterise the different types of public-private partnerships used to develop markets in the space sector, public-private partnerships are one of the forms of partnership between the public and private sectors to develop solutions targeted to meet public objectives. To this end, the author revisits the concepts of comparative advantage and risk transfer to affirm that one of the distinctive advantages of PPPs is the ability to share risks and benefits between public and private parties and "*when utilized*

appropriately, PPPs have the potential to foster markets, enhance national capabilities, and reduce costs, while advancing policy objectives" (Kim, 2023: 1). In this context, new forms of institutional innovation can emerge within existing institutions, or in a more disruptive way, through the creation of new institutions:

> *"new institutions arise when organized actors with sufficient resources (institutional entrepreneurs) see in them an opportunity to realize interests that they value highly...creating a new system of meaning that unites the functioning of disparate sets of institutions."*
>
> Dimaggio, 1988: 14.

1.4. The institutionalization of collaborative innovation: an approach to stakeholder relationships

What is somewhat unique about the collaboration strategy, and particularly interesting for the innovation process, is that it emphasises the role of the actors and the relationships between them and their institutional context not only in mapping the problems, but also in creating and developing solutions (Hartley et al., 2013). In this sense, collaboration can also be understood as the "*result of the mutual commitment, interdependence and responsibility of stakeholders*", emphasising not only the relational dimension of the process, but also the importance of the institutional and cultural framework in which the actors operate for the collaborative development of innovative solutions (Ysträm & Agogué, 2020). This perspective has been explored in the literature from various points of view, especially in the fields of Innovation Studies, Strategic Management, Marketing and Public Management, seeking to generate greater understanding of the relationship between companies and their stakeholders, the emergence of new forms of institutional organisation and the dynamics of innovation driven by public sector.

As DiMaggio and Powell (1983) argue, organisations are motivated above all by the legitimacy that their stakeholders attribute to their actions, highlighting the importance of institutional processes and relational networks rather than the search for efficiency (Gonçalves & Silva, 2021). This is an argument that has been gaining prominence in studies on collaborative innovation in the public sector, especially to highlight that one of the ways to make innovation more permanent and systematic is to "*institutionalize arenas where collaborative innovation can take place*", namely through the "*horizontal institutionalization of the interaction of interdependent but operationally autonomous*

actors who collaborate in a shared effort to define and create public value" (Sørensen & Torfing, 2017: 10). In this context, assuming the importance of institutional processes and respective governance mechanisms associated with collaborative innovation, collaborative governance emerges as a key concept to understand the processes, dynamics and factors that shape collaborative innovation.

Adopting a systemic perspective of collaborative governance as a complex phenomenon composed of institutional processes that involve various stakeholders (public, private and civil society) around a common (public) goal, Emerson and Nabatchi have contributed to the debate around this topic by introducing the concept of collaborative governance regimes (Emerson et al., 2012; Emerson & Ahn, 2022; Emerson & Nabatchi, 2015a, 2015b; Ulibarri et al., 2020). Highlighting four main factors - uncertainty, interdependence, incentives and initial leadership - that act as drivers for the establishment of different collaborative governance regimes, the authors define a collaborative governance regime as:

> "(...) an institution designed for collective decision-making, oriented towards public policies or services, which incorporates autonomous organisations representing different interests, which has procedural norms and rules and which experiences repeated interactions."
>
> Emerson & Nabatchi, 2015a: 19.

Based in this view, collaborative dynamics evolve in three interrelated processes (Emerson & Nabatchi, 2015a): Principled engagement, which refers to the behavioural dynamics between actors and includes joint discovery, shared definitions, interactive deliberation and determinations or decision-making; Shared motivation, which refers to the relational dynamics between actors, including the elements of trust, mutual understanding, internal legitimacy and shared commitment; and, capacity for joint action, which refers to the functional dynamics of developing the capacity for joint action, through combinations of procedural/institutional arrangements, leadership, knowledge and resources. These collaborative dynamics activate collaborative actions, understood as "*intentional endeavours undertaken as a consequence of the collective choices made by a collaborative governance regime during the collaborative dynamic*", and can be considered as the means to achieve the collective objective or goal of the collaborative governance regime (Emerson & Nabatchi, 2015a: 82). According to this view,

collaborative governance regimes will be more sustainable over time if they have the capacity to adapt to the nature and level of the impacts resulting from their joint actions (Emerson et al., 2012).

The study of collaborative governance has mainly centred its focus on the factors and conditions for establishing institutional arrangements that facilitate stakeholder involvement and collaboration. However, some authors have tried to draw attention to the pertinence of looking beyond the regime in which stakeholders engage, suggesting that the main problems rely more on the nature of the collaboration, the processes of developing solutions/joint value, the evaluation of results and the commitment and accountability of the stakeholders involved (Bridoux & Stoelhorst, 2022; Sørensen & Torfing, 2021). The term stakeholder became well-known with the work developed by Edward Freeman (1984) in the field of Strategic Management on Stakeholder Theory to describe "*any group or individual who can affect or is affected by the achievement of the organisation's objectives*" (Freeman, 1984: 46). Looking for an approach that intended to look beyond the company's internal functions, profit generation and benefits generated for its shareholders, Freeman considered the network of relationships of companies as determinant factors in dealing with the transformations of contemporary society (Freeman et al., 2010). Stakeholder thinking is thus a means of understanding an organisation's actions through its stakeholders, emphasising a vision that assumes stakeholder management as a fundamental process for the organisation's success (Donaldson & Preston, 1995; Freeman et al., 2010). This perspective operationalises the relationship between the focal organisation (company) and its stakeholders in a dyadic model where 'focal organisation-stakeholder' relationship evolve (Freeman et al., 2010). Offering classification schemes for stakeholders according to the types of influence they exert on the focal organisation, the theory proposed by Freeman develops around three distinct but complementary approaches: descriptive, which seeks to explain or describe the characteristics and behaviour of an organisation, describing "*the company as a constellation of cooperative and competitive interests that have intrinsic value*"; instrumental, which seeks to identify stakeholders and the means of managing stakeholders to achieve objectives; and normative, which forms the basis of the theory and seeks to analyse the function of the organisation, assuming that "*stakeholders are individuals or groups with legitimate interests in procedural and/or substantive aspects*

of business activity" (Donaldson & Preston, 1995: 66-67, 70-74, 87-88). The fundamentals of Stakeholder Theory were also explored by Mitchell, Agle and Wood (1997) to describe a model of "stakeholder salience" to understand the relationship between stakeholders and the focal organisation based on the perception of the focal organisation's managers of the presence of three attributes: the power of the stakeholders to influence the organisation, the legitimacy of the stakeholder's relationship with the organisation, and the urgency of the stakeholder's claims on the organisation.

Although popular among academics in the field of Strategic Management, some critics claim that this perspective presents a simplistic view of the relationship and role of stakeholders, tending to ignore the multidirectional relationship between the focal organisation and its stakeholders and, above all, between stakeholders (Bridoux & Stoelhorst, 2022; Rowley, 1997). As Rowley (1997: 890) notes, "*firms do not simply respond to each stakeholder individually; they respond, rather, to the interaction of multiple influences from the entire stakeholder set*". Thus, observing the limitations of the dyadic view offered by Freeman and his followers, the author introduces a network perspective assuming the interaction between multiple and interdependent stakeholders as the unit of analysis to propose a network theory of stakeholder influences:

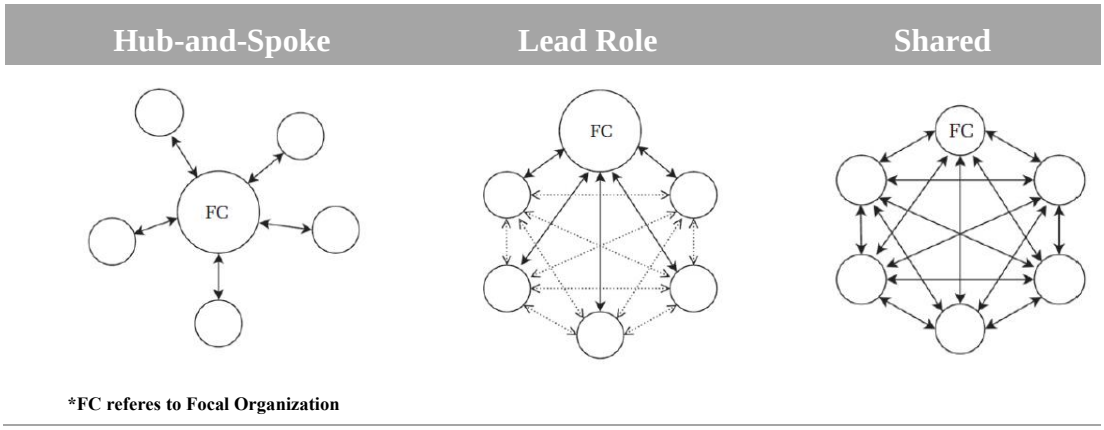
> "Since relationships between stakeholders do not occur in a vacuum of dyadic ties, but rather in a network of influences, it is likely that a company's stakeholders have direct relationships with each other. (...) In reality, it is unlikely that all stakeholders are directly linked to each other (...) but the nature of the relationships between stakeholders influences their behaviour and, consequently, the demands it places on the focal organisation."
>
> Rowley, 1997: 890.

To this end, this perspective incorporates the constructs of social network analysis (centrality and density) to study the patterns of relationships in the stakeholder network, considering also that the centrality of the focal organisation in the network changes according to the influence exerted by the other actors (Rowley, 1997). In line with Rowley's perspective, new approaches have emerged to understand how collaboration between different stakeholders influences the creation of value for organisations. An example of this is the work developed by Bridoux & Stoelhorst (2022) in drawing attention to the need to recognise that the problem of managing the joint creation of value is not just a problem of motivating stakeholders to collaborate, but of motivating them to

collaborate in the face of collective action problems. Understanding collective action problems as those that "*emerge from the tension between actors' self-interests (in the short term) and collective interests (in the long term)*", the authors seek to understand how the governance of interactions between stakeholders ensures cooperation in the face of collective action problems and the joint creation of value. To this end, they draw on Ostrom's (1990) work on design principles for governing co-operation in the face of collective action problems to classify the different forms of stakeholder governance. In this context, for the authors, the term governance refers to the set of rules that organise interactions and support collaboration between actors by defining 'who decides', 'who controls' and 'who gets what' (Bridoux & Stoelhorst, 2022: 218).

In addition to the design principles inspired by Ostrom's work, the authors added two other variables that they considered central to stakeholder theory: the role of managers and the nature and role of trust. They thus identify three different forms of stakeholder governance which differ, on the one hand, in terms of the centrality of the focal organisation and the role of its managers in the governance of stakeholder interactions, and, on the other, in terms of the extent of stakeholder interactions in relation to governance. They also sought to compare the effectiveness of the three forms by analysing two characteristics of joint value creation activities: complexity and dynamism, as presented in **Figure 1**.

Figure 1. Stakeholders Governance Forms



Source: Bridoux & Stoelhorst, 2022

As stated by the authors, the 'hub-and-spoke' form of governance implies the centrality of the focal organisation in relation to its stakeholders and assumes that managers are the final decision-makers. In this case, management authority is the main

mechanism for obtaining stakeholder collaboration. In turn, the 'lead role' form of governance considers the lesser centrality of the focal organisation in the stakeholder network, assuming that collaboration processes take place in an institutional environment conditioned by dominant stakeholders in relation to the others, requiring negotiation processes that attribute greater complexity and dynamism to governance. Finally, the 'shared governance' reflects a network composed of equally positioned stakeholder and is characterised by a high level of trust in the governance system. Governance is, therefore, understood as more than just institutional arrangements, it is constituted through dynamic and complex processes in which relationships between stakeholders and collaborative capacities are developed in multidirectional interdependencies. Analysing these interdependencies is therefore crucial to understanding the emergence of innovation-oriented collaborative institutions.

1.5. Research question and conceptual model

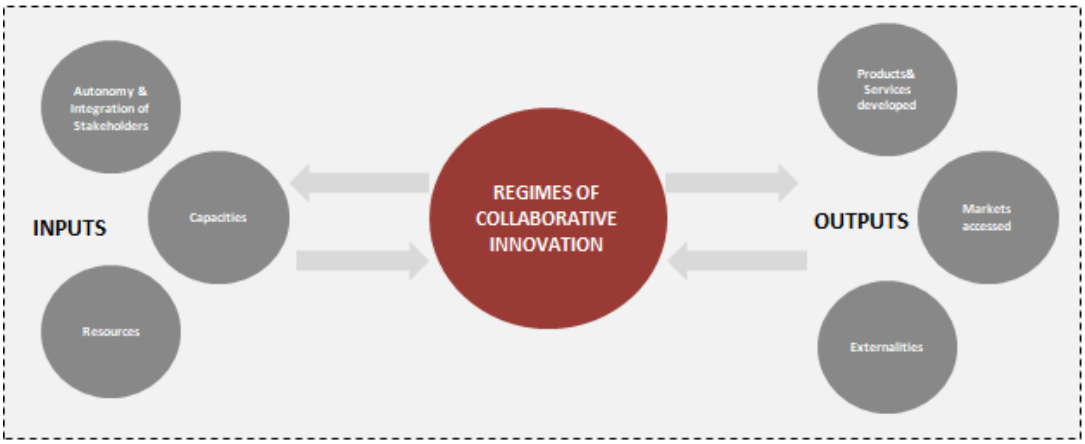
The review of the state-of-the-art shows that the framework in which the phenomenon of collaborative innovation is operationalized incorporates theoretical perspectives from different disciplinary fields, contributing an increased difficulty and complexity in its analysis. In view of the theoretical contributions discussed in previous sections, collaborative innovation is understood in this study as a complex, dynamic and systemic process that mobilizes different public and/or private stakeholders around the joint creation and development of new products, services, processes or business models, through the combination and development of skills, capacities and resources, that respond to collective objectives.

Considering that collaborative innovation can assume different forms and that a way to make it more permanent and systematic is by institutionalizing the relationships between the various stakeholders, namely through the creation of new institutions, the research question that drives this work is the following: Does the performance of the collaborative innovation process vary according to the regime of collaborative innovation in which it is developed?

To answer this question, it is assumed that a regime of collaborative innovation corresponds to the institutionalisation of a collaborative system in which various stakeholders engage and collaborate to provide innovative solutions to complex

problems. It represents an abstraction of the *modus operandi* that transforms flows of inputs in outputs through complex mechanisms of governance and integration of stakeholders, and mobilization of human, technical and technological capacities to the achievement of a collective objective. In this framework, the hypothesis that drives this work considers that it is possible to identify different regimes of collaborative innovation and that each regime perform differently in terms of the flows of inputs it integrates and the outputs it generates. **Figure 2** presents the conceptual framework used for the operationalization of the concept of regimes of collaborative innovation.

Figure 2. Conceptual framework for the definition of Regimes of Collaborative Innovation



The inputs are usually associated with collaborative governance in the literature and includes the level of autonomy of the institutions vis-à-vis its stakeholders, the integration of stakeholders and the collective purpose pursued by the collaborative arrangement. In this context, the term stakeholder is assessed in this work according to Freeman's (1984: 24) definition as parties that "*can affect or are affected by the achievement of an organization's objectives*" and, specifically follows the theoretical framework provided by Bridoux & Stoelhorst (2022) to analyse the stakeholders governance forms, in particular the level of institutional autonomy and the stakeholders´ relative positioning within each regime. The study assumes that adopting collaboration as an innovation strategy involves combining and articulating multiple interests, requiring continuous, dynamic and complex negotiation and learning processes, where the relationship bases in which the regime evolve are formed, developed and changed within an innovation-oriented collaborative space. Additionally, it is also considered that collaborative innovation allows the allocation of skills and capacities from different stakeholders to

develop different types of innovation and pursue different objectives. According to Stojčić (2021), this aspect becomes particularly relevant in the medium and long term, enabling the development of internal resources for innovation, through the accumulation of knowledge, the integration of skills and the emergence of spillover effects.

In this theoretical framework and based on the monitoring process of the Collaborative Laboratories implemented between 2018 and 2022, a qualitative approach is used to study the case of the Portuguese Collaborative Laboratories in an attempt to validate the hypothesis posed and to identify and characterize the different regimes of collaborative innovation in which the Collaborative Laboratories operate, as well as to understand the dimensions that characterise them. As a result, the work described in this thesis has been partially used for the publications prepared by Heitor and Gonçalves (2023) and Heitor, Mendonça and Gonçalves (2024).

CHAPTER 2. RESEARCH CONTEXT AND METHODOLOGY – THE CASE OF THE PORTUGUESE COLLABORATIVE LABORATORIES

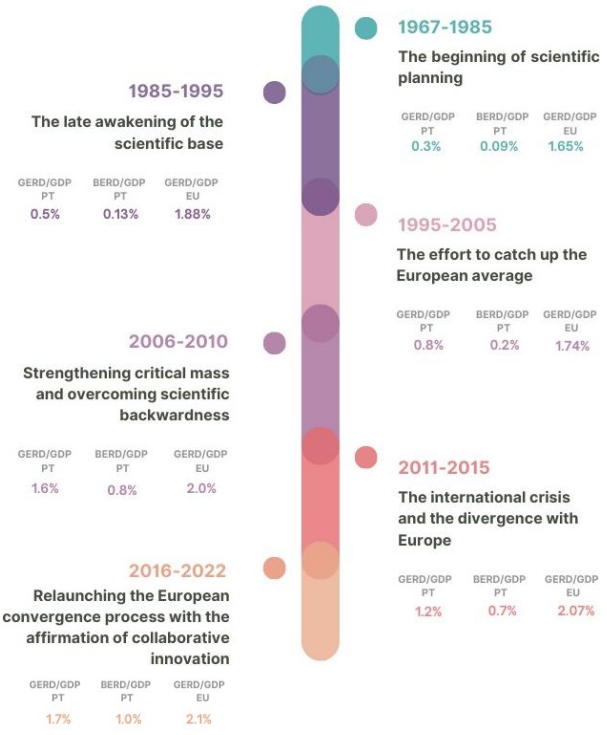
Since 2016, the public policy measure to support the creation of Collaborative Laboratories has sought to strengthen and complement the institutional base of the National Scientific and Technological System, pursuing four fundamental principles (Heitor, 2023): i) the densification of the territory in knowledge-intensive activities through the development of public and semi-public goods promoted by new institutional arrangements geared towards innovation-based growth; ii) the diversification of research and innovation activities in a global system with increasingly fragmented industrial production chains, improving the value of the products and services provided by companies and facilitating the social relevance of R&D activity and its appropriation by society; iii) stimulating global-local knowledge flows, associated with non-linear relationships between research, innovation and social and economic activities; and iv) associating thematic, mission-based programmes with international relevance and local impact. At the end of 2022, 35 Collaborative Laboratories were in operation, formally constituted as private non-profit associations, presenting different associative structures (in terms of number of stakeholders, type of stakeholders and level of involvement) and acting in different thematic areas.

2.1. A step forward in promoting collaborative innovation in Portugal: The evolution of the National Science and Technology System

In the European context, policies to promote collaborative innovation have been implemented mainly through research and innovation framework programmes, bringing together public and private actors to build partnerships oriented to answer common European objectives. In Portugal, policies have mainly evolved from an approach centred on strengthening the scientific and technological system through the capacitation of scientific institutions to the creation of instruments to support collaboration, intensify the R&D investments from the private sector, and to create conditions to the development of new innovation-oriented institutional frameworks engaging academia, companies, public administration and the third sector.

The evolution of the Portuguese scientific and technological system is characterised by six main periods, as presented in **Figure 3**.

Figure 3. Evolution of the National Science and Technology System (1967-2022)



Source: Heitor (2015, 2023)

The first period (1967-1985) corresponds to the "*beginning of scientific planning*" and is characterised by the creation of the National Board for Scientific and Technological

Research[5] as an attempt to create a science and technology system based in centralised coordination and a linear approach to technological change. The second period (1985-1995), in turn, represents "*the late awakening of the scientific base*" characterised by the emergence of the foundations for an organised system, with growing international links motivated by the increasing internationalisation of the Portuguese economy. In addition, in this phase also emerged new R&D programmes and interface institutions (such as technology centres) were created. Occurred between 1995 and 2005, the third period represents an "*effort to catch up the European average*". This period was marked above all by the creation of the Ministry of Science and Technology, which consolidated the effective establishment of a national S&T system, the implementation of international and independent evaluation processes for R&D units and the promotion of the training of highly qualified human resources. This period was followed by "*strengthening critical mass and overcoming scientific backwardness*" between 2006 and 2010, in which strong public investment in S&T was made, strengthening the support to qualify human resources in R&D activities and attract knowledge and human capital, promoting private sector investment and strengthening internationalisation and partnerships between academia and companies. Between 2010 and 2015, the international financial crisis led to a downturn in public investment in S&T (especially in the qualification of human resources) and a decrease of private investment in R&D, which led to a marked divergence with Europe average. This trend changed in 2016 and until 2022 with the reinforcement of public investment in S&T and a significant support to the qualification of high-skilled human resources, associated with a strong increase in private investment in R&D. This period considers, therefore, "*relaunching the process of European convergence with the affirmation of collaborative innovation*" and is characterized by the positive balance of technological payments, in association with the strengthening of exports and partnerships between academia and companies. The implementation of measures to stimulate the emergence of collaborative arrangements towards innovation, such as the incentive to the creation of Collaborative Laboratories also marked this stage of consolidation of the Portuguese scientific and technological system by promoting the institutionalisation of collaboration between different players and the co-responsibility of

[5] In the original, Junta Nacional de Investigação Científica e Tecnológica

the various stakeholders involved in the design and implementation of new strategic research and innovation agendas fostering joint creation of value.

The periods mentioned above were also accompanied by the evolution of public policies centred on three main axes (Heitor, 2023: 196): the first focuses on "people", by investing in the education and training of the population and the development of scientific and academic careers; the second axis, in turn, is directed towards the "promotion of R&D activities", by supporting participation in projects and the integration of researchers and scientific institutions into national and international thematic networks; and, the third, focuses on "institutional development", by reinforcing the role of academic and scientific institutions in society and their articulation with the public and private sectors (Heitor, 2023: 196). As **Table 1** presents, understand the evolution of the public policies associated with institutional development is of major importance to position the growing maturity, size, diversification and density of institutions in Portugal in terms of the historical institutional evolution oriented to collaborative innovation.

Table 1. Main institutional developments oriented to collaborative innovation in Portugal

	Type of institution	**Basis for the constitution and development of new institutions**	**Some examples**
1980	Private not for profit institutions	The legal framework has favoured the creation of private not-for-profit institutions, without direct action from the State and through the voluntary action of groups of researchers, in conjunction with higher education institutions and companies. These new (non-profit) institutions were created with the aim of introducing institutional and administrative flexibility, also boosting greater flexibility in terms of attracting and attracting human resources. This legal regime became particularly popular in the 1990s and later, under programmes such as Ciência (1990-1993).	• Instituto Nacional de Engenharia e Sistemas de Computação (INESC), in 1980; • Laboratório de Instrumentação e Física de Partículas (LIP), in 1986; • Instituto de Telecomunicações (IT), in 1991.
Since 1983	Technology Centres	Initially by direct State action (DL 461/1983) in association with companies and business associations. The first technology centres were formally constituted at the end of the 1980s and considered the public sector participation through IAPMEI, based on legal regime for the creation of private not-for-profit	• Centro Tecnológico da Cerâmica e do Vidro (CTCV), Centro Tecnológico do Calçado Português (CTCP), and Centro de Apoio Tecnológico à

		institutions. These centres subsequently evolved as a result of voluntary action by groups of companies at sectoral level, together with some groups of scientists and technologists and their institutions, to answer the main challenge of increase added value to sectorial value chains through the production of generic knowledge.	Indústria Metalomecânica (CATIM) in 1986; • Centro Tecnológico Têxtil e Vestuário (CITEVE), in 1989; • Centro Tecnológico da Indústria de Moldes, Ferramentas Especiais e Plásticos (CENTIMFE), in 1991.
Since 2006	International Partnerships	Establishment of strategic international partnerships in higher education with the main objective of stimulate networks of research centres across Portuguese universities, cooperating with institutions of global relevance and involving companies and end users. This process was facilitated since 2006/2007 by direct State intervention.	• International Iberian Nanotechnology Laboratory, in 2007; • Atlantic International Research Centre (AIR Centre), in 2017.
Since 2016	Collaborative Laboratories	By action of the State and instituted by the "Science Law" (DL 63/2019, of 16 May), with promotion of public-private collaborative arrangements at institutional level, facilitating qualified employment and the creation of wealth through the economic valorisation of knowledge. The main objective was to contribute to an effective densification of the territory in terms of knowledge-intensive activities, through the growing institutionalisation of forms of collaboration between academic and scientific institutions and the economic and social fabric, namely companies, hospitals, and cultural and social institutions.	• +Atlantic, GreenCoLAB, DTx, MORE, in 2017; • NET4CO2, VOH, VORTEX, Prochild, in 2018; • Food4Sustainability, Smart Energy LAB, BUILT CoLAB, in 2019; • HyLAB, TRIALS, AquaValor, S2AQUAcoLAB, in 2021.

Source: Adapted from Heitor (2023: 242-243)

2.2. The Collaborative Laboratories Initiative

The Collaborative Laboratories support measure was launched in 2016 by the 21st Constitutional Government of Portugal as an incentive for the emergence and support for the consolidation of new institutional arrangements within the existing R&D and innovation structure in Portugal. In an attempt to contribute to the institutional development of the national scientific and technological system, as well as densifying the national territory in terms of knowledge-based activities, the measure was implemented

towards the development of innovative solutions that stimulate processes of knowledge valorisation and dissemination, increase the added value of products and services, and promote greater social relevance of academic research activity and its endogenization by society (Decree-Law no. 63/2019, of 16 May).

This measure does not appear isolated from the system in which is inserted, having been designed and implemented in articulation with the country's efforts to boost exports and increase the technological balance of payments; to increase the number of human resources involved in R&D activities; to increase total R&D spending, mainly in the private sector; and, to increase the Portuguese participation in the European Framework Programme for Research and Innovation. The policy option was thus to stimulate new "*forms of interaction and a non-linear relationship*" between research and innovation activities and economic and social development. By introducing risk-sharing and co-responsibility mechanisms between the public, private and the third sectors, in order to understand and solve complex and large-scale problems that generally cannot be solved within the scope of a single disciplinary, scientific, technological or institutional arena, this measure aimed to respond to the following challenges:

- Stimulating the creation of scientific and qualified jobs generating economic and social development and helping to increase the competitiveness of the productive and social fabric.
- Diversifying and coordinating activities based on proprietary knowledge, promoting processes of technological change and diffusion and the implementation of specific short- and medium-term research and innovation agendas prompted by the identification of complex economic, social or cultural opportunities and challenges of international relevance.
- Promoting the creation of new collaborative arenas for R&D activities throughout the country, including in less populated areas;
- Building collectives that facilitate the co-creation and dissemination of new knowledge, in partnership and networking with relevant players at local, national and international level.

The support for the creation of Collaborative Laboratories was implemented based on a process of identification and recognition of Collaborative Laboratories, through an international evaluation process based on an open public tender. This process was

conducted by the Foundation for Science and Technology, I.P. (FCT, I.P.) and the applications received were discussed and evaluated by an international panel of experts, who recommend the recognition and attribution of the title of Collaborative Laboratory – CoLAB valid for 5 years. This process of selection culminated with the legal constitution of 35 Collaborative Laboratories as private not for profit institutions, whose associative structure is constituted by at least one company and one research unit[6], including also other entities as associate laboratories, higher education institutions, interface and technology centres, business associations, among other. The list of the 35 Collaborative Laboratories can be found in Annex 1.

With territorial expression in all the NUTSII regions of the Portuguese continent, the Collaborative Laboratories focus their agendas around 8 major thematic areas – 'Agri-food', 'Biodiversity and Forest', 'Climate, Space and Ocean', 'Digital and Information Systems', 'Energy and Sustainability', 'Health', 'Materials, Circular Economy and Urban Sustainability', and 'Social Services and Tourism' – having contributed until 2022 to the direct creation of 639 highly qualified jobs (32% of which for PhDs) and the engagement of 295 stakeholders (from which 173 are companies)[7]. The public incentive to build and promote Collaboratives Laboratories was based, therefore, on the need to create autonomous institutions able to answer common objectives, internalize good-jobs externalities in their choices and pursue a dialogue among public and private actors through the development of research and innovation agendas.

2.3. Methodological approach

Considering the complexity of the phenomenon approached in this study, this work is conducted through a qualitative approach and using intensive case study as research method. The process of inducting theory using case studies follows Eisenhardt (1989), constituting a highly iterative and tightly linked to rigorous observations, including hypothesis-testing research for validation purposes, as well as case-oriented processes. Following the literature review, this approach is especially appropriate in characterizing the innovative concept of regimes of collaborative innovation, as this methodological framework allows that the researcher act as an interpreter, constructing and analysing the

[6] The process considered that no associate or partner may hold less than 5% or more than 49% of the participation units.
[7] Information made available by ANI at 2022 Annual Report)

case using the perspectives, understandings, experiences, sense-making processes and interactions of people who are involved in the case (Yin, 2003). It should also be noted that the choice of case studies as the methodological approach follows similar studies in the literature. As a case study representing an empirical enquiry into a complex, social phenomenon that is contemporary, situated in a real-life setting, several sources of information are required to sustain an analytically meaningful case. The collection of information result of the monitoring process implemented by ANI since 2019 and considered two main moments, as follows:

1. Semi-structured interviews performed between 2019 and 2022: During this period, were performed 104 semi-structured interviews totalling over than 520 hours of interviews. The interviews were performed annually during visits to the installations of the Collaborative Laboratories in operation – 8 in 2019; 26 in 2020; 35 in 2021; and, 35 in 2022. The main questions that guided the discussions are presented in Annex I and included four dimensions: Governance model and operational resources, Research and Innovation Agenda, Funding Model and Market Approach and Impacts. The result of this interviews is documented in the 1st, 2nd and 3rd monitoring reports produced by ANI, available at https://www.ani.pt/pt/valorizacao-do-conhecimento/interface/laborat%C3%B3rios-colaborativos-colab/.

2. Thematic Sessions: During annual meetings were organized thematic sessions were each CoLAB presented its results in terms of governance and stakeholders' integration, capacities (human capacity, funding, and technology/infrastructures resources) and results (products/services developed, projects and funding raised and capacities reinforced). These meetings were organized in 2020 (https://www.youtube.com/watch?v=fFchnQD_2q4), 2021 (https://www.youtube.com/watch?v=xv_Wm1qtQwk) and 2022 (https://www.youtube.com/watch?v=9PhZRcEOSas).

Based on the information collected, the cases were selected among the universe of 35 Collaborative Laboratories operating in Portugal, having in consideration the diversity of intervention areas and thematic issues covered by each case and its evolution in terms of governance and stakeholder integration, capacities (inputs), and performance (outputs), striving to achieve institutional variation and thematic diversification. **Table 2** presents

all the cases selected and summarizes the main intervention areas and thematic issues covered. A detailed description of each case is provided in Annex 2.

Table 2. Cases selected for analysis

Case Study	Thematic Area	Description	Main critical intervention
MORE	Biodiversity and Forest	Operates in the city of Bragança in the remote northeastern part of Portugal, close to the border with Spain to promote the development of mountain regions, to generate new products, processes and services. Has contributed to the creation of qualified jobs that generate economic, social and cultural value.	**Densification** of the territory in terms of knowledge-based activities
AQUAVALOR	Health	Operates in the city of Chaves as the first laboratory ever installed in this region. It aims to promote water resources, water-based equipment and, above all, water based thermal, beauty and pharma products. It has attracted and promoted young doctorates for the city of Chaves and created a new labor dynamic in terms of qualified job creation and value-based healthcare together with the integration of multiple actors in the sector's value-chain in the region.	
VORTEX	Digital and Communication Systems	Provides skills on systems for low latency communications in cross-domain mobility applications, as well as verification and validation of software components for autonomous vehicles.	**Diversification** of the research and innovation landscape
VOH	Health	Operates to diversify the research and innovation landscape, complementing the existing structure and the performance of traditional biomedical research laboratories through the validation of innovative methodologies to measure outcomes and costs and to provide trustful scientific evidence under the scope of Value-based Healthcare principles. It has contributed to the creation of qualified jobs for a wide variety of young graduates from several areas (medicals sciences, management, psychology and public relations).	
DTX	Digital and Communication Systems	Provides the implementation of flows of global-local knowledge, between demand and supply, supply and demand with a special focus on Industry 4.0.	Stimulation of **flows of global-local** knowledge
+ATLANTIC	Climate, Space and Ocean	Promotes a knowledge-based blue economy, with emphasis on sustainable coastal areas, ocean sustainability, marine ecosystem's health, ocean literacy. Has contributed to the creation of qualified jobs that generate economic, social and cultural value.	Implementation of "**mission-based**" programs

The cases were then classified on a scale of 1 to 10, considering their position in relation to the limits of operation of each input and output variable.

CHAPTER 3. ANALYSIS AND DISCUSSION

The narratives explored reveal the diversity of regimes of collaborative innovation in which the Collaborative Laboratories operate, as well as its main characteristics, showing that the different regimes coexist. From the analysis of the data collected, it is evident that the regimes of collaborative innovation, as theoretical limits, provide the institutional space for the development of innovative solutions to complex problems and operate according to the influence of input and output variables. **Table 3** summarizes the input and output variables identified as well as their limits of operation.

Table 3. Input and output variables

Variable		Limits of operation	
		From 1	**To 10**
Input	Level of institutional autonomy	Low institutional autonomy	High institutional autonomy
	Stakeholders´ relative positioning (integration)	Horizontally integrated stakeholders, with competing commercial interests, most of the time with a large number of stakeholders involved	Vertically integrated stakeholders, without competing commercial interests and with a small number of stakeholders involved
	Human capability in terms of o*perational skills*	Low and medium-low sophisticated skills	Highly sophisticated skills
	Technical Capability in terms of existing infrastructures	Low and medium-low level technical infrastructures	Highly sophisticated technical infrastructures
Output	Value added and sophistication of g*oods and services produced*	Low and medium-low value-added: Mostly public and semi-public goods and services for current markets, with emphasis on domestic (regional and national) markets, facing only a reduced local competition	High and very high value-added: includes high-value (proprietary) goods together with public and semi-public goods for innovative markets, above all for exports and globally sophisticated markets, facing international competition
	Geography of *markets accessed*	Local/Regional	Global

	Quality of jobs, in terms of good-jobs externalities	Low, with employment conditions similar to average business practices	High, with improved employment conditions relative to the best business practices

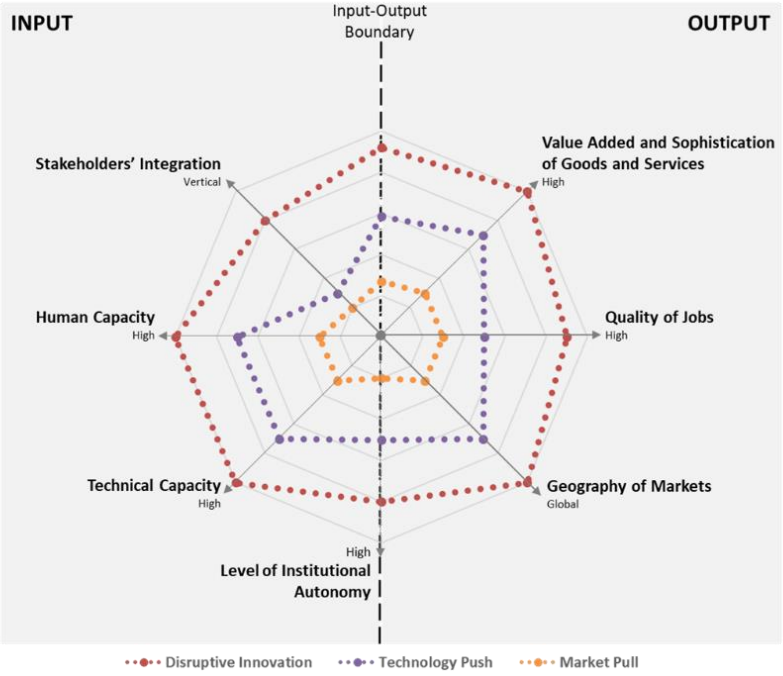
Based on cases analysed, three main regimes of collaborative governance are identified – Disruptive regime; Technology Push regime and Market Pull (or Business as Usual) regime. **Figure 4** presents the theoretical positioning of each regime in relation to the input-output variables. It should be noted that other variables could be used to enrich the analysis, but the choice was to develop a simple, comprehensive and logic framework to better understand the phenomenon.

The **Disruptive Regime** is characterized by collaborative systems composed of usually vertical integrated stakeholders, without competing interests. Usually, large companies are strongly committed with the decision-making processes, operating as facilitators and as customers. Stakeholders constitute both the input and output of value generation, as they operate in terms of identifying breakthrough needs and allocating resources (input), and in terms of integrating the proprietary goods and services produced into their portfolio. The operational skills required present a high level of skills sophistication and teams are relatively small but composed of highly specialized and experienced human resources. The level of technology innovation and product sophistication is very high and disruptive, leading to the development of breakthrough solutions oriented to answer stakeholders' competitive needs. The access to markets is stakeholder driven, since the stakeholders constitute the main customers of the solutions developed.

The **Technology Push Regime** refers to those collaborative systems that are based in the constitution of technological alliances between stakeholders or joint ventures between competitors. Usually, this regime is composed of a large number of horizontally integrated stakeholders and is characterized by a strong involvement of stakeholders in decision-making processes, directing activities and resources to answer their specific applied research strategic needs. This regime is often based on roadmaps that drive the interaction of large companies and non-business R&D entities and is characterized by the constitution of large teams, with medium and high-sophisticated skills. Potentially, presents highly sophisticated products that answer stakeholders' strategic needs (focused

on product innovation), and generally, the solutions are directly incorporated in stakeholder's portfolio that can be used to answer global market needs.

Figure 4. Positioning of the Regimes of Collaborative Innovation in relation to input-output variables



The **Market Pull (Business as Usual)** integrates the collaborative systems that are composed of a large number of stakeholders, but without competing interests as the influence of non-business entities is decisive. In this regime, the stakeholders' role is more dedicated to support operations and define priorities, acting as facilitator rather than a customer or market intermediary. Teams are composed of low and medium-low sophisticated skills, with sectorial experience, to answer both technological and non-technological innovation. The level of product sophistication is low, since it is focused on market services and service innovation. Institutions that operate under this regime are focused in offering knowledge-intensive business services with emphasis on domestic markets (mostly composed of SMEs), to answer current sectorial needs.

The application of the conceptual model developed for the analysis of the regimes of collaborative innovation to the selected Collaborative Laboratories – MORE, AQUAVALOR, VORTEX, VOH, DTx and +Atlantic – reveals the relative position of each case in terms of the flows of inputs they integrate, and the outputs generated in the

framework of the collaborative innovation process. **Table 4** presents the classification of each case considering its position in relation to each input and output variable.

Table 4. Classification of the selected cases

	MORE	AQUAVALOR	VORTEX	VOH	DTx	+Atlantic
Level of institutional autonomy	6	6	2	5	8	2
Stakeholders´ integration	6	6	3	6	6	2
Human capability	5	5	5	4	4	4
Technical capability	3	3	6	4	6	3
Value added and sophistication of goods and services	3	2	5	3	5	4
Geography of markets	2	2	5	2	3	3
Quality of jobs	3	3	5	4	4	4

When compared with the regimes of collaborative innovation, it is possible to verify that each case studied present particular specificities, as presented in **Figure 5** and detailed in Annex 3. The analysis clearly shows that different collaborative arrangements follow different regimes to attempt promoting the increase of sophistication in new product/services development to answer needs of global markets together with good jobs externalities.

The analysis also shows that regimes of "horizontal" integration among stakeholders, which are most of the occasions associated with a comparatively small number of partner institutions, reveal relevant employment dynamics and product sophistication when compared with collaborative laboratories associated with regimes of "vertical" integration.

Figure 5. Position of the selected cases in relation to the regimes of collaborative innovation

CHAPTER 4. CONCLUSION

The dispersion of the literature on the topic of collaborative innovation increases the complexity of the analysis of the phenomenon, highlighting that in this field there is a lot of work to do. Seeking to contribute to the development of a more stable theoretical body, this work sought to develop the idea of the existence of different regimes of collaborative innovation and test the hypothesis that these regimes develop and evolve depending on

the inputs integrated in the collaborative arrangement (level of institutional autonomy and stakeholders' relative positioning, as well as internal capabilities, in terms of the level of skills used and the level of technical infrastructures) and the outputs generated in this process (added value of goods and services produced, the geography of markets used and good-jobs externalities). The conceptual model developed was tested to differentiate three regimes of collaborative innovation, revealing the complex nature of collaborative arrangements – Disruptive innovation, Technology push and Market pull (or Business as Usual). The conceptual model developed and applied in this study allows to differentiate the capacity to build socially robust consortia and innovation networks promoting good jobs under different conditions, affirming that the collaborative institutional context integrate complex dynamics and modus of operation that change and evolve along time. It also affirms that the looking for externalities is of major importance, and that the quality of jobs generated within the collaborative process is critical for evaluating and promoting collaborative innovation.

Using a qualitative approach based, the conceptual framework of regimes of collaborative innovation is applied to the analysis of six Collaborative Laboratories implemented in Portugal in the period 2018-2022. The analysis shows that different collaborative arrangements follow different regimes and that this position can move between the limits of the theoretical regimes and evolve according to the dynamics of inputs-outputs. The analysis also presents that regimes of "horizontal" integration among stakeholders, which are most of the occasions associated with a comparatively small number of partner institutions, reveal relevant employment dynamics and product sophistication when compared with the cases associated with regimes of "vertical" integration. The model developed for the definition of the regimes of collaborative innovation can be further used to analyse the performance of collaborative arrangements, expanding the analysis also to include other input-output variables. Further developments in this framework will contribute to achieve a comprehensive and stable theoretic body to better understand the conditions in which the regimes of collaborative innovation evolve.

Finally, one of the expected impacts of this work is that it will help Collaborative Laboratories to better understand the conceptual framework in which they operate and the position they occupy in relation to the theoretical regimes of collaborative innovation,

showing that the process of collaborative innovation depends on a complex, dynamic and diverse set of input and output variables, and that different strategies can be adopted.

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APPENDICES

Annex 1. List of the 35 Collaborative Laboratories implemented in Portugal in the period 2018-2022

Acrónimo	Designation	Thematic Area	Location
+Atlantic	Collaborative Laboratory for the Atlantic	Climate, Space and Oceans	Peniche; Lisboa; Porto; Ponte de Sôr
4LifeLAB	4LifeLAB	Health	Porto
AccelBio	AccelBio	Health	Cantanhede
AlmaScience	Cellulose for Sustainable Smart Applications	Materials, Circular Economy and Urban Sustainability	Almada
AquaValor	AquaValor	Health	Chaves
B2E	Blue BioEconomy CoLAB	Climate, Space and Oceans	Matosinhos
BIOREF	Research and Innovation on Biorefineries	Energy and Sustainability	Matosinhos; Lisboa; Portalegre
BUILT CoLAB	Collaborative Laboratory for the Future Built Environment	Materials, Circular Economy and Urban Sustainability	Porto; Lisboa
C5LAB	Sustainable Construction Materials	Materials, Circular Economy and Urban Sustainability	Linda-a-Velha
CECOLAB	Collaborative Laboratory Towards Circular Economy	Materials, Circular Economy and Urban Sustainability	Oliveira do Hospital
CEiiA - S2uL	Smart and Sustainable Urban Living	Materials, Circular Economy and Urban Sustainability	Matosinhos
Colab4Ageing	Colab4Ageing	Health	Coimbra
CoLab4Food	Collaborative Laboratory for Innovation in the Food Industry	Agri-Food	Vila do Conde
CoLABOR	Collaborative Laboratory for Work, Employment and Social Protection	Social Services	Lisboa
Data CoLAB	Data CoLAB	Digital and Communication Systems	Viana do Castelo
DTx	Digital Transformation Laboratory	Digital and Communication Systems	Guimarães

FeedInov	Innovative Feed Strategies for Sustainable Animal Production	Agri-Food	Santarém
Food4Sustainability	Food4Sustainability	Agri-Food	Idanha-a-Nova
ForestWISE	Collaborative Laboratory for Integrated Forest & Fire Wise Management	Biodiversity and Forest	Vila Real
GreenCoLAB	Green Ocean Technologies and Products Collaborative Laboratory	Climate, Space and Oceans	Faro
HyLAB	Green Hydrogen Collaborative Laboratory	Energy and Sustainability	Sines; Lisboa
InnovPlantProtect	Innovative bio-based solutions for crop protection	Biodiversity and Forest	Elvas
KIPT	KIPT	Tourism	Loulé
MORE	Mountains of Research	Biodiversity and Forest	Bragança; Mêda
NET4CO2	NETwork for a Sustainable CO2 Economy	Energy and Sustainability	Porto
ProChild	CoLAB Against Poverty and Social Exclusion	Social Services	Guimarães
S2AquacoLAB	S2AQUAcoLAB	Climate, Space and Oceans	Olhão
SFCoLAB	Smart Farm CoLAB	Agri-Food	Torres Vedras
Smart Energy LAB	Smart Energy LAB	Energy and Sustainability	Lisboa
TRIALS	CoLAB TRIALS	Health	Évora; Lisboa
VectorB2B	Drug Developing	Health	Lisboa
VG CoLAB	Vasco da Gama CoLAB, Energy Storage	Energy and Sustainability	Porto
Vines&Wines	Portuguese Vines and Wines, competitiveness and sustainability	Agri-Food	Vila Real
VOH.CoLAB	Value for Health CoLAB	Health	Lisboa
VORTEX	CoLAB on Cyber-physical Systems and Cyber Security	Digital and Communication Systems	Vila Nova de Gaia

Annex 2. Guidelines for semi-structured interviews

A. Governance model and operational resources

Please assess the topic taking into consideration, but not limited to, the following:

A.1. Strategic vision

A.2. Number and type of associates

A.3. Governance structure, decision-making process and leadership

A.4. Resources

A.4.1. Infrastructures and equipment

A.4.2. Financial

A.4.3. Human resources, considering the level and nature of qualified and scientific employment created

B. Research and Innovation Agenda

Please assess the topic taking into consideration, but not limited to, the following:

B.1. Evolution on the medium-term research and innovation Agenda

B.2. Work Plan implementation, considering the technical and scientific solutions to the large-scale and complex problems defined

B.3. Knowledge transfer strategy (licensing, ownership strategies, IPR protection policy)

C. Funding Model and Market Approach

Please assess the topic taking into consideration, but not limited to, the following

C.1. Evolution on the financial and business plan

C.1.1. Diversification of funding sources

C.2. Internationalisation strategy

C.3. Differentiation and sectorial approach

C.4. Establishment of international collaborations

D. Impacts

Please assess the topic taking into consideration, but not limited to, the following:

D.1. R&D outputs and generated benefits

D.2. New employment created (skilled technical-scientific jobs)

D.3. New collaborations established

D.4. International outreach

D.5. Territorial (national/regional/local) outcomes

Annex 3. Description of the Collaborative Laboratories analysed

MORE – Mountains of Research	
Location	Bragança and Mêda
Description	MORE aims to promote and stimulate the development of mountain regions, seeking to generate innovation in new products, processes and services. This CoLAB operates in enhancing by-products of agro-industrial and forestry activities, together with the development of natural ingredients for different industrial sectors and branding in the food sector.
Input Analysis	
Level of institutional autonomy	Integrating 15 stakeholders in its associative structure (3 Higher Education institutions; 4 SMEs; 4 interface centres; 3 Associations/Cooperatives, and 1 public administration entity), MORE presents a high level of autonomy.
Stakeholders´ relative positioning (integration)	The participation units are distributed equally among the stakeholders, except for 4 entities – 1 SME; 1 Higher Education Institution; 1 Interface Centre and 1 Business Association – that together gathers more than 40% of the participation units. The stakeholders relative positioning is considered relatively horizontally, but without competing commercial interests involved.
Human capability in terms of operational skills	The human resources structure is composed of 42 people (9 PhDs; 26 M.Sc; and 7 B.Sc.), 5 of them foreign. In terms of operational skills, the level of human capacity is considered medium-high allowing to answer to internal R&D developments/projects and external market needs.
Technical Capability in terms of existing infrastructures	The level of technical capacity is considered medium-high. The proximity to its stakeholders, in particular Instituto Politécnico de Bragança, facilitates the access to specialized equipment, facilities, and resources to the development of activities on sustainable agriculture and forestry, low consumption agriculture, "green" technologies, ecosystem resilience and resource and raw material efficiency.
Output Analysis	
Value added and sophistication of goods and services produced	The main challenge in terms of value added and sophistication of goods and services is the small scale of companies within the thematic area/sectors in which MORE operates, which difficult the leverage of significant R&D investments to "new product development". The strategy fostered by MORE is carried out in two ways: R&D contracts, consulting services or the participation in R&D consortiums to developed innovation projects; and the development of internal R&D projects based on the identification of stakeholders needs to develop new technology or to elevate the development of the existing one, referring mostly to the development of public and semi-public goods and services for current markets. The value added and sophistication of goods and services produced is considered medium-low.
Geography of markets accessed	MORE answer mostly the needs of the domestic markets. The customers are mainly national micro and small companies and public administration entities. The international markets are still inexpressive.
Quality of jobs, in terms of good-jobs externalities	Employment conditions similar to average academia practices, representing a low level in the quality of jobs.

AquaValor - Centro de Valorização e Transferência de Tecnologia da Água	
Location	Chaves
Description	The installation of the AQUAVALOR in the city of Chaves as the first research laboratory ever installed in this region with long standing roots in water thermal treatments. Their agenda includes the promotion of collaborative research and innovation engaging SPAs and local institutions together with water companies, medical hydrology societies, geothermal energy companies and digital operators oriented towards collaborative platforms to promote water resources, water-based equipment and, above all, water based thermal, beauty and pharma products.
Input Analysis	
Level of institutional autonomy	Integrating 18 stakeholders in its associative structure (2 Higher Education institutions; 2 large enterprises; 8 SMEs; 1 interface centre; 3 Associations/Cooperatives, and 2 public administration entities), AQUAVALOR presents a high level of autonomy.
Stakeholders´ relative positioning (integration)	The participation units are distributed equally among the stakeholders, except for 2 entities (1 Higher Education Institution and 1 public administration entity) that together gathers more than 20% of the participation units. The stakeholders relative positioning is considered relatively horizontally.
Human capability in terms of operational skills	AQUAVALOR human resources structure is composed of 13 people (8 PhDs; 3 M.Sc.; and 2 B.Sc.), 1 of them foreign. Although AQUAVALOR revealed the capacity to promote the attraction of young doctorates for the city of Chaves, in terms of operational skills, the level of human capacity is still considered medium due to the scarcity of skilled human resources in water-based product development.
Technical Capability in terms of existing infrastructures	The level of technical capacity is considered medium. The challenges associated with the multidisciplinary of experience-based product and service design in the areas of thermal treatments have limited the capacity to design and test new equipment and, above all, the development of beauty and pharma products.
Output Analysis	
Value added and sophistication of goods and services produced	AQUAVALOR operates in the area of water thermal treatments and value-based healthcare, on the bases of the operation of small and medium size specialized companies together with large water supply operators. However, the value added and level of sophistication of the goods/services developed is still considered medium-low, answering only current markets.
Geography of markets accessed	The goods/services provided answer mostly the needs of domestic markets. Although the involvement of foreign organisations in the association structure, the international markets are still inexpressive.
Quality of jobs, in terms of good-jobs externalities	AQUAVALOR fosters the improvement of employment conditions relative to the best business practices and the level of quality of the jobs created is considered medium-high.

VORTEX – Laboratório Colaborativo em Sistemas Cíber-físicos e Cíber segurança	
Location	Vila Nova de Gaia
Description	VORTEX is oriented to transfer cutting-edge research into tangible solutions in the areas of cyberphysical systems and cybersecurity and its vision is to become the largest hub for accelerating knowledge and technology transfer in these areas.
Input Analysis	
Level of institutional autonomy	Integrating 5 stakeholders in its associative structure (2 Higher Education institutions; 1 Large Enterprise; 1 SME; 1 interface centre), VORTEX is particularly associated with a very large international system operator presenting a low level of autonomy.
Stakeholders´ relative positioning (integration)	VORTEX operates on a vertically integrated consortium, with a small number of stakeholders, without competing interests. One large company – Cap Gemini – holds most of the participation units (49%) taking control on the decision-making processes. The stakeholder structure reveals a high level of maturity in collaboration and the long-standing relationships among the stakeholders has facilitated and accelerated VORTEX consolidation.
Human capability in terms of operational skills	The human resources structure is composed of 27 people (6 PhDs; 16 M.Sc.; and 5 B.Sc.), 4 of them foreign. In terms of operational skills VORTEX integrates medium-high sophisticated skills on systems for low latency communications in cross-domain mobility applications, as well as verification and validation of software components for autonomous vehicles.
Technical Capability in terms of existing infrastructures	Benefiting from the resources and capacities from its stakeholders, VORTEX presents medium-high sophisticated technical infrastructures to address the challenge of ground truth measurements that the auto industry is facing in order to adopt "smart systems and solutions".
Output Analysis	
Value added and sophistication of goods and services produced	VORTEX strategy is based on the creation of relevant scientific and technology competences and the development of a competitive portfolio of technology bricks targeting relevant business industries and external clients, following the exploitation of resultant R&D assets and generated services. Its portfolio comprises applied R&D services for the development of complex systems and Minimum Viable Products, feasibility studies and the offer of expert services in critical technology domains. Besides the services provided, VORTEX also integrates an approach to Intellectual Property Rights asset exploitation through trade secret, licensing and copyright models. VORTEX presents a portfolio of medium value added trying to develop proprietary goods for innovative markets, above all for exports and globally sophisticated markets, facing international competition.
Geography of markets accessed	VORTEX clearly address global markets related with European automobile industry.
Quality of jobs, in terms of good-jobs externalities	The level of qualify of jobs is medium-high, with improved employment conditions relative to the best business practices. This case shows the effect of export-based targeting, in which VORTEX employs workers in the local market but reaches global markets, creating a multiplier effect in the local economy.

VOH – Associação para a Investigação em Valor e Inovação Tecnológica em Saúde	
Location	Lisbon
Description	VOH has the mission of helping citizens and organizations to measure value in Health. Working alongside healthcare sector stakeholders (providers, professionals, patients, citizens, pharma, etc.) in implementing pilots in a real-life context and developing innovative methodologies and services to measure health outcomes, VOH aims to position itself as a Value Based healthcare) specialist, offering scientific consulting services and tools, and being unique for its competencies in key areas of expertise: digital health, data science and artificial intelligence, health literacy and communication, economy and management.
Input Analysis	
Level of institutional autonomy	Integrating 4 stakeholders in its associative structure (1 Higher Education institution; 2 Large Enterprises; 1 R&D institution), VOH presents a medium-high level of autonomy.
Stakeholders´ relative positioning (integration)	VOH operates on a vertically integrated structure, with a small number of stakeholders, without competing interests. The Higher Education Institution – UNL - Universidade Nova de Lisboa – assumes the lead role in the stakeholder's relationship. The stakeholders are vertically integrated, without competing commercial interests.
Human capability in terms of operational skills	The human resources structure is composed of 7 people (3 PhDs; 4 M.Sc), 1 of them foreign. In terms of operational skills VOH integrates medium sophisticated skills, including medicals sciences, management, psychology and linguistics sciences to validate innovative methodologies to measure outcomes and costs and to provide trustful scientific evidence under the scope of Value-based Healthcare principles.
Technical Capability in terms of existing infrastructures	VOH presents medium-low sophisticated technical infrastructures, relying solely on the resources and capacities of its stakeholders, in particular Universidade Nova de Lisboa.
Output Analysis	
Value added and sophistication of goods and services produced	VOH is centered on patients and the excellence of health care, through the approach of "value-based health care" and the practice of "lean processes" and has stimulated the integration of multiple actors in the health value-chain, complementing the existing structure and the performance of traditional biomedical research laboratories. Providing services of design, mapping, assessment, optimization, and planning in health care, using scientifically validated methods for measuring/analyzing outcomes, operations and costs, VOH focus on delivering solutions, including those using digital monitoring technologies. Although the potential of sophistication of goods and services is high, the low institutional maturity of VOH has not yet allowed the development of a portfolio of high-value (proprietary) goods.
Geography of markets accessed	The technologies and solutions are developed to address global markets, but VOH still lacks the capacity/resources to build an international competitive position.
Quality of jobs, in terms of good-jobs externalities	The level of qualify of jobs is medium-high, with improved employment conditions relative to the best business practices.

DTx - Digital Transformation Laboratory	
Location	Guimarães
Description	DTx develops applied research in different areas linked to digital transformation of industry. With this main objective, DTx intends to implement new approaches in the conception and development of cyber-physic systems, capable of integrating transdisciplinary perspectives (engineering of systems thinking), combined with creative thinking (design thinking), complexity and multidisciplinary of knowledge, in the promotion of open innovation and its sustainability in the creation of products, services and interfaces in cyber-physic systems.
Input Analysis	
Level of institutional autonomy	Integrating 18 stakeholders in its associative structure (3 Higher Education institutions; 11 Large Enterprises; 2 SMEs; 4 interface centres), DTx presents a medium level of autonomy in relation to its stakeholders.
Stakeholders´ relative positioning (integration)	The participation units are distributed in two groups among the stakeholders, allowing that some stakeholders assume a prominence position in decision-making processes. The stakeholders relative positioning is considered relatively horizontally, without competing interests.
Human capability in terms of operational skills	The human resources structure is composed of 49 people (14 PhDs; 28 M.Sc; 7 B.Sc.), 4 of them foreign. In terms of operational skills DTx integrates medium sophisticated skills in the field of Data Science, Computer Science and Engineering.
Technical Capability in terms of existing infrastructures	Benefiting from the resources and capacities from its stakeholders, in particular Universidade do Minho and Bosch, DTx presents medium-high sophisticated technical infrastructures to address the challenge of the digital transformation of industry.
Output Analysis	
Value added and sophistication of goods and services produced	DTx considers the mission of digitalizing the industry, including goods and services to Smart interiors, Digital Manufacturing, Moulded electronics, and Additive Manufacturing. Its portfolio is under development and presents medium value added trying to develop proprietary goods for innovative markets, above all for exports and globally sophisticated markets, facing international competition.
Geography of markets accessed	DTx has a clear action on the implementation of flows of global-local knowledge, between demand and supply.
Quality of jobs, in terms of good-jobs externalities	The level of qualify of jobs is medium-high, with improved employment conditions relative to the best business practices.

+Atlantic, Associação para um Laboratório Colaborativo do Atlântico	
Location	Matosinhos; Peniche; Lisboa; Ponte de Sôr
Description	+ATLANTIC aims at advancing knowledge on the interactions between the Ocean, Atmosphere, Climate and Energy in the Atlantic, through an integrated and holistic approach from deep sea to space.
Input Analysis	
Level of institutional autonomy	Integrating 13 stakeholders in its associative structure (3 Higher Education institutions; 4 SMEs; 4 interface centres; 3 Associations/Cooperatives, and 1 public administration entity), +Atlantic presents a low level of autonomy in relation to its stakeholders.
Stakeholders´ relative positioning (integration)	The participation units are distributed equally among the stakeholders. The stakeholders are horizontally integrated, with competing commercial interests, increasing the complexity and difficulty of the collaborative operation.
Human capability in terms of operational skills	The human resources structure is composed of 49 people (10 PhDs; 32 M.Sc; and 7 B.Sc.), 11 of them foreign. In terms of operational skills, the level of human capacity is considered medium-high allowing to answer to the development of R&D projects.
Technical Capability in terms of existing infrastructures	The level of technical capacity is considered medium-low, relying solely on public funding and on the resources and capacities of some of its stakeholders.
Output Analysis	
Value added and sophistication of goods and services produced	The main challenge in terms of value added and sophistication of goods and services is the competitive framework of companies, which difficult the relationship among stakeholders, the decision-making processes and the strategic orientation to leverage significant private R&D investments to "new product development". The strategy fostered by +Atlantic relies on R&D funded projects and the development of internal R&D projects based on the identification of stakeholders needs, referring mostly to the development of public and semi-public goods and services for current markets. The value added and sophistication of goods and services produced is considered medium-low.
Geography of markets accessed	+Atlantic answer mostly the needs of the domestic markets but targets global markets.
Quality of jobs, in terms of good-jobs externalities	The level of quality of jobs is medium. The need to attract talent improved some employment conditions, but the strong dependence on co-funded projects has not yet allowed the creation of stable good-jobs externalities.