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FACULTY OF ECONOMICS AND BUSINESS

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The assembly of top management teams at academic spin-offs in the Belgian biotech industry:

A case study of K.U. Leuven Research and Development

Lucas M. Denys

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Thesis submitted to obtain the degree of

Master of Business Economics
Major Entrepreneurship

Promoter: Prof. Dr. Wynand Bodewes
Assistant: Nazlihan Ugur

Academic year 2013-2014

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In the knowledge-based economy, universities need to expand their mission statement with a mission for economic and social development. Technology transfer organizations handle the commercialization of the academic research that is conducted at universities. One method of commercializing this research is the creation of academic spin-offs. This thesis focuses on the creation of academic spin-offs in the Belgian biotech industry. An important aspect of creating such a spin-off is the assembly of the top management team. A case study is conducted on the mechanisms that are used by K.U. Leuven Research and Development (LRD), the technology transfer organization of the K.U. Leuven, for the assembly of the top management teams in academic spin-offs in the biotech industry. This case study consists of a semi-structured interview with the general manager of LRD. The results from the case study generally agree with the literature, additionally a lot of insights are given on topics that have not yet been discussed in literature. Additional case studies and extended research will be needed to further confirm these findings.

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Table of Contents

General Introduction

In the second half of the 20th century, there was a shift in the developed countries from an industrial economy, in which natural resources and labor were the key resources, to a knowledge-based economy, in which knowledge is the key resource. The two major drivers of this shift were the IT revolution and the increasing globalization (Houghton et al., 2000). The IT revolution has enabled the codification of knowledge into information, and the widespread commodification of that information over the Internet. The increasing state of globalization removed the majority of barriers in the trade of goods and services as well as in the flow of capital, forcing companies above a certain size to compete on an international playing field.

This shift to the knowledge-based economy had profound implications on the way countries and companies competed for their piece of the pie (OECD, 1996). Investments in R&D, education and training grew substantially. A lot of attention went to the distribution of knowledge and how this could be optimized in national or regional innovation systems. Highly skilled labor became increasingly important as unskilled labor decreased in value, in order to be able to maximize the use of technology for efficiency gains. Science-based technologies, like ICT and biotechnology, offer great opportunities for innovation in this new situation. Public research institutions and universities became an important part of stimulating economic growth. In the study of national innovation systems, the Triple Helix model rose to prominence (Leydesdorff and Etzkowitz 1997, 1998, 2000), underlining the importance of three-way interactions between science, industry and government.

In order to comply with the new demands for a university, the paradigm of the Entrepreneurial University was created (Etzkowitz 1983, 2003, Branscomb et al., 1999, Etzkowitz et al. 1998, 2000, Van Looy et al. 2011). The Entrepreneurial University has three missions: teaching, research, and economic and social development. The third mission involves maintaining good industry-science links. These industry-science links include the creation of technology-oriented enterprises, collaborative research, contract research, know-how based consulting, intellectual property rights management, and several informal forms of interaction. To be able to successfully manage these industry-science links, universities founded Technology Transfer Offices (TTO's). In order to commercially exploit the academic research that is conducted at a university, its TTO handles all the activities of this university along the technology transfer value chain: the exploration, technical validation and exploitation of knowledge-based opportunities.

Three critical factors have been identified for a successful functioning of a TTO: decentralization, the creation of proper incentives for researchers, and the pooling of critical specialized resources such as legal counseling and business development (Debackere et al., 2005). The creation of academic spin-offs plays a pivotal role in successful TTO's, since academic spin-offs are particularly well positioned to orchestrate the transformation of scientific knowledge into commercial applications. This transformation process can be divided into four stages: the generation of business ideas from research, the finalizing of new venture projects out of ideas, the launch of spin-offs from these projects, and the strengthening of the economic value created by the spin-off (Ndonzuau, 2002).

One of the main reasons for failure of academic spin-offs is not so much the poor quality of the business opportunity, as the poor quality of management (Timmons, 1994). This is why, at the creation of a new spin-off, TTO's must appropriate a significant amount of attention to the assembly of the top management team. The top management teams of academic spin-offs have been shown to systematically underperform in terms of net cash flow and revenue growth compared to those of independent new ventures (Ensley et al. 2005, Visintin et al. 2014, Ortin-Angel et al. 2014). It has been claimed that this is due to the fact that the management teams of academic spin-offs are more homogeneous in terms of education, industry experience, functional expertise and skills (Ensley et al. 2005). Another possible cause is the possibility that academics might have other objectives besides profit in managing their business (Visintin et al. 2014).

An adequately performing top management team must possess both extensive technological knowledge and business acumen, in order to make informed decisions in the international high technology competitive environment (Frohman et al. 1981). This necessity for a wide array of skills is why entrepreneurial teams usually outperform single founders (Visintin et al., 2014). Former academic researchers who have gathered a couple of years of industry experience are found to best combine the different tasks that are asked of a spin-off manager (Ortin-Angel et al. 2014). It has also been shown that teams with shared previous experiences and past memberships of the same team perform especially well (Ensley et al., 2002).

When assembling a management team, TTO's must pay careful attention to the team composition in order to optimize the team dynamic. This is a balancing exercise: the perfect team needs simultaneous integration and differentiation of several contrasting profiles (Visintin et al., 2014). Integration is needed for good team cohesion; without it the team members will not be able to build a good foundation for mutual understanding and respect. But differentiation is essential at the same time, to guarantee that members will challenge each other's opinions by approaching matters from a different point of view.

In this thesis, the context plays an important role. This research is set in the Belgian biotechnology industry. One can say that Belgium has been performing rather well in recent years, based on several innovation indicators (BDI 2013, Eurostat 2013). This indicates that Belgium, and in particular the knowledge regions of Brabant Wallon and Vlaams-Brabant, has adapted well to the knowledge-based economy. The majority of this innovation happens in ICT and biotechnology. The total annual turnover of the Belgian biotech industry is estimated at 1.9 billion euro, accounting for 16% of Europe's annual turnover (Flandersbio website). The Belgium innovation system has always focused on this industry, resulting in a very good supporting infrastructure. The policy framework on the different governmental levels, that has impact on the creation of academic spin-offs in the Belgian biotech industry, will also be discussed in this thesis. K.U. Leuven Research and Development (LRD), the TTO of the K.U. Leuven, has been instrumental in the development of the Belgian biotech industry. Founded in 1972, it was one of the very first technology transfer offices in Europe. Since then LRD has acquired an international reputation of excellent quality, inspiring many other TTO's to follow its example. Key figures for LRD in 2009 are: a total turnover of 136 million euro, about 1200 new contracts managed; 156 invention disclosures resulting in the filing of 73 new patent families (Price Waterhouse Coopers, 2011). LRD has already created over 100 spin-off companies, of which 85 are still active (LRD website).

Since LRD is one of the most successful TTO's in the world, with a long history of commercializing scientific research, it is the perfect subject for this study. The research in this thesis consists of a case study of the top management team assembly mechanisms at LRD. This case study is performed by analyzing an extensive semi-structured interview with Mr. Paul Van Dun, the general manager of LRD. This interview includes questions about how LRD finds and evaluates potential applicants for management positions, how the participation of academic researchers in the management of the spin-off is handled and how LRD ensures a good management team dynamic.

1 The commercialization of scientific research

1.1 Innovation systems and the knowledge-based economy

1.1.1 The shift to the knowledge-based economy

Before the industrial revolution, people lived in an agricultural economy where land is the key resource. The industrial revolution created an industrial economy, in which natural resources and labor were the key resources. The current situation in the developed countries is described as the knowledge economy: knowledge is the key resource now. The UK Department of Trade and Industry (1998) described the knowledge economy as: '… one in which the generation and the exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of all types of knowledge in all manner of economic activity.'

Houghton et al. (2000) identify two major drivers for the shift to the knowledge economy: the rise of knowledge intensity of economic activities, and the increasing globalization of economic affairs. Knowledge has always played an important role in the economy, a farmer or a miner also need knowledge to succeed in their economic activity. But in recent years the increasing degree of incorporation of knowledge into economic activities has profoundly changed the operation of the economy and the basis of competitive advantage. This rise of the knowledge intensity of economic activities is driven by the information technology revolution and the increasing pace of technological change.

Table 1: Evolution of the world's capacity to store, communicate and compute information, absolute per capita, compound annual growth rate, and percentage in digital format (Hilbert M. et al., 2011)

		1986	1993	2000	2007	CAGR 1986–2007
Storage	MB optimal compression per capita (installed capacity)	539	2,866	8,988	44,716	23%
	Percent digital	0.8%	3%	25%	94%	
Broadcast	MB optimal compression per capita per day (effective capacity)	241	356	520	784	6%
	Percent digital	0.0%	0.0%	7.3%	25%	
Telecom	MB optimal compression per capita per day (effective capacity)	0.16	0.23	1.01	27	28%
	Percent digital	19.8%	68.5%	97.7%	99.9%	
General-purpose computation	MIPS per capita (installed capacity)	0.06	0.8	48	968	58%
Sample of application-specific computation	MIPS per capita (installed capacity)	0.09	3.3	239	28,620	83%

The IT revolution has enabled the codification of knowledge into information, and the widespread commodification of that knowledge over the Internet. The evolution of the world's capacity to store, communicate and compute information can be seen in Table 1.

Globalization is driven by national and international deregulation, and by the IT related communications revolution. The unprecedented current state of globalization removed a lot of barriers in the trade of goods and services and the flow of capital. These changes force firms to adopt an international strategy, in which labor that is not knowledge intense is often delegated to developing countries. A frequently used index of globalization is the KOF index (Dreher A., 2006). The recent evolution of this index for Europe is shown in Figure 1.

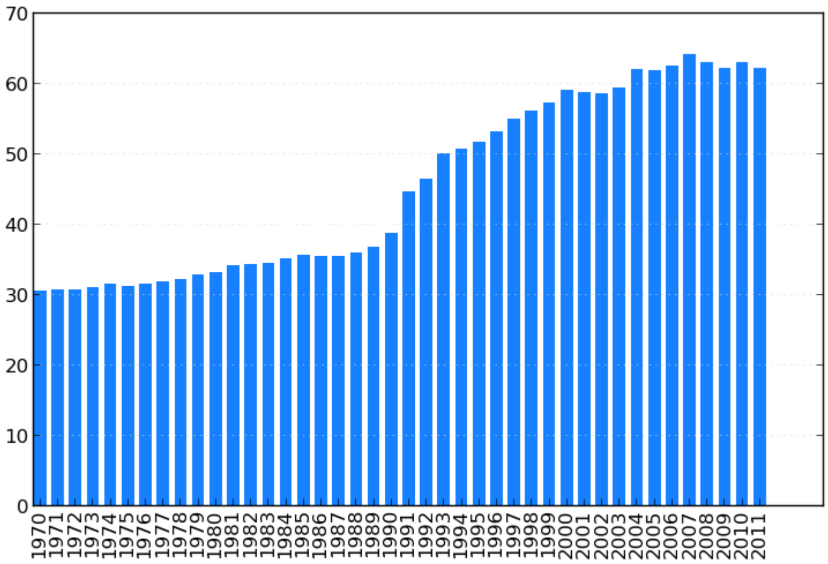


Figure 1: KOF index of globalization for Europe, 1970-2011 (Dreher A., 2006)

Figure 2 and Figure 3 provide evidence of the shift to the knowledge economy. Figure 2 shows that since 1970, the percentage share of knowledge-sector employment has been steadily increasing. Figure 3 illustrates that the percentage share of the value added that the knowledge-sector accounts for also grows year after year. Now that it has been shown that the developed countries have undergone an important shift to the knowledge-based economy, it is time to examine the implications of that shift.

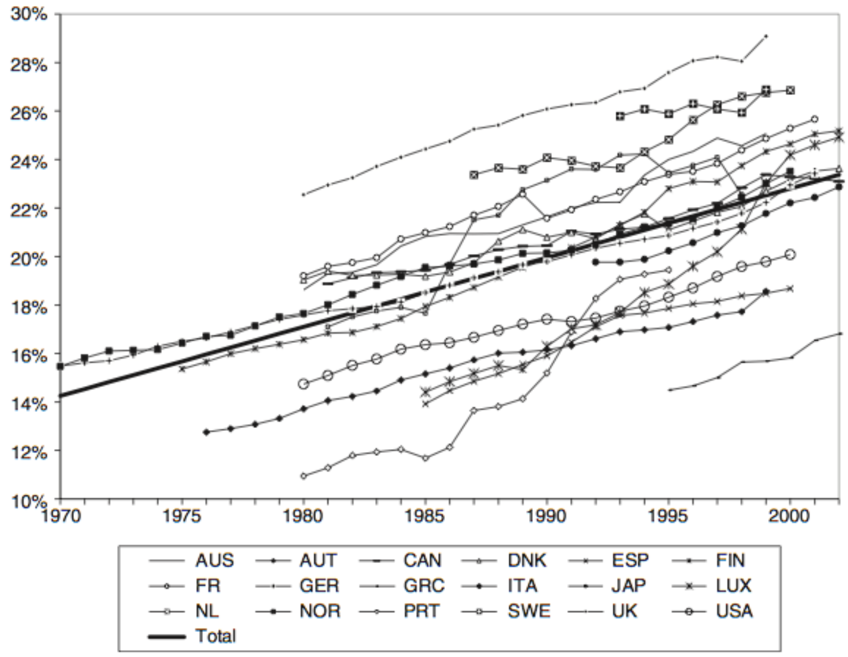


Figure 2: Percentage share of knowledge-sector employment (headcounts) by country (actual values) and regressed for all countries (total), 1970-2002 (Rohrbach D., 2007)

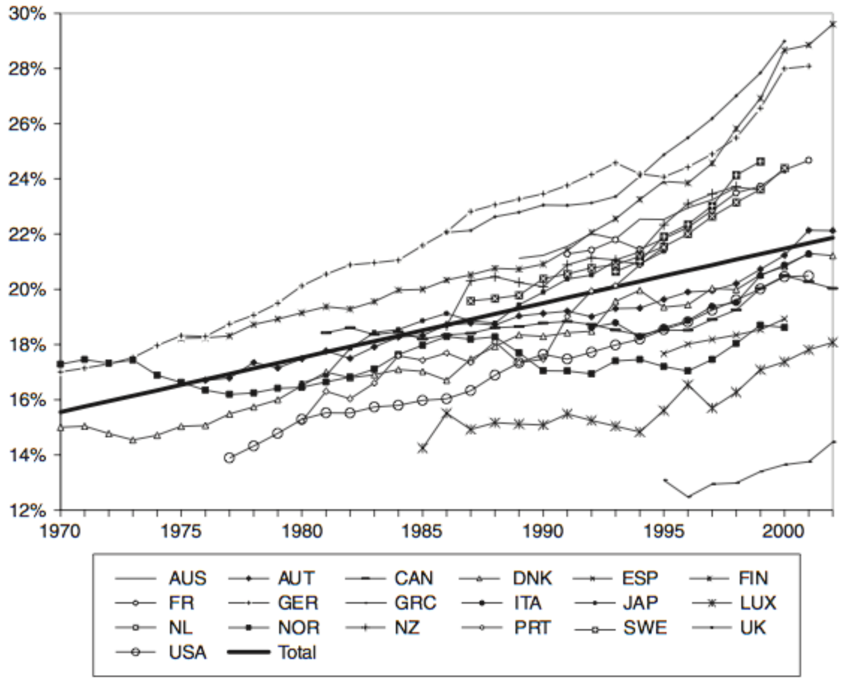


Figure 3: Percentage share of knowledge-sector value added by country (actual values) and regressed for all countries (total), 1970-2002 (Rohrbach D., 2007)

1.1.2 The knowledge-based economy: trends and implications

In a 1996 report, the OECD discussed the most important trends and implications of the shift to the knowledge-based economy. They observed a trend in OECD economies towards growth in high-technology investments, high-technology industries, more highly-skilled labour and associated productivity gains. The implications that were identified by the OECD are related to four different topics: knowledge investments, knowledge distributions, employment and science system.

1.1.2.1 Knowledge investments

In 1996, economists were attempting to more directly incorporate knowledge and technology into theories on driving productivity and economic growth. In these “new growth theories”, investments in research and development, education and training, and new managerial work structures are key.

1.1.2.2 Knowledge distributions

The distribution of knowledge through formal and informal networks is an essential part of the knowledge-based economy. As mentioned earlier, the IT revolution enabled an enormous increase in the world’s capacity to store, communicate and compute information. In order to be able to use all this codified information, tacit knowledge should be acquired by individuals and firms through continuous learning. In the knowledge-based economy, the traditional linear model of innovation has been replaced by an interactive model where producers and users interact with each other in the exchange of both codified and tacit knowledge (figure 4). In this new situation, it is important to study the configuration of national innovation systems: the flows and relationships between government, academics and industry. This topic will be further discussed in chapter 1.1.3.

1.1.2.3 Employment

As mentioned earlier, highly-skilled labour becomes more valuable in the knowledge-based economy, as unskilled labour decreases in value. This forces the developed economies to upgrade their human capital and to provide conditions in which firms can adapt their organization in order to maximize the use of technology for efficiency gains.

1.1.2.4 Science system

Public research institutions and universities become an important part of stimulating economic growth in the knowledge-based economy. There will need to be close collaboration with the industry in order to commercialize scientific and technological findings. These industry-science links will be further discussed in chapter 1.2, since they are of particular importance to this literature review.

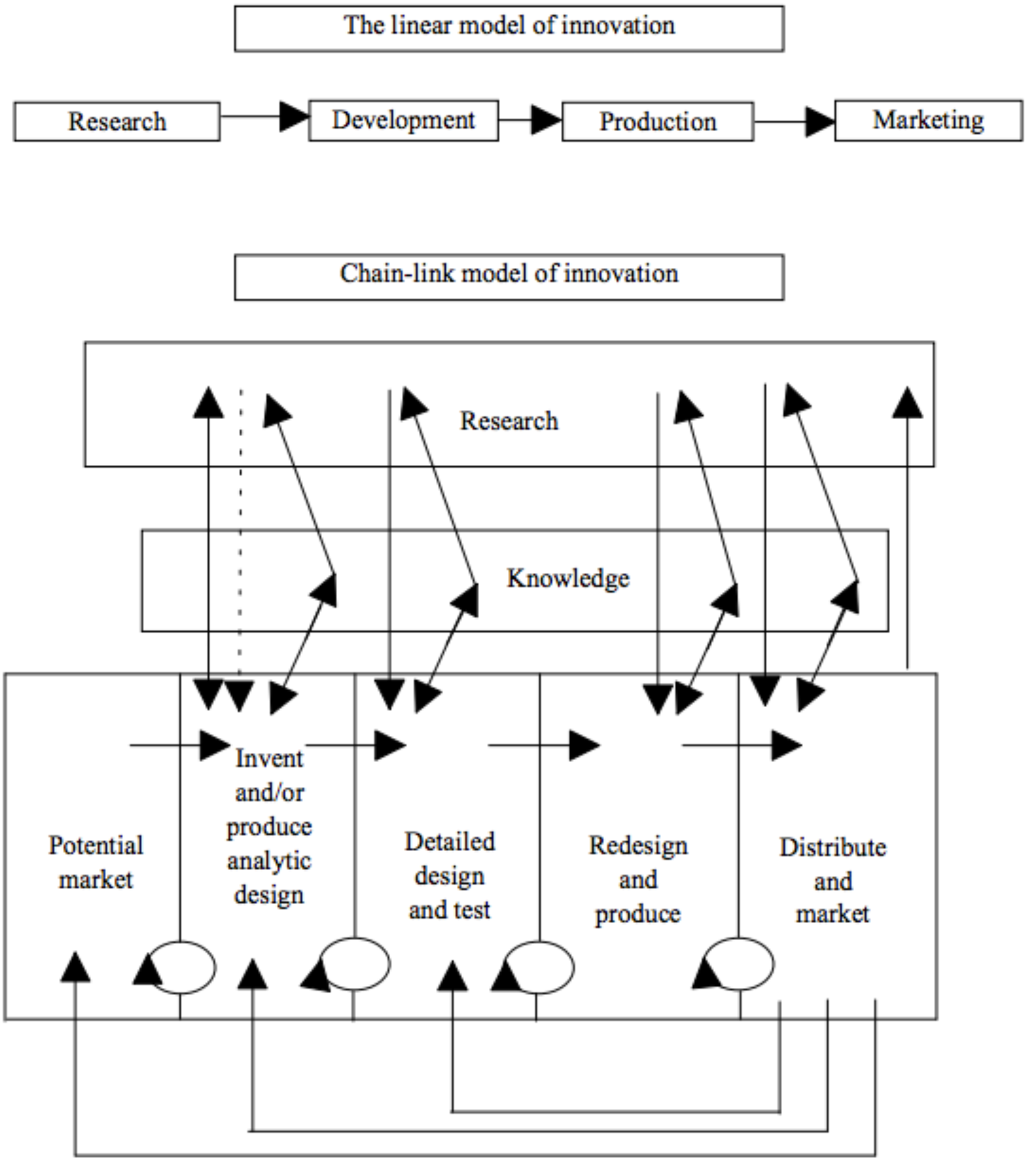


Figure 4: The different models of innovation (Landau R. et al., 1986)

1.1.3 Innovation systems and the triple helix concept

As mentioned earlier, national innovation systems can be defined as the flows and relationships between government, academics and industry. A report from OECD (1997) provides an overview of alternative definitions used in literature:

- "*The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*." (Freeman, 1987)

- "*The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state*." (Lundvall, 1992)

- "*A set of institutions whose interactions determine the innovative performance ... of national firms*." (Nelson, 1993)

- "*The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country.*" (Patel and Pavitt, 1994)

- "*That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.*" (Metcalfe, 1995)

Table 2: Core knowledge flows in national innovation systems (OECD, 1997)

Type of knowledge flow	**Main indicator**
Industry alliances	
Inter-firm research co-operation	Firm surveys Literature-based counting
Industry/university interactions	
Co-operative industry/University R&D Industry/University co-patents Industry/University co-publications Industry use of university patents Industry/University information-sharing	University annual reports Patent record analysis Publications analysis Citation analysis Firm surveys
Industry/research institute interactions	
Co-operative industry/Institute R&D Industry/Institute co-patents Industry/Institute co-publications Industry use of research institute patents Industry/Institute information-sharing	Government reports Patent record analysis Publications analysis Citation analysis Firm surveys
Technology diffusion	
Technology use by industry Embodied technology diffusion	Firm surveys Input-output analysis
Personnel mobility	
Movement of technical personnel among industry, universities and research	Labour market statistics University/Institute reports

Central in all these definitions is that national innovation systems consist of a set of institutions that all interact with each other. These interactions transfer knowledge between the institutions. Table 2 gives an overview of the different types of interactions in national innovation systems, and how they can be measured.

In chapter 1.2, we will further discuss the interactions between industry and universities/research institutions. Cooke et al. (1997) make the point that innovation systems need not be restricted to national levels. The national approach should be complemented by innovation systems on sub- and supernational levels as well. A more recent overview of the literature on regional innovation systems is provided by Asheim et al. (2011).

A more detailed description of the dynamics between industry, academia and government can be found in the work on the 'Triple Helix' concept (Leydesdorff and Etzkowitz 1998, Etzkowitz and Leysdesdorff 1997, 2000). Figure 5 illustrates the evolution of the mode of interaction between universities, industry and the government. The leftmost model represents a situation where the state encompasses both industry and academia, and the interactions between them. Such a model was implemented for example in the Soviet Union and in other socialist regimes. The model in the middle represents a situation with separate institutional spheres that have strong borders between them, as was the situation in most developed countries in the 1990s. The model to the right represents the Triple Helix Model. This model 'is generating a knowledge infrastructure in terms of overlapping institutional spheres, with each taking the role of the other, and with hybrid organizations at the interfaces'. (Etzkowitz and Leydesdorff, 2000).

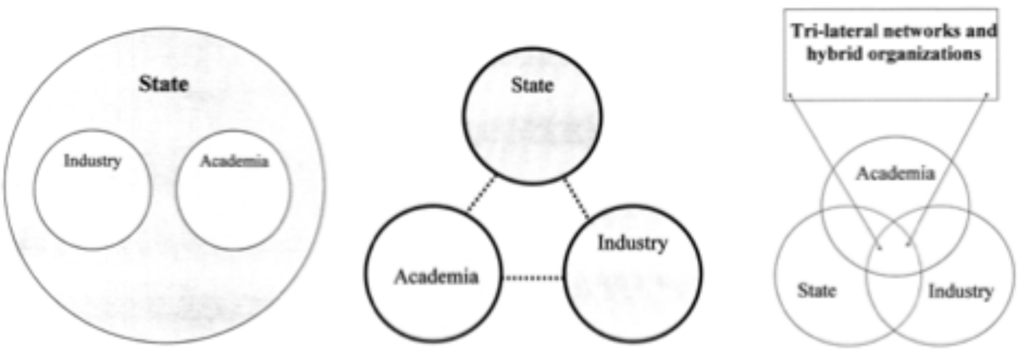


Figure 5: An socialist model, a "laissez-faire" model, and the Triple Helix Model of university-industry-government relations (Etzkowitz and Leydesdorff, 2000)

1.2 Industry-science links and the entrepreneurial university

After the shift to the knowledge-based economy, the role of universities has become much more important. Besides education and the quest for new knowledge, the entrepreneurial university has the extra mission to make its research commercially useful (Table 3). Entrepreneurial universities are expected to show the following characteristics: greater involvement in economic and social development, intense direct commercialization of research results, patent and licensing activities, the institutionalization of spin-off activities, and managerial and attitudinal changes among academics with respect to collaborative projects with industry (Etzkowitz 1983, 2003, Branscomb et al. 1999, Etzkowitz et al. 1998, 2000, Van Looy et al. 2011). The way in which entrepreneurial universities fulfill these tasks will be further discussed in chapter 1.3.1.

Table 3: The three missions of the entrepreneurial university (Etzkowitz, 2003)

Expansion of university mission		
Teaching	Research	Entrepreneurial
Preservation and dissemination of knowledge	First academic revolution	Second academic revolution
New missions generate conflict of interest controversies	Two missions: teaching and research	Third mission: economic and social development; old missions continued

Industry-science links refer to the different types of activity that make use of the knowledge flows between the industry and the science sector. A lot has been written to support the fact that creating and maintaining good industry-science links has a positive effect on innovation performance (Feller 1990, Rothwell 1992, Rosenberg et al. 1994, Dodgson 1994, Mansfield et al. 1996, Mansfield 1991, 1997, Branscomb et al. 1999, OECD 2000). On a micro-economic level, these interactions are interesting for firms because they offer access to new knowledge that might be commercially viable. This is extremely important to be able to stay competitive in high technology industries like ICT and biotechnology (Cockburn et al. 2000, Zucker et al. 1998, Mowery 1998). For universities and public research institutions, industry-science links offer welcome additional funding and good job prospects for their students. Furthermore, research by Van Looy et al. (2004) has demonstrated the beneficial effect of good industry-science links on research performance.

1.2.1 The different forms of industry-science links

Debackere et al. (2005) give an overview of the different forms of activity happening at the interface of science and industry:

- Start-up of technology-oriented enterprises by researchers from the science-base generated at the research institutes. This activity is the main focus of this paper, and will be further discussed in the following chapters.
- Collaborative research: defining and conducting R&D projects jointly by enterprises and science institutions, either on a bi-lateral basis or on a consortium basis
- Contract research and know-how based consulting by science commissioned by industry
- Development of intellectual property rights by science both as a tool indicating their technology competence as well as serving as a base for licensing technologies to enterprises. Those intellectual property rights are not limited to the establishment of patent portfolios, but also include the protection of design topologies, the establishment of frameworks for material transfer agreements, the protection of databases, the property rights on tissue banks, etc.

- Others: co-operation in graduate education, advanced training for enterprise staff, systematic exchange of research staff between companies and research institutes.
- Informal forms of interaction: informal contacts, gatekeeping processes, and industry-science networks on a personal base. These informal contacts and human capital flows are ways of exchanging knowledge between enterprises and public research, which are more difficult to quantify, but nevertheless extremely important and often a catalyst for instigating further formal contacts. In our following research on the role of 'outsiders', these informal contacts will play an important role. More is written on this subject by Allen (1977) and Matkin (1990).

In order to manage the industry-science links, technology transfer organizations (TTO's) have emerged at research universities to act as a mediating institution. In the next chapter, the ways in which TTO's manage these industry-science links will be examined. The management of industry-science links from the industry side will be briefly discussed in chapter 2 for the Belgian biotechnology industry. European, Flemish and Belgian policies to stimulate innovation performance will be discussed in chapter 3.

1.3 Technology transfer organizations

1.3.1 The activities of TTO's

TTO's have a gatekeeping function: they assist both academics and industry professionals in maintaining better industry-science links. Not all TTO's have the same activities, but visiting websites of several TTO's shows that all TTO's, in some way or another, offer support for academics, services to firms and assistance to spin-off companies. Activities of TTO's are often beneficial to several parties at once. This is why some activities might be discussed twice in the following overview, from both the perspective of academics as well as the perspective of firms.

1.3.1.1 Support for academics

TTO's help research teams with the valorisation of their research findings through licensing agreements or the creation of spin-off companies. Landry et al. (2013) has used the value chain perspective to examine the different activities TTO's undertake in these processes. There are three chronological stages in the valorisation of research findings: the exploration of knowledge-based opportunities, the technical validation of those opportunities, and finally the exploitation of those opportunities. We will now briefly discuss the most important activities in these stages. Figure 6 shows some of these activities on the value chain of technology transfer.

- Intellectual property management support: One of the most important jobs of a TTO is assisting researchers with the management of their intellectual property rights. It needs to be examined whether an innovative finding can be protected by an intellectual property right, like a patent right.

Figure 6: The technology transfer value chain (Landry et al., 2013)

- Legal assistance is necessary with regard to the drafting and negotiating of different kinds of contracts, like confidentiality disclosure agreements, material transfer agreements, research agreements and license agreements. Sometimes legal assistance is also provided to solve judicial disputes.
- Industry networking: If a research team has produced findings with commercial potential, they can decide to valorise their findings through licensing or the creation of a spin-off company. In both cases, TTO's help the research team with finding the necessary partners or licensees. They do this through their informal contact network, and through different kinds of networking initiatives.
- Education: TTO's often offer courses to research teams to teach them how to commercialize their findings. They also offer coaching, mentoring and sometimes access to templates.
- Access to funding: Some TTO's also help researchers in finding additional funding for their research, from dedicated government funds, venture capitalists, angel investors, or other industry sources.
- Science parks and incubators: Some TTO's provide create an innovative environment where new companies can rent office space and where a lot of related companies are close to each other to stimulate interactions.
- Interactions with spin-offs: In some cases, parent organizations keep interacting with spin-offs long after their inception. Treibich et al. (2013) has studied these interactions and has identified four major patterns.

1.3.1.2 Services provided to firms

The services that TTO's provide to incumbent firms are less important for the development of this paper, so they will not be discussed in detail here. Research collaborations and science consulting, as previously discussed in 1.2.1, are the two most important services. These are often organizations in long-term partnerships. Companies can also rent office space in science parks to be close to the innovation process, and of course they can engage in the different kinds of networking activities that are organized by the TTO.

1.3.2 Characteristics of succesful TTO's

Debackere et al. (2005) provide an overview of various studies that evaluate different mechanisms to adequately deal with industry-science links from the university perspective. He identified three critical factors: decentralization, the creation of proper incentives and pooling of critical specialized resources.

1.3.2.1 The creation of incentives for researchers

There are two important aspects to incentivizing researchers: the evaluation system and the management of intellectual property rights. The ownership of a part of the intellectual property rights for their research findings stimulates researchers to achieve commercially relevant results. At the same time, the evaluation system should not only look at the teaching and research achievements of faculty, but also at the applications in industry of the researcher's work.

1.3.2.2 Decentralization

Bercovitz et al. (2001) have shown for US universities that a decentralized model of technology transfer, through a dedicated and specialized TTO, characterizes most of the universities with a high record in industry-science links. Further evidence from the US is provided by Siegel et al. (1999). Polt (2001) confirms that these results are also applicable to the EU countries. In this decentralized model, the responsibilities for transfer activities are located close to research groups and individuals. The best way to implement this decentralization is by installing a matrix structure within the university. This allows the research groups to be more actively involved in the commercial exploitation of their research findings. In this structure, only a minimal central support infrastructure is needed to assist the decentralized teams with things like intellectual property management and business development.

1.3.2.3 Pooling of critical specialized resources

The aforementioned matrix structure allows universities to exploit economies of scale for the specialized support services, while keeping the benefits of decentralization. Because these central specialized units take care of all the administrative issues, researchers can completely focus on R&D of their inventions. These specialized units can acquire the necessary know-how in matters like patent rights and licensing, and they provide a central access point for connections with the industry.

1.4 The creation of academic spin-offs

Debackere et al. (2005) state that the creation of academic spin-offs plays a pivotal role in successful university TTO's. They are particularly well positioned to orchestrate the transformation of scientific knowledge into commercial applications. Fontes (2005) takes a closer look at this transformation process that is performed by academic spin-offs, and she identifies three major types of transformation functions:

1. <u>Bring to the market</u> (directly or indirectly) results from research conducted at research organizations, in the form of technologies, products or services.
2. <u>Improve accessibility</u> to industry-oriented knowledge, being exploited by research organizations below its potential, by increasing the quality of supply and/or expanding the range of applications or users.
3. <u>Actively intermediate</u> in knowledge and/or technology transfer from research organizations and its absorption by particular users, by identifying knowledge that can answer to specific needs and assisting in its adjustment to particular contexts.

Spin-offs fulfill these functions by performing a variety of tasks during the transformation process, with a lot of feedback between the different tasks. The combination of these tasks, their starting point, and their position in the spectrum between the academic and the market environment is summarized in figure 7.

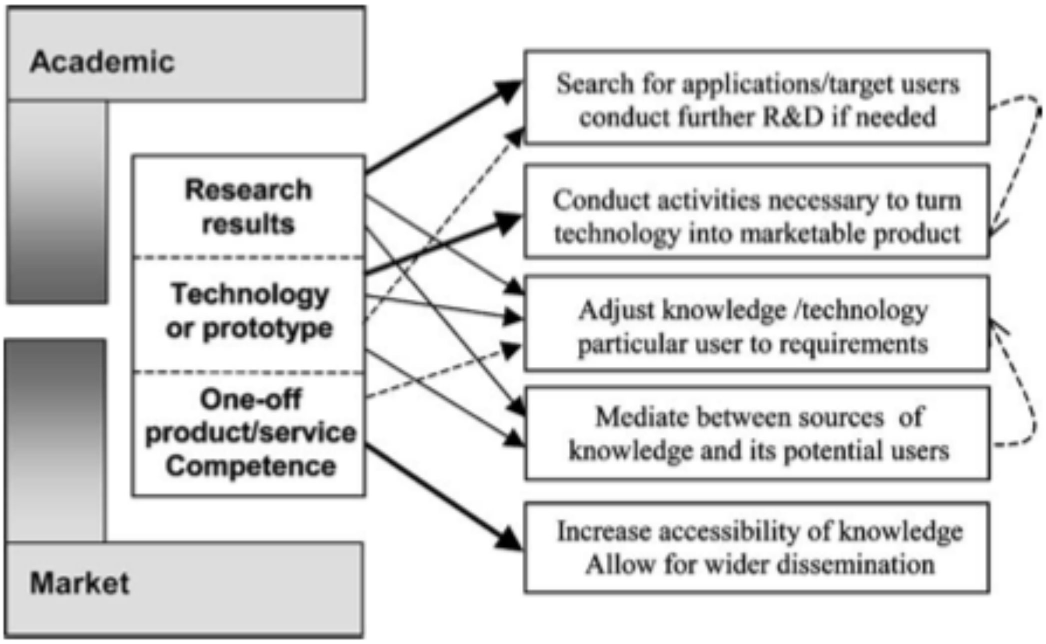


Figure 7: The combination of tasks performed by spin-offs during the transformation process (Fontes, 2005)

How the spin-offs fulfill their three transformation functions by performing this variety of tasks is characterized in detail in table 4.

Ndonzuau et al. (2002) has built up a stage model of academic spin-off creation, composed of four successive stages interacting in a more or less sequential manner:

1. Generation of business ideas from research
2. Finalizing new venture projects out of ideas
3. Launch of spin-off firms from projects
4. Strengthening the creation of economic value by spin-off firms

It is important to note that a selection process occurs at each stage: not all research results eventually lead to successful spin-offs of course. These four stages are also not completely independent of each other; each stage depends on the work that is done in the other stages. This global process of sequential stages is illustrated by figure 8.

Ndonzuau (2002) has identified the major issues that entrepreneurs face during each stage of the creation of a spin-off firm. During the first stage, the biggest problem is the reconciliation of two opposite conceptions: the ‘scientific’ conception which considers science as an end in itself, and the ‘economic’ conception which considers it more as a means to achieve a commercial goal.

Table 4: Transformation functions, starting points, tasks conducted and spin-off contributions (Fontes, 2005)

Function	Start from	Process	Contributions
Bring to market research results or technologies	Research results 'looking for application', technologies or prototypes	• Indentify opportunity for application of research results; conduct further R&D • Technology is developed to prototype/pilot plant stage, allowing test of production/market issues • Technology is transformed in product (consider production, market, regulatory issues) • Product is taken to the market (alone or in alliance) or technology is licensed/sold	Enable the market exploitation of research results or technologies that might have remained unused or Prove viability of idea/reduce uncertainty, making application of technology interesting to other firms Replace RO: consented or even encouraged
Improve accessibility of under-exploited industry-oriented knowledge	Knowledge already being applied to industrial problems (consultancy; one-off products), but reduced scope given academic constraints	• Specialise in activity and professionalise supply • Conduct market expansion activities Two possible modes of exploitation: • Act as mediator to competence offered by RO, facilitating its wider use • Fully assume the supply: develop own products or services based on previous RO experience	Improve access to knowledge or technology being exploited below its potential: — improving quality of supply and/or — expanding range of applications/users May complement RO (facilitator) or replace RO (potential for institutional hostility)
Active intermediation in knowledge transfer & absorption by specific users	Identification of situation where knowledge available at RO can answer to particular users' needs	• Identify appropriate knowledge: match technology with problem to solve Two possible modes of exploitation: • Simply connect and translate between RO/user • Conduct process, adjusting technology to company requirements and competencies: — lead whole process or assist in some areas; — perform activities from research to training	Assist others in transformation process, acting as 'co-producers of innovation' Enable existing firms to access/evaluate RO knowledge that might have remained unintelligible Fit technology to users' specific requirements and facilitates integration into their knowledge base Complement RO, assisting it at two levels: — identification of users for knowledge produced; — industrial implementation activities

The major hurdles to be overcome in the second stage consist mainly of protecting the intellectual property and to develop a business plan and a prototype. The financing of this development stage can also be a problem. In the third stage, the two major problems are the availability of resources and the relationships that should be established between the spin-off firm and its mother university. In this stage, spin-offs need to acquire the necessary intangible resources: competent people with the necessary expertise and connections. Important tangible resources include material and financial resources. Sometimes spin-offs don't need to acquire certain resources themselves in this stage, if they can have access to them through the university. It is also important in this stage to make agreements with the university in order to avoid potential conflicts. Fontes (2005) states that at the end of the transformation process, spin-offs either complement or replace their mother university. The different scenarios of positioning of a spin-off relative to its mother university are depicted in figure 9.

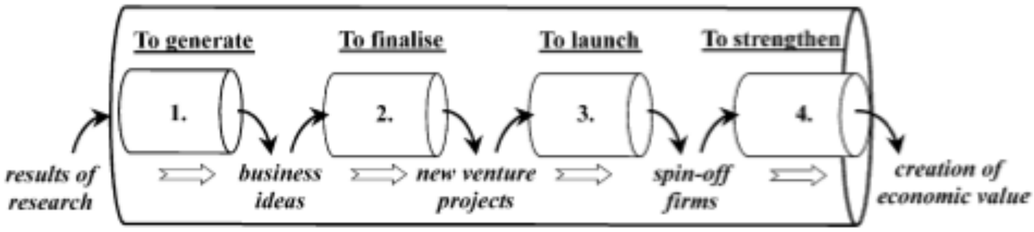


Figure 8: The sequential model for the creation of academic spin-offs (Ndonzuau, 2002)

At a personal level, researchers need to decide in the fourth stage whether they want to keep on working part-time at the university or whether they want to commit fulltime to the spin-off. In the last stage, Ndonzuau (2002) identified two specific problems: the relocation risk and the non-exploitation of full industrial potential of technological projects. The first problem deals with the challenge policymakers need to face to keep the local economy an attractive location for spin-off companies. The second problem can be encountered when spin-offs don't grow fast enough to be able to exploit the full potential of the technologies they have developed.

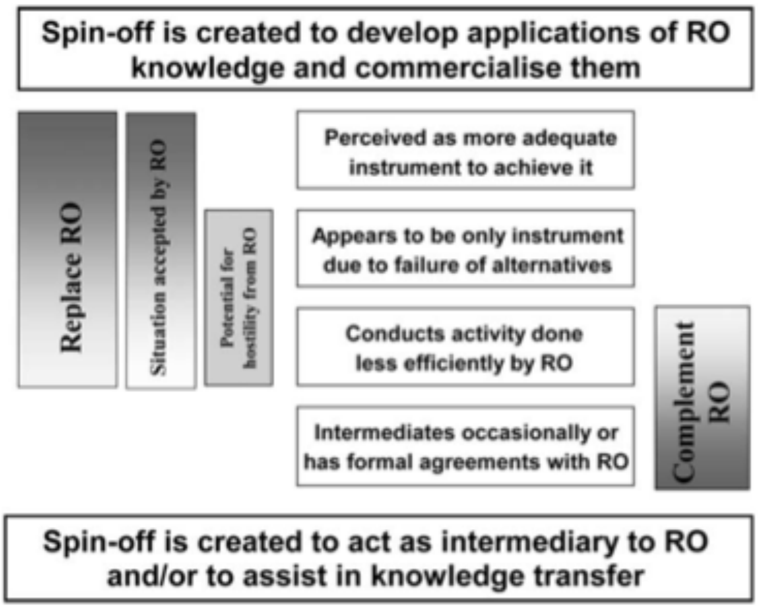


Figure 9: The positioning of spin-offs relative to their mother organization (Fontes, 2002)

Now that the theoretical framework for the commercialization of scientific research has been examined, it is time to look at how the commercialization of scientific research works in the Belgian biotechnology industry. We will discuss all three agents in the Triple Helix Model (industry, government, university) and how they interact with each other. First it is important to give a broad overview of the Belgian innovation system. Although we will focus on Flanders, the Brussels and Wallonia regions will also briefly be discussed. In chapter 2.2 the state of the biotechnology industry in Flanders will be discussed. Chapter 2.3 will provide an overview of the current policies on each governmental level that have an impact on innovation in the biotechnology industry in Flanders. Finally, chapter 2.4 will take a closer look at the performance of K.U. Leuven Research and Development, the TTO at the University of Leuven.

2 The assembly of top management teams

Numerous studies have shown that one of the main reasons for failure of firms in general, and of academic spin-offs in particular, is not so much the poor quality of the business opportunity as the poor quality of management (Timmons, 1994). So, as to ensure the success of their academic spin-offs, technology transfer organizations should try to understand how to build a succesful management team for the development of the new venture. Before they can do that, they must try to identify characteristics of a succesful entrepreneurial management team. It is obvious that this should be a major point of concern to technology transfer organizations, since the management teams of academic spin-offs are usually found to be significantly lower performing in terms of net cash flow and revenue growth than independent new ventures (Ensley et al. 2005, Visintin et al. 2014, Ortin-Angel et al. 2014). In this chapter we will examine what has been written in the literature about different aspects of the assembly of top management teams. First we will look at what kinds of positions are necessary in a management team. Then we will look at the group composition and dynamics of a good managament team.

2.1 The functional roles in a top management team

Although some academic spin-offs are of course founded and managed by individual entrepreneurs, this thesis will focus on entrepreneurial teams because technology-based ventures, and academic spin-offs in particular, are more frequently founded by a team than by individuals (Visintin et al., 2014). The success of start-ups in high-tech industries depends on the full exploitation of technology as a core resource for the competitive advantage (Hamel et al., 1994); this requires the capacity to effectively integrate technology features and business skills (Frohman et al., 1981). The university researchers whose research insights are ultimately commercialized into an academic spin-off usually lack business skills and expertise (apart from some notable exceptions). However, it has been shown that the development of a new business cannot succeed without management expertise (know-how) and good social networks (know-who) (Mustar, 1997). On the other hand, business skills alone are insufficient because a thorough knowledge of the technology is essential to the decision making process of the management team in a high-tech venture. So a successful academic spin-off must possess the combination of both business skills and technology expertise. Compared to single founders, entrepreneurial teams are more likely to possess the combination of these capabilities (Chowdhury 2005, Colombo et al. 2010). In these cases, the academic researchers often develop an appreciation that for the venture to be successful they may need to step aside and take a more technical role and bring in entrepreneurs and managers who do have the appropriate human capital in terms of commercial skills (Lockett et al., 2005). Typically, this will be in the form of becoming a technical consultant or a chief scientific officer.

2.2 Characteristics of a successful top management team

In order to discover the reasons behind the underperformance of academic spin-offs, Ensley et al. (2005) performed a comparative study, between academic spin-offs and independent ventures, that focused on the management team composition and dynamics. They found that the management teams of academic spin-offs are more homogeneous in terms of education, industry experience, functional expertise and skills than those of independent ventures. The authors argue that this is partly to blame on ‘localized isomorphic behaviour’: academic spin-offs will institutionalize themselves towards the norms of the university and the succesful ventures it has produced, rather than towards their own industry. Another cause of the homogeneous academic spin-off management teams is the fact that the professional environments of academics don’t change as drastically in time as those of people in industry.

Including academics in the management team of an academic spin-off has been shown to decrease the venture performance (Bonardo et al. 2010). Visintin et al. (2014) suggest that this is due to the possibility that academics might have other objectives besides profit in managing the business, such as implementing personal ideas, enhancing academic prestige or buying new research infrastructure. In order to be a successful entrepreneur, scientists need to reconcile a conception of science as a means in itself with a more economic conception of science (Ndonzauau et al., 2002). Ortin-Angel et al. (2014) show that, once scientists have been able to reconcile these two conceptions and gain industry experience, their managerial capabilities might surpass those of managers without a scientific background. In the Leuven region, external management expertise already comes on board in most cases in the early phases of spin-off activity, rather than having the original inventor become CEO or become a member of the management team (Gilsing et al., 2010). A lot of the CEO’s of academic spin-offs are former researchers with previous management experience, supporting the case of Ortin-Angel et al. (2014).

Now it has been established that a good management team includes both technological and business experts, it is time to further investigate the composition of a successful management team. Visintin et al. (2014) show that the simultaneous integration and differentiation of academic and non-academic profiles exhibits superior levels of performance. To have good team cohesion, it is necessary that the different members of the management team have a good foundation of understanding between them, both on a professional and a personal level. This requires a good integration of academic and non-academic profiles. Offering the academic profiles training in some basic commercial skills, and offering the non-academic profiles the necessary technological education can be very helpful for this integration. As mentioned earlier, it is also quintessential that the management team possesses both technological and business skills. A structural differentiation of the management team allows the different team members to complement each other’s skills. The empirical research of Visintin et al. (2014) showed that the management team size should be as small as possible and that the diversity in academic status should be minimized. They also showed that similarity in prior experience and common past memberships in the same team have positive effects on management team performance. Ensley et al. (2002) have shown that the cohesion of a top management team is positively related to new venture growth. This cohesion however, should allow for cognitivie conflict, so the different managers can challenge and complement each others vision in a constructive way.

3 A case study of a TTO: K.U. Leuven Research and Development

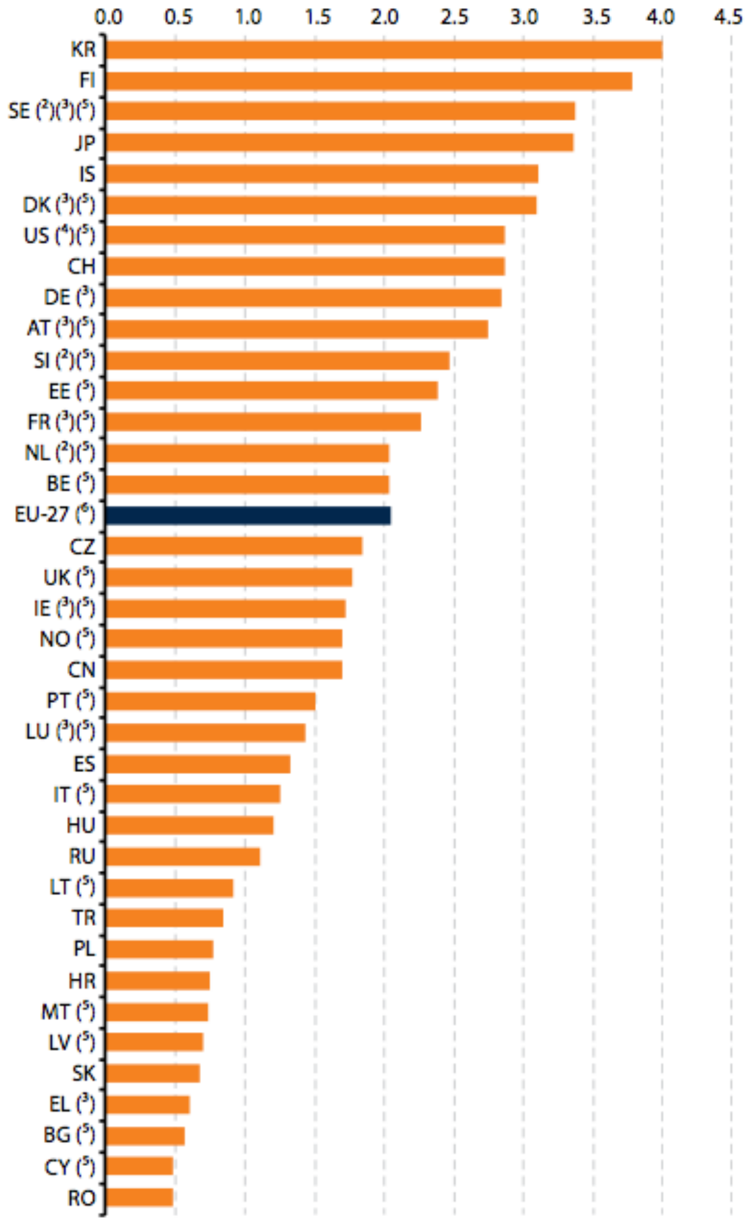
3.1 Innovation in Belgium

Eurostat, the statistical office of the European Commission, provides a lot of insights on the innovation performance of the European countries (and some other countries, for comparison). Belgium does not seem to be a top performing country in terms of innovation, when we look at indicators like government budget appropriations or outlays on R&D (GBAORD), the R&D expenditures as percentage of GDP (figure 10), or the average annual growth rate of the R&D expenditures. In fact, Belgium's R&D indicators are often around the EU average. The percentage of tertiary students that are in the so-called STEM fields (science, technology, engineering and manufacturing) is only around 16%. That is the third lowest percentage in the EU, and less than half of the percentage in the top performing country (Finland, 35.1%). In terms of the amount of patent applications to the European Patent Office (EPO) per million inhabitants, Belgium scores slightly higher than the European average (Table 5). Yet at 130 patent applications per million inhabitants Belgium reaches only a tenth of the top performer (Lithuania, 1310 patent applications).

On the regional level however, Belgium is performing well with two regions (the provinces Brabant Wallon and Vlaams Brabant) in the top 30 of highest R&D expenditures per inhabitant (figure 11). These regional innovation systems are fuelled by the presence of high performing universities and research institutes, and clusters of innovative companies. Furthermore, Belgium is the fourth best performing country in terms of innovative enterprises as a percentage of total enterprises (figure 12). Only Germany, Luxembourg and Israel do better.

The amount of venture capital investments has varied a lot in Belgium in recent years (Table 6). If we normalize these amounts by dividing for the amount for each country by its GDP, it is obvious that the normalized amount in Belgium is way lower than those in the Scandinavian countries, Germany or the UK. Stimulating venture capital investments by providing more favourable regulations might boost this amount, as will be discussed in chapter 2.3.

In the end it is a difficult task to compare the innovation performance of different countries, since different indicators tell different stories. BDI (Bundesverband der Deutschen Industrie) tries to solve this problem by combining a lot of indicators into a weighted combination of indicators on education, research, industry and state. The scores of this combined innovation indicator are shown in Figure 13. Belgium ranks in third place, behind Switzerland and Singapore. So we can conclude that overall, Belgium is a very innovative country, although there are some specific areas in which it can improve its performance.

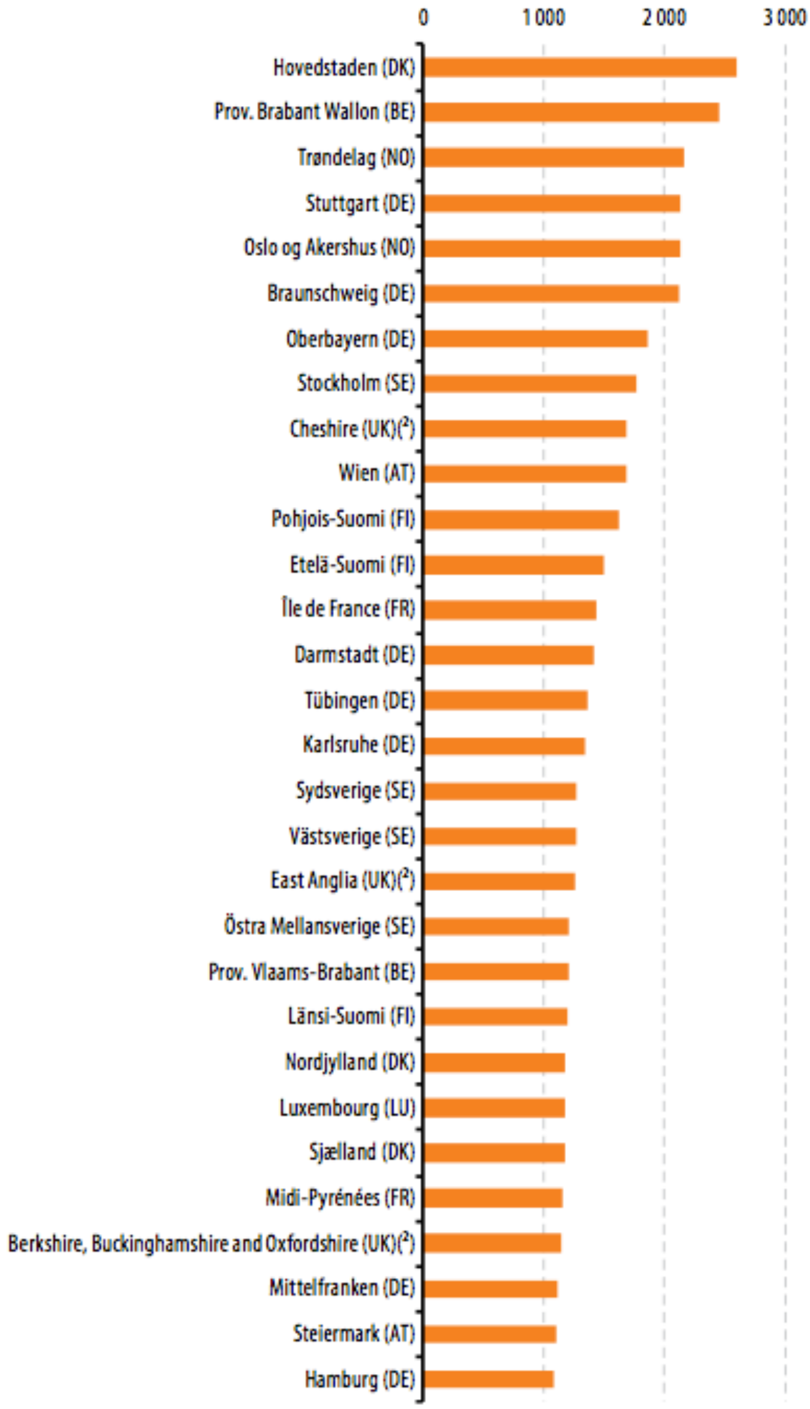


(1) KR, RU and TR, 2010; JP, IS, US and CN, 2009; CH, 2008; EL, 2007.
(2) Break in series.
(3) National estimate.
(4) Excludes most or all capital expenditure.
(5) Provisional data.
(6) Eurostat estimate.

Figure 10: R&D expenditure as percentage of GDP in 2011 (Eurostat, 2013)

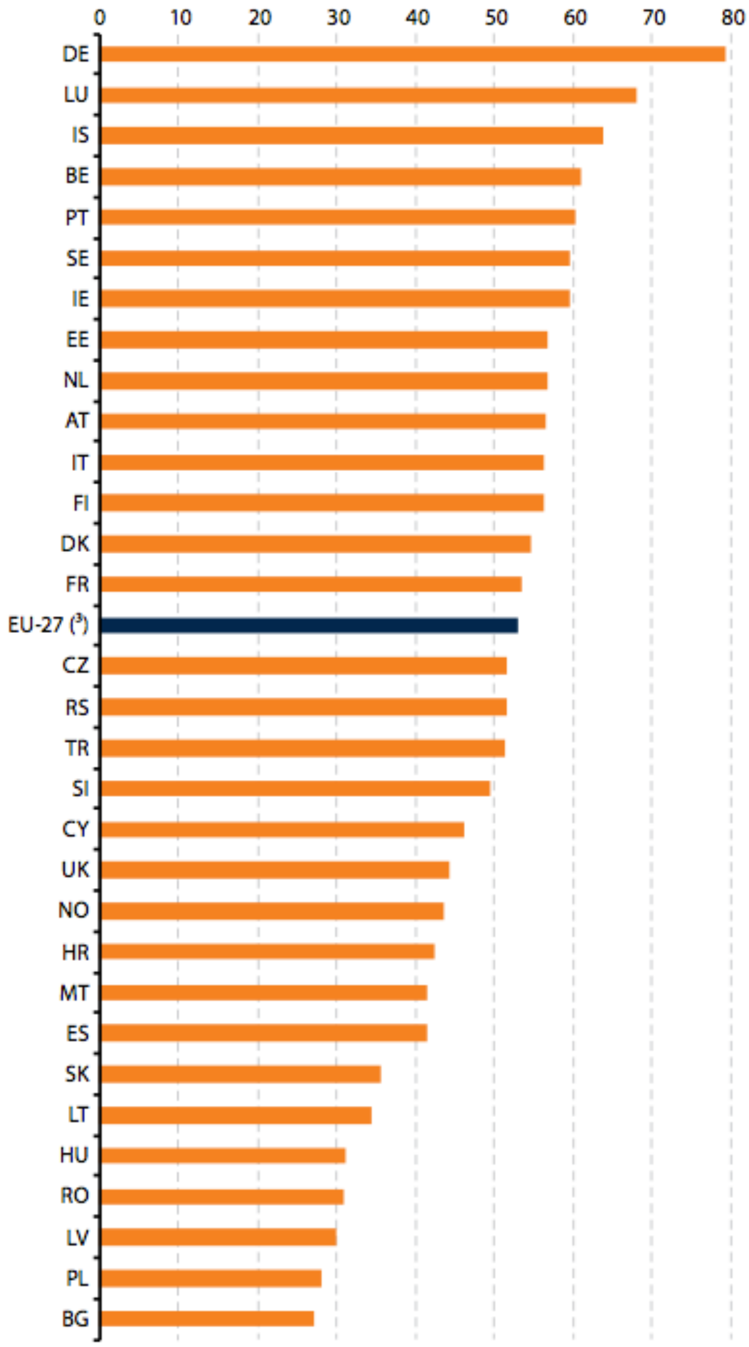
Table 5: Patent applications to the EPO, total number, per million inhabitants, and average annual growth rate (Eurostat, 2013)

	Total		Per million inhabitants		AAGR
	2005	2010 (²)	2005	2010 (³)	2005–2010 (⁴)
EU-27	56 788	54 721	116	109	−0.7
BE	1 502	1 412	144	130	−1.2
BG	24	12	3	2	−12.9
CZ	109	270	11	26	19.9
DK	1 169	1 350	216	244	2.9
DE	23 914	21 880	290	267	−1.8
EE	6	51	4	38	53.4
IE	275	353	67	79	5.1
EL	111	79	10	7	−6.6
ES	1 356	1 458	32	32	1.5
FR	8 366	8 751	133	135	0.9
IT	4 894	4 443	84	74	−1.9
CY	17	14	22	18	−3.8
LV	19	24	8	12	6.1
LT	9	22	3	6	19.6
LU	101	83	219	165	−3.8
HU	135	203	13	20	8.5
MT	11	7	28	16	−11.5
NL	3 490	3 236	214	195	−1.5
AT	1 515	1 581	185	189	0.9
PL	128	308	3	8	19.2
PT	124	110	12	10	−2.4
RO	29	40	1	2	6.6
SI	109	165	54	81	8.6
SK	31	33	6	6	1.3
FI	1 322	1 167	253	218	−2.5
SE	2 410	2 879	267	308	3.6
UK	5 614	4 795	94	77	−3.1
IS	31	19	105	59	−9.3
LI	26	47	738	1 310	12.6
NO	489	409	106	84	−3.5
CH	3 199	2 971	431	382	−1.5
HR	33	25	8	6	−5.4
TR	166	321	2	4	14.1
AU	1 109	759	54	41	−9.0
CA	2 446	1 793	76	62	−7.5
CN	1 655	3 356	1	2	19.3
IL	1 404	1 069	210	169	−6.6
IN	588	770	1	1	9.4
JP	21 764	16 777	170	148	−6.3
KR	5 122	3 501	106	80	−9.1
RU	304	212	2	1	−7.0
TW	749	1 291	33	46	14.6
US	36 536	24 744	123	97	−9.3



(¹) DK, BE, DE, SE, UK, AT and FR, 2009.
(²) National estimate.

Figure 11: Top 30 regions in terms of R&D expenditure per inhabitant (Eurostat, 2013)



(¹) Innovative enterprises i.e. enterprises that implemented any type of innovation (including enterprises with abandoned, suspended or ongoing innovation activities).
(²) EL, data not available.
(³) EU-27 excluding EL.

Figure 12: Innovative enterprises as percentage of the total of enterprises (Eurostat, 2013)

Table 6: Total venture capital investment in million EUR (Eurostat, 2013)

	2007	2008	2009	2010	2011
EU-15	69 357	51 105	21 806	39 713	42 977
BE	1 011	667	1 048	482	583
BG	39	15	6	5	11
CZ	70	36	61	38	193
DK	1 197	505	493	436	378
DE	8 144	7 100	2 412	4 804	4 397
IE	321	76	59	48	51
EL	90	232	41	10	9
ES	2 759	1 601	913	2 471	2 253
FR	12 105	8 517	3 445	5 939	9 249
IT	1 705	3 222	1 415	895	1 185
LU	43	368	78	85	221
HU	51	34	191	45	78
NL	3 498	1 707	764	1 318	2 048
AT	356	217	138	127	124
PL	781	727	480	504	689
PT	211	396	299	201	367
RO	156	123	83	80	48
FI	840	482	388	419	420
SE	2 543	3 270	1 261	3 114	2 164
UK	34 533	22 746	9 052	19 365	19 526
NO	757	760	623	984	721
CH	857	1 238	719	1 525	680

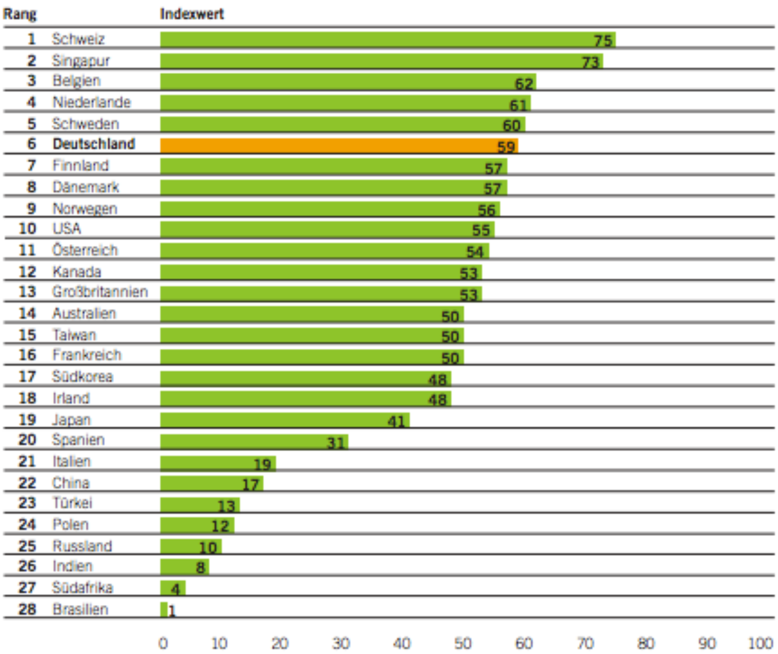


Figure 13: Total result of 'Innovationsindikator' study (BDI, 2013)

3.2 The Belgian biotechnology industry

Before we discuss the state of the Belgian biotechnology industry, it is important to provide a clear definition of biotechnology. The OECD defines biotechnology as: 'the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services'. Modern biotechnology is becoming the driving force of dramatic changes in innovation processes in many sectors (e.g. pharmaceutical, agriculture, food, chemical, environment, energy etc.). Due to its pervasive nature, stimulating developments in modern biotechnology is considered to be highly important, as is the competitiveness of the European Industry (Price Waterhouse Coopers, 2011). Biotechnology is also a science-based technology. Innovation in science-based technologies, like ICT, biotechnology or advanced materials, demand very strong industry-science links. In a quantitative survey conducted by NautaDutilh (2013), 10 Belgian university TTO's were asked in which sectors they intended to incorporate spin-offs in the next 12 months (figure 14).

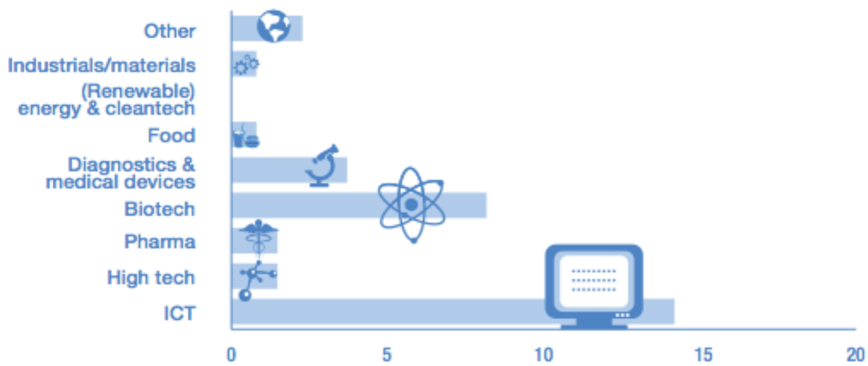


Figure 14: Sectors in which Belgian TTO's intend to incorporate spin-offs in the next 12 months (NautaDutilh, 2013)

This survey showed that the biotechnology sector is the second most popular sector, after ICT. The supremacy of ICT can be explained by the lower amount of start-up capital that is needed compared to the necessary capital in biotechnology. Biotechnology projects also have a lower success rate. This explains that, when the respondents where asked about the sectors in which they have active projects that could evolve into spin-offs during the next five years, the difference between biotechnology and ICT is smaller (Figure 15).

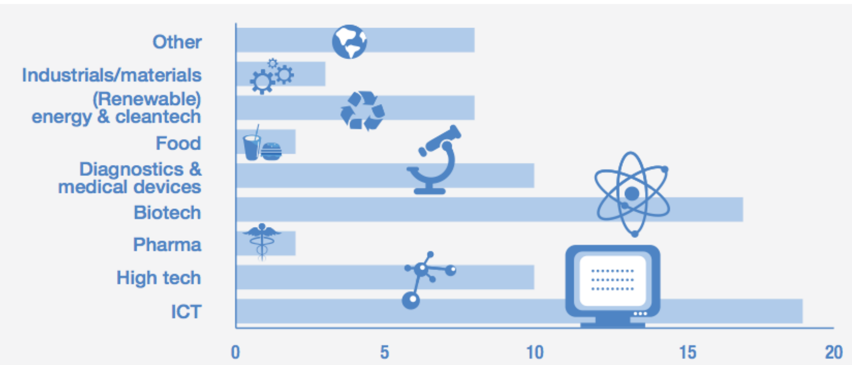


Figure 15: Sectors in which Belgian TTO's have active projects that could evolve into spin-offs in the next five years (NautaDutilh, 2013)

The Flandersbio website, the Invest in Flanders website and the Business Belgium website give an overview of the Belgian biotechnology industry's key facts and figures:

- There are over 140 companies active in the Belgian biotechnology industry (7% of such companies in Europe)
- The total annual turnover of the biotech industry is estimated at 1.9 billion euro, accounting for 16% of Europe's turnover
- The biotech industry ranks 3rd for R&D expenditures in Belgium, accounting for almost 10% of Europe's biotech R&D expenditures
- 13.000 employees are active in this industry in Belgium
- Since 2005, 6 Flemish biotech IPO's have raised, between them, 310 million euro
- 941 patents are owned by 33 companies
- The presence of 5 universities fuel the growth of biotechnology hubs, resulting in 13 research parks and 14 incubators, several research institutes, academic hospitals and clinical research organisations.
- With IMEC and VIB (Flanders institute of biotechnology), there are 2 world-leading research institutes in Belgium
- There are 3 supraregional biotechnology industry federations: Essenscia, Bio.be and EuropaBio
- There are 3 regional industry federations: FlandersBio (Flanders), BioWin (Wallonia) and BrusselsLifeSciences (Brussels)

Contrary to the general trend in Belgium, the biotechnology industry in Belgium shows very high venture capital investments per dedicated biotech company, as is illustrated in Table 7.

Table 7: Venture capital investments in the biotechnology industry (Flanders Investment and Trade, 2013)

	Total in € million	Venture capital per dedicated biotech company in € million
Belgium	118	2,8
France	242	1,6
Flanders	**85**	**1,6**
United Kingdom	238	0,9
Germany	213	0,5
Sweden	47	0,4
The Netherlands	29	0,4
Walloon Region	-	-
North-Rhine Westphalia	-	-

Figure 16 summarizes all the strengths of the Belgian biotechnology industry along the value chain.

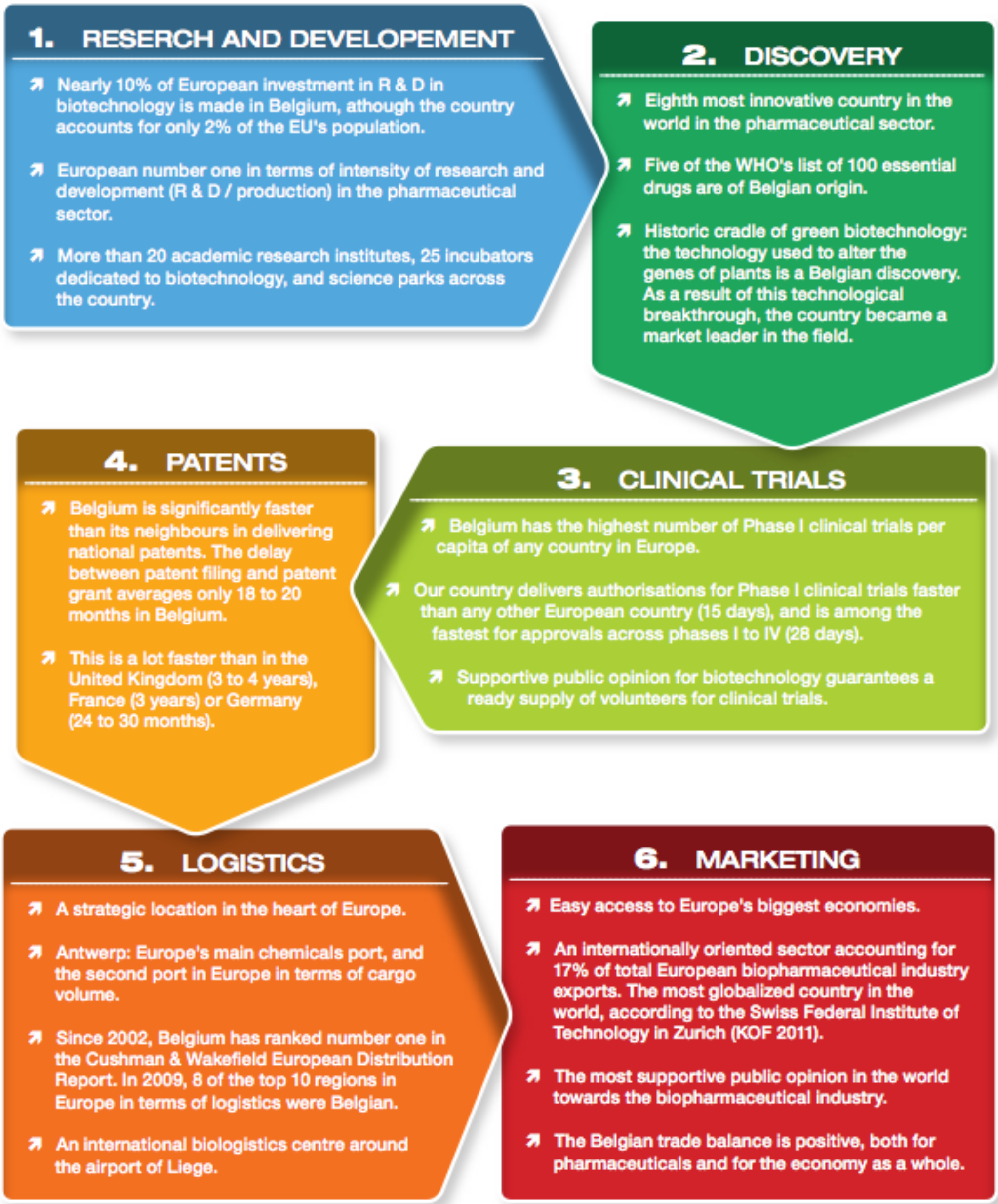


Figure 16: The strengths of the biotechnology industry along the value chain (Belgian foreign trade agency, 2011)

3.3 Policies regarding technology transfer

Now that an overview of the Belgian biotechnology industry has been provided, it is time to look at the policies regulating technology transfer in Belgium. In the Triple Helix Model, the interactions between government, industry and science have a big impact on the innovation performance. First we will provide general policy principles that allow the government to create the perfect environment for technology transfer, then the Belgian and European policies will be evaluated.

3.3.1 Policy principles

Before we examine the current active policies, it is important to establish some policy principles: which tasks can/should governments perform in order to stimulate innovation performance? Gilsing et al. (2010) have developed a framework of policy design principles for fostering technology entrepreneurship; along the four institutional layers that affect spin-off foundation and success rates (Figure 17).

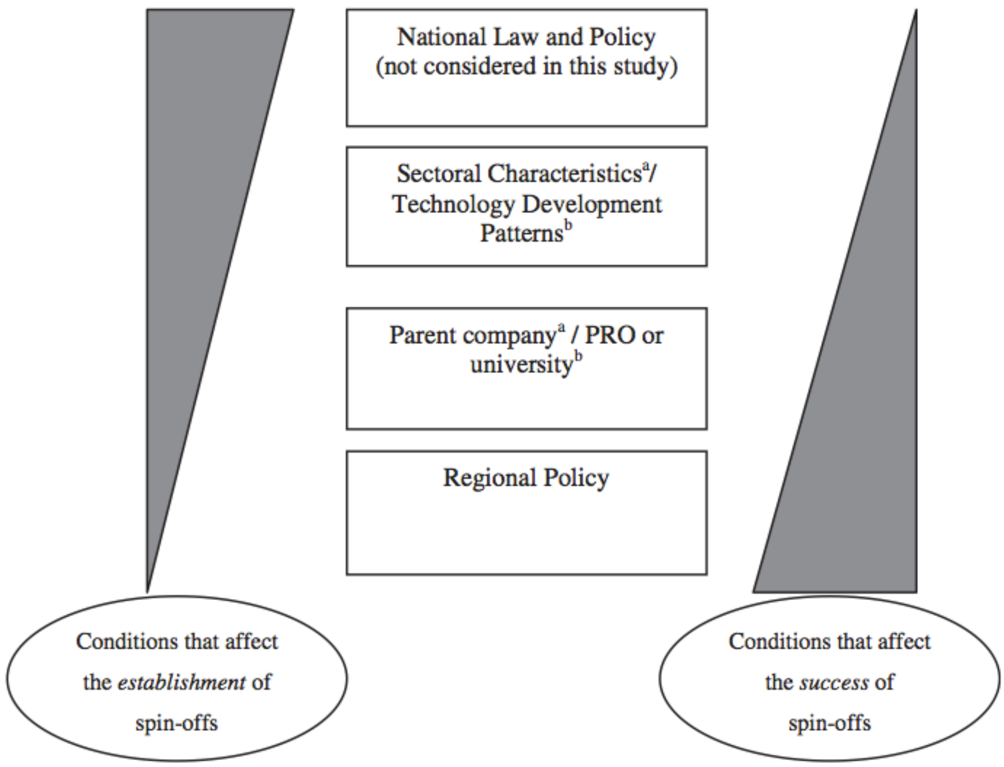


Figure 17: The four institutional layers that affect spin-off foundation and success rates (Bekkers et al., 2006)

It is important to make a distinction between policies aimed at stimulating the creation of spin-offs, versus policies aimed at improving the success of spin-offs. We will now discuss the overview of different policy principles, as compiled by Gilsing et al. (2010).

3.3.1.1 Policy principles directed at the creation of spin-offs

Gilsing et al. (2010) identified three major requirements for policies to stimulate the creation of academic spin-offs:

- Create technology transfer policies at universities and public research organizations tailored to the characteristics of the technological field:

  if the new technology is embedded in a more development–based technological field, then transfer mechanisms such as co-location, mobility of researchers and informal regional networks are more effective;

  if the new technology is embedded in a more science-based technological field, then spin-offs are more effective.

- Stimulate universities and public research organizations to attract and/or retain eminent scholars and build leading PhD programs as well as build a socially supportive entrepreneurial climate.

- Stimulate universities and public research organizations to gradually loosen and disconnect their ties with a particular spin-off firm, to motivate the spin-off to develop a strong market orientation and obtain access to new contacts and information.

3.3.1.2 Policy principles directed at the success of spin-offs

Gilsing et al. (2010) also formulated requirements that should be fulfilled by policies directed at stimulating the success of spin-offs:

With regard to spin-offs with radically new (emerging) technologies that may threaten the position of incumbent firms, regional policy should (Gilsing et al., 2010):

- Provide a certain degree of protection to these ventures by offering incubation facilities and funding;

- Facilitate the ongoing flow and exchange of ideas and knowledge by encouraging a transparent and open dialogue about the significance of emerging technologies;

- Facilitate the development of trust between firms to reduce coordination costs and support initiatives towards experimentation with emerging technologies.

With regard to spin-offs with new technology that extend existing technologies and market strategies by incumbent firms, public policy should provide (conditions that enhance) transparency of both the supply and demand side of the market for technology.

Public policy should provide means for spin-offs–such as well-regulated science parks–to operate independently from parent companies, so they can engage in frequent interaction with others.

3.3.2 Belgian Policy

Debackere et al. (2005) give a good overview of the Belgian institutional framework for academic technology transfer. The following has been adapted from their overview, with some updates where necessary.

3.3.2.1 The legal basis for research contracts

The legal basis for research contracts between universities and third parties, articulated by government Decree in Flanders since 1995, stipulates that all costs directly linked to the execution of contract research (namely the use of infrastructure, services or personnel from the university) are at the expense of the principal of the contract. It also determines that all research contracts have to be approved by the university administration. There are no other regulations for Flemish universities (Debackere et al., 2005). So, most of them have their own internal regulations that arrange and monitor these matters. These internal regulations determine the minimum overhead costs that must be applied in these contracts, the method of payment and the possibility of personal remuneration for researchers.

3.3.2.2 Intellectual property rights

The IPEG Consulting website gives a good description of the Bayh-Dole act and its impact on technology transfer in the US:

The Bayh-Dole Act is a US law dealing with intellectual property arising from US federal government-funded research. Adopted in 1980, Bayh-Dole (named after the two senators that drafted this bill) gave US universities, small businesses and non-profits intellectual property control of their inventions that resulted from such funding. Faster and stronger technology transfer was a principal argument for Bayh-Dole. Bayh-Dole permits a university, small business, or non-profit institution to get ownership of an invention in preference to the government. The US Bayh/Dole Act resulted in a strong technology transfer profession in the U.S. Such licensing programs now exceed $1 Billion in annual royalties to universities, promoting research and further innovation.

It goes on to talk about the situation in European countries:

In Europe we have none of that. European policy makers have so far limited themselves to subsidizing university research, but failed to make the next move, namely to ensure that knowledge, produced as a result of European tax payers money would be "clawed" back to Europe by means of patenting those results and institutionalizing the monetization practices. In Europe, the division between academia and industry is still long and deep. Historically, any potential industrial applications of scientific discoveries made within universities are still deemed public knowledge and, therefore, not protected by patents. Many European academic researchers are only hesitantly, if at all, interested in the exploitation of their research in the private sector. This view has to change. Not that there are no Bayh-Dole-like *laws in Europe. Several countries, among which UK, Germany, Denmark and Belgium have technology transfer legislation supporting university commercialization of publicly funded research. Those countries, though attempting to enact legislation similar in effect to the Bayh-Dole Act, were by far not of the same impact as the US counterpart.*

In Belgium, intellectual property rights legislation belongs to the policy area of the Communities. In Flanders, the transfer of research results that can lead to exploitation (including patens, licenses and other intellectual property rights) must be arranged between the university or research centre and the principal of the contract. The Decree of 1998 determines that the property rights from research carried out by university researchers belong to the university. This leaves out the possibility for researchers to obtain the rights to their own research results, unless the university fails to exploit these results within a time span of 3 years or rejects the researcher's request for filing a patent.

3.3.2.3 The creation of academic spin-offs

The Decree of 1995 also determines the criteria that need to be fulfilled before a university can invest in spin-offs. Financial participation is only possible if the research results that lead to the creation of a spin-off, as well as other intangibles, are exploited. The university can accept shares in exchange for these intangibles, but it can never own the majority of the voting rights. The university is further entitled to participate in specialized venture funds that are created to support this financial participation.

3.3.2.4 Public programs to stimulate industry-science links

The federal-regional political system in Belgium introduces a high level of complexity that impedes the development of a consistent policy promoting ISLs. The public promotion of industry-science links is therefore less significant, both in terms of volume and influence (Polt, 2001). Nevertheless, there are some programs established in recent years to stimulate industry-science links. The liaison or interface offices that universities are establishing to improve their industry-science links receive some public support from the regional governments. Nevertheless, many of these interfaces are too small; LRD (see chapter 2.4) being the notable exception (Polt, 2001).

3.3.3 European Policy

Rothwell et al. (1992) give an overview of the evolution of European technology policy from 1960 until 1990 (Table 8). The evolution is one towards more interdepartmental cooperation in order to improve technology transfer by an orchestrated approach of science and industry policy. It is also clear that the interest in improving industry-science links has increased, along with a tendency to measure their effectiveness. Later in this chapter, we will zoom in on the European programs aimed at the biotechnology industry. First some views on the strategy of the European Union will be discussed.

Maes et al. (2011) present the views of some of Europe's leading research-intensive universities as a contribution to the development of the EU strategy and the initiatives that will follow from it. They note that the research efforts of research-intensive universities have been impoverished, with some notable exceptions, in comparison with other systems because of marginal-cost funding of research, the allocation of research funding on criteria other than excellence, and an obsession with bureaucratic even-handedness. In order to solve these issues and improve the research that is done in European universities, they advise the EU to focus on these five objectives:

1. Stimulating excellence by investing heavily and wisely in competitive, frontier, undirected research;
2. Attracting and nurturing the best talents for research of each generation;
3. Creating a barrier-free space for European researchers to move around in;
4. Ensuring the development of and access to major, state-of-the-art research infrastructures;
5. Orchestrating collaboration in globally significant research programmes.

Maes et al. (2011) also suggest an approach to improve the enabling and catalysing of innovation in Europe. They think the European priorities should be:

1. Enhancing supply of relevant university capacity;
2. Stimulating business demand;
3. Improving university-business interactions.

They propose that the EU focus their efforts on the stimulation of the four interacting driving forces of innovation:

1. Competitively driven research
2. Dynamic entrepreneurship
3. Competitive, fair market environments
4. Adequate financial resources

Table 8: Evolution of European policy from 1960-1990 (Rothwell et al., 1992)

1950s and 1960s	*Science Policy* – Scientific education – University research – Basic research in government laboratories	*Industrial Policy* – Grants for R&D – Equipment grants – Industrial restructuring – Support for collective industrial research – Technical education and training	*Firm Size Emphasis* – Emphasis on large firms and industrial agglomeration – Creating national 'flagship' companies – Public R&D funds go mainly to large companies – Paucity of venture capital
	LITTLE COORDINATION OR ACTIVE COLLABORATION BETWEEN SCIENCE POLICY-MAKERS AND INDUSTRIAL POLICY-MAKERS		
Mid-1970s to Early-1980s	– As above – Some concern over lack of university-industry linkages	*Innovation Policy* – Grants for innovation – Involving collective research institutes in product development – Innovation-stimulating public procurement	– Increasing interest in small and medium-sized firms (SMFs) – Many measures introduced to support innovation in SMFs – Continuing paucity of venture capital
	INCREASING INTERDEPARTMENTAL COORDINATION		
Early-1980s To date	– Increased emphasis on stimulating university-industry linkages – Increased emphasis on 'strategic' research in universities	*Technology Policy* – Selection and support of generic technologies – Growth in European policies of collaboration in pre-competitive research – Emphasis on inter-company collaboration	– Emphasis on the creation of new technology-based firms – Growing availability of venture capital
	INTERDEPARTMENTAL INITIATIVES		
	GROWING INTEREST IN ACCOUNTABILITY AND IN MEASURES FOR EVALUATING THE EFFECTIVENESS OF PUBLIC R&D POLICIES		
	INCREASING CONCERN OVER GROWING REGIONAL ECONOMIC DISPARITIES. NATIONAL AND LOCAL GOVERNMENT INITIATIVES TO ENHANCE THE R&D POTENTIAL OF THE LESS DEVELOPED REGIONS: ACCELERATED ESTABLISHMENT OF REGIONAL TECHNOLOGY INFRASTRUCTURES. EG SCIENCE PARKS. TECHNOPOLES. INNOVATION CENTRES		

A study by Price Waterhouse Coopers (2011) for the European Commission analysed the different aspects of the European biotechnology industry and how they could be improved. Apart from identifying the issues that could be handled by the European level of government, they also stated suggestions for national and regional governments.

Table 9 summarizes the advise of the Price Waterhouse Coopers study (2011) on improving the technology transfer system in Europe.

Table 9: Policy actions to be undertaken by the different levels of government (Price Waterhouse Coopers, 2011)

	Level of action		
Market Structure	EU	National	Regional
• Assess outcomes of the TTO programme implemented by the EIF	X		
• Determine best performing TTOs in Europe and encourage restructuring of existing TTOs towards role model TTOs	X	X	
• Strengthen these TTOs with the provision of management, scientific and financial supports			X
• Encourage regions and state to apply for creation of new European emerging TTOs through competitive funding mechanisms	X	X	X
Information and Communication			
• Document and communicate the inventions (e.g. patents) relevant to KBBE that are not being used in a firm's business to be used by other firms (i.e. open innovation-easy transfer of innovation inward and outward- through licensing, joint ventures, spin-offs)		X	X
• Promote the concept of "role model TTOs", and the importance of CSFs and EPIs		X	
Operations and Implementation			
• Define the governance, skill mix and services within the TTO role model, and organise specific training programmes for TTO leaders and key executives		X	X
• Build up a network of investors to support European TTOs in an open and competitive model	X	X	
• Define a harmonised, independent, centralised patent filing process within the cluster	X	X	
• Develop mechanisms aiming to increase the value perception and the return of the patent filing process to motivate scientists to file patents	X	X	
• Boost and stimulate "Open Innovation" within companies and research institutes		X	X
• Create preferentially patent families rather than individual applications		X	X
Regulations and Taxing			
• Identify and remove regulatory barriers for TTOs	X	X	
• Define processes for simultaneous filing at national and EU levels (e.g. valid in all member states)	X		
• Make the IP filing an affordable and faster process	X		
• Harmonise and create unified "IP Law (i.e. patent, utility model, trademark, copyright, authors' rights etc)" between Member States throughout Europe	X		

Now that the European policies on technology transfer have been discussed, it is time to focus on the European policies that are focused specifically on the biotechnology industry. Aguilar et al. (2013) provide an overview of 30 years of European biotechnology programmes. In figure 18, a timeline is shown including the amount of member states, the biotechnology programmes, the budgets for these programmes and the topics of these programmes since 1975. The first European biotechnology programmes focused on building the foundations of European biotechnology in areas such as transnationality, industrial participation, research management, reinforcing the science base and promoting industrial exploitation of results. In 2002, the European Commission launched its first strategy on biotechnology, creating a catharsis in which dialogue with stakeholders, policy development and research planning and management moved from being fragmented and uncoordinated to being interdependent. The latest European program, Horizon 2020, is a more integrated approach to European science policy than previous programmes, and specifically considers promoting excellence in science, establishing a sound industrial leadership and expressing an ambition to address current and future societal challenges (Gaspar et al., 2012).

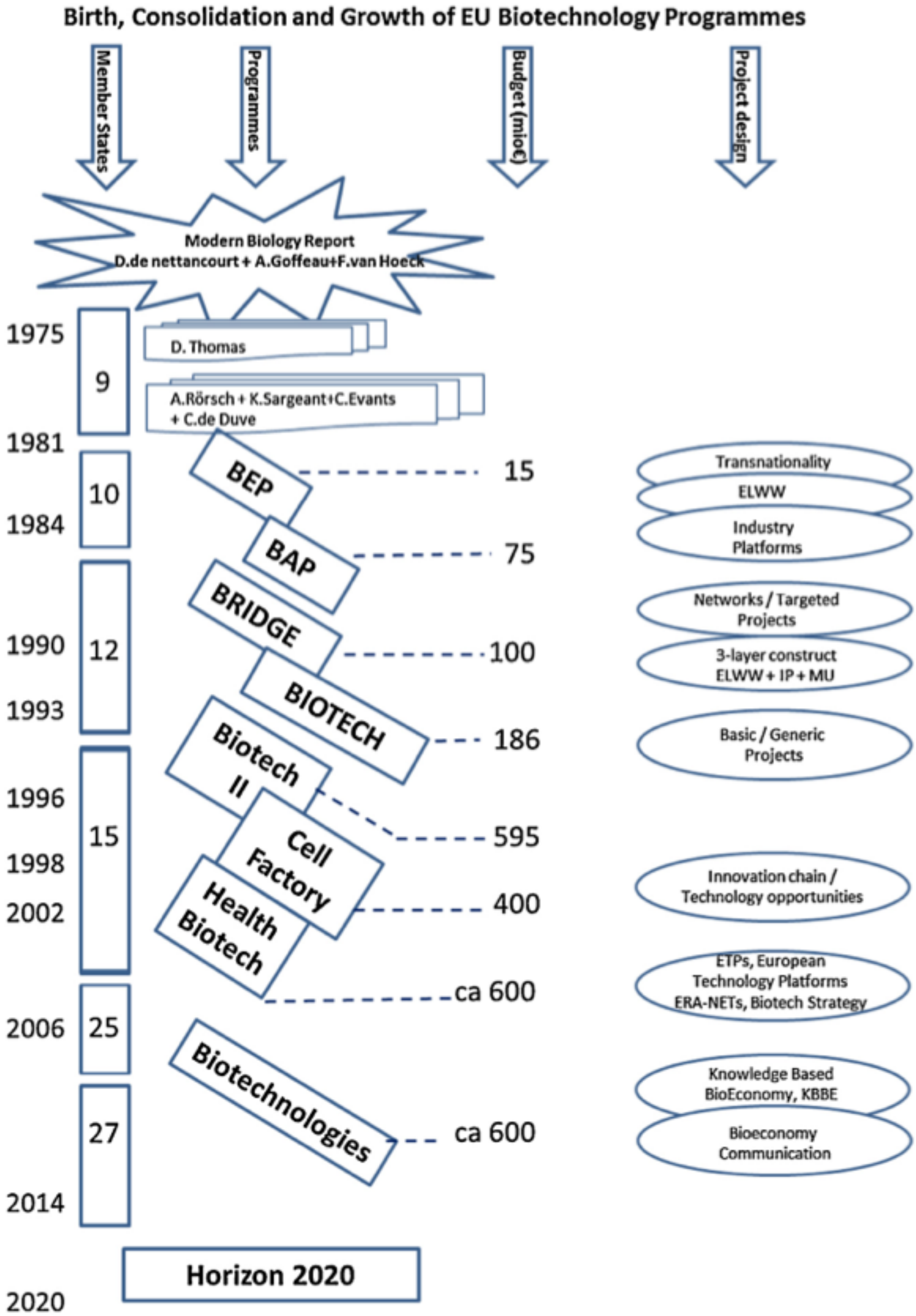


Figure 18: Birth, consolidation and growth of EU biotechnology programmes (Aguilar, 2013)

3.4 The Leuven knowledge region

Most of the following information has been adapted from 'Leuven, knowledge pearl' (2013), an info brochure distributed by K.U. Leuven Research and Development.

The KU Leuven Association, including University Hospitals Leuven, is consistently ranked among Europe's top 20 academic research centers and is continually working to enhance and reinforce this position. The network of university hospitals, which together make up University Hospitals Leuven, enrich the Leuven region with one of Europe's most modern and dynamic healthcare infrastructures. Figure 19 gives an overview of the Leuven knowledge region.

Figure 19: Overview of the Leuven knowledge region (K.U. Leuven Research and Development, 2013)

The role of the KU Leuven Association in the Leuven knowledge economy region is closely linked to the achievements of the nanoelectronics research institute IMEC. IMEC performs world-leading research on nanoelectronics and has global partnerships in ICT, healthcare and energy. Furthermore, several departments of the Flemish Interuniversity Institute for Biotechnology (VIB) are also located in Leuven. The KU Leuven Association, the Leuven-based VIB departments and IMEC have a combined R&D budget of € 664 million and employ about 20,500 people, 8,000 of whom are researchers. Most of the 135 KU Leuven and IMEC spin-off companies are located in or around Leuven. Approximately 300 high-tech companies have set up operations in the Leuven region.

Created in 1972 as one of the first technology transfer offices in Europe, K.U.Leuven Research & Development (LRD) has a long tradition in promoting and supporting the transfer of knowledge and technology from the universities to industry. It provides an integrated approach to technology transfer covering research collaboration, patenting and licensing, and spin-off creation. Key figures for LRD in 2009 are: a total turnover of 136 million euro; about 1200 new contracts managed; 156 invention disclosures resulting in the filing of 73 new patent families; increase of the number of spinoffs created to a cumulative total of 89 (Price Waterhouse Coopers, 2011). Figures 20 and 21 show that LRD has booked a lot of progress since 2002 on technology transfer and academic performance indicators.

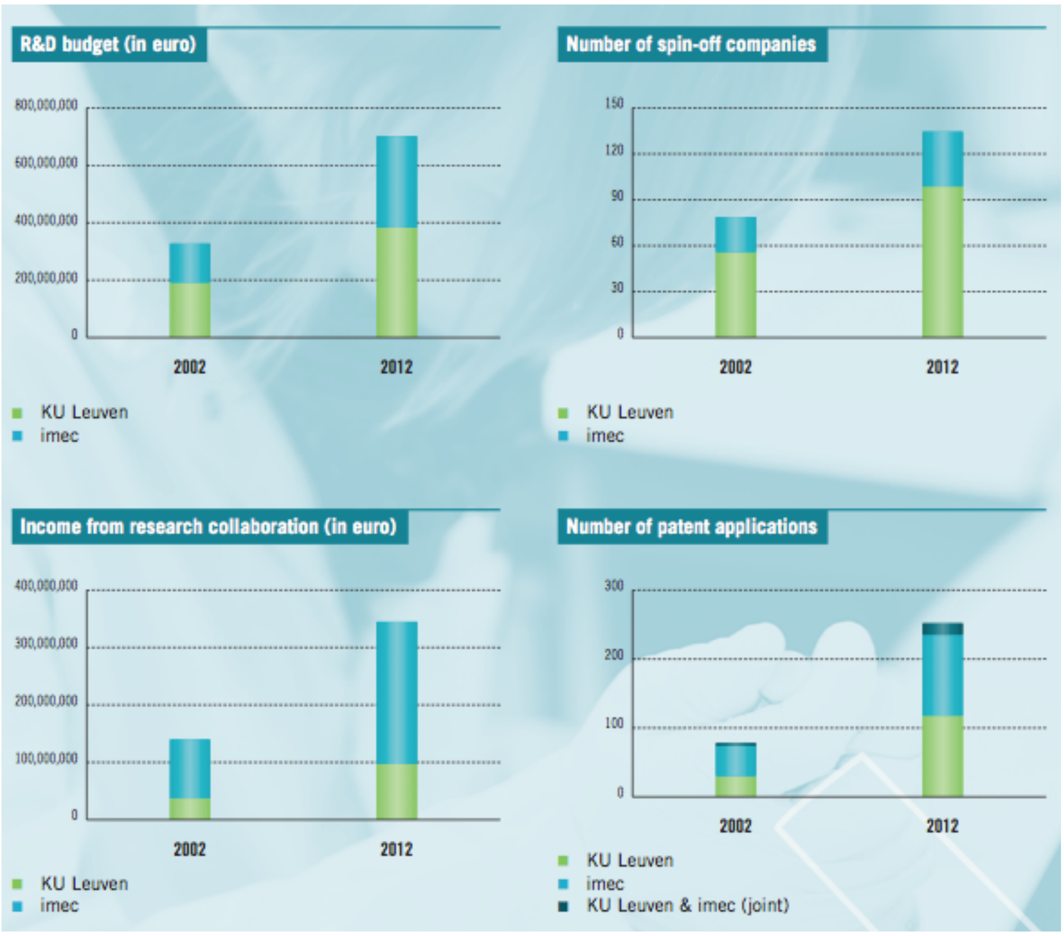


Figure 20: Evolution over the last ten years of R&D budget, number of spin-off companies created, income from research collaborations and number of patent applications (K.U. Leuven Research and Development, 2013)

Several incubators, science parks and business centres in the Leuven region provide state-of-the-art lab and office space for innovative spin-off companies as well as international research-intensive companies. Together, they constitute a technology belt around the city of Leuven. The Haasrode Science Park, with a total area of 136 hectares, accommodates tens of high-technology businesses, employing approximately 5,000 people in total. The Arenberg Science Park, with an area of 13 hectares, was opened in 2004. This science park, situated close to IMEC, consists of four clusters, of which two focus on biotechnology and two on ICT and other high-tech sectors. A third science park, Leuven Noord, will be developed by 2017. The Leuven Bio-incubator offers multifunctional ventilated office and L3 lab space as well as general and technical, logistical and environment-technical support to R&D intensive biotech companies. The KU Leuven Innovation and Incubation Centre (I&I) provides shared facilities, equipment and services to young businesses.

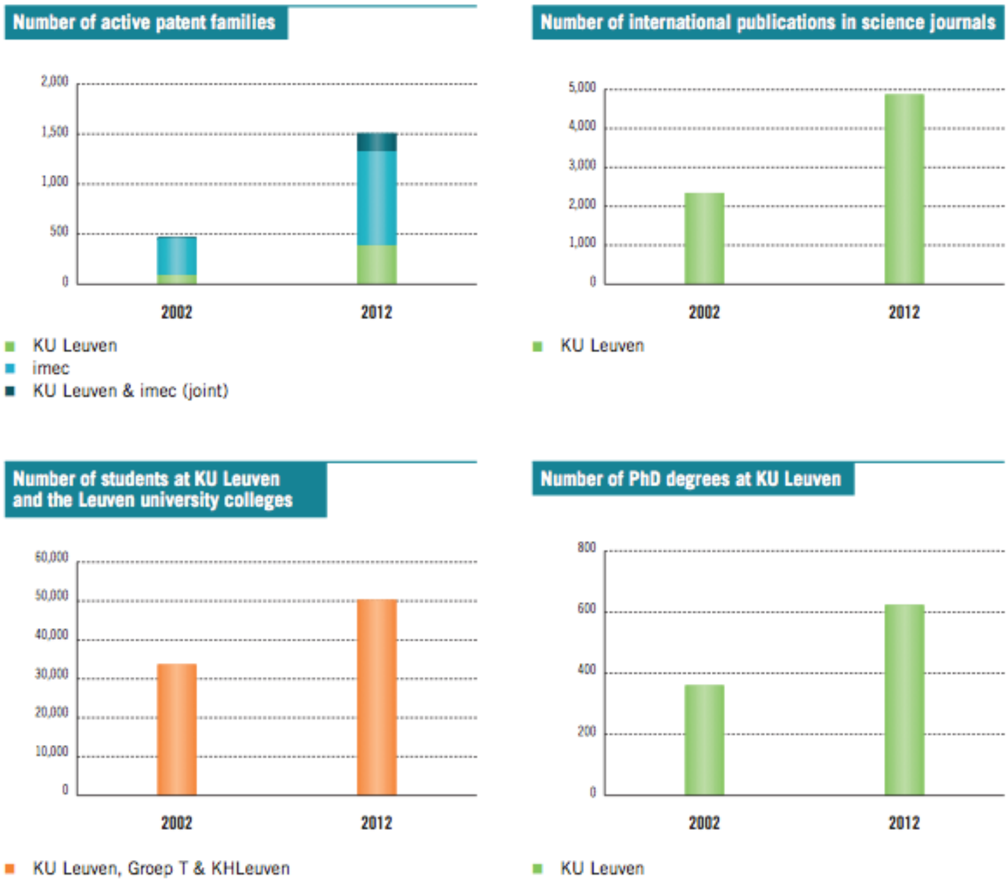


Figure 21: Evolution over the last ten years of 4 academic performance indicators (K.U. Leuven Research and Development, 2013)

The Leuven Innovation Networking Circle, Leuven.Inc, stimulates high-tech entrepreneurship by bringing together like-minded people from academic research groups, high-tech start-ups, consulting agencies, venture capitalist firms, and well-established companies in the Leuven region. In addition to this horizontal network, several specialized technology platforms are in place. DSP Valley focuses on the design of hardware and software technology for digital signal processing systems. LSEC is dedicated to creating IT security awareness in the industry at large. The Center for Drug Design and Discovery (CD3) aims to discover new drugs. Neuroelectronics Research Flanders (NERF) focuses on unravelling the neuronal circuitry of the human brain. The Leuven Medical Technology Centre (L-MTC) has developed expert skills in medical imaging, healthcare automation, biomaterials and tissue regeneration, biomonitoring and biocontrol. The Leuven Materials Research Centre (Leuven-MRC) monitors and coordinates research on materials development. The Leuven Food Science and Food Research Centre (LFoRCe) conducts ground-breaking research on the relationship between food and health. PharmAbs focuses on generating tailor-made monoclonal antibodies. The Leuven Centre on Information and Communication Technology (LICT) combines the expertise of electronics engineers, computer scientists and sociologists in the ICT field. In addition, the Vlaams-Brabant Innovation Centre aims to support innovation in SMEs.

Strong and dynamic triple helix cooperation between industry, knowledge institutes and government has led to a very favorable entrepreneurial climate. The city of Leuven and the province of Vlaams-Brabant collaborate closely on regional development. Together with the knowledge economy regions Eindhoven (The Netherlands) and Aachen (Germany), Leuven forms a strong cross-border network, ELAt (Eindhoven-Leuven-Aachen triangle). ELAt is one of the top European technological regions, promoting a knowledge economy via cross-border and interregional cooperation. Together with the biomedical clusters of Cambridge (UK) and Heidelberg (Germany), Leuven has formed the Health Axis Europe alliance to foster health innovation across Europe. Health Axis Europe promotes collaboration in the areas of regenerative medicine, stem cell research, medical devices and personalized medicine with a focus on research, development and education as well as on procuring financial support, particularly from within the funding structures of the European Union. Recently, Leuven joined the Community of Ariane Cities, which aims to strengthen the cooperation between cities and industrial organizations involved in European space transportation programs.

3.5 Overview of LRD's academic spin-offs in the biotech industry

LRD is one of the best performing Technology Transfer Organizations in the world regarding the creation of high quality spin-offs. Since the foundation of LRD in 1972, 102 spin-offs have been created. 85 of these companies are still active. In order to illustrate the strong performance of LRD in biotech related sectors, I provide an overview of 17 succesful spin-off projects of LRD:

- ADx NeuroSciences focuses on the development of (i) novel (bio)markers for use in dementia diagnosis (Dx) (Alzheimer's (AD), Parkinson's and other neurodegenerative diseases) and (ii) companion diagnostics. ADx NeuroSciences builds on its leading expertise, development know-how and capabilities to offer innovative solutions - from concept to clinical value - for Pharma and IVD.

- AlgoNomics provides integrated immunogenicity services to develop safer and more effective biopharmaceuticals. In 2009, this company was acquired by Lonza Group.

- Arcarios focuses on the development of innovative therapeutics in the field of bone and joint diseases. Its products are aimed at actively restoring bone or joint defects and address a clear unmet medical need.

- Better3Fruit develops new fruit varieties that meet the higher requirements of present-day consumers with respect to quality, safety and health.

- BioRICS develops and sells algorithms and software for measuring, analysing and predicting responses of living organisms, mainly humans, and use these biological responses for real time monitoring and management of the individual in sport performance, fitness and health.

- Cartagenia is a spin off project at the Center for Human Genetics, UZ Leuven and the KU Leuven Department of Electrical Engineering. Cartagenia's mission is to revolutionise the use of genetic information in standard medical practice by delivering a unique combination of highly specialized and reliable data management, integration, and mining applications.

- Complix is a biotech company dedicated to the discovery and development of protein therapeutics for pharmaceutical and medical device applications using its proprietary alpha-body™ technology.

- FORMAC is a specialty pharmaceutical company engaged in drug delivery and development. Our mission is to increase pharmaceutical R&D productivity and product value by enhancing the performance of (pre)clinical drug candidates and marketed drugs.

- FUGEIA is an innovation-driven company active in the field of health and nutrition with a focus on gut health. The company develops proprietary products and technologies targeted for a broad range of market segments, including dairy and non-dairy beverages, ready-to-eat cereals, cookies and biscuits, bread and pastry, as well as dietary supplements and therapeutics. Fugeia's products are the fruit of several years of pioneering research on natural plant-based compounds that improve health and well-being, and prevent diseases.

- IFAST (Innovative Flavor & Aroma Science & Technology) develops and commercialises intellectual property, technology and know-how related to the organoleptic and functional properties of foods and beverages.

- ImCyse was founded in 2010 and develops vaccines that are primarily targeted at immunological diseases, such as Multiple Scleroses (MS).

- IriDM focuses on discovering better drugs faster through an innovative proprietary approach that integrates biology, screening technologies, chemistry and computational science.

- Okapi Sciences aims to develop drugs to treat viral infections in both pet animals and livestock. In 2014, Okapi Sciences was acquired byAratana Therapeutics.

- reMYND offers services and tools to support drug discovery in Alzheimer's disease and neurodegeneration. reMYND offers in vivo drug testing in a wide variety of transgenic mouse models and is experienced in the generation of yeast strains expressing human (or other) genes.

- RNA-TEC specialises in RNA - unmodified as well as with base and/or sugar modifications - and non-radioactive isotopically labeled (13C and 15N) nucleic acid products. RNA-TEC's customers primarily consist of university research laboratories, large research institutes and pharmaceutical companies. RNA-TEC was acquired by IDT in 2006.

- ThromboGenics is a biopharmaceutical company focused on developing innovative ophthalmic medicines. ThromboGenics' core product, JETREA, represents a paradigm shift in the treatment of symptomatic vitreomacular adhesion.

- TiGenix is a biomedical company active in the area of tissue engineering and cell-based therapies. The company focuses on developing, marketing and selling innovative procedures and products for successful repair and regeneration of tissues, based on state-of-the-art technologies in cell biology, bio-surgery and bio-materials sciences.

3.6 Objectives and methodology

The research goal of this thesis is to examine how the assembly of top management teams is handled by K.U. Leuven Research and Development (LRD). By doing this, I hope to identify certain strategies that TTO's can follow in order to improve the assembly of successful top management teams for academic spin-offs. Finally, I will critically reflect on the way LRD handles this, and try to make suggestions for improvement if necessary.

I want to gain insight into how LRD handles the following tasks: deciding which management positions need to be filled, evaluating the entrepreneurial and managerial capabilities of academic researchers, generating a sufficiently large pool of qualified candidates for management positions, identifying succesful candidates for a position, and offering incentives to persuade managers to commit to the academic spin-off. These different tasks are performed in a more or less chronological order, and they are of course dependent on each other. Each task is a very complex undertaking, with a lot of different aspects that technology transfer organizations need to keep in mind.

To investigate these matters, I will conduct an interview with Paul Van Dun, the general manager of LRD. This interview will result in an overview of the actions that LRD undertakes to ensure a qualitative assembly of top management teams in the academic spin-offs of the KULeuven. Additionally, the interview will explore how LRD has evolved over time, and what LRD does differently compared to less succesful technology transfer organizations.

Paul Van Dun is general manager of KU Leuven Research & Development, the technology transfer unit of KU Leuven, and coordinates the activities in contract research, patenting, licensing, spinoff creation and regional development. He is also managing director of the venture fund Gemma Frisius Fund, board member of the Fondation Fournier-Majoie pour l'Innovation, chairman of the Centre for Drug Design and Discovery and board member or president of several high tech companies. From 2006 - 2010, he was elected vice-president of ASTP (Association of European Science & Technology Transfer Professionals, The Hague). In 1991 Mr. Dun joined KPMG, after which he took up a position with Investco/LPM, the private equity and venture unit of KBC Group, where he was active in portfolio management, legal issues and acquisitions. He was employed at KBC Private Equity NV. He is also member of the board of directors of several spin-off companies and of Capricorn Venture Fund II. He has degrees in law (KU Leuven), tax sciences (FHS Brussels) and business administration (KU Leuven).

I conduct a semi-structured interview with Paul Van Dun, in which I ask him several questions I deem important, whilst allowing him to mention additional aspects that might be essential in revealing the strategies used by LRD in the assembly of top management teams. This subchapter will give an overview of the predetermined questions and some follow-up questions.

- Does LRD evaluate the entrepreneurial and managerial capabilities of the academic researchers that create the spin-off?
    - What if the researchers are deemed incapable of being a competent manager?
        - Do they get extra training to gain managerial capabilities?
        - Are they advised to join the company in a more technological position?

        - Does this situation sometimes result in conflict? How are these conflicts handled?
    - How often do the academic researchers fill a leading managerial role in the company?
- How does LRD decide which management positions will need to be filled at the creation of a new spin-off?
    - Is there a blueprint of a perfect management team, consisting of a predefined number of positions?
    - Does LRD always try to install a management team or is the spin-off managed in some cases by a single entrepreneur?
- Does LRD manage the assembly of the management team in cooperation with the CEO or the academic researcher?
- In what order are the different positions of the management team filled?
- How does LRD generate a sufficiently large pool of external applicants to fill management positions?
    - Is there a formal procedure or is this mainly handled through informal contacts?
    - Does LRD have much difficulty in finding sufficient promising applicants?
    - Which kinds of profiles does LRD generally search for? What are the basic requirements for applicants to a management position?
    - Does LRD attract applicants on an international base?
- How does LRD identify succesful candidates for a management position?
    - How important are each of these characteristics?
        - Educational background
        - Industry experience
        - Functional expertise
        - Technical skills: the level of competency within various functional areas
        - Human skills: the ability to interact effectively with diverse groups of individuals
        - Conceptual skills: the capacity to learn and apply new knowledge
    - Is the impact of this new manager on the team dynamics considered?
        - Does the new manager need to share the same strategic vision with the rest of the management team?
        - Is the affinity of the new manager with the other managers considered?
        - What if there are ideological or interpersonal conflicts between the new manager and the rest of the management team?
    - Is the impact of this new manager on the team composition considered?
        - Wich efforts are done to stimulate differentiation in the management team regarding different characteristics?
        - Which efforts are being done to ensure good team integration?
    - Does a new manager need to prove himself during a trial period or is he offered a fulltime position right away?
- How does LRD incentivize management applicants to accept the job offer and commit to the spin-off?
    - Are the new managers offered partial ownership of the company?
    - Is this process strongly regulated or is there room for negotiation?
- How have the practices of LRD changed over time?
- How do the practices of LRD compare to those of other TTO’s?

4 Findings & Discussion

In this chapter, the literature on top management teams will first be briefly revisited. Then the findings of the interview with Mr. Paul Van Dun will be shared. Finally, the findings of the interview will be compared to the insights stated in literature.

The top management team of a succesful academic spin-off must possess the combination of both business skills and technology expertise (Frohman et al., 1981). It has also been stated in literature that high-tech companies are more often succesfully founded by an entrepreneurial team than by a single founder, since a team is more likely to possess all the necessary skills that are needed to create a high-tech venture (Chowdhury 2005, Colombo et al. 2010). According to Lockett et al. (2005), the academic researchers, whose results will be exploited in the academic spin-off, more often join the company as a technological adviser than as a manager. Moreover, Bonardo et al. (2010) have stated that including academics in the management team of an academic spin-off has been shwon to decrease the venture performance. In contrast, Ortin-Angel et al. (2014) argue that managers with a strong scientific background often make for better managers than managers without a scientific background. Ensley et al. (2005) have observed that management teams of academic spin-offs are usually more homogeneous in terms of education, industry experience, functional expertise and skills than those of independent ventures. Visintin et al. (2014) describe finding the perfect team composition for stimulating good team dynamics as a balancing exercise where one must try to achieve simultaneous integration and differentiation of academic and non-academic profiles. This is necessary because a good management team needs cohesion and mutual understanding, as well as complementarity of skills and different points of view that challenge each other. Visintin et al. (2014) also found that the management team size should be as small as possible, that the diversity in academic status should be minimized, and that similarity in prior experience and common past team memberships can be very beneficial.

“When starting a new venture, the three most important drivers of succes are the team, the team and the team”, Paul Van Dun told me. This confirms the views in literature on the importance of the management team in academic spin-offs. In most cases, LRD decides to create a spin-off only after they have already been in contact with the researchers for a long time. It is rather an exception when LRD decides to create a spin-off with an academic researcher they barely know. This can be expected, since researchers come to LRD at an early stage when they start thinking about protecting their results through intellectual property management. Subsequently, several possible ways of valorization are considerd before eventually deciding in some cases that starting a spin-off is the best way to commercialize the research results. So the people at LRD usually have a pretty good idea of the entrepreneurial and managerial capabilities of the academic researchers. And sometimes, the researchers proceed to important management positions in the spin-off, albeit under supervision of a more experienced mentor. But this mostly happens in cases where no external capital is needed. When external capital is needed, the external investors tend to demand highly experienced managers, pushing the academic researchers towards a more technological supportive role. If the researchers are poised on becoming managers themselves, LRD has long talks with them to discover their real motivations and to manage their expectations of what the managing job would be like. If after these talks, LRD feels that the researchers understand how different the managing job will be from their current research position, and if the researchers have the right motivation to create a succesful venture, the researchers can fill the management position.

One of the first actions that need to be undertaken when LRD decides to create a new spin-off is to determine what kind of management positions will need to be filled. Paul Van Dun confirmed that there is always need for people with technological insight and people with business development skills, which is conform to the literature (Frohman et al. 1981). But the proportions of importance of technology versus business development differ greatly among the different kinds of spin-off opportunity. For example, some deep life sciences projects still have 2 years of research ahead of them before they will be able to start thinking about making money. In those cases technological skills will be more important than business development skills. In other cases the technology is rather simple, and the biggest challenge will be excellent business development. In these cases, of course, more people will be needed with good business skills. Spin-offs in the biotechnology industry are almost always rather high-tech, and so every management team member needs to have a very strong affinity with biotechnology. If the management team member does not have an education in biotechnology, he or she should at least have industry experience. The tasks of the CEO are not always very well defined. Because the founding teams of academic spin-offs are still small in the beginning (on average 4 people), the CEO sometimes needs to fulfill several tasks. In most cases, the CEO needs to possess both technological skills and business skills to some point, although there are exceptions.

Once LRD has determined which management positions will need to be filled, they look at the potential management members that have already showed interest in creating this venture. LRD knows these people well from years of coöperation. Afterwards, LRD determines which additional profiles will need to be attracted. In the past, LRD sometimes hired a headhunter in order to find good management members. They have had bad experiences with this. Paul Van Dun explained to me that he does not believe that a good entrepreneurial manager for a spin-off would sign up with a headhunter. They take their faith in their own hands and they search for the specific opportunity that interests them. It also happens that the applicants are not currently looking for a new opportunity, but that they might be willing to give up their current job to join the spin-off. So, since headhunters are not an option, the major way of identifying potential new managers is through the network of LRD. Because of the fact that LRD has already been active for a long time, and their number of employees has grown from 12 to 80 employees over the last 15 years, they have an extensive number of contacts in a variety of industries. The employees also attend a number of networking events. If they meet somebody who shows potential, they often talk about this persons future professional interests. Afterwards, these people send their resume to LRD, which is kept in a database. Additionally, on average two people per day send in their resume voluntarily to LRD, people that LRD has had no previous contact with. This has everything to do with the succesful international reputation of quality that LRD has acquired throughout the years. If then, at a point in the future, LRD needs somebody for a new management position, they will go through this database. If this does not yield a satisfactory result, the employees of LRD all make inquirements in their network about the type of profile they are looking for. This informal network of LRD extends internationally, because a lot of LRD's activities have an international basis. This is due to the fact that, in high-tech industries, competitors come from all over the world. As a result of this international nature, a lot of members of the board of directors of academic spin-offs come from outside of Belgium. Also some executive management members are from countries other than Belgium, although this is a smaller number since they would have to permanently relocate. Despite of the extensive network of LRD, Paul Van Dun admits that finding the right applicants for a good management position still remains one of the biggest challenges for the creation of a spin-off.

Paul Van Dun described the attributes of the ideal spin-off manager as a bit paradoxical: they need to have the skills and the experience to run a high-tech company in an international competitive environment, while they need to be able to work (in the beginning) in a company of around only 4 people where they have to do a lot of things themselves and forego all the comfort (like a huge salary, multiple assistants, a company car, …) that jobs at big corporations would offer them. These people are motivated to make these sacrifices because they find this entrepreneurial job more enthralling. They like the responsibility, the feeling that they are realizing their full potential and that they are making a positive change. Sometimes however, managers decide after a while that the sacrifice is too big and they return to their corporate jobs.

The average age of starting spin-off managers is around 33 years old, although this varies greatly. The educational background, the industry experience, the functional expertise and the technical skills of a manager are all aspects that are important in the selection of potential applicants. These characteristics can be found on the resume of the applicants, and for each job a certain level of these characteristics is almost always a conditio sine qua non for being considered for the job. The human skills and the conceptual skills are evaluated through a series of conversations with the applicants, with and without the other team members. During these talks, certain skills of the applicants can be evaluated, like their talent for commercial negotiation. The most important talks are the ones with the other team members. In these talks, there needs to be a mutual concordance between the new applicant and the other members of the management team, both on a strategic, ideological and personal level. This confirms the views presented in the paper of Ensley et al. (2002) on top management team cohesion. Since recently, LRD is also considering the level of differentiation of the top management teams. They combine young enthusiastic managers with more experienced mentors, and managers with commercial talent with managers with deep technological insights, incorporating the advise from literature (Ensley et al., 2005).

The reputation of LRD as the founding organization of several succesful spin-offs is quintessential in its success. This positively influences the amount of applicants for management positions, as well as their motivation to fill the position. This reputation has been carefully built over time. A rigorous evaluation of spin-off opportunities is the most important way to guard the reputation of LRD, hereby maintaining its label of excellent quality. For LRD, the goal is not to create as many spin-offs as possible, as would be welcomed by policymakers and public opinion, but to build sustainable businesses. At LRD, managers are not always immediately incentivized with stock in the spin-off. They usually get stock options or warrants. This way they are bound to the success of the company. Typically, the management team combined owns around 25% of the stocks. Regarding the salary, there is a big difference among the types of spin-offs. Overall, the salary is often low relative to other job opportunities for managers, and the applicants are motivated by other aspects of the position than the salary. Spin-offs that need a lot of external investment will be compelled to hire very experienced managers, for which the investors will be happy to pay a more sizable salary. Managers with less experience are sometimes given a chance at a spin-off that is self funded, and they usually have to make do with a lower salary. These managers are generally motivated by the opportunity they are given to prove themselves, and the attractiveness of the job description.

The best performing management teams, according to LRD, consist of people that have previously worked together. This strongly confirms the results of Visintin et al. (2014). It often happens that a top performing management team loses interest in a venture after its growth has stagnated or it has been acquired by a bigger company. In these cases, entire management teams often jump on a new opportunity from LRD, sometimes even bringing along the other employees of the previous spin-off.

Overall, the findings of the interview confirm the insights from literature. The interview, however, also shed light on some topics that are not yet discussed in literature, such as the process of finding promising applicants for management positions. The interview also underlines the importance of a certain flexibility in the assembly process of a management team. It is always important to keep in mind the specific characteristics of the people involved and the uniqueness of the opportunity, this is why all findings will always be more of a guideline than an exact law.

That being said, let's look at the agreements and slight differences between the literature and the interview findings in detail. Paul Van Dun strongly confirmed the need for both business and technological skills in the management team of an academic spin-off. This indeed means that, in most cases, the academic researchers take on a more technolical advisory role, if they decide to join the company. LRD is aware of the dangers of too homogeneous teams, and they actively strive to reduce this. Most teams are therefore heterogenous in all the aspects mentioned in literature as well as in their level of experience. If LRD includes the academic researchers in the management team, the motivations and expectations of these researchers are carefully examined and managed. When considering an applicant for a managing position, the characteristics mentioned in literature (education, functional expertise, industry experience, human and conceptual skills) are more of a prerequisite for being considered than the basis on which the hiring decision is made. In the biotechnology industry, a strong affinity with biotechnology is an absolute must for every applicant. The most important information on the applicants is gathered through several conversations, with and without the rest of the management team. These conversations allow the applicant to propose his vision for the company and to demonstrate his human and conceptual skills. Most importantly, the conversations with the rest of the management team allows LRD to examine the level of cohesion that can be expected to grow between the different team members. This shows that the dynamics of the management team are actively considered by LRD in their team assembly decision making process, confirming the statement in literature that team dynamics are very important.

5 General Conclusion

This thesis started by explaining the shift to the knowledge-based economy. This shift was caused by the IT revolution and an increasing trend of globalization (Houghton et al., 2000). In this new paradigm, knowledge became the key resource in the economy. It was suddenly possible to codify, process and communicate knowledge on a massive scale. Meanwhile, because of the removal of trade barriers, it became necessary to compete in an international environment.

This shift to the knowledge-based economy had profound implications on the way countries and companies competed for their piece of the pie (OECD, 1996). Investments in R&D, education and training grew substantially. A lot of attention went to the distribution of knowledge and how this could be optimized in national or regional innovation systems. Highly skilled labor became increasingly important as unskilled labor decreased in value, in order to be able to maximize the use of technology for efficiency gains. Science-based technologies, like ICT and biotechnology, offer great opportunities for innovation in this new situation. Public research institutions and universities became an important part of stimulating economic growth. In the study of national innovation systems, the Triple Helix model rose to prominence (Leydesdorff and Etzkowitz 1997, 1998, 2000), underlining the importance of three-way interactions between science, industry and government.

In order to comply with the new demands for a university, the paradigm of the Entrepreneurial University was created (Etzkowitz 1983, 2003, Branscomb et al., 1999, Etzkowitz et al. 1998, 2000, Van Looy et al. 2011). The Entrepreneurial University has three missions: teaching, research, and economic and social development. The third mission involves maintaining good industry-science links. These industry-science links include the creation of technology-oriented enterprises, collaborative research, contract research, know-how based consulting, intellectual property rights management, and several informal forms of interaction. To be able to successfully manage these industry-science links, universities founded Technology Transfer Offices (TTO's). In order to commercially exploit the academic research that is conducted at a university, its TTO handles all the activities of this university along the technology transfer value chain: the exploration, technical validation and exploitation of knowledge-based opportunities.

Three critical factors have been identified for a successful functioning of a TTO: decentralization, the creation of proper incentives for researchers, and the pooling of critical specialized resources such as legal counseling and business development (Debackere et al., 2005). The creation of academic spin-offs plays a pivotal role in successful TTO's, since academic spin-offs are particularly well positioned to orchestrate the transformation of scientific knowledge into commercial applications. This transformation process can be divided into four stages: the generation of business ideas from research, the finalizing of new venture projects out of ideas, the launch of spin-offs from these projects, and the strengthening of the economic value created by the spin-off (Ndonzuau, 2002).

One of the main reasons for failure of academic spin-offs is not so much the poor quality of the business opportunity, as the poor quality of management (Timmons, 1994). This is why, at the creation of a new spin-off, TTO's must appropriate a significant amount of attention to the assembly of the top management team. The top management teams of academic spin-offs have been shown to systematically underperform in terms of net cash flow and revenue growth compared to those of independent new ventures (Ensley et al. 2005, Visintin et al. 2014, Ortin-Angel et al. 2014). It has been claimed that this is due to the fact that the management teams of academic spin-offs are more homogeneous in terms of education, industry experience, functional expertise and skills (Ensley et al. 2005). Another possible cause is the possibility that academics might have other objectives besides profit in managing their business (Visintin et al. 2014).

An adequately performing top management team must possess both extensive technological knowledge and business acumen, in order to make informed decisions in the international high technology competitive environment (Frohman et al. 1981). This necessity for a wide array of skills is why entrepreneurial teams usually outperform single founders (Visintin et al., 2014). Former academic researchers who have gathered a couple of years of industry experience are found to best combine the different tasks that are asked of a spin-off manager (Ortin-Angel et al. 2014). It has also been shown that teams with shared previous experiences and past memberships of the same team perform especially well (Ensley et al., 2002).

When assembling a management team, TTO’s must pay careful attention to the team composition in order to optimize the team dynamic. This is a balancing exercise: the perfect team needs simultaneous integration and differentiation of several contrasting profiles (Visintin et al., 2014). Integration is needed for good team cohesion; without it the team members will not be able to build a good foundation for mutual understanding and respect. But differentiation is essential at the same time, to guarantee that members will challenge each other’s opinions by approaching matters from a different point of view.

In this thesis, the context plays an important role. This research is set in the Belgian biotechnology industry. One can say that Belgium has been performing rather well in recent years, based on several innovation indicators (BDI 2013, Eurostat 2013). This indicates that Belgium, and in particular the knowledge regions of Brabant Wallon and Vlaams-Brabant, has adapted well to the knowledge-based economy. The majority of this innovation happens in ICT and biotechnology. The total annual turnover of the Belgian biotech industry is estimated at 1.9 billion euro, accounting for 16% of Europe’s annual turnover (Flandersbio website). The Belgium innovation system has always focused on this industry, resulting in a very good supporting infrastructure. The policy framework on the different governmental levels, that has impact on the creation of academic spin-offs in the Belgian biotech industry, will also be discussed in this thesis. K.U. Leuven Research and Development (LRD), the TTO of the K.U. Leuven, has been instrumental in the development of the Belgian biotech industry. Founded in 1972, it was one of the very first technology transfer offices in Europe. Since then LRD has acquired an international reputation of excellent quality, inspiring many other TTO’s to follow its example. Key figures for LRD in 2009 are: a total turnover of 136 million euro, about 1200 new contracts managed; 156 invention disclosures resulting in the filing of 73 new patent families (Price Waterhouse Coopers, 2011). LRD has already created over 100 spin-off companies, of which 85 are still active (LRD website).

Since LRD is one of the most successful TTO’s in the world, with a long history of commercializing scientific research, it is the perfect subject for this study. The research in this thesis consists of a case study of the top management team assembly mechanisms at LRD. This case study is performed by analyzing an extensive semi-structured interview with Mr. Paul Van Dun, the general manager of LRD. This interview includes questions about how LRD finds and evaluates potential applicants for management positions, how the participation of academic researchers in the management of the spin-off is handled and how LRD ensures a good management team dynamic.

Overall, the findings of the interview confirmed the insights from literature. The interview, however, also shed light on some topics that are not yet discussed in literature, such as the process of finding promising applicants for management positions. The interview also underlines the importance of a certain flexibility in the assembly process of a management team. It is always important to keep in mind the specific characteristics of the people involved and the uniqueness of the opportunity, this is why all findings will always be more of a guideline than an exact law.

That being said, let’s look at the agreements and slight differences between the literature and the interview findings in detail. Paul Van Dun strongly confirmed the need for both business and technological skills in the management team of an academic spin-off. This indeed means that, in most cases, the academic researchers take on a more technolical advisory role, if they decide to join the company. LRD is aware of the dangers of too homogeneous teams, and they actively strive to reduce this. Most teams are therefore heterogenous in all the aspects mentioned in literature as well as in their level of experience. If LRD includes the academic researchers in the management team, the motivations and expectations of these researchers are carefully examined and managed. When considering an applicant for a managing position, the characteristics mentioned in literature (education, functional expertise, industry experience, human and conceptual skills) are more of a prerequisite for being considered than the basis on which the hiring decision is made. In the biotechnology industry, a strong affinity with biotechnology is an absolute must for every applicant. The most important information on the applicants is gathered through several conversations, with and without the rest of the management team. These conversations allow the applicant to propose his vision for the company and to demonstrate his human and conceptual skills. Most importantly, the conversations with the rest of the management team allows LRD to examine the level of cohesion that can be expected to grow between the different team members. This shows that the dynamics of the management team are actively considered by LRD in their team assembly decision making process, confirming the statement in literature that team dynamics are very important.

The insights provided by this case study are very enlightening, but it is important to also keep in mind the limitations that are inherently implied in this type of research. The results from a case study always pertain to only one case. The extent to which these results can be generalized depends on the level on which one can say that the case is a good representation of the entire population. There are a lot of different types of TTO’s in the world, with varying levels of experience, different ranges of activities, and probalby also with different operating mechanisms. Thus it would be unwise to draw general conclusions regarding all technology transfer organizations, based on this one case study.

This is why further research on this topic will benefit from further case studies, preferably performed on a wide range of different cases. This would allow researchers to discriminate general factors that attribute to a good top management team assembly mechanism from factors that are due to mere coincidences. Furthermore, a quantitative study that explores the different informal mechanisms in which potential management position applicants are identified would be necessary.

List of figures

List of tables

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