The triple helix at the science and technology parks of Catalonia

M. Carmen Adán and Joan Bellavista
Catalan Network of Science and Technology Parks (XPCAT)

Next year will be the 25th anniversary of the the El Vallès Technology Park: the first technology park to be created in Catalonia and the first to begin its activity with companies that are situated in Spain. The year 2012 will also mark the 15th anniversary of the first science park in Spain, Barcelona Science Park, where for the first time a university, the University of Barcelona, led the development of a park. Next year, 22@ Barcelona will celebrate 12 years of developing a model that is close to the Knowledge City of Scandinavia and the dimensions of some current Chinese parks, but also embraces innovation management based on tools, experiences and structures such as clusters, living labs and the smart city. This has already made the district into an international benchmark, as stated by Jan Annerstedt (2011) at the last International Association of Science Parks (IASP) World Conference in Copenhagen. The progress of science and technology parks in Catalonia has gathered speed in the last two decades[1]. Initially, the aim was to import successful models; now international benchmarks are created that incorporate 'sticky knowledge' (Townsend, Soojung-Kim & Weddle, 2009) from the territory, which generates unique economic value that is difficult to copy - sticky - to link the agents in the innovation system and their dynamics with a specific geographic location.

Existing theoretical models, such as the triple helix drawn up by Henry Etzkowitz and Loet Leydesdorff (1997) and the National Innovation System by Lundvall (1992), place science and technology parks as central elements in the innovation system and as the basis of economic and social development in the territory. An overview of the history and time scale of Catalan parks enables us to make an initial analysis of the empirical reality in Catalonia.

The emergence of knowledge-based economic and development models position the university as the central agent in the process of knowledge capitalization (Etzkowitz & Leydesdorff, 1997). The classical sociological model formulated by Merton (1977) considers scientists as unselfish in their task, but compensated for by the recognition of their professional colleagues. In the second academic revolution, knowledge

1. More recent projects in Catalonia are also being led by universities, such as the UPC's Innovation Park, the UAB Research Park, LaSalle Technova Barcelona, ESADE Creapolis and the UPF Research Park. Other projects such as the Barcelona Biomedical Research Park and Biopol'H support the creation of an environment in which universities, clinical laboratories, companies and hospitals collaborate to lead innovations in the health sector. The experience of the oldest incubator in Europe, Barcelona Activa, led to the creation of the Barcelona Nord Technology Park to house technology companies when they leave the incubator. Innovation in traditional sectors in Catalonia, such as the wine, tourism and leisure industries, is central to two projects led, among others, by Rovira i Virgili University, the Science and Technology Park for the Wine Industry and the Science and Technology Park for Tourism and Leisure. The traditional automotive industry in El Baix Llobregat also constitutes the basis of the industrial sector in this territory. The potential transfer of technology and innovation from companies situated in this territory to sectors whose importance is increasing, such as aerospace and mobility, led to the creation of Deltabcn in Viladecans. Closely associated with the territory and its economic and social development are the Science and Technology Park of the University of Girona, the Lleida Agri-food Science and Technology Park, the Technology Park of Tarragona, the Tecnoparc of Reus, the TecnoCampus Mataró-Maresme, the Catalunya Central Technology Park and Orbital 40. All of these were created to interact and relate with agents in their environment and contribute to promoting competitiveness in the relevant business sector. More recent park projects such as the BZ Barcelona Innovation Zone, a project led by the Zona Franca Consortium, and the Parc de l'Alba, designed around the Alba synchrotron, aim to attract large-scale business projects.

is transformed into profitable capital, and science and technology are considered an endogenous variable in the economic system (Schumpeter, 1949). In this context, economic motivation acquires a status that is comparable with scientific progress, which has significant consequences. It affects the definition of the role of scientists, as the task of entrepreneur is added to the more traditional roles of teaching and research. In addition, it affects the social organization of science: the production of knowledge in this new context is characterized, according to Gibbons' Model 2, by the participation of a heterogeneous group of actors who must collaborate in a multidisciplinary context (Gibbons et al., 1994). Furthermore, a new mission of universities is introduced: economic and social development is added to the functions of teaching and research that universities have carried out to date.

Universities are increasingly adopting this third mission to transfer their knowledge to industry and society in general. According to the triple helix model, we must add institutional differentiation between public control (government and public research) and private control (the company and the market) to the initial relationship that links science and the market. The dynamic relationship between universities, companies and government is what lies behind the new paradigm of knowledge-based economic and social development. Integration and conflict between the three helixes is what guides the course and direction of innovation. The interactions between these three institutional areas promotes the exchange of structures and functions in new 'interface' spaces that act as intermediaries between the agents that comprise the innovation system. Some examples of these hybrid spaces are offices for technology transfer, business incubators and science and technology parks. According to the triple helix model, this emerging system is configured at a global scale. However, the subsystems that make up the system are the result of local trajectories (Etzkowitz & Leydesdorff, 1997).

Currently, economists, sociologists and politicians agree on promoting a more relevant future for local, regional and megaregional territories by developing research and innovation ecosystems, and boosting the number of connections in networks that help to attain development objectives (Florida, 2009; Munroe & Westwind, 2007; Townsend, Soojung-Kim & Weddle, 2009). The importance of the location of economic agents to economic and social development was highlighted by Alfred Marshall (1920) when he defined the concept of economies of agglomeration in the industrial districts of northern Italy; by the GREMI group when it included cultural and social aspects as innovation resources (milieux innovateurs, Maillat, 2002); by Porter (1991), in the development of the concept of 'cluster'; and by Krugman when he included the spatial dimension as a key element in explanations of the nature of economic forces (Krugman, 1991). As well as the spatial dimension, the triple helix model links local and global strategies, based on the dynamic interaction between different institutional and functional spheres - universities, companies and government - and enables an analysis of the emerging knowledge-based paradigm (Etzkowitz et al., 2000).

As the involvement and dynamic relationships between universities, companies and government have increased in the configuration of the innovation system, science and technology parks have become more prominent. Parks are agents of the innovation system that act as intermediaries in the value chain (science-technology-business and market) and contribute to creating bridges between other agents in the system, on the basis of a shared language and culture: that of entrepreneurship. Parks fulfil the third mission of universities. This is revealed in the numerous definitions of the concept of a park, which, among other characteristics, highlight their role in the management of knowledge, technology and innovation. This management is highly specific and the responsibility of a team of professionals who are qualified for the task. Parks also boost mechanisms of knowledge and technology transfer from universities to help in the creation of companies and in their growth. The most widely used definition of a science and technology park is that of the International Association of Science Parks (IASP):

A science and technology park is an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a science and technology park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high-quality space and facilities. (IASP Board, 2002)

One of the functions of enterprising universities is to improve the contribution of the university to innovation and to the creation of value in production and business processes, and to facilitate the interaction between public and private research. Catalan universities are currently in a strong position in research, as shown by rankings of Spanish public universities for 2009 (Buela-Casal et al., 2010). According to the criteria analysed in this article, six of the Catalan public universities are situated among the eleven top positions in global rankings of research productivity.

Two Catalan universities are among the top 200 universities in the world according to the Times Higher Education (2010) ranking, which takes into account the quality of universities' teaching, research, internationalization and innovation. However, the quality of universities in Catalonia continues to be more focused on parameters of research than those of innovation, as reflected in a recent study on the Catalan innovation system drawn up by the OECD (2010). Catalan universities have successfully adopted teaching and research roles, but their role as enterprising universities is still relatively new.

In Catalonia, universities have gradually incorporated entrepreneurial functions through the establishment of technology transfer offices (OTRI), and subsequently through the creation of the first park in Spain to be associated with a university, Barcelona Science Park (PCB), in 1997. Currently, nine of the twenty-four Catalan parks have been directly promoted by universities. In addition, universities are directly or indirectly present in almost all park projects, not only through ownership or promotion, but also through contracts, collaboration agreements, offering of science and technology services and innovation management services. In addition, Catalan parks house 192 public R&D and public technology centres. A total of 43% of Catalan parks house university OTRI offices, to unify objectives and bring services associated with R&D groups and centres to the companies that are located in the same environment.

Nevertheless, knowledge is generated not only through research in university departments, but also through studies carried out in corporate research and development departments, technology platforms and other advanced services that provide knowledge for the development of future products and processes. The services that are offered by universities and the parks themselves to public and private R&D units housed in park spaces would not be available if the companies had to cover the costs of investing in and maintaining the highly specialized equipment and services. The availability of these services is particularly relevant for the survival of spin-offs or small technology-based companies that can be founded and grow due to the easy, economical access to these infrastructures. According to Tapan Munroe (2010), the sharp increase in the number of workplaces in the USA over the last decade is not due to large companies, but to jobs created by start-ups. The growth of this kind of company promotes employment and economic growth.

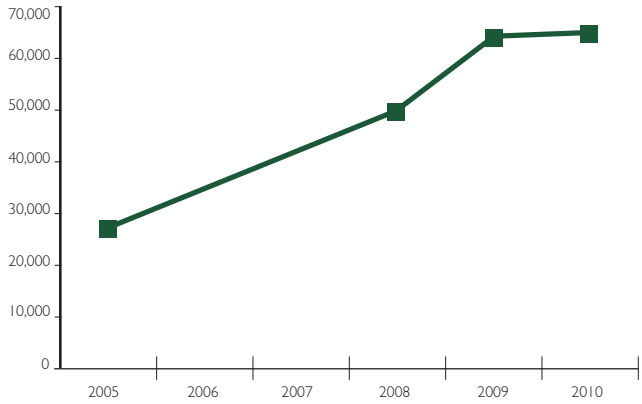
In Catalonia, the total number of workers in parks in 2010 was 65,043 (XPCAT, 2011). Employment growth in Catalan parks since 2005[2] has been very positive, with an average year-on-year increase of 28%[3]

2. The first year for which official data are available on parks in the Catalan Network of Science and Technology Parks (XPCAT).

3. In the analysis of these data, we should take into account that during the 2005-2010 period, projects were consolidated for parks that had been in operation for over ten years, and the number of park projects in Catalonia increased in the same period.

Graph 1

Evolution of the number of workers at Catalan parks (2005-2010)



Source: drawn up by the authors on the basis of the 'Activity Report' of the Catalan Network for Science and Technology Parks for 2010, 2009 and 2008.

(Graph 1). In the last year, the growth slowed down, possibly as a direct result of the economic situation, even though the trend continued to be positive. These data are particularly relevant if we compare them with the year-on-year variation in the employed population of Catalonia, which dropped from the end of 2008 to the end of 2010 (Idescat, 2011).

Catalonia has quickly recognised the central role of people and talent in its transition to a knowledge-based economy (OECD, 2010). The percentage of R&D staff who work in Catalan park facilities has been very high since data have been available[4], at around 50% (XPCAT, 2011). This figure contrasts with the percentage of R&D staff in the total employed population in Spain, which, according to data available for 2007, was only 9.8 in every thousand

Table 1

Services offered by Catalan parks

	PTV	PCB	PR UAB	22@	Technova	PRBB	PRI UPC	PCT UdG	PTC Lleida	PT Tarragona	Tecnoparc	PT BCNord	TCM	b_TEC	PT Catalunya Central	ESADE	PR UPF	P Tourism Leisure	P Wine Industry	Deltabcn	Biopol'H	BZ	P Alba	Orbital 40
Financial and legal services				X	X			X		n.d	n.d			X	n.d	X			n.d	X			n.d	
Company relocation assistance			X	X		X			X			X	X	X		X								X
Own risk capital and seed funding	X	X	X	X	X							X		X										
Access to financing (risk capital and seed funding)	X	X	X	X	X		X	X	X			X		X		X	X				X	X		X
Meeting rooms, auditorium	X	X	X	X	X	X	X	X	X			X	X	X		X	X	X		X	X			X
Bank office and services	X		X	X	X	X	X					X		X		X	X							
Cafeteria, restaurant	X	X	X	X	X	X	X	X	X			X	X	X		X	X			X	X			X
Catering service	X	X	X	X	X	X	X	X	X			X	X	X		X	X			X	X			X
Event organization	X		X		X	X		X	X			X	X	X		X	X			X	X			X
Hotel	X		X	X			X	X					X	X		X					X			X
Intellectual property consultancy service		X	X	X	X	X	X	X	X			X		X		X	X							
Nursery			X	X										X										
Laboratory services		X	X		X	X	X	X	X				X											X
Management support services (consultancy, etc.)	X		X	X	X	X	X	X	X			X	X	X		X	X	X			X			X
Marketing and communication services			X	X	X	X	X	X	X				X	X		X		X						X
Medical services			X	X			X							X										
Public transport			X	X	X	X	X	X	X				X	X		X	X	X		X	X			X
Nearby residential areas			X	X	X		X						X	X		X		X		X	X			X
Administrative services				X	X		X		X			X		X		X								X
Security services	X	X	X	X	X	X	X	X	X			X	X	X		X		X		X				X
Shops in the park	X		X	X	X		X						X	X		X				X				
Sports services			X	X	X	X	X	X					X	X		X		X		X				X
Training			X	X	X	X	X	X		X		X	X	X		X	X	X			X			X
Travel agency	X		X	X										X		X								
Videoconference room	X	X	X	X	X	X	X		X	X		X	X	X		X				X	X			X

Source: XPCAT (2010), 'Activity Report', Catalan Network of Science and Technology Parks.

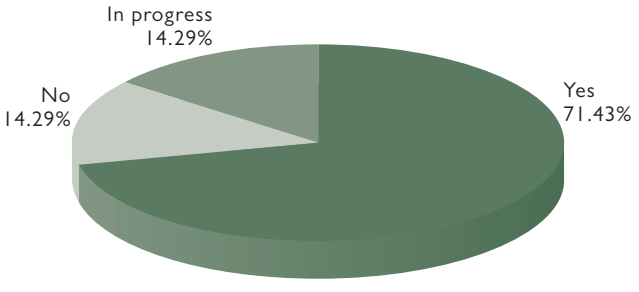
4. Data are available from 2009 onwards.

employed people (Cotec, 2010). Although it appears contradictory, in periods of high unemployment, a considerable number of vacancies are reported for skilled posts in areas in which there are not enough trained professionals to carry out the tasks (Munroe & Westwind, 2007). Attracting and retaining talent is important. Richard Florida (2010) stated in his recent book, *The Great Reset*, that territories that have talent working in high value-added services and that have a high concentration of the creative class attain higher revenues, more innovation and a better aggregate economic performance.

In addition to exchange between science and the market, an efficient innovation system requires other externalities produced by agents in the territory that can be exploited by the production system. Parks are one of the few spaces in which the concentration and creation of knowledge is proactive and drives this economic change (Rooks, 2011). Investing in incubators and science and technology parks is a successful formula for the creation and growth of start-ups and to revitalize the economy (Munroe, 2010). The creation of start-ups and technology-based companies is key to the sustainability of employment and economic growth (Munroe & Westwind, 2007). Science and technology parks help start-ups to grow in the different stages of company development, and support all of the needs that they have in this process of growth (Townsend, Soojung-Kim & Weddle, 2009).

Graph 2

Incubators in Catalan parks



Source: XPCAT (2010), 'Activity Report', Catalan Network of Science and Technology Parks.

In Catalonia, 85.72% (Graph 2) of parks have, or are in the process of creating, an incubator. In 2010, Catalan parks had incubated 328 companies in 26 operating incubators, and the number of companies incubated has increased steadily since data have been available, which is for the period 2007-2010 (XPCAT, 2011).

The number of innovative and technology-based companies in Catalan parks in 2010 was 2,385, which is 10% more than in the previous year. Over 80% are small companies or microcompanies, that is, companies that have fewer than 49 employees. In a highly competitive economy with continuous technological change, it is essential to have as many interactions as possible to be able to respond to the uncertainties of new knowledge (OECD, 2002). In many cases, the company in the strongest position is not the fastest, the most economical or that which launches the best product or process, but that which is best adapted to the environment (Ferràs, 2011). Small and medium-sized companies can adapt to the rapid, frequent changes in a dynamic environment such as the knowledge-based society. The survival of SMEs in a changing environment has meant that the laboratories of large companies, which were relatively self-sufficient until the mid-twentieth century, and had their own technology support systems for developing products, are now increasingly open to combining internal and external innovation fronts (Etzkowitz & Leydesdorff, 1997). Henry Chesbrough's (2010) model of open innovation explains how the way of interacting in the innovation process between the supplier and the customer becomes a real relationship system that we can see reflected in parks, which are open, immediate environments that reach beyond their own physical boundaries to other units located at a distance.

According to the initial conclusions of a study led by Aurelia Modrego, professor of Economy at the Carlos III University of Madrid, the revenue of innovative SMEs[5] located in parks is 40% higher than that of SMEs with similar characteristics situated in other environments (*El Economista*, 2011). There is still little available data on the

5. According to the definition of an innovative company used by the Spanish National Statistics Institute (INE), which is the basis of the data used in this study.

revenue of parks in Catalonia. However, using the partial data that are available, the evolution since 2005 indicates that the total revenue of parks, including that of companies and the other agents housed in their spaces, has risen to over seven billion euros in 2010. The study also estimates that the tendency for companies to launch new products, services or processes on the market is 25% higher in innovative companies in parks than in innovative companies located outside parks. This is particularly relevant if we consider that according to innovation indicators (Cotec, 2010), Catalonia continues to be below the European average in the number of innovative companies out of the total number of firms. The location of SMEs in parks may help not only to boost innovation, but also to accelerate the entire process and to facilitate the transition to a decisive change in productive model that would give Catalonia a competitive advantage over other territories.

The list of the main sectors in Catalan parks (Table 2) reflects the emergence of new production sectors among parks' priority areas. The most prevalent sector is that of ICT, telecommunications and the media. A total of 54.17% of Catalan parks include this sector in their priority areas. This is followed by environmental technologies, which are present in 50% of science and technology parks, biotechnology and life sciences in 37.50%, agrifood in 29.17%, and materials technologies, also in 29.17%. A comparison of data from 2010 and 2009 shows that the number of parks that cover the sectors of environmental technologies, agrifood and materials technologies has increased (XPCAT, 2011).

In the public policy sphere, state governments and, particularly in recent years, regional and local governments have realised the benefits of bringing together R&D and knowledge and technology resources in one space as a strategy for the growth of knowledge-based

Table 2

Sectors in Catalan parks

Name of park	Space engineering and aeronautics	Agrifood	Architecture	Biotechnology and life sciences	Human and social sciences	Design and engineering services	Electronics, microelectronics	Enology	Pharmacy	Finances	Training and education	Industry and manufacturing system	IT and software	Metal, metallurgy	Mobility	Nanobioengineering, nanotechnology	Optics	Health	Food safety and nutrition	Food technology	Energy technologies	Materials technology	Environmental technologies	Medical technologies	ICT, telecommunications, media	Tourism, leisure	Chemistry	Innovative units in any sector
El Vallès Technology Park				X								X	X								X		X		X			
Barcelona Science Park		X		X					X							X							X	X	X			
UAB Research Park				X			X									X				X	X	X	X		X			
22@ Barcelona						X																	X	X	X			
La Salle Technova Barcelona													X											X	X			
Barcelona Biomedical Research Park (PRBB)				X					X															X				
Research and Innovation Park of the UPC	X	X	X			X						X	X		X	X	X			X		X	X		X			
UdG Science and Technology Park		X		X		X	X					X	X							X		X	X			X		
Lleida Agri-food Science and Technology Park		X		X															X			X	X		X			
Technology Park of Tarragona																					X						X	
Tecnoparc Technology Park		X		X		X			X				X				X	X	X				X		X			
Barcelona Nord Technology Park						X							X										X					
Tecnocampus Mataró (TCM)																X		X					X	X				
b_TEC Barcelona Innovation Technology											X				X						X		X					
Catalunya Central Technology Park																						X	X					
ESADE Creapolis																												X
UPF Research Park (Social Sciences and Humanities)					X																							
Science and Technology Park for Tourism and Leisure																									X	X		
Science and Technology Park for the Wine Industry								X																				
Deltabcn-Aerospace and Mobility Park of Viladecans	X														X													
Biopol'H				X					X							X		X										
BZ Barcelona Innovation Zone		X			X																							
Parc de l'Alba				X		X	X									X					X	X	X	X	X			
Orbital 40. Science and Technology Park of Terrassa	X	X															X	X				X	X		X	X		

Source: XPCAT (2010), 'Activity Report', Catalan Network of Science and Technology Parks.

economies (Rooks, 2011). Regulatory measures, incentives, funding and various park development programmes are used as part of political strategy in various countries and regions of the world, including the USA, Brazil, England, China and Poland.

The availability of strong infrastructure and an analysis of the experience of funding and managing this infrastructure, including its successes and mistakes, can provide new guidelines for formulating strategy and public policy for the mid- to long-term future of science and technology parks (Chesbrough, 2010). The Government of Catalonia's public policy on parks has been mainly focused on the creation and promotion of some of the existing projects, in collaboration with organizations such as universities and city councils. In addition, since 2005 the Government of Catalonia has established a system of agreements with the Catalan Network of Science and Technology Parks (XPCAT) to promote activity as a network and the development of the entire movement of Catalan parks and its impact on the territory.

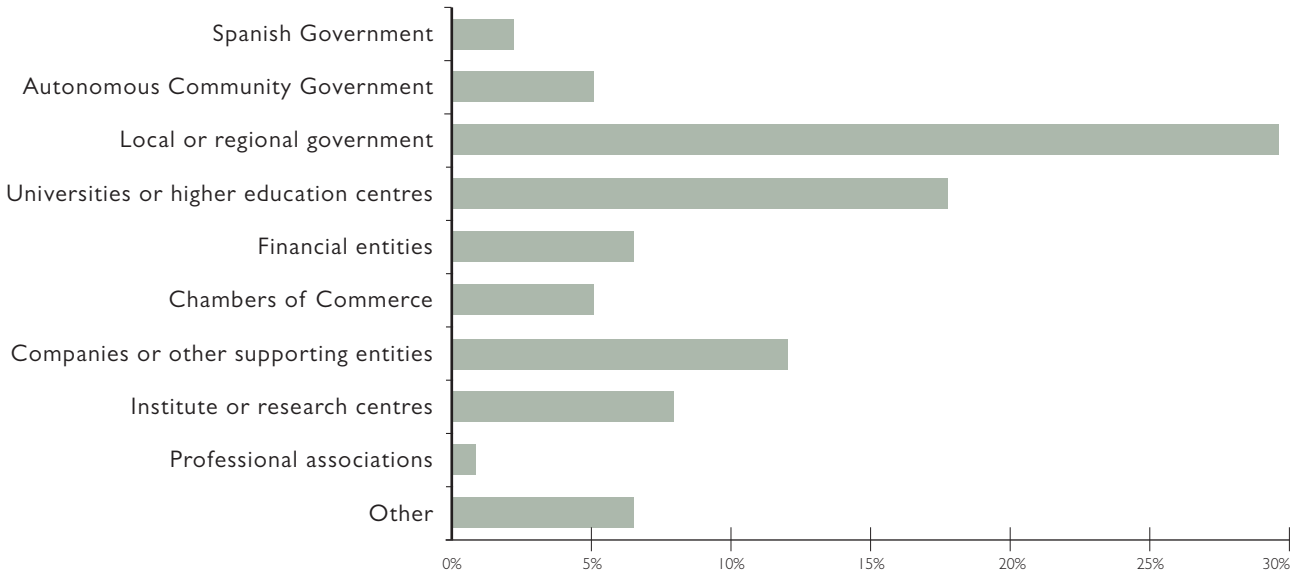
As can be seen in the following graph (Graph 3), 26% of the owners or promoters of Catalan parks are local or regional government bodies such as city councils and provincial councils, followed by universities and higher education centres, at 19%, and then by private companies and entities that support companies, including associations or groups of businesses, at 18% (XPCAT, 2011). According to these indicators, which take into account the presence of the different institutions rather than their degree of participation, the three helixes of the innovation system coexist in Catalan parks. The result of coordinating all the actions of the three helixes and the rest of the agents in the system outlines the path that should be followed to guide the Catalan innovation system.

To complement the analysis of Catalan parks, we should add a new helix to the model: that of internationalization (Leydesdorff, 2011). A total of 54% of foreign companies in Spain are located in Catalonia (OECD, 2010). The percentage of international companies in science and technology parks is almost 10% (Graph 4) according to data from 2010, which represents a growth of 5 points as compared to the previous year (XPCAT, 2011).

The private sector illustrates that the coordination of local and global trajectories is key to promoting innovation. Most companies in Catalan parks are of local origin, at over

Graph 3

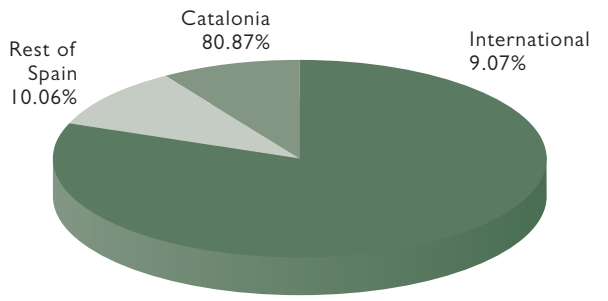
Entities that are owners and promoters of Catalan parks



Source: XPCAT (2011), 'Activity Report 2010', Catalan Network of Science and Technology Parks.

Graph 4

Origin of companies in Catalan parks



Source: XPCAT (2011), 'Activity Report 2010', Catalan Network of Science and Technology Parks.

80% (Graph 4), but many of them are founded with a global mentality and product. There are numerous examples of this, including: Zolertia, a company in El Vallès Technology Park whose activity on the international market accounts for over 80% of its total revenue (APTE Tecno 2011); Estacions Nàutiques, a company whose headquarters are in the Science and Technology Park for Tourism and Leisure (PCT), which has recently exported its know-how to the Inter-American Development Bank (IDB); the Smart Mobility project promoted by Creafutur, a foundation housed in ESADE Creapolis whose collaborators include the MIT Media Lab in Boston and the company Hiriko Driving Mobility; the first augmented reality project presented in Europe and created with Google technology by companies in the Lleida Agri-food Science and Technology Park (PCiTAL); the company Miraveo, a UPC university spin-off housed in the Barcelona Nord Technology Park, which for strategic reasons develops its business in Silicon Valley from its headquarters in Barcelona[6]. Catalan parks are also attractive locations for international companies seeking new spaces to expand their market. Over 9% of companies in Catalan parks are international. For example, Airborne is an aeronautics company in the UdG Science and Technology Park. In addition, the Danish company Winners World Wide recently set up its first Spanish office in 22@ Barcelona[7] as part of its internationalization strategy.

For the overall efficiency of the system, the aim is 'not only to increase and improve the technological capacity of the production system or the stock and the scientific and technological capacity of lecturers and researchers, but also to increase the complexity of paths of internal relationships and connections of all agents in the global world' (Piqué, Bellavista & Adán, 2008). That is why parks are organized in networks in the local environment through XPCAT[8], in the state environment through APTE[9] and connected with international nodes through IASP[10] and WAINOVA[11], to ensure the flow of both local and global knowledge.

The evolution of the financial system will have a considerable influence on the development potential of the instruments and infrastructures that enable progress towards the future research and innovation system. Currently, limited access to loans and the instability of the financial system has dragged all the sectors of the economy into an economic recession that has already had a noticeable impact on employment, companies and governments (Castells, 2011). It should be taken into account that financing of technology-based companies through risk capital is effective, but needs to be complemented by the increasing participation of business angels and new networks of local investors (Townsend, Soojung-Kim & Weddle, 2009).

According to its Greek origins, the word *crisis* means separation or rupture. Crises are situations of change that open up a wide range of opportunities for the future, as well as periods of reflection to select the social and economic model that we want for our country. It is the ideal moment to establish a new social contract and a new contract between the people, resources and the capacities that we have to move forward. In this context, science and technology parks in Catalonia and in the rest of the world are in a privileged position as a tool that groups all elements of research and innovation in the same physical space and in an organized network for the transfer of activities that outline the future paradigms (Bellavista &

6. Other examples of innovations with an international impact can be found in XPCAT's e-newsletter (www.xpcat.net).

7. Information from the news section of the 22@ Barcelona website, www.22barcelona.com.

8. Catalan Network of Science and Technology Parks (XPCAT).

9. Association of Science and Technology Parks of Spain (APTE).

10. Internacional Association of Science Parks (IASP).

11. World Alliance for Innovation (WAINOVA).

Sanz, 2009; Bellavista, 2009). It has been shown that technological and innovative companies are withstanding the recession better than other kinds of companies. In addition, some of the most successful current companies, such as Google, were created in periods of crisis (Engel, 2007; Munroe, 2010). Richard Florida stated that Barcelona was the hub of a megaregion in a process of development that could play a very important role in the future (Florida, 2010). The result will depend on whether Catalonia knows how to make use of its strategic advantages by coordinating universities, companies and the government through instruments such as science and technology parks, whose effectiveness has been demonstrated in many countries of the world. This will put Catalonia in a leading position in the global economy. Thus, it will opt for a sustainable model of economic and social development, which ensures the transfer of knowledge, technology and innovation into social and economic well-being for citizens.

References

Annerstedt J (2011), 'Future Megatrends for Science & Technology Parks. Create your own roadmap!', XXVIII IASP World Conference on Science and Technology Parks, Copenhagen (Denmark), 19-22 June.

Bellavista J., Adan Mc (2009), 'Los parques científicos y tecnológicos en el desarrollo de la ciencia, la tecnología y la empresa', *SEBBM,* 161 (September).

Bellavista J, Sanz L (2009), 'Special section on science and technology parks: habitats of innovation', *Science and Public Policy,* journal of science, research, technology, innovation and policy, vol. 36 (7): 499-509.

Bellavista J (2009), 'Preparant les universitats i els parcs científics i tecnològics per a la postcrisi', *Memòria Socioeconòmica de Barcelona 2008,* Consell Econòmic i Social de Barcelona (CESB), Barcelona: 127-131.

Buela-Casal G, Bermudez Mp, Sierra Jc, Quevedo-Blasco R, Castro A (2010), 'Ranking de 2009 en investigación de las universidades públicas españolas', *Psicothema,* vol. 22 (2): 171-179.

Castells M (2011), 'Crisis y sistema', *La Vanguardia,* 30 de juliol.

COTEC (2010), *Tecnología e Innovación en España. Informe Cotec 2010,* Fundación Cotec para la Innovación Tecnológica: Madrid.

El Economista (2011), 'Las pimes ubicadas en los parques tecnológicos facturan un 40% más', 19 July 2011.

Engel J (2007), 'Understanding, fostering, and managing creativity and innovation'. Paper presented at the XXIV IASP World Conference, Barcelona, Spain, 1-4 July 2007.

Etzkowitz H, Webster A, Gebhardt C, Cantisano Br (2000), 'The future of the university: evolution of ivory tower to entrepreneurial paradigm', *Research Policy*, 29: 313-330.

Etzkowitz H, Leydesdorff, L (1997), 'A Triple Helix of University-Industry-Government relations' in Etzkowitz & Leydesdorff (Eds.), *Universities and the Global Knowledge Economy. A Triple Helix of University-Industry-Government relations,* London: Pinter Publishers.

Ferrás X (2010), *Innovación 6.0. El fin de la estrategia,* Plataforma Editorial, Barcelona.

Chesbrough Hw (2010), 'Open Innovation on Science and Technology Parks', Jornada d'Immersió Estratègica de Parcs Científics i Tecnològics de Catalunya, 21 and 22 June, Caldes de Malavella (Girona).

Chesbrough H W (2009), *Innovación Abierta,* Plataforma Editorial, Barcelona.

Florida R (2010), *The Great Reset: How New Ways of Living and Working Drive Post-Crash Prosperity.* HarperCollins Publishers.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M (1994), *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies,* London: Sage Publishers.

Krugman P R (1991), *Geography and Trade.* MIT Press, Cambridge, MA.

Leydesdorff L (2011), 'The Triple Helix, Quadruple Helix,...and an N-tuple of Helices: Explanatory Models for Analyzing the Knowledge-based Economy', *Journal of Knowledge Economics*, vol.2 (2): June.

Lundvall B A (1992), *National Systems of Innovation,* London: Pinter Publishers.

Maillat D (2002), *From the industrial district to the innovative milieu: contribution to an analysis of territorialized productive organizations,* http://www.unine.ch/irer/wp9606b.doc

Marshall A (1920). *Principles of Economics.* London: MacMillan.

Merton R (1977), *La sociología de la ciencia. Investigaciones teóricas y empíricas,* Madrid, Alianza Editorial, 2 vols.

Munroe T (2010), 'Incubators Fertile Ground for Job Creation', *Contra Costa Times,* 07.03.10.

Munroe T, Westmind M (2007), *Silicon Valley: The Ecology of Innovation,* Euromedia Comunicación: Malaga.

OECD (2010), 'Catalonia, Spain'. *OECD Reviews of Regional Innovation.* OECD Publications: Paris.

OECD (2002), *Dynamising National Innovation Systems,* OECD Publications: Paris.

Piqué Jm, Bellavita J, Adán Mc (2008), 'Catalunya i la connexió al sistema d'innovació global', *Paradigmes*, 0 (May): 151-164.

Porter, M. (1991), *La ventaja Competitiva de las Naciones,* Barcelona: Editorial Plaza & Janés.

Rooks L (2011), 'Nuturing Knowledge Ecosystems', XXVIII IASP World Conference on Science and Technology Parks, Copenhagen (Denmark), 19-22 June.

Schumpeter J (1949), 'Economic Theory and Entrepreneurial History' in Clemence (Ed.), *Essays on Economic Topics of J.A. Schumpeter.* Kennikat Press: New York.

Times Higher Education (2010), Times Higher Education world university ranking, http://www.timeshighereducation.co.uk/world-university-rankings/2010-2011/top-200.htm (09/11/10).

Townsend A, Soojung-Kim A, Weddle R (2009), *Future Knowledge Ecosystems. White Paper,* Creative Commons Atribution-Noncommercial-Share Alike 3.0, California.

XPCAT (2011), *Memòria d'activitats 2010*, Xarxa de Parcs Científics i Tecnològics de Catalunya.