

# University research parks: What is their real effect on university research outputs?

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University Research Parks (URPs) are technology-based geographical enclaves placed in the surroundings of a university campus that benefit from the knowledge generated in the university and its affiliated research centres. Because of the close proximity between knowledge providers and knowledge users, URPs are expected to exponentially multiply R&D activities and strengthen the ties between academia and industry so that they mutually reinforce each other activities.

The existing literature on the advantages firms get for being located in a URP is rich. Nevertheless, from the standpoint of universities, there is little empirical evidence on how URPs impact on research activities at universities. Aiming at bridge this gap, in this paper we survey the Catalan case, and investigate whether there are statistical significant differences in the research outputs when the university has an affiliated URP. We

also examine the level of research activity taking into account the creation strategy of the URP.

The study is divided in two main stages. First, we conduct a comprehensive review of the history, mission and vision of a selected number of universities. From this analysis it is possible to determine when the URP was created, the role played by the university in this process, and the creation strategy of the park. Main performance indicators are also collected. In a second stage, we graphically test our hypotheses. The database comprises information for the period 2004-2013. Research outputs under analysis include: publications, patents, spin-offs, and R&D contracts.

Keywords: university research park; publications; spin-offs; patents; R&D contracts

JEL classification: I23; O32

## 1. INTRODUCTION

Knowledge has become a key resource for competitive advantage in terms of innovation and technology transfer. Learning how to generate knowledge and successfully manage it is increasingly gaining importance. Companies that want to survive need to be continuously innovating and find new ways of doing things and solving problems. Innovation has become the essence of the knowledge-based society.

In this context, the knowledge generated within higher education institutions has become a very valuable source for industrial innovation (Chang et al., 2006; Sanz-Menéndez & Cruz-Castrol, 2003). In order to facilitate knowledge creation and accelerate its diffusion, universities have been provided with several support infrastructures that offer advanced services. Indeed, the establishment of technology transfer offices (TTO) for the commercialisation of research activities, the improvement in the facilities for the incubation of new enterprises (spin-offs), and the creation of university research parks has bolstered technology transfer processes at universities.

For the purpose of this paper, we concentrate on university research parks (URP) and their role in strengthening the ties between academic discoveries and industrial applications –measured in terms of publications, patents, spin-offs, and R&D contracts–. URPs are a particular type of science parks which main function can be defined as promoting research and development by the university in partnership with the industry. Universities started building up these spaces very rapidly as a result of different policies designed to foster knowledge transfer activities. In Spain, URPs emerged in the 90's. Following the recent work of Berbegal-Mirabent et al. (2016) we posit that two main strategies are envisioned in the creation stage, differentiating between planned parks and unplanned parks. Going a step further, in this study we argue that the creation strategy does play a role in the outcomes of the university to which the park is affiliated to. That is, the creation strategy that followed the park when it was established will shape the performance of the university.

Aiming at test these hypotheses, we propose a two-stage analysis, adopting an exploratory approach that combines both qualitative and quantitative data. Data refers to 6 Catalan public universities and covers the period 2004-2013. In the first stage we analyse the creation strategy of the URP and their mission and vision. This information allows us classifying each park as planned or unplanned. Next, in a second stage we graphically analyse how research outputs have evolved during this period, and the potential role played by the park.

## 2. CREATION STRATEGIES OF UNIVERSITY RESEARCH PARKS

According to the Association of University Research Parks (AURP) a “Research Park” is an expression mainly used in USA, whereas in Canada, Europe, Asia and Latin America other expressions are preferred such as “Science Park” or “Technology Park”. For the purpose of this paper we will use the term “university research park” in order to denote a powerful mechanism for technology and economic development within a university context.

In a URP the university acquires a prominent role, acting as the main driver for knowledge creation and knowledge diffusion. Following the Triple Helix model (Leydesdorff & Etzkowitz, 1996), different conditions are needed in order to foster the creation of a URP: (i) a technological offer, that is, universities, research groups, and research institutes; (ii) a technological demand, including firms and public institutions that require university's knowledge and expertise; and (iii) governmental bodies, public agencies and institutions that support (mostly economically) the supplier side. The geographical concentration of all these agents leads to the creation of the park, which is expected to attract talent and investment, promote growth and enhance the economic prosperity of the region (Leyden et al., 2008).

URP projects are usually supported by the attraction of high-technology firms, either through joint ventures or by the entry of firm tenants. Also R&D institutes are incorporated in various forms. Open innovation platforms, virtual networks and online markets are additional complements that help URPs reduce search efforts and costs. This ecosystem of innovation is completed with business angels and venture capital firms committed with the valorisation of technological discoveries from early embryonic stages to final products and services.

Similar to any other policy instrument aimed at narrow the gap between science and industry, URPs do not follow a unique scheme. Evidence from different URPs reveals that the creation of a URP can be driven by different actors and alignment of interests, and be subject to cultural behaviours and practices already embedded in the territory. These facts suggest that some parks may emerge organically, while others require of some institutional help in order to create something from scratch. Prior relevant studies in this field include the works of Cooke and Morgan (1994), Braczyk and Cooke (1998), and Koh et al. (2005). These studies converge in that the concentration of innovative activities is based on the presence or the absence of a deliberated creation scheme, and that URPs' birth is influenced by different factors, including not only those strictly related with the technological capacity and resource availability, but also those referring to the historical heritage and culture of the territory. Additionally, according to Bigliardi et al. (2006) science parks' mission and strategy may change overtime, being them usually redefined once the park has come into operation.

In a recent work Berbegal-Mirabent et al. (2016) dive into the creation strategies of URPs and differentiate between *planned parks* and *unplanned parks*. In the first strategy, the park is created as a mechanism to foster research activities among academics in partnership with industry, assisting in the growth of new ventures, the establishment of university-business alliances for R&D purposes, and promoting economic development. The university is provided with specific buildings and services to attract both private and public research entities as well as firms to settle there. The close proximity among the different actors is expected to generate knowledge spillovers. Said differently, the park is built from scratch, therefore, there is no explicit evidence whether the park will effectively respond to the expected plan as this strategy tends to follow a demand *push* approach. Consequently, one of the main difficulties this strategy entails lies in the ability of attracting a critical mass of scientific talent and knowledge-based companies. A well-developed marketing strategy is indeed needed to ensure the sustainability of the park in the long term. Successes and failures during the project may require modifications in the strategy, expansions and even changes in the relationships

between the stakeholders. This typology of URPs is usually a by-product of regional governmental policies in an agreement with a university, some anchor institutions and key opinion leaders. By using housing as an urban proposal URPs help creating a society of entrepreneurs and innovative corporations.

Somewhat different is the strategy followed by unplanned parks. Such parks are not the result of a strategically planned economic development policy, but rather of an organic growth that emerged spontaneously among different actors and local players. This model envisages universities to be highly entrepreneurial and committed with knowledge and technology transfer activities. Aiming at improving the externalities and the interrelations between the different stakeholders located in the region, a specific unit is created to manage all the activities that emerged spontaneously, and thus, formalise the establishment of the park. Precisely, the main challenge planned parks face is the creation of this unit. Prior to formalising the park the different stakeholders might have already worked independently. The creation of a centralised unit might create some tensions that could hamper the relationships among the stakeholders.

### 3. HYPOTHESES DEVELOPMENT: URPS AND THEIR IMPACT ON RESEARCH OUTPUTS

Universities' role as drivers for regional development has grown exponentially in the last 20 years, becoming central their contribution through knowledge and technology transfer processes. This active involvement of universities in third mission activities is a direct consequence of the transformation that the higher education system has experienced over the years, moving from a teaching-oriented model towards an entrepreneurial one (Clark, 1998).

Incentives aimed at encourage researchers to engage in such activities have been progressively designed, and researchers are now organised in powerful research groups that work in discovering and generating cutting-edge devices and technologies to attract both talent (students and researchers) and funds (public and private). For corporations, but for SMEs in particular, universities are seen as the ideal partner to outsource their R&D activities. Also, by working close with universities, firms gain access to a wide array of human capital, knowledge, and networks. This growing interest of firms in collaborating with universities has caused the restructuring of the research at universities, and justifies the need for the creation of specific infrastructures (science parks) and services able to capitalise the synergies that arise from university-business collaborations.

A key point of this research is to determine how URPs emerge and their effect on research activities at universities. It is widely acknowledged that such infrastructures facilitate knowledge exchange between academics and businesses, increasing the probabilities to conduct applied research and commercialise the results. Despite literature is rich in the analysis of URPs, there is a lack of empirical evidence on the effect of such infrastructures on the quantity and quality of the research outputs of their parent organisation, universities. Therefore, we posit that those universities with a URP will be able to generate more

knowledge and, thus, be more prolific in the creation of research outputs with a commercial application.

Going a step further, we also argue that the creation strategy of the URP does play a role in the research outcomes of the university. The rationale behind this lies in a critical feature that distinguishes planned from unplanned parks: the behaviours of the academic community towards research and technology transfer activities. While in the former strategy these behaviours need to be boosted, in the later they are already manifest. Although both typologies of parks can perform well, we hypothesise that the creation strategy that followed the park when it was established will shape its future performance. The industry fabric of the territory, the culture, and the traditions may also play a critical role in this process. Therefore, different patterns are expected among cases.

## 4. METHOD

### 4.1. Sample

The sample under study considers the 6 Catalan universities that have in-person education, and their respective URPs: Universitat Autònoma de Barcelona (UAB), Universitat de Barcelona (UB), Universitat de Girona (UdG), Universitat de Lleida (UdL), Universitat Politècnica de Catalunya (UPC), and Universitat Pompeu Fabra (UPF).

### 4.2. Data and method

#### *Stage 1: Creation strategies*

The main goal of this stage is to determine the creation strategy of the URPs under analysis. To do this, we first embarked into an in-depth analysis of the history of each park, its mission and the vision. Information used at this stage was mainly gathered from the websites of the parks as well as from documents coming from different sources such as the university, the organisations related to the park, and the local government. Based on this information, it was possible to classify each park either as planned or unplanned. This classification scheme was then revised by a panel of experts. This panel include professors from different Catalan universities with a well-acknowledge scientific background in technology transfer processes. With their input, the final classification was achieved. Table 1 provides some key performance indicators of the URPs analysed. Because some information was unaffordable, missing values have been indicating with the acronym "NA" (not available).

**Table 1. Comparison of performance indicators.**

University	UB	UAB	UPC	UPF	UdG	UdL
Year of creation	1997	2007	2005	2006	2007	2005
Area (m <sup>2</sup> ) - total	86,638	NA	334,000	55,000	75,000	75,000
Area (m <sup>2</sup> ) - constructed	58,847	NA	10,000	NA	36,000	100,000
Buildings	6	3	13	1	6	8

University	UB	UAB	UPC	UPF	UdG	UdL
Initial investment (thousand €)	60,000	44,700	NA	80,000	60,000	NA
Research groups	12	154	201	NA	33	8
Research centres and institutes	15	NA	27	7	NA	NA
Firms located in the park	45	72	150	NA	93	108
Institutions and support entities	26	30	NA	NA	24	NA
People employed	2,200	4,000	NA	1,393	1,300	1,400

Source: Self-devised. Data from 2014 is used, except for UB and UdG which is from 2013.

### Stage 2: Effect of URPs on research activities

In a second stage we use several descriptives and graphics to illustrate the potential effect of the park on research activities. At this point, we relied on a series of indicators of performance that consider both basic and applied research outputs. The proxy used to represent basic research outputs was the number of publications in top journals (indexed in the ISI Web of Science). Applied research outputs were operationalised through three indicators: number of patents granted by the Spanish OEPM, number of spin-offs created, and income from R&D contracts. Data for this stage covers the period 2004-2013 and come from the IUNE observatory. At this point it is important to remark that because the URP from UB was created in 1997, it is not possible to assess the impact of the park on research outputs. Nevertheless, we decided to also include this park in the analysis, and examine how research outputs have evolved during the period for which data were available. Average values for the variables of interest are shown in Table 2.

Table 2. Average values for the variables of interest. Period 2004-2013.

University	Publications	Patents	Spin-offs	R&D contracts income*
UAB	2,929.4	6	4.2	12,584.4
UB	3,367.6	7	2.1	12,276.2
UdG	414.0	2	1.2	2,584.2
UdL	329.4	1	0.5	1,876.5
UPC	1,323.5	29	7.8	21,432.9
UPF	669.7	1	0.7	5,253.2

\*In thousand euros.

## 5. STAGE 1: CREATION STRATEGIES

### 5.1. Parc de Recerca (UAB)

UAB is characterized by a continuous and sustained effort in promoting research and knowledge transfer. This process is supported by technical services and technological platforms that encourage researchers to engage in such activities. The articulation of different channels and agents (students, academics, researchers and firms) is what really makes possible this active participation in knowledge transfer activities. Because such an environment

facilitates knowledge and innovation exchange among the different stakeholders, over the years, public and private research centres started flourishing in the surroundings of the university. Several high-tech companies and firms operating in the biomedical sector in particular, also decided to settle there, giving birth to a geographical concentration of knowledge. In 2007 the activity that once had emerged spontaneously was formalised with the creation of the UAB Research Park.

The park was expected to be intimately linked to UAB project and become an instrument to promote research and knowledge transfer. To fulfil these requirements, a private foundation was created, resulting from a joint partnership between the university, the Consejo Superior de Investigación Científica (CSIC) and the Institut de Recerca i Tecnologia Agroalimentària (IRTA). In order to ensure a proper alignment between the park and UAB's objectives, the director of the park should be a member of the governing council of the university.

The specific objectives pursued with the creation of the UAB Research Park were: (i) to provide specific support to research centres and institutes located in Campus UAB Bellaterra; (ii) to facilitate and stimulate knowledge, relationship and cooperation between the different centres located in the park and the existing research groups and centres of UAB; (iii) to promote outdoors the research activity and the outcomes generated; (iv) to encourage leading innovative companies and research institutions to locate in the park; (v) to facilitate the identification of opportunities and how knowledge can be applied among the different stakeholders located in the park, accordingly, the park should be provided with specific units that by acting as knowledge brokers bridge the gap between science and industry; (vi) to strengthen the technical services of the park and UAB in order to provide high-quality services to researchers; (vii) to support new venture creation; and ultimately (viii) to assist in and contribute to the development of science and technology in Catalonia. The mission and vision of the park are shown below:

**Mission:** To promote knowledge and technology transfer between university research groups and businesses, as well as to facilitate and support their R&D capabilities in order to respond to the increasing demands of society for innovation and new cutting-edge discoveries.

**Vision:** To become the reference organization for companies and researchers in stimulating knowledge transfer in their area of influence and internationally as an engine of economic and social development.

Nowadays UAB Research Park hosts several research centres and institutes as well as numerous companies that act in close collaboration with researchers from UAB, CSIC and IRTA, the three main institutions leading this project. The associated hospitals that collaborate with UAB together with the Park constitute the so-called Esfera UAB.

From the above, it can be interfered that UAB has always been actively involved in the promotion of university-business partnerships that lead to cutting-edge research and its rapid valorisation in the marketplace. The entrepreneurial spirit and the structure of the campus mirrors the efforts put by the different stakeholders involved (research institutes and centres, companies, multidisciplinary affiliated centres and mixed research centres). Given these considerations, we suggest that UAB Research Park was intended to unify under an umbrella

brand all these activities that emerged spontaneously. Accordingly, we posit this park to follow the unplanned park typology.

## 5.2. Parc Científic de Barcelona (UB)

Following the trends in the United States and some other leading European countries, some Spanish regions observed that a close collaboration between universities and firms was a really promising strategy that contributes to the revitalization of the region and its economy. In the 90s Barcelona has already created such an atmosphere. A critical mass of researchers working at UB was enthusiastically committed with knowledge transfer activities. PCB was the first URP to be established in Spain.

Established by the University of Barcelona in a joint consortium with the Fundació Bosch i Gimpera and Caixa Catalunya on 26 September 1997, the Barcelona Science Park (PCB) was the first science park in Spain. Today PCB is an international leader in fostering innovation, welcoming more than 2,200 professionals. After establishing the foundation in charge of managing and leading the project, the PCB started its first stage of construction, including the construction of a laboratory building (*Cluster Building*), the reform of *Tower D* with office spaces. These construction activities were completed between 1999 and 2001. These buildings came into operation progressively, and they are now currently hosting several research institutes, more than 70 companies (including start-ups and spin-offs), a business incubator for biotechnology firms, a considerable number of research groups and a wide variety of support services. It also organises more than 120 activities per year to promote scientific culture involving about 6,000 people annually.

From then on, the strategic plan of the PCB has faced several changes, particularly, the renovation and restructuring of the infrastructure that finished in 2011. The main scientific organizations at the PCB are the Institute for Research in Biomedicine (IRB Barcelona), the Institute for Bioengineering of Catalonia (IBEC), the Molecular Biology Institute of Barcelona (IBMB-CSIC) and the Bosch i Gimpera Foundation, which is the technology transfer and innovation centre of the university. Entities located at the PCB mainly work in the areas of biomedical (medical biotechnology, pharmacy, chemistry and medical devices), environment, ICT and agro-food sectors.

As reflected in its mission and vision, the aim of the park is to bridge the gap between universities and businesses, facilitating knowledge flows between academia and industry. The park also offers different types of spaces for rent, such as laboratories and equipped offices, and provides basic services including restaurants, communication services. The park also has an auditorium, several meeting rooms.

**Mission:** The mission of PCB is to manage effectively and efficiently the spaces that the University of Barcelona has allocated for its development, providing quality services to its clients and users that facilitate the transfer of knowledge between the university and the research and business sectors.

**Vision:** PCB vision consists in becoming the ideal park where institutions and companies can transfer knowledge with the university.

We argue that PCB follows a hybrid creation strategy, evidencing that as any strategic action, the creation and establishment of a park may suffer from variation over time. While its origins clearly reveal an organic growth, the park benefited from an assisted plan and major interest from policy makers in order to ensure its sustainable growth and serve as a model for other regions.

### 5.3. Parc Científic i Tecnològic (UdG)

The Parc Científic i Tecnològic of UdG was conceptualized at the end of the 90s. The first documents of the park are dated in 1998. At that time, the Vice-chancellor and the President of the Social Council of UdG were interested in promoting the involvement of the university and its units in the development of the region. These wishes and interests became a reality in the first proposal, drawn up at the end of 1998. Nevertheless, it was not until the end of 2001 that the Foundation in charge of managing the park was created. The promoting entities of the park were the university and its Social Council, the City Hall of Girona, the Chamber of Commerce of Girona, the “Diputació” of Girona, and the Federation of Business Organizations of Girona (FOEG). The mission and vision are as follow:

**Mission:** The park must create, develop and expand:

- an attractive physical space (buildings and environment);
- a set of scientific and technological facilities; and
- services related to innovation and technology, which contribute differentiating competitive factors to knowledge-based entities.

**Vision:** To establish itself as a fundamental promotional actor for the economic development of the regions of Girona, based upon knowledge and technology.

Initially the university obtained some land near the roundabout in front of the campus, in the neighbourhood of Montilivi. Later, with the involvement of the City Hall, the Creueta area was decided. A road joins this area to the Montilivi campus where the university is located, allowing a quick link between the university facilities and the park. The urbanization process started in 2003. In the forthcoming years different buildings were built, starting with the Jaume Casademont building in 2004 and finishing with the Catalan Institute of Water Research in 2007. The Jaume Casademont building was the first of being occupied (May 2007). The official inauguration of the research park was on September 2007. The park is complemented with a variety of facilities such as 3 restaurants, 3 auditoriums, 8 meeting rooms, and 2 seminar rooms.

Clearly, the URP of UdG emerged from the need to promote and improve the economic and regional development of Girona and its neighbourhoods. As previously mentioned, the first idea is dated in 1998, but it was not until 2001 when it started taking form. The park was completely finished in 2007, the year where the official inauguration took place. This time lag in completing the project suggests several implications. First, the existence of a deliberated strategy for creation the park, thus, it best fits with the typology of planned parks. Second, that some difficulties might have hampered completing the project in a shortened period of time.

#### 5.4. Parc Científic i Tecnològic Agroalimentari de Lleida (UdL)

The academic offer at UdL includes degrees on agro-food, processing industry, crop science, industrial engineering, forest engineering and biotechnology among others. This offer matches with the main features of the region, a territory with a strong tradition in agro-food industry (e.g. fresh fruit, olive oil, wine, pigs, etc.), animal nutrition, and a natural cluster of irrigation technology and industrial and farm machinery. In the recent years this region has suffered a transformation process towards services of added value related to agro-food industry, and intensive sectors related to knowledge and high technologies are increasingly growing (e.g. bio products, environmental and material engineering, food health, etc.).

Given the characteristics of the territory and aiming at revitalize the economic activity of the area the Lleida City Council, together with the University of Lleida, decided to set up the Lleida Agro-food Science and Technology Park (PCiTAL). Both UdL and Lleida City Council are the founding partners of the park consortium, taking equal shares in it. Thanks to the contributions of the European Regional Development Fund, in 2005 the Park was finally created. It was regarded as a policy instrument that should: (i) strengthen UdL's research groups, the interaction between them and attract new researchers; (ii) strengthen the competitiveness of the industry fabric of Lleida's area of influence by promoting innovation, the provision of on-demand R&D services and the dissemination of the results to businesses; (iii) secure new business activities with high added value; and (iv) create new qualified jobs and new professional opportunities for young university graduates.

PCiTAL was conceived as an ambitious, strategic commitment for Lleida, stressing and fostering values of innovation, quality, specialization, dynamism, scientific and academic prestige, and a clear desire for true leadership. The competitive advantage of the park relied on the opportunity for a clear specialisation in the agro-industry. Today it offers an opportunity to increase the competitiveness of the business network through innovation and knowledge transfer with the scientific and academic world. PCiTAL mission and vision are as follow:

**Mission:** To explore new innovative technologies in order to achieve more sustainable areas and to develop new business through clusters of biomaterial industry. Three are the main pillars of the park: innovation, sustainability and commitment to the territory.

**Vision:** To become one of the main scientific and technological platforms in the agro-food sphere in Catalonia, Spain and southern Europe, acting as a pole for innovation and capable to attract technology-based businesses.

One of the main characteristics of the park is its bioclimatic and sustainable design. PCiTAL is placed in an emblematic part of the city, Gardeny Hill, a former military complex. By re-urbanizing an old military headquarter, the project has recovered unused spaces of the city and reintegrated them into civilian life. Gardeny Hill allocates most of the park's infrastructures comprising laboratories, technology transfer centres, business nurseries, office buildings for technology and advanced services companies, and some other common facilities for all stakeholders located in the park. Three additional sites complement Gardeny Hill: the Arboretum, located beside the agronomy campus and holding well-documented collections of living plants and crops from the Mediterranean arc, the ETSEA campus which hosts the Lleida

Agro-food Research Institute (IRAL), and the Health Campus with the Lleida Biomedical Research Institute (IRBLleida). Recently, in order to promote Lleida and the park as a pole of green biotechnology industry (eco-product industry) the brand Lleida Biotech has been created.

Since the eighteenth century, Lleida has shown a strong emotional attachment to the land and has maintained a long tradition dedicated to traditional agriculture. The quality of the wines, the extra virgin oil, sweet fruit (e.g. pears, apples, peaches and nectarines), are some of the Lleida's greatest products. Also, the region of Lleida comprises a large proportion of farms, the majority of which conforms a vertically integrated farming system that comprises livestock farming companies and animal feed factories. All these firms work with an integrated production system that has led to the development of a transforming industry that includes a variety of services dealing with the drying, weighting and the packing of food. Companies operating in this sector require modern technologies for preserving, transforming and packing the products in order to reach international markets in the most suitable conditions. Aiming at helping local companies to achieve a competitive status in the international market, UdL found in the agro-food industry the specialisation needed to differentiate from other universities. Thus, although an industrial agro-food cluster existed prior the establishment of the park, the creation strategy of PCiTAL clearly responds to a planned action. PCiTAL is thus a result of a regional policy strategy that aims at revitalising the economic activity of Lleida by focusing on the specific sector of agro-food.

### 5.5. Parc de Recerca i Innovació (UPC)

UPC is a public higher education institution in the fields of engineering, architecture and sciences. This university is one of the leading institutions in innovation, research and technical development of its kind in Spain, and it is recognized worldwide for its results in basic and applied research, and for developing an intense activity aimed at transferring technology and knowledge to the business sector and society.

UPC is characterised by a wide distribution in the Catalan territory. The main campus is located in Barcelona, but it also have other campuses in Castelldefels, Manresa, Sant Cugat del Vallès, Terrassa and Vilanova i la Geltrú. These different locations facilitate the interaction of UPC with the social and economic industrial sector of Catalonia. Because of this distribution in the territory, several clusters called "*territorial technological poles*" responding to regional needs were created. Some examples include the Mediterranean Technology Park (PMT) in Castelldefels, the Barcelona Technology Park (PTB), the Science and Technology Park in Terrassa (PCTT) and the Technology Park in Vilanova (PTVG).

In the recent years UPC has been actively involved in the creation of new structures in order to promote research and foster technology transfer, involving the participation of research institutes, technology centres, foundations, hybrid centres, spin-offs, seed companies, etc. The existence of regional initiatives and their rapid growth entailed, however, a managerial challenge. There was therefore a need for a coordination unit able to efficiently manage the different stakeholders and ensure a single institutional approach in pursuit of increasing the

benefits arising from the potential of such innovative activity, but ensuring that the specificities of each territory were not neglected. Aware of this reality, in 2002 the idea to formalise a research park took form. Nevertheless, it was not until 2005 that the Governing Council of UPC approved the creation of the “Parc de Recerca i Innovació de la UPC” (PRI-UPC). PRI-UPC objectives are: (i) to increase the wealth of its community by promoting innovation and a competitive spirit among knowledge-generating companies and institutions located at or associated with the park; (ii) to foster and facilitate research; (iii) to foster the dissemination of knowledge; (iv) to facilitate contact between universities and the private sector and the transfer of university research results to society; and (iv) to create technologically innovative companies. To accomplish with this goals, PRI-UPC has been provided with incubation spaces for spin-offs and start-ups, labs, and co-working spaces. Its mission and vision is shown below:

**Mission:** The mission of the park is twofold. On the one hand, to coordinate its actions with the Board of Trustees to become a socioeconomic catalyst between the UPC, government bodies and businesses; and on the other hand to underpin the UPC’s commitment to society by fostering research, innovation, results transfer and technological progress.

**Vision:** PRI-UPC is a highly concentrated knowledge and technology hub with the mission of returning value to society and promoting better quality of life. PRI-UPC provides facilities, technological infrastructures and value-added services, all aimed at fostering synergies between research stakeholders and companies and ultimately designed to ensure successful projects and enterprises.

PRI-UPC clearly exemplifies the strategy of an unplanned park. The formalisation of the park responds to the need to systematically organise all activities that were created in the surroundings of the university. This strategy is also reflected in the territorial model of UPC (a key feature in unplanned parks), consisting in local technological poles. The result is a clustered park spread throughout the Catalan territory.

### 5.6. Parc de Recerca Biomèdica de Barcelona (UPF)

Parc de Recerca Biomèdica de Barcelona (PRBB) was officially inaugurated on 15 May 2006. It is a joint initiative of the university (UPF), the Catalan Government and the Barcelona City Council. It is situated in front of the Barcelona seafront, next to the building Dr. Aiguader and Hospital del Mar. The seven centres located in the park employ 1,400 people from more than 50 different countries, and has an accumulated R&D budget of approximately 80M€ per year. The PRBB Consortium manages and maintains the park and its facilities. The governing council is the board of rectors including representatives from the three main founders and promoters. This consortium is chaired by the Conselleria d’Economia i Coneixement.

The PRBB was created with the main purpose of being positioned as an inspiring environment at the forefront of biomedical research. This scientific infrastructure conforms a stimulating scientific community and an advanced technology platform with a critical mass of world-class researchers giving answers to basic and clinical issues in biomedicine. The close physical connection of the PRBB with the Hospital de Mar provides an excellent insight into clinical reality. The scientific activity of the park is performed in fields of biomedical informatics and systems biology, gene regulation and epigenetics, cell and developmental biology,

pharmacology and clinical physiopathology, human genetics and evolutionary biology, and epidemiology and public health.

Consistent with the mission and vision of the park, PRBB objectives are the promotion of research, knowledge transfer and innovation between businesses and organizations located in the Park. In order to achieve these goals the promotion and marketing of the park are essential for generating awareness among potential stakeholders. The park is complemented with high value-added services for the companies and institutions located there.

**Mission:** To generate disruptive knowledge in life sciences and biomedicine, as well as economic opportunities for the region and Barcelona. PRBB also promotes the dialogue with the public about science and medical research. The specific missions are:

- Maintain and adapt the scientific spaces according to the needs of the institutions of the park in a sustainable, efficient and collaborative manner, providing a quality service.
- Continuously improve the park's services to internal and external customers, in collaboration with the users' committee and the physical facility of PCB-UB.
- Promote the park as one of the leading centres of biomedical research to the outside and manage the dialogue with the general public in collaboration with the institutions of the park. It also develops activities for residents to create community.

**Vision:** PRBB provides an open scientific infrastructure so that the institutions of the park can perform biomedical research that is internationally competitive.

The organizational model of the park is cooperative, promoting synergies and collaboration. The research centres pay for the rent of the space in relation to area and type, and for the different services provided by the park. The park receives no structural subsidies. By sharing advanced scientific-technical services and common spaces, the park facilitates the establishment of interrelationships between the different partners located in the park as well as and inter-institutional collaboration whilst respecting the individual identities and autonomy of each centre. Only one building with avant-garde architecture conforms the PRBB. By occupying 55,000 m<sup>2</sup> it is one of the largest buildings in Barcelona. It has a fluid geometry, no classical front views and appearing weightless. The elliptical and conical shape of the building and the exterior frontage of wood and glass without reaching the ground reinforce the sensation of a floating structure. The structure is supported by 110 metal clamps on the deck. Only 40% of the structure is supported by traditional concrete cores.

PRBB seems to best fit within the category of planned parks. The decision to create the park was related with the need to promote scientific research in medicine-related disciplines. It is thus reasonable to think that its emplacement is not accidental (near the Hospital de Mar, one of the leading hospitals of Barcelona).

## 6. STAGE 2: EFFECT OF URPS ON RESEARCH ACTIVITIES

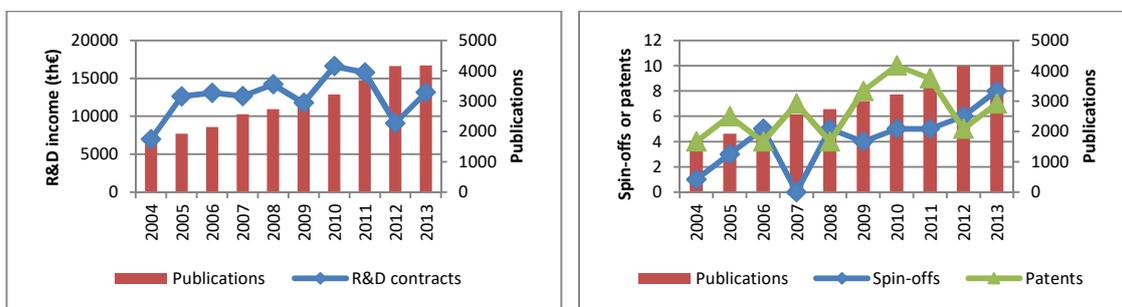
In this stage we graphically illustrate and discuss the evolution of the performance of the six universities under analysis in terms of four main research outputs: publications, patents, spin-offs, and R&D contracts income. As it can be interfered from Figures 1 to 6, universities are

readapting their ways of operating, experimenting a significant shift from a teaching-oriented model, towards a research-oriented one. However, because universities' objective function also includes teaching activities, research and technology transfer activities are still far from their true potential. Not all universities are following the same path.

### 6.1. Parc de Recerca (UAB)

Even though research is not mentioned in the mission and vision of the park, UAB is characterised for an active activity in publishing, surpassed only by UB. Due to the creation of the park, knowledge transfer activities have improved. As shown in Figure 1, the economic crisis that Spain suffered in the period 2008-2012 caused some reductions in terms of R&D contracts (this decrease could be considered as a normal phenomenon as thousands of companies in Spain were bankrupted).

Figure 1. Evolution of research outputs (UAB).

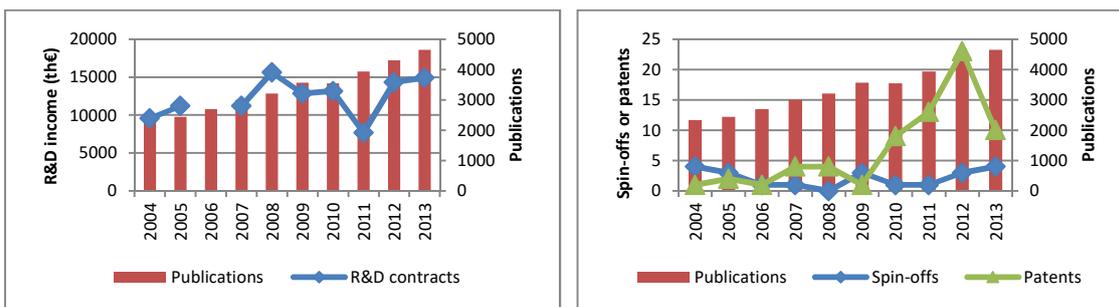


The analysis of the data indicates that UAB is promoting knowledge and technology transfer between university research groups and businesses, as stated in its mission. Both patents and spin-offs are in a constant growth since the creation of the park. The spontaneous emergence of the park might help explain why this university has been able to create the appropriate atmosphere to accomplish with their mission and vision.

### 6.2. Parc Científic de Barcelona (UB)

Results shown below (Figure 2) reveal that UB park's mission is properly aligned with the strategy of the university, facilitating the establishment of successful university-industry partnerships that foster knowledge exploitation.

Figure 2. Evolution of research outputs (UB).

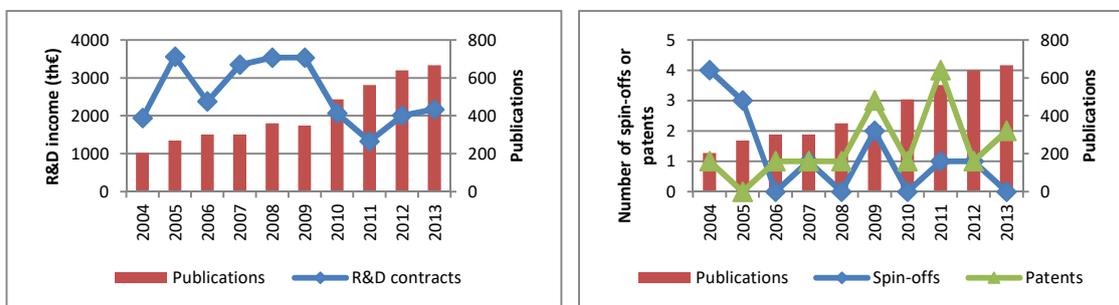


The fact that the creation of the park followed a hybrid creation strategy could be one of the reasons why the research outputs the university have improved. UB has developed a stronger relationship with the industry, exhibiting the highest activity in disseminating and commercializing research. However, there is still room for improvement in terms of creating new ventures. Despite the downward trend in 2013, the park seems to have contributed to the development of cutting edge discoveries. The number of patents has increased substantially in the recent years. This might probably be linked with the academic offer of the university, well-acknowledged in the fields of engineering, medicine, pharmacy and biotechnology.

### 6.3. Parc Científic i Tecnològic (UdG)

As the history of the university reveals, the park was promoted by the government as a mechanism to foster economic development in the region of Girona. This objective is also reflected in the mission statement of the park, which aims to become an attractive space for innovation and technology services. The impact of the park on research outputs is somewhat inconclusive (Figure 3). While basic research measured by the number of publications has increased in the recent years, the effect on applied research outputs dilutes. R&D contracts with businesses decreased, signalling that the ties with industry are still weak. As for the number of patents and academic ventures, the pattern is unclear. All in all, these figures suggest that the positive knowledge spillovers that the park was expected to create have not been developed.

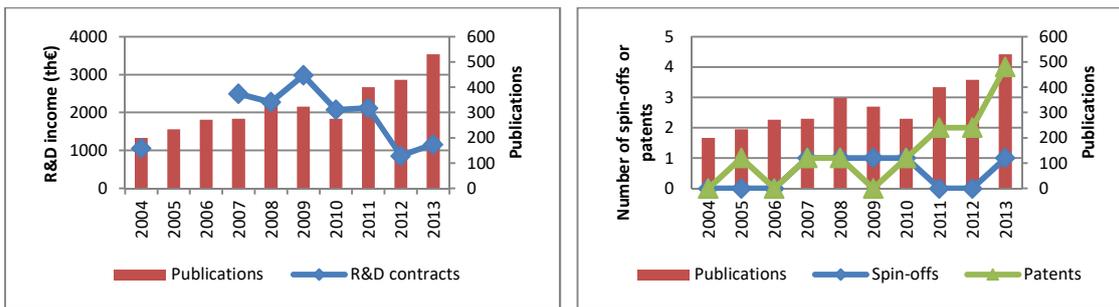
Figure 3. Evolution of research outputs (UdG).



### 6.4. Parc Científic i Tecnològic Agroalimentari de Lleida (UdL)

UdL park mission is based on three main pillars: innovation, sustainability and commitment to the territory. Data (Figure 4) shows that the park has had a positive effect in safeguarding knowledge and intellectual property through patents. As for the number of spin-offs, although it has risen since the creation of the park, its number is still low, signalling that the entrepreneurial culture of the university is in an embryonic stage. It is worth highlighting the research results in terms of publications. For the period 2008-2010 they followed a downward trend, which was corrected in the subsequent period 2011-2013.

Figure 4. Evolution of research outputs (UdL).

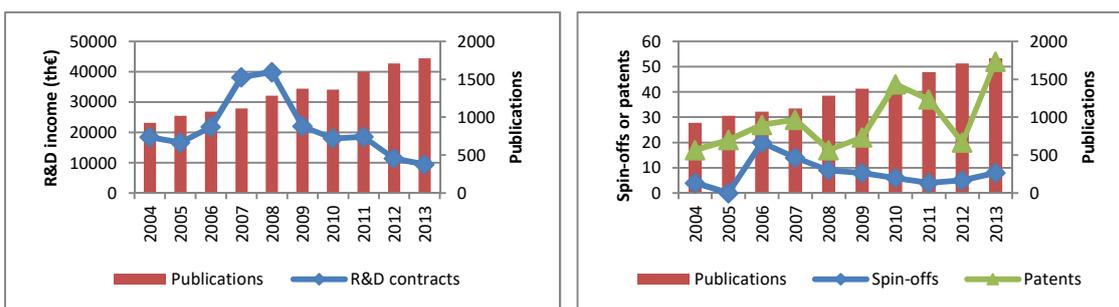


Although data for R&D contracts income is incomplete, it is possible to infer that there is an urgent need to rethink how the park (and by extension, the university) is bridging the gap between academia and industry.

### 6.5. Parc de Recerca i Innovació (UPC)

Data from UPC confirm that this university has a strong commitment to uncovering and growing the entrepreneurial culture among its faculty staff. The creation of the park in 2005, helped increase the research outputs of the university. Similar to the other universities, the economic crisis has negatively affected its activities, as shown in the evolution of R&D contracts income. Nevertheless, in absolute terms, this university is among the firsts in Spain in establishing university-business alliances for R&D activities that result in lucrative incomes. In both spin-offs and patents, it seems that the creation of the park has implied the creation of a specialised unit that offers technical advice and helps researchers to face all the administrative steps that entail patenting or starting-up a business. Again, when considering absolute numbers, UPC outperforms the other universities in these activities. However, it is difficult to figure out the real impact of the park.

Figure 5. Evolution of research outputs (UPC).

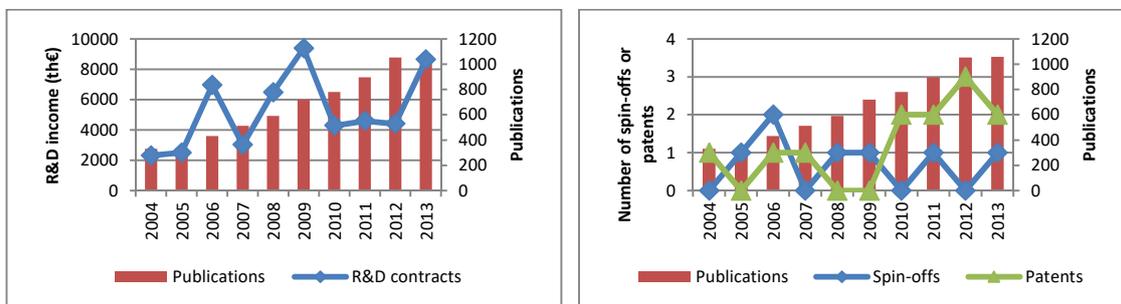


### 6.6. Parc de Recerca Biomèdica de Barcelona (UPF)

The effect of the creation of the park is quite noticeable for UPF, particularly, in terms of disseminating knowledge through publications and cooperation with industry (R&D contracts income) (Figure 6). The number of patents has also increased in the recent years, whereas the number of spin-offs is rather low. These numbers suggest that although the willingness to

become a referent in the biomedicine field, the incentive system for researchers does not match with this accomplishment.

Figure 6. Evolution of research outputs (UPF).



## 7. DISCUSSION AND CONCLUSIONS

From the study conducted we observe that although universities have been provided with specific infrastructures aimed at fostering knowledge transfer activities, not all universities had been able to make the most of them. The rationale behind this may relate to an inefficient leverage of the resources (unclear strategic goals and how to allocate resources) and the absence of an alignment of interests (stakeholders with different interests). It is also worth considering the economic situation of Spain during the period under analysis. In 2008 Spain suffered a severe economic crisis. The results of the crisis were devastating, including a strong economic downturn that still persists as of today.

While the mission and vision stated in the statutes of the parks were ambitious, we believe they should be much more specific and convincing in order to have an impact on research outputs. Because resources are scarce and not all territories have a similar economic development, universities need to find out what are their strengths, and position themselves as leaders in that specific area. The creation of strategy of the park also plays a role. The mission statement of unplanned parks seems to be much better aligning with the real outputs of the university than planned parks. This fact evidences that soft factors (e.g. entrepreneurial culture, technology transfer behaviours) are much more difficult to get developed than hard factors (e.g. infrastructures).

Overall, we can conclude that although the establishment of the parks has helped universities to start considering technology transfer activities as part of their daily activities (research outputs have undoubtedly experienced a substantial increase), there is still a long way to go. Structures are not enough. There is a need to create the behaviours that motivate academics getting involved in such activities.

This study represents one of the first attempts to analyse how URPs can help to bridge the gap between science and industry. More research is indeed needed in order to shed new lights on this issue. Although the analysis conducted followed a rigorous methodology, there are some limitations that should be pointed out. First, an important limitation of this study refers to data availability. Also, it would have been interesting having access to data before 2004 (UB

established the park in the late 90s) as well as for the years 2014 and 2015. This data would have allowed us to infer how universities are starting to recover after the severe economic crisis. Future studies should also consider the whole sample of Spanish universities.

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