Commercialization of University Patents: A Case Study

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The primary aim of this paper is to explain why some patents are exploited, through, spin-off formations and/or through licensing to established companies, while others are not. The study employed qualitative methods incorporating a case study approach of 22 patents from a portfolio of 82 patents from a university in Scotland. Interviews with the TTO director of the University and seven other universities TTO Directors were also conducted. Whether a patent is commercially exploited, and the way in which it is exploited is influenced by three main factors: (i) the entrepreneurs and the inventors, their characteristics and motivations; (ii) the characteristics and nature of the technologies; and (iii) the TTOs' lack of resources and a due diligence system. The study suggests for how TTOs can enhance their decision-making process, regarding which discoveries to patent in order to improve the overall effectiveness of commercialization process in universities.

INTRODUCTION

Commercialization of university patents is becoming an important agenda, leading to new manifestations towards entrepreneurial university. The importance of commercialization of university patents can be seen through the contribution of university spin-offs towards local economic development (Etzkowitz, 2002; Etzkowitz, 2003; Shane, 2004). The influence of Route 128, Silicon Valley in the US and the Science Park in Cambridge in the UK (Oakey, 1995, Etzkowitz, 2003) are recognised by policy makers as sources of industrial innovations that could trigger and provides job opportunities. Extensive researches have been done on commercialization of university patents. However, there is scarce evidence of studies looking into how decision making process in commercialization, were exercised in universities. Universities keep patenting their inventions even though the ratio of exploited patents is small compared to unexploited patents.

This paper tries to discuss this issue looking into the views of the inventors of unexploited patents, patents that were commercialized through spin-offs and patents that were commercialized though licensing to established companies.

The research question for this paper is *who are the actors involved and how the decision making process of commercialization of university patents have been made?*

LITERATURE REVIEWS

There are three major factors that influence whether a patent is likely to be exploited, or otherwise.

Individual Characteristics, Motivations and Ability to Recognise Opportunities

There is substantial research on entrepreneurship which focused on personal characteristics as a predictor of entrepreneurial activity (Roberts, 1991a) or champions to new ventures. Robert's (1991a) study of high technology entrepreneurs demonstrated that the factors that led inventor-entrepreneurs to form spin-off companies are outgoing characteristics, extrovert personalities, are from families with business background, independent, have work experience, achieved higher education and skills, and are dissatisfied with existing jobs. The main factor that pushes inventors towards being entrepreneurial is the desire to see their inventions being commercially exploited and only then followed by their desire for wealth creation and independence (Blair and Hitchen, 1998; Shane, 2003; Shane, 2004). On the other hand according to Khilstrom and Laffont, (1979) those inventors who license their patents to established companies may not fulfil all the characteristics above, and may prefer to be an employee. As for those inventors whose patents were not exploited, some do possess entrepreneurial traits but other factors which will be discussed later influenced why their patents were not exploited (Ismail, 2007, Ismail et al 2010).

Organisational Resources and Capabilities

Spin-off ventures are different mode of exploitation compared to traditional licensing or others. They developed out of a non-commercial environment. Thus, during their formation these companies would acquire different resources from other start-ups and licensing to established companies. The resources that are required at the launch period are: the technologies, a strong network, participation of the inventors or entrepreneurs in the product development, and skills/capabilities of TTO.

Characteristics of Technologies

Spin-offs occur in situations where technologies are at an early stage, have strong patent protection, multipurpose and involve technological breakthroughs (Shane, 2001a; Shane, 2001b; Shane, 2004). Established firms refuse to exploit early stage, multipurpose and radical technologies as they were considered costly to develop, and constitute high risk. New technologies may cannibalise their existing production process, and may compete with existing products. (Shane, 2000a; Shane and Khurana, 2003; Shane, 2001a; Shane, 2004).

Networking and Involvement of the Inventors

Studies indicate that inventors with strong networks and social ties, would facilitate spin-off formations (Shane and Cable, 2002; Lockett et al., 2003b; Shane and Stuart, 2002; Shane 200, Ismail et al, 2010). These networks help the founders of new ventures to access external funding and potential customers. Some organisations and firms that the inventors had worked with would become first customers for the new ventures (Perez and Sanchez, 2002). Next is the commitment of the inventors to product development. In fact, commitment begins at the opportunity recognition stage and continues until the company has been formed and sustained. Inventors' commitments are important because most of the university technologies are at an embryonic stage when the companies were formed, which involve tacit knowledge (Thursby et al., 2001; Shane, 2004). Similar trends occur to inventors who licensed their inventions to established companies (Thursby and Thursby, 2001; Ismail, 2007). Those who did not have contacts with industries were most likely no to have their inventions exploited (Colyvas et al., 2002).

Resources and Capabilities of TTOs

TTOs should have skilled and experienced officers, well versed with the legal aspects of patents and patenting. TTOs also need to have good negotiation skills with inventors and investors, a good link with inventors and faculties, industry, private financiers, which would lead to quality approach to inventions and thus could secure funding for spin-off formations.The skills and capabilities of the TTOs are

important in the decision of what to patent and then which route to commercialize the patents. It was emphasised in literatures that wrong selection can lead to many patents being granted and not exploited. Wrong selection and high market expectation (McAdam et al., 2004) may lead to increased low quality spin-off companies which would perform poorly and would be unsustainable (Lambert, 2003; Raven, 2006). The TTOs skills and capabilities are associated with affecting the availability of resource (Lockett et al., 2003a; O'Shea et al., 2008) from which they are able to employ quality surrogate entrepreneurs or patent agents to evaluate disclosures before proceeding further (Franklin et al., 2001; Siegal et al., 2004). Lockett et al. (2003a) further noted that the availability of resources (stock of technologies, and skilled staff), incentives and rewards, business development capabilities and the ability to access external finances and networks, were the main factors that facilitates the formation of spin-off companies in universities. It could be further concluded that the entrepreneurial role of TTOs, their expertise and networking abilities, their ability to recognise opportunities and organise equity ownership for the spin-offs are the characteristics required to succeed in the ventures (Lockett and Wright 2005; Powers and McDougall 2005 and O'Shea et al., 2005). However, these studies focused solely on the TTOs' skills and competencies but did not look at how the TTOs were involved in the decision making process. Universities favour licensing their patents to established companies when the technologies are at the later stages. They were also influenced by the inventors who were not interested in becoming involved in commercialization activities but were only willing to be involved in product development. Licensing then only required the inventors to commit to product development. Late stage technology commitment is not as great as early stage technologies (Thursby and Thursby, 2004; Markman et al., 2005). Thus, if the inventors are not willing to be involved with a very complicated process of spin-off formations (Vohora et al., 2003, Birley, 2003) licensing to established companies are the more suitable route.

METHODOLOGY

The paper is based on a single case study in one of the universities in Scotland. Two types of patents were selected: exploited and unexploited patents. A total of 22 patents from its portfolio were selected, of which six patents were licensed to spin-off companies, another 6 patents were licensed to established companies and 10 patents were not exploited. One of the inventors has two patents, thus the actual number of inventors involved were only 21. The University TTO Director was interviewed to get deeper understanding on the commercialization process. Another six TTOs directors were interviewed to strengthen this understanding, of which three were English universities and the other three from Scottish universities. Inventors were interviewed in depth, using semi-structured questionnaires. The interview data were analysed using case analysis and cross-case analysis aided by Nvivo software.

FINDINGS

Background of the Inventors

Inventor-entrepreneurs are younger than both the inventors of unexploited patents and those whose patents were licensed to established companies. Table 1 shows the classifications of patents and their inventors. All the inventors are from science and engineering departments, except one from the faculty of education. The average age of the inventors of the unexploited patents, at the time of the interviews, was 52 years, the same as the average age of those who licensed their patents to established companies. At the founding of their spin-off companies, the average age of the inventor-entrepreneur was 35 years. At this age, the inventors were still young, and energetic, and they were highly motivated. These average ages are consistent with studies by Roberts (1991a). All the inventors for unexploited and those patents that were licensed to established companies have PhDs and hold administrative posts, and are very senior than the inventor-entrepreneurs. Two inventors from the spin-off group hold Masters Degree (MSc) and four others have PhDs. The majority of the inventors (70%) in this study (17 out of 21) have industry experience either as employees or consultants. Of the 4 inventors who had no industry experience, 3 were inventors of unexploited patents, while the other one commercially exploited his patent by licensing to an

established company. The finding is consistent with previous studies (Shane and Venkataraman, 2000; Shane, 2000a; Shane, 2000b; Vohora et al., 2003; Shane, 2003; Shane and Khurana, 2003; Shane, 2004; Elfenbien, 2005, Ismail et al, 2010).

TABLE 1:
TYPES OF PATENTS AND THEIR INVENTORS' DEPARTMENT

	Patent Numbers or companies	Departments
Unexploited patent n = 10	1.	Education and Computer
	2.	Electric and Electronic Engineering (EEE)
	3.	Centre for Photonics
	4.	Pure and Applied Chemistry
	5.	Naval architecture and Marine Engineering
	6.	Chemistry and Process Engineering
	7.	Electric and Electronic Engineering (EEE)
	8.	Immunology Dept, SIBU (Strath. Inst for Biomedical Science)
	9.	Pure and Applied Chemistry
	10.	Pure and Applied Chemistry
License to spin-off company n=6	11/Co. A	Mechanical Engineering
	12/Co.B	Bio Engineering
	13/Co.C	Pure and Applied Chemistry
	14/Co.D	Electric and Electronic Engineering (EEE)
	15/Co.E	Physics
	16/Co.F	Computer Science
License to establish company n=6	17	Bio Engineering*
	18	Bio Engineering*
	19	Pure and Applied Chemistry
	20	Computer Science
	21	Pure and Applied Chemistry
	22	Pure and Applied Chemistry

Note*= from one inventor

Motivation to Commercialize

All the patent holders said that their main motivation for the commercial exploitation of their research was to see their inventions being utilised. Their desire for their research results to be useful is universal among the inventors interviewed. However, for each type of patent, the degree of motivation is somewhat different. The inventors whose patents were licensed to established companies are professors or senior academics. They are quite risk averse, especially involving any entrepreneurial activities, which are required in setting up and running a spin-off company. Thus, they generally prefer their patents to be licensed as this would not require further effort on their part, except to support the licensees, if required. The inventors whose patents were licensed to spin-off companies have the highest desire level to see their inventions being adopted. This high motivation drives them to form companies to commercially exploit their technologies, as they believe that this route of exploitation is the best way to ensure the success of their technologies. This is the push factor identified by Shane (2004).

All the inventors whose patents were not commercially exploited also wanted their technologies exploited. They considered commercial exploitation of their patents to be a symbol for success. They also have 'need for achievement' personalities. This is the prime reason they initially committed to conduct research project. However, these inventors were not willing to go out to market their technologies. They were normally busy with administrative and academic works and not willing to invest their time for commercialization activities.

Opportunity Recognition and Industrial Experience

Inventors and industry played a dominant role initially recognising the opportunities for the exploited patents. Industrial experienced played an important part in recognising the opportunity for both types of commercialized patents, especially for those licensed to spin-off companies. Industry knows the market applications and the market size for the technologies. There is a demand for technologies where university inventions are near to industry applications. The TTO did not contribute to the recognition of the opportunities in any patents that were licensed to spin-offs. For example inventors of Patents 12, 14 and 16, which were licensed to spin-off Companies B, D and F respectively, recognised the opportunities before the TTO. However, the TTO did play an important role for two technologies that were licensed to established companies (Patents 20 and 22). This is an obvious difference between the two types of patents. This finding supports Colyvas et al. (2002) who reported that the role of TTOs is useful when marketing activities are most important for certain technological areas, whose existing links between academia and industry are weak. This study also shows that the companies that helped to recognise the opportunities for a particular patent became licensees of that invention after they funded further works into the inventions. The establishment of links between industry and researchers through prior work experience in the industry, either as employees or as consultants, helped them to know the market and recognise the opportunity. As such, the opportunities were recognised when the research projects were formulated or during the course of the research when results were analysed. This supports findings by Shane (2000) and Shane and Khurana (2003).

The Stage of Technologies

In this study, the majority of patents that licensed were at proof of concept stage. All the technologies (100%) of unexploited patents, half (50%) of the technologies that were licensed to spin-off companies and half (50%) of the technologies that were licensed to established companies were at proof of Concept stage (POC). This supports Thursby et al. (2001) who reported that 75% of the technologies that were licensed were at proof of concept stage. Five patents were at prototype level, of which two were exploited through established companies and three were licensed to spin-off companies.

The Roles of Technology Transfer Office

The main tasks of the TTO of a university are to facilitate, manage and being the agent for the transfer of technologies from the University to the market. But the involvement of the TTO in the perception of the inventors varies from being very helpful to non-cooperative. The holders of the

unexploited patents claimed not to have received enough help from the TTO to market their inventions. Half of the inventors of the patents that were exploited through spin-off companies, commented that they did not received much help in forming their companies while the other half claimed that the TTO was very supportive. In contrast, all the inventors whose patents were licensed to established companies claimed that the TTO was very supportive and helpful. More than half of unexploited patents holders reported that the TTO did not have sufficient resources, skills and capabilities to help them market their patents. This lack of resources, skills and knowledge of the TTO is recognised by the TTO Director himself. The University has research programmes covering a wide range of technologies. The TTO Director thought that it is impossible for the TTO staff to be experts in all fields. Hence it is difficult for the TTO to market all the University inventions.

The Decision to Patent

The decision to file for a patent for a newly disclosed technology normally involves the inventor, the TTO or the industry individually, although the decision could be made jointly by more than one of the parties above.

Generally, the finding shows that the TTO took more active participation in the decision to seek patent protection in the case of unexploited patents. Of the 10 unexploited patents, three were decided by the TTO, three by the combined decisions of the inventors and the TTO, two by the inventors themselves and two by industry. In certain circumstances, the TTO and inventors influence each other in deciding to pursue patents, but the industry decision became paramount if they funded the research project.

The patents that the University licensed to established companies showed a slightly different pattern. Half of the decisions to seek patent protection were made by the TTO, and another half by the research team and the industry partner. The inventors were more influential in the decisions for the patents that were licensed to spin-off companies.

The Decision to Commercialize

The decision to patent that led to the 'intention to exploit' for unexploited patents mainly was decided by the TTO. The decisions on three patents were made by the TTO alone, and another three by joint decisions of the inventors and the TTO. This included two patents that have a potential to be exploited. The decision on the remaining two patents was made jointly by the industry and the inventors. Half of the decisions to commercialize through licensing to established companies were initiated by the TTO and the other half by the research teams or the inventors.

This differed from the decisions to exploit the patents through licensing to new spin-off companies. All of these decisions were initiated by the inventors. For patents that were licensed to new spin-off companies, different actors initiated the decisions to patent and the decisions to commercialization. For nearly half of the inventions the TTO initiated patent protection. This might have been due the inventors not seeing the importance of their patents initially, due to a lack of entrepreneurial awareness. However, they recognised the potential after their commercial network were strengthened. Hence all the decisions to exploit the patents were decided by the inventors.

DISCUSSION

Inventors' Background, Industry Experience and Opportunity Recognition

Most of the inventors for unexploited patents were very senior and hold administrative posts in their departments as heads of department. The inventors who licensed their patents to established companies are in similar situation. Their average age is 52. They enjoyed stable positions and are comfortable with their posts. These types of inventors were risk-averse. Another reason is the University, at the time their patents were granted (before the year 2000), was only encouraging licensing to established companies rather than forming spin-offs.

This group of inventors looked at spin-offs as a risky which academic staff should not be involved in. This is the main reason why they sought to commercialize their research through licensing to established

companies. Most of the inventors whose patents were exploited through spin-off companies were young lecturers who considered their standard of living to be outside the comfort zone of the professors. For the young inventors, even though the main drive was to see their inventions being utilised, the secondary objective to create wealth was also very strong.

The finding showed that 70% of the patent holders whose patents were not exploited had prior industry experience. It is very tempting to disprove that industry experience would facilitate the commercialization of patents. But looking more closely at these unexploited patents, it became clearer that the technology itself, even if it was patented, was not really ready for the market. The fact the patents are unexploited was more likely due to the technologies being immature, inefficient proof of concept and were unreliable, as suggested by Hsu and Bernstein, (1997). The chance of the patents being unexploited increase if the inventors hold administrative posts, such as Heads of Department and Deans. Administrative works limits their time for efforts to commercialize their patents.

Conversely, for exploited patents, industry experience seems very important factor that led to the research results being exploited through spin-off or established companies. Prior knowledge of their industry helped identify customer needs, manufacturing and sales needs, finally leading to identifying of opportunities (Vohora et al., 2003). This finding is consistent with previous studies which suggest that inventors who had prior industry experience are more likely to form companies (Shane, 2000a; Shane, 2003; Shane and Khurana, 2003; Shane, 2004; Elfenbien, 2005) to exploit their inventions.

In the case of the inventors that license their patents to established firms, their prior working experience in industry as consultants or employees helped them get contacts to license their technologies (Colyvas et al., 2002; Thursby and Thursby, 2000;Thursby and Thursby, 2001; Thursby et al., 2003). Industrial experience and the technology stage led the inventors to recognise and exploit the opportunity. In summary if the TTO or industry recognised the opportunity, the patent is more likely to be exploited through established companies via licensing. If it is the inventors who recognised the opportunity, then the patents are more likely to be exploited through spin-off formations.

Motivation Factors of the Inventors

The main difference between inventors who licensed their technologies to established companies and the ones who formed spin-off companies to exploit their technologies was the latter's willingness to take risks and make increased efforts in the ventures. The former are risk-averse and would prefer other parties to push their technologies into the market.

The Stage of Technology

In the case of unexploited patents, all were claimed to be at proof of concept stage but were not exploited. Henderson et al. (1998), and Hsu and Bernstein (1997) suggested that most of these technologies are of low quality with insufficient proof of concept: thus, they are not commercially viable (Trajtenberg, 1997). This is generally reflected in the unexploited technologies in this study. There was 'insufficient proof' of the concept, that most could not attract interest for commercialization, the exception being Patents 9 and 10, which had shown market potentials.

Of the patents that were licensed to new spin-off companies, half were at the embryonic stage, thus the technologies are uncertain and need huge investments for further development. University technologies that are at a very early stage of development and are unproven cannot be licensed easily to established firms. Such firms are more likely to exploit later stage technologies. These concur with Shane (2001a, 2004).

This study also found that the inventors who wanted to market their newly patented technologies have little seed money and initial funding to form spin-off companies with. This inhibits the inventors from building prototypes or other efforts to prove the commercial viability of their inventions. Respondents in this study further said that prototypes were only built when the companies had been incorporated and had received funding from sources that are designed to support the commercialization process (mainly government).

Shane (2004) stated that, established firms tend to license late stage technologies, however in this study they exploited one early stage technology (Patent 19) and three were proof of concept stage technologies (Patents 17, 18 and 22). The possible explanation here is that the companies that adopted those technologies were already involved with the inventors from early on in their research projects as suggested by Markman et al. (2005) and Colyvas et al. (2002). Another reason why the University licensed this type of technologies to established firms is to conduct further research in collaboration with industry expertise.

Since the final outcomes of the technologies are not known but some proof of the concept had been shown, the University only received low royalty payments, which are normally paid as lump-sum payments until the inventions enter the market. Markman et al. (2005) said that universities normally considered this type of 'licensing' as money for sponsored research but the company would be given first refusal rights for 'proper licensing' if the technologies come good later on.

Another reason why the TTO tries to license early stage or proof of concept stage technologies to established companies was to have long-term relations with them. These relationships should ease the efforts to secure future sponsorships or contract researches, even though the money is not as much as the license for later stage technologies.

The amount of monies to be received by universities depended on the stage of the technologies licensed and the form of payment (cash, sponsored research or equity of the licensing companies). It would also be influenced by the aims and overall objectives of the universities with regard to the commercialization policy, such as to support government innovation policy, to develop the regional economy or to purely generate cash for the University.

The TTO Roles, Decision to Patent and to Commercialize

There are few reasons the University patent the inventions even though they were not exploited. This may be to gain financial benefit in the future, to obtain funding, as strategic reasons, to test the market of the inventions, to allow academic staffs to conduct research without competition, and to gain collaboration with other organisations. These lead the TTO seek patent protection for some inventions.

Half of the inventors of patents that were licensed to established companies commented that industrial network lead to their patents being exploited. One of the reasons is, prior to 2000 the university focused their licensing efforts towards established companies. Indeed before the year 2000, there was no real push for the formation of technology spin-off companies in UK universities, as suggested by Clark, (1998).

Spin-off company formation activities in UK universities were mainly driven by 'entrepreneurial scientists' who had work experience with industry. The opportunities were commonly identified by their industry partners or clients for whom the inventors worked (Companies C, D and F). In these cases, the new spin-off companies did not receive adequate support from the TTO. Assistance in writing business plans was limited and resources for product development and market testing were not available.

This had led the inventors to believe that the TTO is only capable of licensing patents to established firms but not capable enough in helping inventors to exploit their patents by forming spin-off companies. Since 2000, the policy of the University changed towards giving more support towards spin-off formation activities. This was basically driven by the change in government policies and availability of various funds to support the exploitation of new technologies from universities. Although more proactive policies were introduced, initially, individual motivation and initiatives were identified to be the main drivers for company formations. With the new policies, the TTO through the Centre for Entrepreneurship provided entrepreneurial courses that coached inventors in the identification of opportunities, writing business plans, raising finance and networking with financiers and local businesses. Ventures were then financed with the help of seed funds that had been set up by the government. Thus, post-2000, companies like Companies A, B, and E, received more support from the TTO than older spin-offs. The TTO is now also in the process of upgrading their staff and their policy guidelines, a process which was also noted by Lockett et al. (2003b; 2005) in other universities. In fact the TTO still does not have any due diligence system as to how to evaluate new technology disclosures, although it claimed to have been involved with spin-off company formations since 1982 . Even if the due diligence system is set up, it requires quite an

effort to bring the TTO staff to the high level of competency required to analyse and evaluate new technologies, and then manage their commercialization process as contended by Vohora et al. (2002).

There is a significant perceived difference in the support given by the TTO to inventors whose patents were licensed to spin-off companies and those whose patents were licensed to established companies. In the case of patents that were licensed to established firms, all inventors reported that they were satisfied with the services given by the TTO. All of them commented that the TTO was very supportive, knowledgeable, highly skilled, highly capable, and were experts in negotiation skills. The latter are more satisfied with the TTO, mainly due to the fact that the TTO was originally formed when university spin-offs were not in fashion, hence the expertise in the office was based around marketing patented technologies to established companies. Efforts to license to spin-off companies and to established companies require different skills and capabilities.

It was also noted that most of the patents that were licensed to established firms were in life sciences, such as patents on drugs and bioengineering. The TTO has the right skills by training its people in these skills or bringing in experienced people by offering higher pay and/or some kind of rewards system (Siegal et al., 2003a; 2003b; 2005). This is because licensing to established companies gets the most cash as quickly as possible for the universities.

Forming companies to license patents requires the University to incur initial investment costs and extra efforts are required from the TTO, and the University will only get a financial return when the company is sold or has an IPO. Another issue is that major activities in licensing to established companies stop (just need to monitor the companies) when the licensing agreements and contracts were signed, especially for late stage technologies. However, for spin-offs the TTO needs to be involved beyond the start-up stage (Lockett et al., 2003a; Lockett and Wright, 2005).

This is illustrated by Patent 10 whose technology was tested and was found to be very viable, but no licensee could be found. Finally, a decision was made to form a spin-off company to market products using the technology. Similarly, Patent 16 that was initially licensed to, but was not exploited by, Orange was finally licensed to a new spin-off Company F.

Over and above all the considerations that are discussed, the TTO has to take account of the University's overall objectives and strategies for commercial exploitation of their patents. Different licensing strategies are associated with different outcomes, such that universities that primarily seek R&D capital have lower commercial revenues and fewer spin-off formation activities. In this study the director of the University's TTO revealed that the main objective to the University is licensing for cash and sponsored research, though this is not mentioned in the official University policy. This is understandable as this policy is the least risky. It was found that most universities have the same policy, such that spin-off formation would be efforts of last resort as mentioned by Markman et al (2005).

LIMITATION OF THE STUDY

This study has provided important insights into the decision making process of commercialization of university patents. However, the study has a number of limitations. First, the study is based on a case study of the patents of one University, which may affect its generalisation. Second is the way the sample was accessed. The TTO staff selected the patents and the corresponding inventors to be interviewed. There might be unknown sample selection bias.

There is also a potential non-response bias. The study involved a case study and interviews with the inventors, inventor-entrepreneurs and with other key informants. Many inventors that licensed their patents to established companies refused to be interviewed as they feared the projects would be known by other parties. In addition, many of the inventors were too busy to be interviewed. Thus, the data are limited to those who were willing to be interviewed and not randomly selected.

Another limitation is that one individual in a company or a research group has provided the data. Although the respondents are comprised of inventor-entrepreneurs and heads of the research groups, who were responsible for the management and development of the firm and the projects, the possibility that a common response bias might have inflated the findings of this study cannot be ruled out.

CONCLUSION

The decision to seek patent protection involved combination of actors: from the inventors alone, to the TTO and the inventors, and in some cases the companies that funded the projects were also included in the decision-making. Both types of patents, the exploited and unexploited, demonstrated specific patterns.

The inventors and the TTO play crucial parts in the decisions to exploit the patents. Interestingly the decisions to exploit the patents differed between patents that were licensed through spin-off companies and those patents that were licensed to established companies.

All the decisions to exploit through spin-off formations were done by the inventors. On the other hand, the decisions to license the patents to established companies involved a combination of players, either by the inventors and the licensees, the inventors alone, the TTO alone, or the TTO and the inventors together. The TTO office played proactive part and is an important actor in helping identify opportunities for the inventors with quality inventions, but who do not want to get into commercialization efforts. With this type of inventors, the TTO would normally decide to license their patents to established companies.

The findings also revealed that the University does not have either a systematic approach or clear policies nor applied due diligence as to which patents should be given priority when seeking patent protection. A systematic selection process and clear policies might help reduce the number of unexploited patents. Most of the disclosures that fulfil the standard criteria will immediately be filed for UK patent protection. International filing would proceed if potential licensees are identified. The decision to seek patent protection is based on information from the inventors or on information from the general disclosure form.

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