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**How does corporate R&D activities impact on the research  
performance of science based organizations? The case of  
IPATIMUP**

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**Bio**

Daniela Margarida da Silva Campos graduated at the Polytechnic Institute of Cávado and Ave in Health Informatics. Currently, she is graduating from the Master program in Economics and Management of Innovation at the University of Porto. This dissertation is part of the Master's program.

Prior and during part of the time of this dissertation, Daniela worked as a Functional Consultant in a Portuguese technological company and gained experience in implementation of information systems in health centers, customer support and trainee. At this moment she is working as sales manager in a micro enterprise.

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Definitely, this project allowed me to meet and work with great people and understand that scientific and professional excellence is governed by the humility and simplicity of human being. These people are and will be a true inspiration to me.

## **Abstract**

Traditionally, the collaboration between university and the industry evolved associated to a kind of specialization with university focusing on basic research, whilst the industry mostly performing applied research, depicting what is usually called the ‘linear model’ of innovation. Recently, some other forms of collaboration emerged, characterized by more informal and interactive relationships between academia and industry, with corporate research and researchers assuming a more proactive position in the process.

At the scientific level, the vast majority of literature highlights and analyses the dependence of corporate R&D on academic research, being rather unexplored the role that corporate R&D might have in scientific outcomes of public R&D organizations. Thus, the aim of the present dissertation was to analyse, resorting to a case study methodology, how corporate R&D activities impacted on the research performance of a science based organization.

The analysis of the case study evidenced that indeed corporate (Coimbra Genomics) R&D greatly influenced IPATIMUP’s performance in terms of procedures, learning opportunities and capabilities to promote more and better innovative research. Several critical factors have mediated the relation between corporate R&D and the research performance of IPATIMUP. In particular, knowledge proximity existent between corporate and academic players, based on previous shared professional experiences, enhanced trust and therefore facilitated the process of establishment and development of the project and overcame obstacles related to geographical distance (Porto-Coimbra-China). In the present case study no evidence existed that the composition of researchers’ age or gender was crucial to the development of the project. In contrast, the combination in a single team of individuals with distinct expertise - knowledge of life sciences and basic research by IPATIMUP’s researchers and the technological expertise associated to more applied research by firm’s collaborators - was critical for the outputs of the project, namely the development of a new product.

These findings suggest that policy makers, while seeking to protect the autonomy and freedom of academic researchers, should place greater emphasis on creating effective policies to promote university – industry cooperation networks, particularly with R&D producing corporations. In times of economic recession and state budget constraints allocated to public R&D, U-I collaborations might allow public research institutes/ university to obtain additional financing for basic and applied research as well as advanced training.

**Keywords:** Innovation; Corporate R&D; University – Industry collaboration; Research Performance

**JEL-Codes:** O31; O32; O34; O38

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## **1. Introduction**

Collaboration between University and the Industry plays a crucial role in the development of science and technology (Motoyama, 2013). Traditionally, this cooperation evolved associated to some kind of specialization with the university focusing (more) on basic research, which aims at generating (new) knowledge (Motoyama, 2013), whereas the industry mostly performing applied research seeking to commercialize research and technology outcomes (Schartinger, 2002), depicting what is usually called the ‘linear model’ of innovation (Guan and Zhao, 2012).

Recently, some other forms of collaboration emerged, characterized by more informal and interactive relationships between academia and the industry, with corporate research and researchers assuming a relevant and more proactive position in the process of University-Industry (U-I) interaction (Guan and Zhao, 2012; Perkmann et al., 2012; Motoyama, 2013). These interactions take multiple forms, with interaction channels ranging from inter-organizational relationships (e.g. collaborative research, contract research or consulting) to spin-off companies and IP transfer including patenting and licensing (D’Este and Perkmann, 2011; King et al., 2011).

Although extant literature claim that U-I links are characterized by an interactive and win-win relations, the vast majority of studies (e.g., Mansfield, 1990; Cohen et al., 2002; Furman and MacGarvie, 2009; Freitas et al., 2012; Guan and Zhao, 2012; Perkmann et al., 2012) highlighted and analysed the (supposedly high) dependence of corporate research and innovation on academic research, implicitly assuming a rather passive role of corporate R&D.

It is therefore rather unexplored the role that corporate R&D might have, and how that relation happens and evolves, in fostering the scientific outcomes public R&D organizations. In other words, it remains scientifically unexplored how corporate R&D activities might influence public science/academia. This topic has been recently addressed by Coccia (2014) who analysed how new technological paradigms in medicine (that results of academic research), driven by cell and molecular biology, impacted on corporate R&D [the pharmaceutical industry] in order to support and accelerate the drug discovery process. However, this study does not analyse how corporate R&D and/or corporate’s needs may be impacting on R&D academic performance. Thus, the present work aims to analyse, through a case study

methodology, this unexplored research question.

The dissertation is structured as follows. Section 2 reviews the main relevant literature. First it reviews the main definitions of corporate R&D. Second, it examines the main research topics within literature of corporate R&D in order to provide a context for the study. Third, it analyses the determinants of university/science – industry collaboration and a proposal framework of analysis. Section 3 discusses the adequate methodology for the research question, presents a brief description of IPATIMUP as a pertinent case study, describes the information gathering process, and makes a description of the project under study. Section 4 analyses the results of interviews according to the theoretical framework. Section 5 presents the main conclusions of the study and discusses the implications for public policy authorities and the limitations of the study and avenues for future research.

## 2. Literature review the impact of corporate R&D on science performance

### 2.1. Definitions of corporate R&D

Research and Development (R&D) is understood as an important element in an economy's capacity to innovate (Tunzelmann et al., 2010) and has become a critical element for firms to ensure economic performance and their survival in the market (Cefis, 2010). Traditionally, Research and Development activities have been classified as basic research that has been competence of the public sector (Public R&D) and applied research that has been seen as the competence of industry (Corporate/Industry R&D) (Cox and Gagliardi, 2009).

Lin et al. (2010: 51) define 'corporate R&D' as "... a process via which firms generate new products and/ or new processes which can be commercialized afterwards...".

Cefis (2010) argues that 'corporate R&D' is the capability to exploit new ideas and then to generate new products and processes, whereas other authors (e.g, Moncada-Paternò-Castello, 2010; Hara and Shimizu, 2011; Haak and Wu, 2013) consider 'corporate R&D' as characterized by knowledge creation and increases in a firm's ability to explore external resources that involve radical projects based on new technologies.

Although the main dimension of R&D activities in firms is the applied research (see Table 1), Hara and Shimizu (2011) and Haak and Wu (2013) highlight the relevance of basic research and the role of doctoral scientists in the knowledge creation by firms.

**Table 1: Definitions of corporate R&D**

Study	Definition	Key dimensions	Type of R&D activities
Lin et al. (2010)	"R&D is a process via which firms generate new products and/or new processes <b>which can be commercialized afterwards</b> (either by the firms themselves or by licensing the R&D to other parties)."	Firm; new products; new processes	Applied Research
Cefis (2010)	Capability to exploit new ideas and generate new products and processes	Firm; new products and processes	Applied Research
Moncada-Paternò-Castello (2010)	Capability to generate and acquire new technology	Firm; new technology	Applied Research
Haak and Wu (2013)	Corporate R&D is usually associated with long-term oriented, innovative, radical projects based on new technologies	Firm; new technologies	Basic Research
Hara and Shimizu (2011)	Knowledge creation and enhances a firm's ability to assimilate and exploit external resources	Firm; knowledge creation	Basic Research

Source: own elaboration.

This type of R&D activities can be influenced by the sector of activity (Hara and Shimizu, 2011). Specifically, in sectors like pharmaceutical or biotechnologies, the basic research can be more frequent (Hara and Shimizu, 2011) while in sectors like electronics or ICT, the applied research plays a more important role (Lin et al., 2010).

In the context of the present work, we follow the same line of thought as Lin et al. (2010) considering corporate R&D as a process by which firms generate new knowledge, new products and new processes which can be disseminate for other parties.

## **2.2. Main research topics within the literature of corporate R&D**

In last years the topic of corporate R&D has been the subject of wide debate and discussion in the literature. Through an extensive search on the bibliographical database Sci Verse Scopus using ‘corporate R&D’ as a search keyword, we obtained 125 articles.<sup>1</sup> By analyzing all papers’ abstracts we identified the main topics that each study have focused. These included by decreasing order of the amount of papers published (cf. Table 2): the determinants of R&D investment; the internationalization of R&D activities; collaboration between academia and industry; the impact of corporate R&D on firm’s performance; and the impact of R&D subsidies on private R&D.

About 21% of all the studies published on corporate R&D (indexed in Scopus) focused on understanding the determinants of corporate R&D investments. The main determinants found in the literature includes: opportunities provided by the scientific sector (Abdelmoula and Etienne, 2010; Moncada-Paternò-Castello, 2010), spillovers (Abdelmoula and Etienne, 2010; Moncada-Paternò-Castello, 2010), market structure (Lin et al., 2010; Abdelmoula and Etienne, 2010; Moncada-Paternò-Castello, 2010), firm’s characteristics (e.g., firm’s age and size) (Etienne, 2010; Lin et al., 2010; Moncada-Paternò-Castello, 2010; Hirschey et al., 2012; Rhee and Yoo, 2013; Saad and Zantout, 2014) appropriability (Lin et al., 2010; Abdelmoula and Etienne, 2010; Moncada-Paternò-Castello, 2010), profitability (Abdelmoula and Etienne, 2010; Hirschey et al., 2012), access to finance (Lin et al., 2010; Moncada-Paternò-Castello, 2010), incentives (Pereto, 1998; Klassen et al., 2004; Lerner and Wulf, 2007; Lin et al., 2010; Abdelmoula and Etienne, 2010), corporate governance structure (Dong and Gou, 2010; Lee, 2012; Rhee and Yoo, 2013), and macroeconomic environments (Klassen et al., 2004; Lee, 2012; Cincera et al., 2012).

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<sup>1</sup> The reference date for this search is October 11<sup>th</sup>, 2014.

Another topic which attracted a reasonable amount of attention is the ‘internationalization of R&D activities’. This terminology is widely used in the literature but some authors have shown preference for the term ‘globalization of R&D’ to refer to the same phenomenon. Dachs and Pyka (2010) says that internationalization of R&D activities is defined by trans-border technological alliances, share of joint scientific publications involving authors from different countries, international mobility of researchers and a trans-border financial flows related to science and technology, whereas Guimón (2011: 77) define this process as “...the high and increasing share of R&D activities that MNE’s are performing through their international network of subsidiaries”. The main driving factors and attractors of foreign-located innovation activities found in the literature are the market size (Hedge and Hicks, 2008; Dachs and Pyka, 2010; Moncada-Paternò-Castello et al. 2011; Aoyama and Parthasarathy, 2012; Liang et al., 2014), the high level of scientific and technological capabilities (Reddy, 1997; Hedge and Hicks, 2008; Dachs and Pyka, 2010; Moncada-Paternò-Castello et al., 2011; Liang et al., 2014), quality of R&D personnel (Tijssen, 2009; Vivarelli, 2011; Wang, 2014), strong IPR protection (Tijssen, 2009; Dachs and Pyka, 2010; Moncada-Paternò-Castello et al., 2011; Belderbos et al., 2013), and public support of R&D activities (Moncada-Paternò-Castello, 2011).

The impact of corporate R&D on firm’s productivity is addressed by 5% of the studies. The positive impact is mainly felt in firms operating in high- and medium-tech sectors; corporate R&D tend to have minor productivity impacts in firms from low-tech sectors (Graves, 1989; Gassman et al., 2009; Kumbhakar et al., 2012).

A very small fraction of studies analyze the role of public support on corporate R&D. Dumont (2013) and Burger et al. (2013) observed that public support has stimulated companies to carry out additional R&D activities and stimulated the spending in innovation.

The topic that is the focus of the present dissertation - university-industry collaboration – has attracted a relatively low percentage of studies (13%). Within it, Mansfield (1991) observed that approximately 10% of the product and process innovations could not have been developed without academic research. Additionally, other authors (e.g., Jaffe, 1989; Cohen et al., 2002) show that university research has a significant impact on corporate patents and enhances new corporate R&D projects. More recently, Furukawa and Goto (2006) and Hara and Shimizu (2011) show that industry-based doctoral

scientists play an important role in stimulating in-house knowledge creation and knowledge diffusion outside the firm's boundaries.

From analyzing this stream of the literature it is possible to realize that the vast majority of studies focuses on the dependence of corporate research and innovation on academic research and less so the other way around.

**Table 2: Main research topics within the literature of corporate R&D**

Topic	Description	Main Studies	Percent (%)
Determinants of R&D investment	Main determinants of corporate R&D investments by firms	Pereto (1998); Klassen et al.(2004); Lerner and Wulf (2007); Lin et al. (2010); Abdelmoula and Etienne (2010); Moncada-Paternò-Castello (2010); Dong and Gou (2010); Hirschey et al. (2012); Lee (2012); Cincera et al. (2012); Rhee and Yoo (2013); Saad and Zantout (2014)	21
Internationalization of R&D activities	Main driving factors and attractors of foreign-located innovation activities	Reddy (1997); Hedge and Hicks (2008); Tijssen (2009); Dachs and Pyka (2010); Guimón (2011); Moncada-Paternò-Castello et al. (2011); Aoyama and Parthasarathy (2012); Belderbos et al. (2013); Liang et al. (2014)	14
University – Industry Collaboration	Universities and public research institutions are an important external resource in corporate R&D	Jaffe (1989); Mansfield (1991); Cohen et al. (2002); Furukawa and Goto (2006); Hara and Shimizu(2011)	13
The impact of corporate R&D on firm's performance	The corporate R&D has a significant impact on company's productivity especially in high and medium - tech sectors	Graves (1989); Gassman et al.(2009); Kumbhakar et al. (2012)	5
The impact of R&D subsidies on private R&D	Public support can stimulate companies spending more in innovation	Dumont (2013); Burger et al. (2013)	3

*Note:* the grey cells identify the stream of research within it the present dissertation develops its argument.

*Source:* own elaboration.

### **2.3. Determinants of University/science – industry collaboration: a proposal for a framework of analysis**

University – Industry (U-I) collaboration have emerged as a separate field of research in the last few years (Rothaermel et al., 2007). According to the literature, there are two main ways through which U-I collaboration might occur: university entrepreneurship and academic engagement. University entrepreneurship involves patenting, licensing and creating of new firms based on university research outcomes (Rothaermel et al., 2007), whereas academic engagement is defined as knowledge-related collaborations encompassing academic researchers and firms, and usually involve ‘person-to-person’ interactions (Perkmann et al., 2012).

Since the aim of the present dissertation is to analyse how corporate R&D might impact on academic research outcomes and given that studies within the topic ‘university

entrepreneurship' do not explicit focus on the linkages between the university and firms/corporations, our literature review is mainly addressing studies within the 'academic engagement' stream.

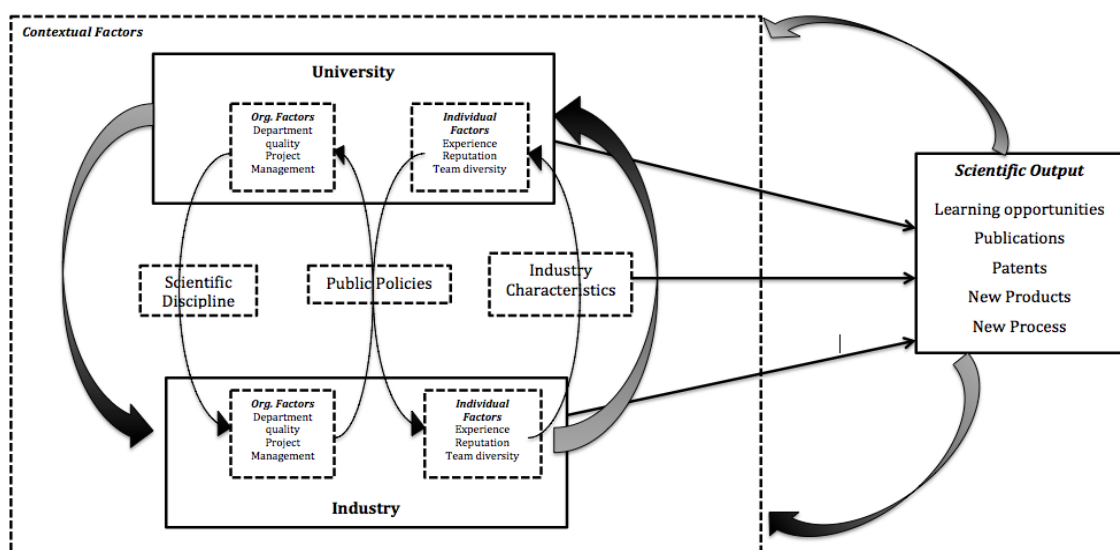
This latter literature highlights two main aspects: the motivations of academic engagement, and the determinants of successful/ research performance of academic engagement.

Theoretically, in an economy geared to innovation and competitiveness in research and development (R&D) activities, inter-relationships between the university and private enterprises constitute a priority strategy and a tool in knowledge – based economies (Olmeda – Gómez et al., 2008). U – I relationships are examples of inter-organizational relationships, which can be motivated by a variety of rationales, such as efficiency and reciprocity (King et al., 2011). On the one hand, the motivations of academic researchers to work with industry are informed by main four rationales: complementarities between their academic work and industry engagement (D'Este and Perkmann, 2011; King et al., 2011), mobilizing resources that complement public research funding (D'Este and Perkmann, 2011; King et al., 2011), acquisition of additional resources for research (e.g. accessing laboratory equipment) (Neely et al., 2011), learning opportunities via novel insights, ideas and techniques that eventually result in published scientific research (D'Este and Perkmann, 2011) and employment opportunities (Olmeda – Gómez et al, 2008). On the other hand, industry partner's reasons for involvement are based on accessing academic expertise to benefit their R&D and/ or product development activities, gaining insights on emerging technologies and enhancing their knowledge bases (King et al., 2011), sharing risks and costs (Dalpé, 2013; Fiaz, 2013), and gaining prestige by forging alliances with reputed universities (Olmeda – Gómez et al, 2008).

In literature, there are determinants that may influence the success of collaboration and research performance or serve as barrier to its success (see Table 3). These determinants are related to distinct types of factors (individual, organizational and contextual factors) and occur through different channels – see Figure 1.

Indeed, according to literature, the results from academic research can be transferred to firms and industries through a variety of channels, including publication of fundamental research or inter – institutional co – authorship of research articles (Cohen et al., 2002;

Olmeda – Gómez et al., 2008; Teixeira and Mota, 2012; Goel and Goktepe – Hultén, 2013), collaborative research<sup>2</sup> (Cohen et al., 2002; Perkmann and Walsh, 2009; D’Este and Perkmann, 2011; King et al., 2011; Guan and Zhao, 2012; Perkmann et al, 2012), contract research<sup>3</sup> (Cohen et al., 2002; Perkmann and Walsh, 2009; D’Este and Perkmann, 2011; King et al., 2011; Perkmann et al., 2012), consulting<sup>4</sup> (Cohen et al., 2002; Perkmann and Walsh, 2008; Perkmann and Walsh, 2009; D’Este and Perkmann, 2011; King et al., 2011; Perkmann et al., 2012; Goel and Goktepe – Hultén, 2013), informal interactions in meetings/ conferences (Fiaz, 2013), personnel mobility (Cohen et al., 2002) and, in a more formal way, licensing (Cohen et al., 2002).



**Figure 1: Framework of analysis of determinants of University/science – Industry collaboration**

Source: own elaboration.

Perkmann and Walsh (2009) established that collaborative forms of interaction, such as collaborative research, contract research and consulting, are seen by industry as more important and valuable than IP transfer, such as licensing. In same study, the authors found that collaborative research with industry results in academic publications while this is less true for relationship with more applied objectives, such as contract research and consulting. However, consulting facilitates interactive learn which in turn indirectly benefits scientific production by generating new ideas and new research projects.

<sup>2</sup> Collaborative research refers to “research jointly pursue by university and industrial partners – commonly with public funding (King et al., 2011: 540).

<sup>3</sup> According to King et al. (2011: 540), contract research is “application – oriented research and development activities carried out by university – commissioned and funded by industry”.

<sup>4</sup> Consulting refers to research or advisory services provided by individual academic researchers to their clients (Perkmann and Walsh, 2008).

**Table 3: Factors influencing the success of collaboration and research performance: a synthesis of the literature**

Study	Main Topic	Country	Determinants of relationship			Research Field	Main Conclusions
			Individual Factors	Organizational Factors	Contextual Factors		
Powell et al. (1996)	Networks of learning as access to knowledge	USA	Experience; Reputation	Trust; Project Management; Absorptive Capacity	Industry Characteristics	The development of a absorptive capacity and skill at managing collaborations as well as the increased awareness of new projects and reputation as a valuable partner are all benefits to collaboration	
Dalpé (2003)	Why academic researchers are still important players in industry	Canada	Reputation	Project Management; Absorptive Capacity; Trust	Industry Characteristics; Geographical Proximity	The capacity of a new firm to get financing is correlated with the reputation of researchers, as measured by citations to their scientific publications	
Furukawa and Goto (2006)	The role of corporate scientists in innovation	Japan	Reputation; Experience			Biotechnology/ Pharmaceutical	The existence of corporate scientists is important for companies to absorb external knowledge and its crucial that they conduct high quality research and have solid reputation in the research community
Lacetera (2009)	The determinants of a company's choice to outsource research projects to academic organizations	USA		Department quality	Industry Characteristics		Outsourcing a project to a university allows a firm to commit not to terminate or alter a scientifically valuable project before completion
Furman and MacGarvie (2009)	The Importance of academic science in the emergence of industrial research capabilities	USA			Geographical Proximity		Firms at early stages of development appear most likely to collaborate locally while firms with greater R&D capabilities engage in both local and distant collaboration
Barnes et al. (2006)	The determinants for an effective management of collaborative R&D projects	UK	Experience	Project Management			Inexperienced or ineffective project managers had a negative impact on collaboration
Shimizu and Hara (2011)	The role of doctoral scientists in corporate R&D	Japan	Doctoral Degree				Doctoral scientists play an important role in stimulating in-house knowledge creation and knowledge dissemination outside the firm's boundaries
Thune (2011)	The potential factors in U-I partnerships	Norway	Experience	Project Management; Trust	Geographical proximity; Public Policies	Engineering	Geographical proximity eases communication and that is more efficient to collaborate when partners are stimulated in the same geographical area
Melkers and Xiao (2012)	Characteristics of academic scientists who are engaged in funded research	USA	Gender				In field of electrical engineering, women scientists have a higher likelihood to conduct emerging technology research while in field of biological science men tend to be more likely to be funded in new technologies areas.
Freitas et al. (2013)	The role of U-I interactions for innovation in mature and emergent industries	Brazil			Industry Characteristics		University research and developments projects with firms in emergent industries are less likely to be the result of academic initiatives
Harris and Lyon (2013)	How collaboration is operating and approaches to building trust in U-I relationships	UK		Trust		Environmental	Trust is vital when crossing professional cultural boundaries as people are opening themselves to vulnerability and risk.
Jaffe (1989)	The effects of academic research on industry innovation	USA			Scientific Discipline		A significant effect of university research on corporate patents is found, particularly in the areas of Drugs and Electronics

(...)

Study	Main topic	Country	Determinants of relationship			Research Field	Main Conclusions
			Individual Factors	Organizational Factors	Contextual Factors		
Mansfield (1991)	The effects of academic research on industry performance	USA			Scientific discipline	The contribution of academic research on industry innovation has been considerable in industries like drugs and ICT	
Schartinger et al. (2002)	Determinants of knowledge interactions	Austria	Experience	Department quality	Scientific discipline	Technical sciences and R&D intensive manufacturing tend to use direct research cooperation more intensively, service industries and social sciences rest more on personnel mobility and training.	
Cohen et al. (2002)	The role of public R&D on industrial R&D	USA			Scientific discipline; industry characteristics	The impact of public R&D is strong in the drug and medical equipment industries and large firms	
Sherwood and Covin (2008)	How factors may affect the successful transference of technology knowledge between partners			Trust		Trust between partners is a significant factor of successful knowledge acquisition for tacit knowledge	
Barbolla and Corredera (2009)	Critical factors for success in U-I partnerships	Spain	Experience			A higher percentage of university research groups taking part in successful projects knew their industrial partners	
King et al. (2011)	How university department quality shapes their engagement with industry	UK	Reputation	Department quality	Scientific Discipline; Industry characteristics	The relationship between department quality, researcher's reputation and industry involvement differs according to disciplinary orientation and firm's size	
Bishop et al. (2011)	The benefits of U-I collaborations	UK		Department quality	Geographical Proximity	Geographical proximity between partners is significant only for benefits associated with direct assistance in problem solving and research quality of the university is a critical factor for firm's outcomes	
Fuentes and Dutrénit (2012)	The impact of channels of interaction on the perceived benefits by researchers and firms	Mexico	Age; Gender; Experience; Reputation	Trust	Public Policies; Industry Characteristics; Geographical Proximity; Scientific Discipline	The main characteristics of researchers that foster long-term benefits for firms are related to individual and institutional characteristics, such as doctoral degree, field of knowledge, research team and the acquisition of public financing for research	
Perkmann et al. (2012)	Determinants of academic engagement		Experiences; Age; Gender; Reputation	Project Management; Department Quality	Scientific Discipline; Public Policies	Factors like age, gender, experienced researchers, reputation and management skills had a positive impact on academic engagement	
Lakpetch and Lorsuwanarat (2012)	A model for measuring the knowledge transfer effectiveness of U-I alliances			Trust; Project Management	Industries Characteristics	The influence of cultural differences between university - industry partners can be problematic to the alliance projects, so a manager should establish teamwork in order to break the monoculture	
Fiaz (2013)	The importance and the role of U - I collaboration in economic development	China		Trust	Public Policies; Industry Characteristics	Proper communication, R&D capacity and R&D tendency are the main factors to sustain U-I collaborations	
Goel and Goktepe-Hultén (2013)	The effects of personal and professional characteristics on academic patenting	German	Age; Gender; doctoral degree	Group Leader	Scientific discipline	Researcher's age, group leadership, doctoral degree and hard sciences were more likely to result in patenting	

Source: own elaboration

Regarding the *individual factors* that might explain the U-I interactions, Perkmann et al. (2012) argue that individuals' characteristics like experience, reputation, team diversity or a doctoral degree (cf. Figure 1), play an important role in predicting academic engagement.

Given that engagement is often seeded by personal contacts, more *experienced* researchers (academic researchers or corporate researchers) are likely to have larger networks, enabling them to find potential partners (Perkmann et al., 2012). Perkmann et al. (2012) confirm that scientific productivity is generally positively related to engagement, i.e, the best and most successful scientists are also those who engage most with industrial partners. Moreover, Schartinger et al. (2002) highlight that previous knowledge interactions by university departments will expand the contact network relevant for knowledge spill-over to industry and thus increase the probability of future interactions and Barbolla and Corredera (2009) show that a higher percentage of university research groups taking part in successful projects knew their industrial partners from previous collaborations. In addition, Barnes et al. (2006) found that inexperienced or ineffective project managers had a negative impact on collaboration and they affirm that experienced partners are better able to understand the capabilities and the limitations of a collaborative venture, and also tend to be more flexible. Thune (2011) highlights the relevance of academic staff or key persons that take care of the practical sides to collaboration, generate activities and function as the point of contact between the companies and academia with a business background and a long experience in co-operation between firms and universities. This suggests that the past experiences of researchers, corporate researchers and academic researchers, constitute an important factor to successful outcomes of collaboration.

King et al. (2011) found that relationship between researcher' *reputation* and industry involvement differs according to disciplinary orientation. For the technology – oriented disciplines, the researchers in the best departments are also those with high industry involvement while for the social sciences, they found a negative relationship. In contrast, in same study King et al. (2011) found that the most successful researchers are able to raise the most resources, which, in turn, enables them to generate even more research outputs, so the best researchers are less dependent on working with industry. Although the literature only emphasizes the relevance of reputation of academic researchers, in same way the reputation of corporate researchers is an important

determinant for collaboration. According to Dalpé (2003) the capacity of a new firm to get financing is correlated with the reputation of researchers, as measured by citations to their scientific publications.

Another important factor is the *team diversity*. Some studies show that researchers with different *ages*, different *genders* and different *areas of knowledge* in same team work can be a stimulus to creativity and that will be profitable for collaboration. Lee et al. (2015) examined the influence of shared leadership and diversity on knowledge sharing and the subsequent effects on team creativity and they found positive relationships between age, gender and knowledge diversity on team creativity. Pitt-Catsouphes et al. (2013) demonstrate that age diversity can stimulate and/ or support creative thinking and might contribute to innovation at the workplaces. Moreover, Bear and Woolley (2011) analyse the role of gender in team collaboration and performance and conclude that gender diversity can enhance group processes and affirms be an important factor in the production of science.

Among *individual and professional characteristics* mentioned above, having a doctoral degree also plays a role in U-I collaboration, mainly for corporate R&D. Shimizu and Hara (2011) explore both direct and indirect contributions of doctoral corporate engineers to R&D by examining their papers and patents and results indicate that these scientists achieved a higher average number of papers and patents than non-doctoral scientists and they play an important role in promoting corporate R&D by linking corporate R&D with university research. Moreover, Goel and Goktepe-Hülten (2013) studied the effects of industry interactions on academic patenting, using a survey of scientists at a large public research organization in Germany and the study revealed that among professional characteristics, having a doctoral degree was more likely to patent. They established that “doctoral education provides scientists with a broader research perspective that enables them to better see the ‘holes’ in research and identify directions that might more likely yield patentable outcomes” (Goel and Goktepe-Hülten, 2013: 558). In addition, Lam (2007) and Thune (2010) demonstrate that doctoral corporate researchers are vital in network configurations and they are seen as “bridge builders” between university and industry, and Fuentes and Dutrénit (2012) conclude that researchers who have PhD degrees are more likely to have a potential impact on the long-term benefits of firms.

In terms of *organizational factors*, a necessary ingredient for a successful U-I collaboration is department quality (cf. Figure 1). Schartinger et al. (2002) show that a precondition for a field of science at a university to be used as interaction partner by industry is the acknowledgement of the department's expertise. Out of the three main activities that universities devote resources to, only research activities result in the development of expertise and scientific excellence, which renders knowledge exchange profitable for their partners, so in order to reduce risk and costs of knowledge interactions, industry tends to look for university departments offering a higher quality of research output. Furthermore, King et al. (2011), using a dataset covering all UK universities, found that the relationship between department quality and industry involvement differs according to disciplinary orientation. Specifically, in technology – oriented disciplines department quality is positively related to industry engagement, in medical and biological sciences, department quality is positively related to industry engagement, particularly when it comes to working with large firms. However, where resources requirements play a less important role, such in the social sciences, department quality is negatively related to industry engagement. Bishop et al. (2011) reveal that is top quality department research of universities that mainly contributes to the development of patentable inventions of firms.

*Project management* is a key issue in the process. Butcher and Jeffrey (2007) and Niesten and Jolink (2015) argue that it is important a focus on establishing common expectations and goals, development of a project plan and store alliance management knowledge in order to apply this in future collaborations are underlined. Thune (2011) studied the success factors in higher education – industry collaboration between four regional universities and energy firms in Norway and concluded that project leadership is a factor that influences the collaboration climate and having an experienced project leader was considered a success factor in all cases.

Relationships between different types of research organizations (academia and industry), with different approaches of actors from different cultures, with varied norms, different perspectives, through styles and values result in conflicts (Lakpetch and Lorsuwannarat, 2012), particularly with respect to perceptions of the quality of work, timing of publishing results and where work is disseminated (Harris and Lyon, 2013). So, a manager should establish teamwork in order to break the tension between different cultures within alliance partners to become more multifunctional (Lakpetch and

Lorsuwannarat, 2012). In this context, there is a need to build a relationship based on *trust*. Harris and Lyon (2013) analysed ten case studies of research collaborations related to sustainability and environmental and examined the different professional cultures and the process of building trust. Results evidenced that trust is shown to be built by having information on others, prior experiences of working together, norms of cooperation (helping each other on specific problems and sharing knowledge and keeping to agreements and honesty), open communications and sanctions exerted on those who might transgress norms of behavior. Moreover, Sherwood and Covin (2008) affirm that trust between partners was a significant factor of successful knowledge acquisition, mainly for tacit knowledge.

Dalpe (2003) shows that there are some limitations on collaborations, and the potential gain in networking depends on the quality of interactions, which involve a diversity of actors with partly conflicting interests. He affirms that relations between actors must be based on trust, built by personal interactions and governed by mechanisms of coordination that help solve conflicts.

Another crucial factor for a successful collaboration is the *absorptive capacity* of organizations. According to Powell et al. (1996) and Azagra – Caro et al. (2013), a firm with a greater capacity to learn is adept at both internal and external R&D, thus enabling it to contribute more to collaboration as well as learn more extensively from such participation. Moreover, internal capability and external collaboration are not substitutes for one another, but complementary. In other words, inter-organizational collaborations are not simply a means to compensate for the lack of internal skills, but a firm's value and ability as a collaborator is related to its internal assets (Dalpe, 2003).

Finally, *contextual factors* (see Figure 1) include factors that are instrumental for the formation of collaborative relationships. In some of the reviewed studies (e.g. Jaffe 1989; Mansfield, 1991; Cohen et al., 2002; Schartinger et al., 2002), the determinants and motivations for U-I engagement differ across scientific disciplines and *sectors of economy activity* and *fields of science* engage in different types of interactions. Schartinger et al. (2002) analyzed the determinants of knowledge interaction between different fields of research and sectors of economy, based on a comprehensive dataset on various types of knowledge interactions between university departments and private firms in Austria in 1990s. Their results suggest that while technical sciences and R&D intensive manufacturing industries tend to use direct research cooperation more

intensively, service industries and social and economic sciences rest more on personnel mobility and training related interactions. Jaffe (1989), Mansfield (1991) and Cohen et al. (2002) show that the impact of public R&D on industry innovation is strong, particularly in the areas of drugs, electronics and ICT.

Additionally, *industries characteristics* have a relevant role in the U-I process. Freitas et al. (2012) explored the role of U-I collaboration for the development of innovation in mature and emergent industries in new industrialized countries based on 24 researches groups in science and engineering departments in universities and public research organizations in Brazil. The authors found that university research and developments projects with firms in emergent industries are less likely to be the result of academic initiatives and public calls for research projects, or to be wholly financed by major public research sponsors than projects with firms in mature industries. In emergent industries, the role of students and firm employees is crucial for mediating between public research organizations and companies. Furthermore, Powel et al. (1996) studied collaborative activities between academia and biotech firms and show that several standard organizational characteristics, such as age and size, appear to be ancillary in accounting for patterns of collaboration.

*Geographical proximity* between partners has been also identified as an important condition for U-I collaboration. Thune (2011) and Fuentes and Dutrénit (2012) affirm that geographical proximity eases communication, and that it is more efficient to collaborate when partners are stimulated in the same geographical area. Additionally, Bishop et al. (2011) find that geographical proximity between partners is only significant for benefits associated with direct assistance in problem solving, supporting the argument that proximity facilitates the exchange of tacit and context-specific knowledge. Additionally, Furman and MacGarvie (2009) argue that firms at early stages of development appear most likely to collaborate locally while firms with greater R&D capabilities engage in both local and distant collaboration.

*Management of university – industry* research collaboration is the key to its success. In this respect, government can play an essential role in process (see Figure 1). A public subsidy for R&D is not only an important financial support for U-I collaboration but may also serve as a useful means of promoting trust among collaboration members resulting in higher innovation performance (Lee and Park, 2006; Okamuro and Nishimura, 2014).

### 3. Methodological considerations

#### 3.1. Main research question and methodologic options

The aim of the present research is to analyze how corporate R&D activities impact on the research performance of a science based organization in its most diverse dimensions, most notably publications and patents.

Given that we aim at understanding how the U-I collaboration evolves and how corporate R&D might impact on public science organization's outcome, according to Yin (2009) such "how" question renders the case study as the preferred methodology. This is further supported by the fact that several reviewed studies with similar research aims (see Table 4) resorted to case studies as their elected methodology.

We selected one science based organization related to life sciences field - IPATIMUP<sup>5</sup>- because, according to literature (Powell et al., 1996; Furman and MacGarvie, 2009; Guan and Zhao, 2012; Coccia, 2014), organizations related with life science are characterized by a strong reliance on scientific developments and, therefore involves high levels of interaction among universities and firms.

**Table 4: Research question and qualitative methodologies: examples of the literature on U-I links**

Study	Research question	Actors (#) involved	Country	Research Field
Perkmann and Walsh (2009)	The impact of university - industry relationships on public research	University; Firm	UK	
Thune (2011)	What potential success factors are relevant when developing and managing higher education - business partnerships	University; Firm	Norway	Engineering
Freitas et al. (2012)	The role of university - industry collaboration for innovation in mature and emergent industries	Firm	Brazil	
Motoyama (2013)	How a university collaborates both with a large firm and a venture firm	University; Firm; Corporate Research	Japan	Nanotechnology
Coccia (2014)	How convergence of scientific fields and new technological paradigms impact on R&D corporate change	Firm	Italy	Pharmaceutical

Source: own elaboration.

#### 3.2. IPATIMUP as a pertinent case study. A brief description

The IPATIMUP, Institute of Molecular Pathology and Immunology of the University of Porto, is a private non-profit association of public utility, founded in 1989 under the

<sup>5</sup> Institute of Molecular Pathology and Immunology of the University of Porto.

aegis of the university of Porto and was one of the four first Associated Laboratories created, in 2000, by the Portuguese Ministry of Science and Higher Education.

In terms of research activity, IPATIMUP focuses on the areas of oncology (cancer and precancerous lesions of the thyroid, stomach, colon and breast cancer, among others) and in populations genetics and forensic.

According to the 2014 activity report, IPATIMUP reached the number of 169 papers published in international indexed journals. Of the 169 articles, 20 were published in journals with impact factor (IF) higher than 6; 65 in journals with IF between 3 – 6; and 59 journals with IF between 1 and 3, being a world – leading institute in scientific production.

To reset the science strategy of IPATIMUP and design of the lines in cancer research area for the coming years, it was created, in 2012, a *task force* involving group leaders and senior researchers. This task force listed the most competitive research lines in the field of cancer in IPATIMUP, where several research groups were formed (see Table 5).

**Table 5: Research groups of IPATIMUP**

Research Group	Aims
Cancer Biology	To identify molecular targets involved in the etiopathogenesis of human cancer with potential applications in early diagnosis and specific therapy
Population Genetics	To understand the origin and evolution of genetic diversity, their consequences and applications
Glycobiology in Cancer	To understand molecular mechanisms controlling alterations of glycosylation that are important in the process of carcinogenesis and cancer progression
Genetic Dynamics of Cancer cells	To understand how do genetic mutations arise in tumor cells and how do they spread in tumor cells and how do they spread in tumor cell subpopulations; and why do these tumor cell subpopulations fluctuate over time and how does this influence, and is influenced by clinical events such as therapy and disease progression
Genetic diversity	To establish a bridge between hypotheses, methods and results from a theoretical approach to neutral human genetic diversity and evolution through time and space, integrating this information in clinical and forensic contexts
Expression Regulation in Cancer	To disclose germline and somatic regulatory mechanisms and molecular circuitries, acting to increase gastric cancer susceptibility, and to confer advantageous features to cancer cell populations.
Differentiation and Cancer	To understand how differentiation shifts predispose and progress to cancer and identify novel biomarkers and therapeutic targets to improve diagnostic, prevention, patient stratification and treatment of cancers of the gastrointestinal tract.
Cancer Genetics	To uncover how epithelial cell - cell and cell - matrix junctions (based on three common epithelial - derived cancers - gastric, breast and colorectal) as well as the surrounding microenvironment, can influence cancer progression.
Cancer Drug Resistance	To translate basic science findings into validation of potentially new molecular targets for cancer therapy, using several in vitro models for different cancer types.

In addition to research activities, the institute has a diagnostic unit (IPATIMUP Diagnostics), whose mission is to provide excellent services in surgical pathology, cytopathology, molecular pathology and forensic genetics. This unit performs annually about 20.000 diagnostic tests, and was one of the first laboratories in the world to implement and validate the use of next generation sequencing in routine practice, being a reference partner for several companies in the pharmaceutical sector (e.g., Bayer, Abbvie, Astrazeneca).

More recently, two new units were created, the innovation unit and the translational research unit. The mission of the innovation unit is to extract economic value of the knowledge generated by R&D activities of IPATIMUP and stimulate the creation of spin-off companies. The translational research unit has as main aims to raise external funds in the form of research contracted, and the integration of IPATIMUP into international networks of translation in oncology and strategic partnerships with industry, in order to reduce its dependence on the public funds in future.

In addition, IPATIMUP was awarded, in 2014, by the Portuguese Pharmaceutical Industry Association (APIFARMA) “Best Research Partner” of the pharma industry, a prize that was attributed in the context of the celebration of the 75 years of APIFARMA.

### **3.3. Data Collection**

Initially, we conducted one face-to-face interview<sup>6</sup> with André Albergaria - Director of IPATIMUP Translational Research Unit, Jorge Lima – Vice – Director of IPATIMUP Translational Research Unit and Hugo Prazeres – Director of IPATIMUP Innovation Unit in order to understand what R&D projects with the industry can be subject of study in the present work.

There was some difficulty finding feasible projects for the analysis, since most projects are partnerships with international industry and therefore protected by confidentiality. Nevertheless, it was suggested a project, still under development, named ‘Using NGS to uncover structural and regulatory variation in gastric cancer’. This project represents our unit of analysis.

“This is the only project that we have that is national in the sense of being a Portuguese company and a Portuguese institute. This is not in fact the most common type of projects we

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<sup>6</sup> Interview in February 27<sup>th</sup>, 2015, lasting one hour.

have; most are projects with international industry.” (André Albergaria, Researcher/ Director of IPATIMUP Translational Research Unit, Porto, February 27<sup>th</sup>, 2015)

In the context of the project in analysis we conducted three interviews with key stakeholders in the process: Carla Oliveira,<sup>7</sup> Principal Investigator and responsible for the scientific development of the project; André Albergaria,<sup>8</sup> director of IPATIMUP Translational Research Unit and responsible for the implementation of the negotiation process with the company; and Nuno Arantes – Oliveira,<sup>9</sup> CEO at the time of the interview and current chairman of the board of directors of Coimbra Genomics.

We asked to respondents questions about how the project was initiated and what were the objectives. We also enquired about the type and frequency of meetings, the frequency of visits and other exchanges, and the nature and degree of interdependence of various participants. We asked the participants to describe how relationships with partners were established and whether they had experienced any problems or barriers, what were the rationales for their decisions to work with partners and what were the benefits from their viewpoint. Finally, we enquired them about the scientific outputs and IP terms.

### **3.4. A description of the selected project**

Coimbra Genomics is a Portuguese start – up that was founded in 2013 by Critical Software, Biocant Park and a group of entrepreneurs and leading scientists in which benefited from an investment of venture capital funds, Portugal Ventures and Critical Ventures. The company’s main mission is to use genomic information to help clinicians make more personalized decisions.

Coimbra Genomics when started its activity deemed it useful to have links to the major players of genomics worldwide and in this context contacted Beijing Genomics Institute (BGI) to see whether there would be any interest in joint projects. They referenced several projects that would be possible to develop in Portugal in various therapeutics and BGI showed much interest in stomach cancer area, since it is a disease with high prevalence, difficult to treat and currently with few treatment solutions and furthermore there are many unknowing about their genetic basis.

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<sup>7</sup> Face – to – face interview in April 1<sup>st</sup>, 2015, lasting one hour.

<sup>8</sup> Face – to – face interview in April 1<sup>st</sup>, 2015, lasting one hour.

<sup>9</sup> Skype Interview in April 14<sup>th</sup>, 2015, lasting half an hour.

From there, Coimbra Genomics (CG) contacted the IPATIMUP to establish a partnership for this project. First, because it was considered by CG a renowned institute with excellent technical and scientific skills in the area. Second, because the CEO of the company knew the institute due to his previous professional experiences.

Gastric cancers are highly heterogeneous and the therapy does not work in general. Currently, the only way to slow down the disease is to have a surgery, which is only efficient in individuals who are diagnosed at a very early stage. When the disease is in the later stages surgery slows the disease but does not cure. Thus it would be very important to find a way to stratify patients with gastric cancer in order to give them more efficient and personalised therapies.

This project aims mainly to collect a number of cases of gastric cancer from tumour and tissues bank, confirm that they have cancer and then try to optimize a pre-stratification strategy. What has happened so far is that people have studied the gastric cancer and made the genome of cancer, took up series completely at random, with great heterogeneity and small numbers which does not allow to find relevant factors.

IPATIMUP tried to combat this categorizing and pre-stratifying cases into groups, more specifically, in three groups considered relevant from genetic and molecular point of view, and then submit them to the sequencing. The aim was to understand whether in each of these groups, in addition to the pre-stratified that allow them to separate, they maintain a 'signature' which made them eligible for a particular therapy.

So, the goal of IPATIMUP, as the scientific project leader, was to choose the series based on its knowledge of gastric cancer, find pre-stratifiers, pre-stratify and send genetic material to BGI to do the sequencing. After BGI send back the data, the next step is to analyse the bioinformatics view all information, integrate it and then try to extract the potential markers that can identify the type of specific therapy for each of those groups.

The advantage of this is that if one really finds something that is characteristic for each group, it won't be necessary sequencing every time it appears in a patient in the hospital. That patient will be routed to the most appropriate therapy to the case.

## **4. Impact of corporate R&D on IPATIMUP's scientific performance. An analysis of the results according to the theoretical framework**

### **4.1. Determinants of the outputs**

#### **4.1.1. Context**

According to the literature, university – industry partnerships are a key strategic pillar for innovation of a country or region. However, in the Portuguese context these partnerships still a challenge that is far from being overpassed. Some studies (e.g., Teixeira and Costa, 2006; OECD, 2013) have shown that in Portugal the links between companies and universities reflect some shortage and lack of sustainability compared with other OECD countries.

Aimed at promoting and boosting the scientific and technological system in order to make it more competitive and streamline the relationship between knowledge centers and enterprises, in the most recent National Strategic and Reference Board (QREN), it were established instruments to encourage such cooperation, where access to finance for certain projects have a mandatory requirement, the involvement of the business sector (Comissão Técnica de Coordenação do QREN, 2013).

Although there is little dynamics in U-I interaction in Portugal, according to the annual evaluation report of QREN (Comissão Técnica de Coordenação do QREN, 2013: 61), until the end of 2012, it was contracted 76 projects of cooperation between companies and research institutions, being biotechnology the scientific area with the second largest number of cooperation projects (13% of the total approved projects), after ICT area (19% of the approved projects) (Comissão Técnica de Coordenação do QREN, 2013: 136).

Institutionally, the area of genomics is very specialized and intensive in highly advanced scientific knowledge, consisting of a small number of players (Dalpé, 2003). So, tacit and informal knowledge plays a key role making the U-I partnerships very relevant in the process (Dalpé, 2003).

## **4.1.2. University – Organizational and Individual Factors**

### **Project Management**

The IPATIMUP is an institute with 26 years of existence, and in terms of organizational structure is well established and divided by departments.

With recent budget cuts allocated to science, IPATIMUP felt the need to create, in 2012, a unit with the objectives of rising external funds and establishing strategic partnerships with industry looking in that way lessen its dependence on the national foundation for science (FCT), the main Portuguese science funding body. The IPATIMUP Translational Research unit serves as an interface between research groups and their industrial partners.

“Within the institute we have the translational unit that help us get the project standing, negotiated with Coimbra Genomics, and this is really good for us.” (Carla Oliveira, Project's Principal Investigator of IPATIMUP, Porto, April 1<sup>st</sup>, 2015).

“Our role is to coordinate the whole process and control it from the beginning to the end.” (André Albergaria, Researcher/ Director of IPATIMUP Translational Research Unit, Porto, April 1<sup>st</sup>, 2015).

This project provided another partnership with industry, one additional experience for the unit, thereby enhancing the project management's skills, permitting to apply that knowledge for the benefit of future partnerships.

### **Department quality**

As mentioned above, the IPATIMUP is a laboratory with 26 years and during that time was asserting its scientific excellence and its expertise in the area of cancer, deserving the national and international recognition. This is was a decisive factor for the establishment of partnerships with industry both at national (Coimbra Genomics) and international level (Beijing Genomics Institute).

“This project arose from our desire to work with Beijing Genomics Institute, of gastric cancer is an area of particular interest because it has a high prevalence both in China and Portugal and there is a technical and scientific capacity in Portugal, in particular in IPATIMUP, which is excellent, the best even international level.” (Nuno Arantes – Oliveira, CEO of Coimbra Genomics at the time of the interview, Skype interview, April 14<sup>th</sup>, 2015).

## **Team Experience/ Reputation**

All the scientific part of the project was structured and is being developed by IPATIMUP, which has as its Principal Investigator (PI) Carla Oliveira.

Carla Oliveira,<sup>10</sup> as most researchers of the institute, has a very robust curriculum in terms of scientific publications in the area (more than 80 publications).<sup>11</sup> She has experience in similar projects and in parallel to this project she is principal investigator of other research projects in gastric cancer. She has a PhD degree in Human Biology by Medical Faculty of Porto, and a Post Doc in Pathology by British Columbia University (Vancouver, Canada), in which she collected an award of Patient Organization ‘No stomach for cancer’.<sup>12</sup> Currently she leads the research group ‘Expression regulation in cancer’ responsible for developing the project under study and is Associate Professor of Biopathology in Medical Faculty of University of Porto.

Besides Carla Oliveira (PI), 7 researchers are part of the research team of the project: Ana Sofia Varanda, PhD student; Ana Valente, Research Trainee; Gabriela Almeida, she also experienced in the area of gastric cancer in which is principal investigator of another similar project (‘Improving gastric cancer patient stratification towards personalised therapy’); Hugo Pinheiro, Post Doc student; Joana Carvalho, Post Doc student with experience in other gastric cancer projects; Patrícia Oliveira, Post Doc student also with experience in gastric cancer and in addition has advanced knowledge in Bioinformatics; and Sara Rocha, Research Trainee.

### **4.1.3. Corporate/Industry - Individual and Organizational Factors**

#### **Project Management**

As mentioned above, Coimbra Genomics is a company founded recently, so still is an embryonic state. Then, we can say that it is an organization that is characterized by a single-celled structure.

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<sup>10</sup> <https://www.ipatimup.pt/site/PersonView.aspx?IsPrintable = True&PersonId= 35&OrgUnitId=0>, accessed in June 29<sup>th</sup>, 2015

<sup>11</sup> [http://www.scopus.com/results/results.url?sort=plf-f&src=s&st1=Oliveira&st2=Carla&nlo= 1&nlr= 20&nls=count-f&sid=8C0A7415417A4AB11CBF05BB5C7A3C28.WIW7NKKC52nn\\_QNxjqAQrIA%3a63&sot=anl&sdt=aut&sl=35&s=AU-ID%28%22Olive%20C3%ADra%2c+Carla%22 +7102223149%29&txGid=8C0A7415417A4AB11CBF05BB5C7A3C28.WIW7NKKC52nn\\_QNxjqAQrIA%3a6](http://www.scopus.com/results/results.url?sort=plf-f&src=s&st1=Oliveira&st2=Carla&nlo= 1&nlr= 20&nls=count-f&sid=8C0A7415417A4AB11CBF05BB5C7A3C28.WIW7NKKC52nn_QNxjqAQrIA%3a63&sot=anl&sdt=aut&sl=35&s=AU-ID%28%22Olive%20C3%ADra%2c+Carla%22 +7102223149%29&txGid=8C0A7415417A4AB11CBF05BB5C7A3C28.WIW7NKKC52nn_QNxjqAQrIA%3a6), accessed in June 29<sup>th</sup>, 2015

<sup>12</sup> <http://www.cienciahoje.pt/index.php?oid=58794&op=all>, accessed in June 29<sup>th</sup>, 2015

Thus, the entire business process is mostly led by two scientists - Nuno Arantes – Oliveira and Bruno Soares. This can confer some degree of flexibility in implementing the partnership process.

“This process was all a very close process between the unit, the institute and the company. So no two teams here working, there was rather a team of researchers, with some of them more focused on project management and others more focused on the scientific thought, the scientific input in its strategic way.” (André Albergaria, Researcher/ Director of IPATIMUP Translational Research Unit, Porto, April 1<sup>st</sup>, 2015)

In this case, the project is funding by Coimbra Genomics and thus the entire management of the logistic process is the responsibility of the firm.

“We rely on the Coimbra Genomics for all negotiations with Beijing Genomics Institute, and this is a plus because these projects that I have direct funding, most of the time I have not only to write them but also manage them from the administrative and financial point of view. Here I am completely free of it, the whole logistic process is managed by the company.” (Carla Oliveira, Project's Principal Investigator of IPATIMUP, April 1<sup>st</sup>, 2015).

“In practical terms what we do is to coordinate the project, manage, subcontracted the Beijing Genomics Institute - the IPATIMUP performs the technical and scientific part.” (Nuno Arantes – Oliveira, CEO of Coimbra Genomics at the time of the interview, Skype Interview, April 14<sup>th</sup>, 2015).

### **Department quality/ Team Experience**

Coimbra Genomics combines the business knowledge of investors and external consultants from several areas– with individuals - Nuno Arantes – Oliveira and Bruno Soares - with a strong scientific knowledge in the area and a considerable entrepreneurial background. These latter individuals were able to identify a market need that led to the emergence of this start-up and therefore the project under study.

Bruno Soares, current CEO of Coimbra Genomics, has an extensive scientific, technological and business experience in the field of biochemistry and DNA sequencing, having been ‘Chief Scientific Officer’ of a start-up also in the genomics area, Base4,<sup>13</sup> and has been involved in the creation of the nanophotonic center at the University of Cambridge.<sup>14</sup>

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<sup>13</sup><https://www.ipo.gov.uk/types/patent/p-os/p-journal/p-pj/p-pj-ukapppub?lastResult=60&perPage=10&startYear=2013&startMonth=June&startDay=26th+-+6475&endYear=2013&endMonth=June&endDay=26th+-+6475&filter=&sort=Publication+ Date&status=undefined> accessed in June 22<sup>th</sup>, 2015

<sup>14</sup><http://www.np.phy.cam.ac.uk/people/alumni>, accessed in June 22<sup>th</sup>, 2015

Nuno Arantes – Oliveira<sup>15</sup> holds a PhD in Genetics, has a very strong curriculum in terms of publications, some of them in the prestigious journal *Science*.<sup>16</sup> He founded several companies in Europe and United States, including the Alfama Inc.,<sup>17</sup> a biotech company dedicated to the development of a new class of drugs based on controlled release of carbon monoxide in specific organs and tissues and also led Portugal's Biotechnology Industry Organization (P-BIO)<sup>18</sup> between 2011 and 2015.

As is clear these two scientists have extensive experience both in scientific research and in their entrepreneurial capacity, which is internationally recognized. This is important because on the one hand it permits to establish contacts with major players in the area worldwide and on the other guarantees important scientific inputs into the development of the project.

#### 4.2. U-I interactions

Relations between different types of organizations, including public R&D institutes and private companies that have characteristics, cultures and different perspectives often result in conflicts and that can be a barrier to partnership (Harris and Lyon, 2013).

In this project one of the difficulties mentioned by all stakeholders interviewed was the negotiation process.

“The first barrier was soon in contract negotiations because we do not speak the same language. There have been many meetings to reach an agreement that is ideal for all.” (Carla Oliveira, Project's Principal Investigator of IPATIMUP, Porto, April 1<sup>st</sup>, 2015).

“The project with the Coimbra Genomics had no trouble beyond those hits that are normal to be discussed, is a business, there are always different opinions, there is always a need *to sit at the table* again... Usually, the projects that give rise to contracts and the discussion of these contracts, the most obvious points that have to be clarified relate to intellectual property issues, how this is managed, which side is which, etc.” (André Albergaria, Research/ Director of IPATIMUP Translational Research Unit, Porto, April 1<sup>st</sup>, 2015).

“In the negotiation process there are always advances and retreats, it is normal one party asking for something that the other thinks it is not right, but that is part of the negotiation.” (Nuno Arantes – Oliveira, CEO of Coimbra Genomics at the time of the interview, Skype Interview, April 1<sup>st</sup>, 2015)

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<sup>15</sup> <http://healthportugal.com/noticias/iihcpconf/nuno-arantes-oliveira>, accessed in June 22<sup>th</sup>, 2015.

<sup>16</sup> [http://www.scopus.com/results/results.url?sort=plf-f&src=s&st1=Arantes+Oliveira&st2=Nuno&nlo = 1&nlr = 20&nls=count-f&sid=EE4396DBDC40D8451219\\_CBFDD1B27BCB.fM4v\\_PBipdL1Bpir\\_Dq5Cw%3a93&sot =anl&sdt=aut&sl=42&s=AU-ID%28%22Arantes-Oliveira %2c+Nuno %22+ 6507120885%29&txGid=EE4396DBDC40D8451219CBFDD1B27BCB.fM4vPBipdL1\\_BpirDq5Cw%3a9](http://www.scopus.com/results/results.url?sort=plf-f&src=s&st1=Arantes+Oliveira&st2=Nuno&nlo = 1&nlr = 20&nls=count-f&sid=EE4396DBDC40D8451219_CBFDD1B27BCB.fM4v_PBipdL1Bpir_Dq5Cw%3a93&sot =anl&sdt=aut&sl=42&s=AU-ID%28%22Arantes-Oliveira %2c+Nuno %22+ 6507120885%29&txGid=EE4396DBDC40D8451219CBFDD1B27BCB.fM4vPBipdL1_BpirDq5Cw%3a9), accessed in June 29<sup>th</sup>, 2015

<sup>17</sup> <http://www.healthportugal-directory.com/pt/membership-directory/alfama-inc>, accessed in June 22<sup>th</sup>, 2015.

<sup>18</sup> <http://www.atlasdasaude.pt/publico/content/p-bio-reforcada-elege-nova-direcao-com-os-olhos-no-futuro-da-inovacao-em-portugal>, accessed in June 22<sup>th</sup>, 2015.

In order to mitigate these barriers/ conflicts this partnerships was sustained on the basis of trust that exists between partners developed by previous professional experiences, since Nuno Arantes – Oliveira is external consultant of IPATIMUP’s Translational Research Unit and IPATIMUP’s Innovation Unit. In addition, and as previously mentioned, the area of genomics/ life sciences is very intensive in knowledge and characterized by a small number of players, which in turn can lead to a certain closeness between them, making the collaborative process more flexible and effective.

“Coimbra Genomics participate in scientific discussion. Every time we decide on a strategy, this strategy is discussed with the company because they are also scientists...The division of labour has been versatile enough for us to manipulate the collaboration of each. As we are working on the same project turns out to be cooperative.” (Carla Oliveira, Project's Principal Investigator of IPATIMUP, Porto, April 1<sup>st</sup>, 2015).

### **4.3. Ongoing outputs of the project**

#### **4.3.1. Learning opportunities/New projects**

Although the project is not yet finalized, for IPATIMUP it has created up to the present date the possibility of obtaining tumour data providing therefore support to research in the upcoming years. Additionally, it provided the IPATIMUP the possibility of creating a relationship of trust with a company encouraging other consortium projects and (eventually) by companies.

“This opened up the possibility of entering in a series of partnerships with Coimbra Genomics that will allow us to compete in Europe, because we have created a degree of enormous trust with them and them with us.” (Carla Oliveira, Project's Principal Investigator of IPATIMUP, Porto, April 1<sup>st</sup>, 2015).

For Coimbra Genomics to work with IPATIMUP and Beijing Genomics Institute allowed the access to samples and clinical cases that are not very common. In a more strategic approach, has enable them to establish relations of trust and trade relations with important players in the field of genomics, enhancing future collaborations and sources of ideas/ knowledge potentially valued by the market.

#### **4.3.2. Publications**

The IPATIMUP retains the right to scientifically explore, in exclusive terms, the project results through publications.

“All that is results for scientific exploration is on our side.” (André Albergaria, Research/Director of IPATIMUP Translational Research Unit, Porto, 1 April 1<sup>st</sup>, 2015).

“We are the sponsor of the project, and the intellectual property that results from the project is ours. Under an agreement that we made with Beijing Genomics Institute, this IP is shared to some extent with them but the ownership of the IP is ours. IPATIMUP grants the possibility to publish, that is, there is a certain freedom of the IPATIMUP to use the results to its scientific or academic advantage.” (Nuno Arantes – Oliveira, CEO of Coimbra Genomics at the time of the interview, Skype Interview, April 14<sup>th</sup>, 2015)

#### **4.3.3. New knowledge/ Patents**

It is expected that from the project it will result proprietary knowledge about genetic biomarkers, which indicate potential therapeutic targets for gastric cancer (e.g. genetic variations that are the cause of gastric cancer and that can be the target for new therapies).

In this context, the idea of Coimbra Genomics is to protect such knowledge through Intellectual Property (IP), namely through patents, that are able to be marketable, creating new products and/or processes.

“For Coimbra Genomics [the project] has opened the possibility to creating new intellectual property in an area that has scientific, medical, social and commercial value.” (Nuno Arantes – Oliveira, CEO of Coimbra Genomics at the time of the interview, Skype Interview, April 14<sup>th</sup>, 2015).

Importantly, scientific knowledge and commercial character that results from this cooperation will tend to influence the interrelation process of the various players. In concrete, it allows IPATIMUP to optimize the scientific process in the genomics area, adding to its already vast scientific knowledge more applied procedures directed to the market opportunities satisfaction.

“Here the needs that have been raised by Coimbra Genomics made that the research group to think objectively to respond to such need... This is a good example that corporate's needs change the way we think and urged us to find out how to address that problem. There is a clear paradigm shift within the academia, within IPATIMUP from the moment we open doors to industry.” (André Albergaria, Researcher/ Director of IPATIMUP Translational Research Unit, Porto, April 1<sup>st</sup>, 2015)

## **5. Conclusions**

### **5.1. Main results and contribution of the study (vis a vis other similar studies)**

In this dissertation we aimed to understand how corporate R&D and/or corporate's needs impacted on academic research performance, which has not yet been sufficiently investigated in the literature.

Through a qualitative analysis, it was demonstrated that collaboration between IPATIMUP and Coimbra Genomics resulted in a win-win relationship. Additionally, evidence was gathered that the corporate R&D has been critical in influencing IPATIMUP's performance in terms of procedures, learning opportunities and capabilities to promote more and better innovative research.

In this context, several critical factors have mediated the relation between corporate R&D and the research performance of IPATIMUP. The scientific discipline (Life Sciences/ Biotechnology) and the industry characteristics (highly advanced scientific knowledge, small number of players, and a very limited diffusion of knowledge) played an important role in the formation of the collaborative relationship. Indeed, the area of biotechnology is very specialized and intensive in advanced knowledge, being therefore highly dependent on academic research/scientific breakthroughs. Knowledge proximity and trust (based on previous shared professional experiences) existent between corporate and academic players overcame issues related to geographical distance (Porto-Coimbra-China).

Extant literature (Schartinger et al., 2002; Dalpé, 2003; Barbolla and Corredera, 2009; Perkmann et al., 2012) evidenced that the most experienced and highly renowned researchers were more likely to engage with industry and thus are key determinants for the success of the partnership and its outcomes. The present case study highlights that both academic and corporate researchers had substantial experience in the genomic area, reflected by the fact that they possessed doctoral degrees granted by international well renowned schools and by the quantity and quality of their scientific publications. Moreover, actors in the process shared previous professional experiences, which enhanced trust and therefore facilitated the process of establishment and development of the project.

It is argued that the diversity of teams, combining researchers with different age, gender and areas of expertise, tend to stimulate creativity (Bear and Woolley, 2011; Pitt-

Catsoupes et al.; 2013; Lee et al., 2015). In the present study, and according to the interviews, no evidence was produced that the composition of researchers' age or gender was crucial to the development of the project. However, the combination in a same team of individuals with distinct expertise - knowledge of life sciences and basic research by IPATIMUP's researchers and the technological expertise associated to more applied research by firm's collaborators - was critical for the outputs of the project, namely the development of a new product.

The evidence gathered in the present study supports the idea of Schartinger et al. (2002) and King et al. (2011) that department quality is one of the most important factors considered by industry when establishing partnerships with universities. Indeed, Coimbra Genomics highlighted this factor as crucial to establish the partnership with IPATIMUP. Furthermore, and in line with previous studies (Butcher and Jeffrey, 2007; Thune, 2011), project management was a key element for the success of the collaboration. Establishing common expectations and objectives and building a trust-based relationship have been essential in overcoming hurdles derived from different cultures and perspectives of the two types of organizations (academic and corporate).

## **5.2. Implications for public policy authorities**

In terms of policy implications, our findings suggest that policy makers should place greater emphasis on creating effective policies to promote university – industry cooperation network due to several reasons.

First, scientific knowledge and commercial character that resulted from this cooperation allowed IPATIMUP to optimize the scientific process in order to respond to market's needs and making more applied research. Notwithstanding, some authors (e.g. Lacetera, 2009; Perkmann and Walsh, 2009; Fuentes and Dutrénit, 2012) have criticized the potentially detractive effects of such 'entrepreneurial' science on the long-term production of scientific knowledge. These authors fear that academic science is being instrumentalized and even manipulated by industry and they listed several risks, such as reduction in academic freedom, the slow-down of open knowledge diffusion and lower levels of research productivity among academics. In this context, in order to maximizing the benefits of academic research, it is relevant the development of policies that increased interaction between academia and firms while protecting the autonomy and freedom of researchers.

Second, and as mentioned earlier, the area of biotechnology is very specialized and intensive in advanced knowledge, being therefore highly dependent on academic research. Thus, the development of biotech is certainly one of the greatest examples of the social benefits that might be derived from investments in science.

Third, in times of economic recession and state budget constraints dedicated to public R&D, this type of collaboration allows public research institutes/ university to obtain additional financing for research and financing for students in their master and doctoral thesis.

### **5.3. Limitations of the study and avenues for future research**

This work has some noteworthy limitations. In order to extract detailed information on the characteristics of collaboration, our analysis was carried out using an single project level data collected from interviews and, necessarily relies on a small sample of observations. In addition, this is an on-going project which did not permit to have a full/comprehensive picture of the project's outcomes. So, further research is needed to expand the size of the sample and include several case studies (preferably projects already completed and with longer time horizon) in order to compare their characteristics.

Another limitation is that our research focused on university – industry collaboration within the life sciences/ biotechnology disciplines that are traditionally far to industrial application. In this context, future research should explore to what degree our considerations apply to other research fields, such as the engineering and chemistry have also traditionally been strongly linked with industrial application. Moreover, our analysis focused only one type of interaction between university and industry – contract research. So, further research should examine other types of interaction like collaborative research (where there is a division of scientific labour between partners) and/or consulting, in order to understand the differences.

Finally, this is a single country study. It would be interesting to analyse the extent to which these results can be generalized to other countries given that cross-country differences may exist specific academic, industrial and political contexts.

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