Technology Evaluation and Licensing in Portuguese Universities

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Abstract
Universities have adopted knowledge valorisation strategies to foster the practical application of research results. Technology transfer offices have been implemented in almost all European universities to evaluate, protect and support the transfer of university's research outcomes. To this end, technology evaluation and licensing activities have been widely adopted and implemented by technology transfer units, allowing universities and inventors to obtain revenues through the establishment of technology transfer agreements. In order to understand this process, and improve our knowledge on specific practices that support technology transfer activities, we looked at strategies and methods used by seven technology transfer units in Portuguese Universities, and one non-university research institution. The sample was defined according to an intentional non-probabilistic sampling technique, utilizing two main criteria: the dimension and the regional influence of the higher education institution. One of the institutions is an R&D organization that is not part of the higher education system, and the rationale for its inclusion was the purpose of obtaining complementary and comparative information. The main research questions were: what is the degree of selectivity of the TTOs in the protection of inventions? What evaluation methods are used? What are the factors that are behind the licensing agreements? Scoring sheets and semi-structured personnel interviews were used to collect information. The results obtained are analysed, in an exploratory manner, under the light of conceptual ideas advanced by the literature. The behaviour of technology transfer offices that are part of universities is compared with the technology transfer behaviour of the R&D institution that is not part of the higher education system. The specific context of Portuguese reality is considered.

Keywords
Technology evaluation and licensing, intellectual property rights, technology transfer, technology transfer units, universities

1-Introduction

Technology evaluation and licensing by universities allow for the conjugation of research results and their practical application, and to potentiate the relation between university and industry, joining together the characteristics of an invention and the needs of the market. In this context of mutual convergence of interests between the university and industry it is indispensable to know the different strategies of knowledge protection and valuation, and to understand the articulation efforts, and the compromises made by universities' Technology Transfer Units (TTUs) that deal with inventions, innovation and the market, enhancing the potential impact that research results have on social and economic activities.

This paper aims to that objective, and to so, the following research questions were proposed:

- What is the degree of selectivity of the TTUs in the protection of inventions?
- What are the factors that are at the origin of licensing agreements?
- What are the main obstacles to technology transfer?
- What are the evaluation methods used by the TTUs?
- What are the main payment modes used by the TTUs regarding the licensing agreements?

- What is the structure of dividend distribution within the university?

The answer to this set of questions is provided through the development of an integrated and systemic approach to the process of valuation of intellectual property pursued by the universities. The present study addresses seven Portuguese universities, and their respective Technology Transfer Units, and the technology transfer activities of a non-university research laboratory, for the sake of comparison. The information was gathered trough extensive interviews with the TTUs and trough the systematic collection of related information.

The structure of the paper is as follows. The following section deals with the conceptual framework of the study, and it characterizes and contextualizes each one of the proposed research questions, by referring to the literature. This section provides examples of valuation practices of inventive activities, and it will form the basis on which the arguments are constructed and the empirical results are analyzed. A systemic and an integrated approach is adopted in this section, constituting a contribution on its own to the study and comprehension of the subject made by this paper. The reviewed literature is quite fragmented and not articulated, and this paper makes the effort of providing a comprehensive overview of the process of valuation of technology by universities' technology transfer units. The conceptual framework is thus not only based on the literature review, but on the integration and articulation of the literature review that is done here.

In the following section, the methodology section, the seven Technology Transfer Units, and the R&D unit, that participated in this study, and that were their subject, are identified, and the research approach is described.

In the last section, the analysis and the interpretation of the empirical results, is made in articulation with the literature review and the conceptual framework defined earlier. This section constitutes the second original research contribution of this paper. It presents new data concerning the technology transfer activities realized by Portuguese universities. Although the results must be read having in mind a specific national delimitation and context, we believe that the results reflect other realities and may constitute a basis on which further research work can be developed.

It is also noteworthy to notice the disparities in behavior between the units that are attached to universities and the R&D unit that it is not affiliated with a university. Although the sample characteristics prevents any generalization of conclusions, the simple fact that in many instances there is a marked difference between the two kinds of institutions, is a remarkable result, and it strongly encourages additional research on this domain.

2- Conceptual framework of the study object: a comprehensive literature review

Technology transfer units have the aim of evaluating, protecting and supporting researchers in their efforts to obtain resources and to commercialize technology (Young, 2007). TTUs are instruments of technology valuation, and the establishment of university-industry relations is one of their main tasks (Siegel et al, 2003; Debackere and Veugeleres, 2005). This technology valorisation units promote the utilization of research results (CEC, 2007) through the evaluation and protection of intellectual property rights, and through the diffusion of information, the negotiation of licensing agreements and the support of spin-off firms (firms created by university staff members, which aim at commercially exploring the results of inventive activities of the universities). They also administer licensing contracts and equity participation, managing the financial resources obtained and proceeding to its distribution according to the intellectual property rules defined by the university. The closer the TTUs are to the researchers, the more efficient they will be (Dodds and Somersalo, 2007) in the establishment of cooperative relations, so they will encourage researchers to share, on a regular basis, information about their research activities and results (Di Sante, 2007).

The communication of research results triggers a process of evaluation and definition of the strategy of protection and commercialization of the invention, which allows the matching of the invention characteristics with the firms development needs. Since the first communication until the association of an invention with a commercialization path, the TTUs assume principles and proceedings of technology valuation that determine the methods and practices of evaluation and licensing of technology, and that conditions the selectivity level of each university at the moment of protection and territorial expansion of the rights over an invention. It is with the aim of better understanding these principles and proceedings that the following subsections will present an integrated review of the literature.

2.1 The level of selectivity in the protection of inventions

Technology licensing is positively correlated with the number of registered patents (Shane, 2004), and the number of communication of research results, the money available for research, and the number of technology transfer professionals influence the number of licensing agreements (Chapple et al, 2005). Universities that are financed by firms perform more applied research, cooperate more with external researchers, either from industry or from other universities, and register a larger number of scientific publications and entrepreneurial results (Gulbrandsen and Smedy, 2005). The number of registered patents tends to be larger when there is an effective collaboration between the institutions specialized in invention protection and the researchers (Saragossi et al, 2003). The increase in the number of patents increases the technology portfolio impact (Owen-Smith, 2003), and there is a high correlation between the development of significant patent portfolios and the number of scientific publications (Stephen et al, 2002, cited by Godinho et al, 2008). The universities with a larger number of publications are also the ones that protect more their intellectual production. On the other hand, the number of patents does not reflect the impact that a university has on the economy, and the number of patents, on its own, does not describe the nature of the inventions nor their commercial value (Agrawal and Henderson, 2002).

This last sentence raises the question of selectivity, and its importance in the process of invention protection. Selectivity in the process of submission of patent applications made by the TTUs has a major impact on its performance (Powers and McDougall, 2005). The largest the technology portfolio, the more are the resources necessary to manage them, and eventually there may be a need to concentrate commercialization efforts on a reduced number of technologies and to bet on those that have a better market potential (Gardiner, 1997). It is important to patent in a strategic way, and the technology transfer professionals must be prepared to spend time, effort and money on this task, as it seems to be one of their most important ones (Dodds and Somersalo, 2007). The decision to patent must be influenced by the market potential of the invention and not by its scientific Excellency, nor by the will of the inventor.

Having made the decision to protect and commercialize an invention, there is now the need to define a strategy of technology diffusion in order to obtain license agreements. The next section addresses this issue.

2.2 The origin of the licensing agreements

To transfer a technology it is necessary to find a window of opportunity (Abell, 1980) that allows that the characteristics and advantages of a technology are matched, in the right moment, with the needs and interests of the firms. The window of opportunity is the moment on which the firms see the technology as being useful to correct, valuate or introduce a product or a process in the value chain or in the market, so that they can gain competitive advantages and are able to maintain or conquer market share. An important factor that is necessary to preview the right timing for the introduction of a technology is related to its development stage and with firm's product replacement cycles. The development stage of a technology must be aligned not only with the right timing, but also with the firm replacement cycle because if the replacement is made too soon, the firm may incur in high change over costs, but if it replaces it too late, it may lose market share (Abell, 1980; Gatignon et al, 1997; Speser, 2007). The window of opportunity is to find firms that are willing to replace or update existing products, or that are in a stage of diversification of their product family. The smaller the introduction costs, and the better the technology adequacy to the firm needs, the larger is the invention value and the probability of licensing it.

With the aim of opening and to take full advantage of the window of opportunity, a strategy of identification of firms with the capacity and the interest in licensing the technology must be adopted, coupled with the definition of a strategy to communicate and publicize the invention value proposition. The next section will address that issue.

2.2.1 The strategy for identification of firms interested and with capacity to license

The strategy for identification of firms must include, in addition to the market and technology description, the identification of the competencies and resources which are necessary to its development and commercialization. A good licensee or technological partner is the one who's able to complement our present resources and competencies to make our invention viable. This action of identification of the tasks to be performed and the appraisal of needed resources presupposes an assessment of the development,

production and distribution stages of the products or processes which will include the technology. In this analysis it is important to have in mind the firms' skills and their production capabilities, as well as their competitive strengths in terms of products, distribution channels, marketing and sales force, which should be helpful to penetrate the market. This analysis can be enhanced if a SWOT procedure or a 4Ps marketing analysis (product, price, promotion, point of distribution) is followed (Di Sante, 2007), this may be helpful to determine what is necessary to commercialize the technology and to assess and select the firms to contact, so that the technology may enter markets that increase its value to potential licensees.

It is also necessary to determine what are the intellectual property rights which are required for the technology to function integrated in a product or in a larger platform (Di Sante, 2007), what is the knowledge that must be transferred to the firms, and to assess if the firms are able to absorb it. It is also necessary to understand how the technology fits within the firms' technology space, so that an alignment is achieved.

While determining the invention potential and attractiveness and while we identify potential partners, it is important to identify the technologies that have to be integrated with our invention to obtain a complete commercial product, and to analyze the possibility of combining the technology with existing products or systems, it is also important to measure the possibility of producing the technology on large scale and with what resources and skills. The technology friendliness use, it's easy and intuitive reproduction and packaging, its robustness, its adaptability to different environments, and the possibility of the user to perform tests and decide on its usefulness are also important factors in technology licensing (Thornatzky and Fleischer, 1990).

The decision to license is associated with the firms perception of risk on an investment. Small firms and start-ups are the ones that are willing to assume bigger risks (Speser, 2006) and more experimentation to test what might work. Large firms have more pre-established compromises and are less flexible in the adoption of new technologies. Established enterprises have a preference for incremental technologies (Shane, 2004) that adds something new to an existing invention or that alters its design. Smaller firms are more willing to adopt technologies in initial development stages (Thursby et al, 2001; Shane, 2001), or technologies that present disruptive characteristics that allow for the development of new generation products based on different scientific domains.

Independently of the firms maturity and size, the adoption of the technology is dependent of their strategic orientation (Miles et al, 1978). Firms whose growth is more dependent on new product and processes continuously seek new technology and business opportunities, and they are potential licensees we should look for. But our technology may not be the only one to solve a particular problem, and it may be useful to firms that want to compete with established ones. Therefore we must pay attention to existing patents that lead to the same results, so that the search for the licensee is oriented to those firms that may require new technologies to maintain or acquire a competitive position. The rhythm of patenting in a certain area and their respective owners and their applications must also be accompanied, as well as the importance of different subclasses of patents to the industry. We should also bear in mind that firms who commercialize previous or similar products are typically good licensees.

The level of complexity of the technology and the market that a firm commands are also important factors to bear in mind in the search for a licensee (Speser, 2006). In short, the task of identification of firms with capacity and interest in licensing requires a systematic work of technology and potential partner analysis, as well as identification of possible sources of financing. Ideally, a good partner for the introduction and development of the technology should:

- Have adequate technological capacity and competences;
- Have the necessary networks and resources;
- Have a significant client base and a strong brand;
- Be able to address the markets that are relevant;
- Have a risk taking attitude.

Having clarified the profile of the firms to be contacted, the next step is the communication and publicity of the technology, an issue to be addressed in the next section.

2.2.2 Technology diffusion

The origin of the licensing agreements is associated with the size and quality of the TTUs and researchers networks - "one's worth can be approximated by the size (and quality) of one's network" (Kolchinsky, 2004:95). TTUs acknowledge that the inventors are the most important source of contacts for licensing (Hsu and Bernstein, 1997), and they are the primary

source in firms identification (Thursby and Thursby, 2004; Young, 2007). Inventors can be a "one stop source of market information" (Di Sante, 2007), and the inventors direct contact with firms is the most important factor in the establishment of licensing agreements, the second most important one is the marketing effort made by the TTUs. Agreements obtained by inventors are made predominantly with large enterprises, while the agreements obtained by the TTUs are made predominantly with smaller firms. The explanation seems to be related with the fact that smaller firms have fewer resources to invest in technology watch and are more receptive to the information provided by the TTUs communication channels. Investment in direct marketing with small firms may prove more useful than marketing directed to large firms (Ramakrishnan et al, 2005). In technology diffusion it's also important to consider the university prior relations with firms and their geographical proximity (Mansfield and Lee, 1996) and strategic position and location, to extend our present collaboration networks having in mind that the majority of university-industry relations are informal in nature (Mowery and Nelson, 1999), and multiples communication channels should be used to effectively communicate the technologies value proposition.

2.3 Obstacles to technology transfer

All communication and licensing strategies encounter obstacles, knowing them is a good principle to avoid or to work to surpass them. Some of the obstacles are the TTUs lack of experience in the management of evaluation and licensing processes (Collins and Wakoh, 2000; Chukumba and Jensen, 2005), the location of the university in a not highly technologically developed region, the universities lack of a clearly defined mission in supporting technology transfer (Friedman and Silberman, 2003), the availability of financial resources (Dodds and Somersalo, 2007), the reduced number of technology transfer personnel (Ramakrishnan et al, 2005), the brand value of the institution and the lack of previous connections with industry (Harmon et all, 1997) are factors that constitute obstacles to the process of technology transfer. Other factors associated with the universities technology transfer practices include information deficiencies, insufficient technology watch, deficient marketing strategies, difficulties in finding business partners with adequate capacities and resources for technology further developments, the lack of entrepreneurial initiative, their inability to determine the technologies investment risk, and the lack of administrative support in preparing financial applications and in project management (Arvanitis et al. 2005).

The early-stage of technology development, the inexistence of a final product, uncertainty in cost estimates or profit margins, the lack of TTUs commitment in a line of business, and the mismatch between technology specifications and industry requirements (Kristofferson and Jonsson, 2003) constitute additional identified barriers to technology transfer.

In short, it is important to understand the technology transfer and licensing barriers, in order to find efficient solutions and alternative ways to surpass them. Understanding the invention, the market, identifying suitable firms seem to be important components that allow for the elimination of some barriers. Another important factor is related to the comprehension of industry motivations to collaborate with the university.

2.4 Evaluation methods

Technology evaluation and the assessment of its commercialization potential is a transversal task that sweeps across the process of technology transfer, allowing us to surpass some of the referred obstacles. Since the invention disclosure until the patent license or assignment several evaluation methods are used. The most common methods are:

- Pre-defined evaluation models and matrices;
- Comparable license agreements and the observation of royalties practiced in industry;
- Evaluation based on development costs;
- Discounted cash-flow method;
- The 25% rule;
- Real options and Monte Carlo simulation methods;
- Patent auctions.

In the following sections we address each method separately.

2.4.1 Pre-defined evaluation models and matrices

Methods based on checklists and in pre-defined evaluation models speed up the process and facilitate the consideration of multiple dimensions of the invention, from the intrinsic quality of the technology to the market potential and profitability, constituting the most widely used instruments in the evaluation of invention disclosures. Some of those instruments are:

- COAP – *Commercial Opportunities Appraisal Process*, developed by Warwick University, in which ten evaluation criteria are scored;
- *Rapidscreen*, it's a process supported by a web service for discovering the opportunities associated with early stage technologies, involving interviews to the research team and experts in the technical field under analysis.
- *IPscore* 2.2, developed by the European Patent Office, was designed to identify potential gains and opportunities, and to reduce evaluation time and costs, can be used to analyze ideas, R&D projects and patents. It is possible to estimate the net present value of a patent and to obtain reports about a patent or a set of patents.
- *Commercialization Quicklook Assessment*, developed by Texas University, allows for the collection of information and the preparation of reports on the commercial potential of the invention.

2.4.2 Comparable license agreements and the observation of royalties practiced in industry

Analysis of previous licensing agreements and the observation of royalties practiced in the industry (royalty standards) may provide guidance to define and defend the payments structure and its value during the negotiation of a technology transfer agreement (WIPO/ITC, 2005). The search for comparable license agreements and royalty standards is an effort that usually pays off (Razgaities, 2003), although the specificity of each technology does not call for standard agreements. But it is important that TTUs build and maintain reference agreements portfolios which can be used if needed (Dodds and Somersalo, 2007).

Databases and publication with royalty standards and licensing agreements are a good source of information. The "Royaltystat" of the US Securities and Exchange Commission, based on the Edgar Archive, is a well known database where payment structures and royalties for many US firms can be consulted.

2.4.3 Evaluation based on development costs

Evaluation based on development costs is rarely a base on which firms negotiate license agreements (Razgaities, 2003). Firms are interested in obtaining technology in an easy and cheaper way than it would cost if they developed the technology by themselves, and the cost of creating a technology has nothing to do with its value (Speser, 2006). The market value is a more appropriate metric for evaluating a technology (WIPO/ITC, 2005). However, the evaluation based on development costs can be used before the start of a project as a way to estimate future costs and future investment.

2.4.4 Discounted cash-flow method

The discounted cash-flow method is widely used by organizations who deal and license technology (Degnan and Horton, cited by Kemmerer and Jiaquing, 2008). The calculus of the discounted cash-flows is important for business profitability discussions and to provide a basis for setting up royalties and other payments value. It is also important when the deal involves a lump sum payment for the utilization of a technology during a specified period of time, or when the creation of a firm is under consideration, providing a basis for the consideration for equity participation.

2.4.5 The 25% rule

The 25% rule is usually applied to the EBIT – Earnings before interest and taxes, and was defined by Goldscheider et al (1970) according to Kemmerer and Jiaquing (2008), suggesting that the licensee pays a fee equivalent to 25% of the invention contribution to the operational results obtained by the product that embodies the technology. The 25% rule divides the value of a technology in four parts: the creation of the invention, the preparation of the invention for industrial reproduction, industrial reproduction, and the sale of the invention, per se, or incorporated in a larger product. Each one of these parts represents one fourth of the invention value and, in this sense, the invention is one of four parts by which the commercialization gain is distributed. If the invention is already prepared for commercialization, it makes sense to define a lager value, say 33% or more, since the invention has already attained a threshold that includes production. In the case of software, these values can ascend to 50%, since the technology is ready for commercialization (Razgaities, 2003).

The rule is a good starting point, adopted by licensors and firms, for royalties' negotiation, thanks to its simplicity, intuitive reasonability and acceptance by many authors (Razgaities, 2003; Grandstand, 2006; Parr, 2007; WIPO/ITC, 2005, Kemmerer and Jiaquing, 2008).

2.4.6 Real options and Monte Carlo simulation methods

The real option method allows the separate evaluation of all the assumptions involved in a cash-flow projection, each assumption having a different level of uncertainty for which different risk-adjusted hurdle rates are defined. This is a

more complex and time consuming approach, but it contributes to a more complete and exact analysis of the investment return(Soares et al, 2007). Monte Carlo simulations are more used than real options method. The probabilistic model generates multiple scenarios regarding the profitability of the investment and the probability of attaining a predefined critical value.

2.4.7 Patent auctions

Patent auctions are gaining increasing importance in the process of technology transfer (Ciardullo and Evans, 2006). Auctions are a quicker way of commercializing patents, provided they are of high quality (EPO, 2008). Auctions can be a way to license patents that otherwise would fall for absence of payments of patents fee, or to commercialize and define territorial extension rights of patents that are in the final stage that precedes the PCT applications stage. However, auctions require a considerable organization and public citation effort (Tansik, 1991) and it is not easy to have several bids for just one technology.

2.4.8 The articulation between the methods

The methods presented above are used in different stages of the evaluation process. In a first stage, preparatory for the submission of a patent application, databases of patents are extensively used, to understand the invention and the state of the art related to it, and the scoring matrices and the rapid report models are used to understand the market potential of the invention.

In a second stage, e.g., when there is a firm that has already demonstrated its interest in the invention, the technology transfer professions tend to recur to comparable agreements and royalty standards, in order to prepare negotiations according to the risk involved. Discounted cash-flow projections are also used, and sometimes, the 25% rule, the real options methods or the Monte Carlo simulations.

Simultaneously with these two stages, the TTUs network of contacts is activated, in order to obtain technical and market counseling, information on investment sources, and to facilitate access to equipment or materials external to the university that are necessary to develop the invention proof-of-concept. Contacts with final users of the technology may also be made.

After the patent is registered auction patents may also be utilized, in this case the payment structure negotiation is relieved because the value is decided by the highest bid.

In general, the systematic work done previously, based on the various evaluation methods, will support the draft of an agreement that is seen positively by both parties, and a balanced distribution the gains will be achieved. To understand the process of negotiation there is the need to address the possible modes of payment that can be considered in this kind of negotiations. The next section addresses that issue.

2.5 Types of payment used in licensing agreements

The definition of the payment structure must consider the different dispositions that influence the value of the technology transfer agreement. Some of those are:

- At the technology level: the invention scope, territorial rights and protection length, the level of exclusivity conceded to reproduce, modify, make further R&D or to develop new products based on the invention, the stage of technology development, the level of complexity and the skills required to use it, its robustness to operate in different environments, its friendly use, easy and intuitive reproduction and packaging, the number of technologies that must be integrated with the invention to obtain a full commercial product, the possibility of mass production, the compatibility with existing systems, the risks and the costs inherent to future developments, and its social and environmental impact;
- At the market level: the present and emergent competitive technologies, the technology strategic importance, the differentiated applications resulting from the invention and the industries envisaged, the applications market size and its growth rate, the strength of existing firms and brands, the marketing, distribution and sales complexity, and the applications life cycle.

These are some disposition which affect the payments value, but there are other dispositions that also deserve attention, such as the rights over the improvements made with or on the technology, the possibility of sub-licensing, the payment of patent fees in several countries, the agreement length, and the exclusivity of rights granted, the inclusion of technical services, the provision of equipment or other resources from the part of the university or the firm, the existence of projects and competing R&D teams, the value of the royalties practiced in the industry and the potential gains from the technology commercialization.

All these dispositions must be considered or appraised so that the nature, the circumstances and the terms of the agreement are reflected in the payment values and in its structure, which can be divided in fourteen categories:

- Single lump sum payment or paid-up license – a single payment for a determined period of time;
- Fixed fee per sold unit or technology utilization;
- Earned royalties, running royalties or pure royalty licenses - royalties based on a percentage of sales or technology utilizations;
- Up-front payment or up-front fee;
- Minimum (annual) cash payment - minimums or minimum royalties or license maintenance fees;
- Stage payments or milestone payments;
- Option agreements and options payments;
- Royalty adjustments;
- Deferred royalty calculations;
- Late payment penalties;
- Termination fees or kill fees;
- Sub-licensing payments;
- Equity payments;
- Support payments.

An agreement may include multiple modes of payments and the above categories are not exhaustive.

2.5.1 Single lump sum payment or paid-up license

This type of payments are typical in agreements whose risk is relatively small (Johnson, 2007), and they provides advantages for both parties. The TTUs administrative control and communication costs are reduced or eliminated, and the firm is not forced to expose sensitive information, and it provides the licensor a significant amount of financial resources. To determine the payment amounts, it is advisable to make a discounted cash-flow projection, to estimate the profitability of a single payment compared to a series of deferred smaller annual payments (Pressman, 2009), and to establish the amount of payment to be made, taking into account the return on investment.

2.5.2 Fixed fee payment

A fixed payment per sold unit or technology utilization may be established. This value must be updated every year by reference to inflation rates (Howard and Johnson, 2001; Poddar and Sinha, 2002).

2.5.3 Earned royalties or running royalties

Running royalties are based on a percentage of the price of the licensed product, or on a percentage of the product sales operational results. This mode of payment shares the risk between the licensor and the licensee, since the licensor receives a larger or a smaller payment depending on the sales success (Wada, 2004). The running-royalties are an important licensor signal of confidence in the invention commercialization success. (Jonhson, 2007). The running-royalties are often used when the uncertainty in forecasting the sales volume is very high and when the technology and its applications are still in an early-development stage and it's believed that the involvement of both parties can positively affect the commercialization success. To establish the royalties percentage to be paid, discounted cash-flows, the 25% rule, royalty standards, or the real option or Monte Carlo methods can be used.

2.5.4 Up-front payment or up-front fee

An up-front payment is a payment required by the licensor whose purpose is to assure the licensee commitment in the invention commercialization success. Up-front payments are obtained in exchange for a reduction in the percentage of royalties (Thalhammen-Reyero, 2008). One common rule used in this modality is the definition of a payment based in the estimative of the value to be obtained in a year where the project is already well under way. It is thus necessary to recur to discounted cash-flow projections, but the value of the up-font payment may also reflect the adequate amount that each party deems necessary to keep the project on track towards its commercial success.

2.5.5 Minimum cash payment

Minimum annual payments are required by the licensor in order that the licensee maintains its exploitation rights. The aim is also to assure that due diligence is being taken by the licensee in the invention commercialization success (Kim and Blacklock, 2009). Its value can be established based on conservative or optimistic scenarios resulting from sales estimative and it can correspond to one quarter or two quarters of the projected royalties for a certain year.

2.5.6 Stage payments or milestone payments

These are payments required to the licensee each time certain development or commercialization objectives or milestones are successfully attained (Wood, 2004; UMIP, 2005; Leone and Oriani, 2007), such as, the conclusion of an R&D stage,

the beginning of sales or the development of a new application based on the technology.

2.5.7 Option agreements and options payments

An option is the right to make future decisions relative to the acquisition or exploration of a technology. Options can be very useful for the development and validation of the technology and its market, and the investors are able to make an informed decision about the acquisition of rights. If an investor wants to conduct additional research and development, the option may include an exclusive right, and in this case, an initial payment is defined. This payment compensates the licensor for deferring its search for licenses during the time the option takes place. Options that imply exclusive rights may condition other opportunities, and in the case the option is not activated, it may affect future deals. Thus, in the option agreement, its duration must be clearly defined, as well as the obligations of each party and the consequences in case the option is not taken. Options agreements generally last for 6-12 months and are very useful in the creation of new enterprises (Franko and Ionescu-Pioggia, 2006). Other options are possible, such as the option to obtain a non-exclusive license after an experimentation and testing period.

2.5.8 Royalty adjustments

An agreement may include the possibility of readjustments of the value of the royalty. A scale of reductions in the percentage of the royalties may be introduced to reflect some circumstances, like the reduction of the value of the invention due to new competing technologies, the impossibility of obtaining the rights in a certain region or the change of an exclusive license into a non-exclusive one (UMIP, 2005). The reduction of royalties may also serve as an incentive to increase sales, and conversely, an increase in the values of the royalty may reflect estimates that sales will increase. The definition of a lower value of royalties, that increases if certain commercial objectives are met, are called kicker royalties (WIPO/ITC, 2005).

2.5.9 Deferred royalty calculations

When there is high uncertainty over the development of the technology and its commercial success and there is a reasonable amount of trust between the parties, it may make sense to define the royalties and other forms of payment after the technology and the market validation has occurred. When payments are set *a posteriori*, it is important to define deadlines for achieve certain results or communicating certain objectives, so that the results can be analyzed and the payments defined according to those results. This mechanism can be used with spin-off firms from the university, where a relation of trust has been built and is present.

2.5.10 Late payment penalties

The date for each payment must be well defined in the agreement and penalties must be established in case of default, to discourage future defaults (Razgaities, 2003).

2.5.11 Termination fees or kill fees

A license presupposes a fixed duration. If a contract is broken, fees must be paid to the institution, to compensate for lost opportunities.

2.5.11 Sub-licensing payments

Sometimes the licensee has access to large networks and has an interest in distributing the technology. Allowing sub-licensing generates more sales and liquidity. Contracts must preview how the gains will be distributed among licensors, licensees and sub-licensees. Sub-licensing is common in exclusive licensing agreements (Franko and Ionescu-Pioggia, 2006).

2.5.13 Equity payments

The university may opt for an equity participation in a firm, assuring financial support for the firm or technology transfer without or at reduced cost for the firm. The most successful universities in terms of technology transfer have always some form of equity in spin-off firms and have explicit and proactive measures directed towards its development (Lockett et al, 2003). The financial return via equity participation is generally higher than the one obtained via licensing, and universities seem to be more engaged in equity if they are more experienced in technology transfer (Bray and Lee, 2000, Feldman et al, 2002).

2.5.14 Support payments

Support from the part of the licensor in terms of technical assistance is particularly important for sophisticated technologies and during the early years of the license where the licensee goes through a learning curve process and it can have an impact in terms of reducing risk. This type of payment also gives the licensor (the university) the possibility of minting the relations with the licensee and establishment of new relations.

2.6 Earnings distribution within the university

Each university has its own rules or set of principles that define how the gains from licensing agreements is distributed within the university actors. Higher fees paid to the inventors seem to be positively related to the number of inventions, to the financial return of the licenses and in the attraction of abler researchers (Lach and Schankerman, 2003) and universities tend to pay larger percentages to inventors that take the initiative of creating their own spin-off firm (Lockett et al, 2003; CEC, 2007). Typically the TTUs receive a percentage of 10% to 25% and the university tends to subsidize directly the activities of the TTU during several years, until it becomes self-sufficient (young, 2007). Many years can pass before self-sufficiency is attained, and the TTUs must reach a balance between the resources available and what they can protect. As a thumb rule, only one in ten invention disclosures' is patentable, and only one in ten patents is licensable. Evaluation practices are thus essential in the process of decision making regarding patents and in the marketing and licensing of inventions.

3. Methodology of the study

This study involved seven Technology Transfer Units (TTUs) from seven universities, and one non-university R&D institution. This sample was defined according to an intentional non-probabilistic sampling procedure and two criteria were used, the size and the regional influence of the university, and the geographical convenience on obtaining the data. The non-university R&D institution was involved in this study to make it possible to collect information that is complementary to the information provided by the TTUs from the universities. This R&D institution was chosen because of its notoriety in terms of technology transfer success. Technology transfer in this R&D institution is made independently by each of its departments and by the executive committee. There is no formal and separate technology transfer unit.

The sample of higher education institutions and their respective technology transfer unit

University	Technology Transfer Unit
University of Aveiro (Universidade de Aveiro)	UATEC – Unidade de Transferência de Tecnologia da Universidade de Aveiro
University of Beira Interior (Universidade da Beira Interior)	GAAPI – Gabinete de Apoio A Projectos e Investigação
University of Coimbra (Universidade de Coimbra)	GATS – Gabinete de Apoio à Transferência de Saberes
University of Minho (Universidade do Minho)	TECMINHO – Associação de interface da Universidade do Minho
New University of Lisbon (Universidade Nova de Lisboa)	GAPI do Madan Parque – Parque de Ciência e Tecnologia
University of Porto (Universidade do Porto)	UPIN – Universidade do Porto Inovação
Technical University of Lisbon (Universidade Técnica de Lisboa)	OTIC-UTL – Oficina de Transferência de Tecnologia e de Conhecimento

Information collection was achieved trough personnel semi-structured interviews with TTUs' Heads of staff, supported by a set of orientations and a questionnaire, that the interviewees were asked to fill. The responses to these questionnaires are presented in graphical form, in the section of analysis and interpretation of results. The interviews were made during March and June 2009, and were conducted in offices of the TTUs. Extensive review of the literature was made, and documental support concerning additional or complementary information was made.

4. Analysis and interpretation of results

The structure of this section follows the titles of the subsections of the literature review section (section 2). Having done a comprehensive review of the literature in that section, it is now important to analyze the empirical results obtained in the light of the integration that was done.

4.1 The level of selectivity in the protection of inventions

Information about the number of patents registered by the institutions of the higher education system in Portugal, including the seven universities under study, was collected in the INPI, the Portuguese National Patent Office, and is presented in the following table.

Evolution of registered patents between 2004 and 2009

Higher Education Institution	2004	2005	2006	2007	2008	2009[3]	Total
Instituto Superior Técnico[1,2]	5	15	17	44	26	23	130
Universidade do Minho[1]	7	8	4	6	4	8	37
Universidade de Aveiro[1]	8	8	1	3	6	4	30
Universidade do Porto[1]	1	3	2	1	7	8	22
Universidade de Évora	2		1	2	4	1	10
Universidade Nova de Lisboa[1]	1			3	1	5	10
Universidade de Trás-os-Montes e Alto Douro					1	7	8
Universidade do Algarve				4	2	1	7
Universidade de Coimbra[1]			1	2	2	1	6
Universidade dos Açores					4		4
Instituto Superior de Engenharia de Lisboa		2				2	4
Faculdade de Ciências da Universidade de Lisboa		1	1				2
Instituto Superior de Agronomia[1,2]				1		1	2
Instituto Superior das Ciências do Trabalho e da				1		1	2
Universidade Católica Portuguesa		1				1	2
Universidade da Beira Interior[1]					1		1
Egas Moniz – Cooperativa de Ensino Superior			1				1
Instituto Politécnico de Leiria		1					1
Instituto Pedro Nunes		1					1
Academia Militar			1				1
Instituto Politécnico de Viana do Castelo			1				1
Instituto de Artes Visuais, Design e Marketing			1				1
Instituto de Ciência Aplicada e Tecnologia				1			1
Total	24	40	31	68	58	63	284

1) Included in the sample of this study.
2) Part of the Technical university of Lisbon.
3) From 01-01-2009 to 31-10-2009.
Source: INPI.

The first four institutions are more active than the rest, who own 10 or less patents each. Between January 2004 and October 2009, Portuguese higher education institutions applied to 536 patents, registered 284 patents, and were denied the registration of 15 patents.

The observation of these numbers suggests that different institutions have different selectivity levels and different protection strategies of their inventions. The same conclusion is extracted from the interviews with the TTUs. The more selective TTUs prefer to patent based on cost estimates related to patent management and in the probability of finding an adequate partner that help to avoid copy and protect future dividends. The less selective TTUs the objective is to increase the number of patents to motivate researchers and to acquire the experience and culture of patent writing, protection and technology transfer.

Some units are not selective when applying only to national protection, but perform evaluation work and identify potential partners when applying to international protection. This strategy has the disadvantage of potentially creating a large portfolio of patents, which is costly to maintain, and difficult to manage (transfer). The existence of lager patents portfolio is not related to a larger number of licenses. The Technical University of Lisbon, where the IST is included, has less license agreements that the University of Minho and the University of Porto. The University

of Minho is the institution with more license agreements, totaling seventeen in the period under analysis.

It is also possible to conclude that the TTUs do not have the resources necessary to expand internationally the protection of patents that are not expected to generate revenue, either via the European way or via the Patent Cooperation Treaty (PCT). Selectivity in the geographical expansion of protection is important and some TTUs use the services of Brokers instead of internally managing the patent portfolio, since the costs of Brokers' services may compensate the costs of maintaining a large portfolio of patents.

4.2 The origin of the licensing agreements

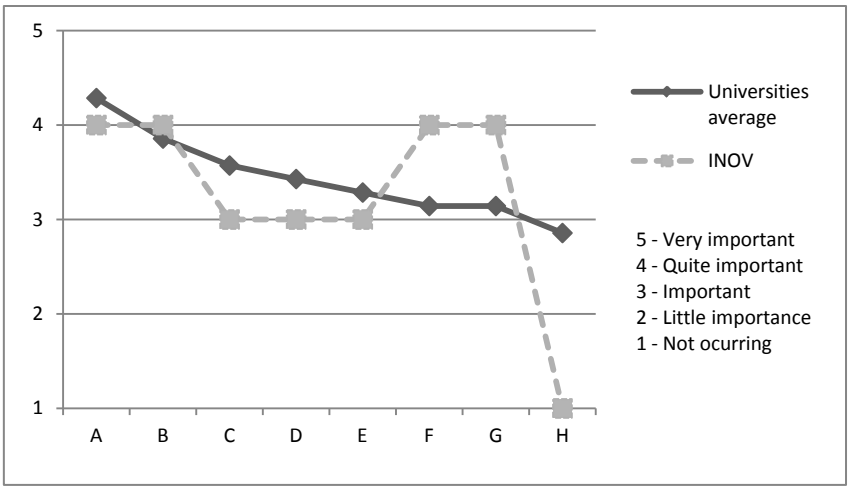
The origin of license agreements is associated with the tactics used to launch the technology in the market, which involves two components:

- The identification of firms interest and with capacity to license;
- The strategy for technology diffusion.

4.2.1 The strategy for identification of firms interested and with capacity to license

The activities that are given highest importance by the TTUs, when searching for potential partners, were related to the assessment of the importance of the technology to the firm, and to the predisposition of the industry to adopt the technology. The results are presented in the graph below. Respondents were asked to score the importance attributed to several factors, in a five point Likert scale. The responses given by the TTUs from the universities are averaged. The response given by the non-university R&D institution is also presented and is compared with the (average) responses given by the universities. The R&D institution is identified by the name INOV.

Identification of suitable firms



A- Identification of firms interested in the technology B- Evaluation of the necessity of the technology for the firm's operations C- Evaluation of the predisposition of the industry to adopt the technology D- Analysis and description of the R&D capabilities necessary to develop and produce the technology E- Evaluation of the possibility of integration of the technology with existing products, processes or systems	F- Evaluation of R&D, production, marketing and sales capacities of the firms in their respective markets G- Analysis of the capacity to produce the technology using the equipment available in the industry H- Analysis of the possibility to establish partnerships between two or more firms to the development, production marketing and sales of products derived from the technology, and to reduce time-to-market and increase market share

Is also noted that other activities identified in the graph, including the possibility of integration of the technology with existing systems and the identification of scientific and technological capacities are considered important to determine the alignment of the technology with the capacities of the firm and the expectations of the licensors. The most important activities for the non-university R&D institution (INOV) are the identification of firms interested in the technology, the assessment of the invention usefulness and need for the firm's operations, the evaluation of R&D, production, marketing and sales capacities of the firms in their respective markets and the analysis of the capacity to produce the technology using the equipment available in the industry. But the other activities are also considered important, except the one

related to the establishment of partnerships between two or more firms, which is the least important to INOV and to the universities. Usually, TTUs work with one partner, and only when needed, in terms of obtaining a complete commercial solution, additional partners are called for.

The development of complete products decreases the perception of risk from the part of potential licensees, increasing the attractiveness of the technology and the probability of obtaining an agreement. The R&D institution, INOV, stresses that many patents were licensed not because they embed an innovative technology, but because there was a complete product, which included a patent, whose functionalities were demonstrated. The development of complete, demonstrable, turnkey solutions and products decreases the risk of the investment and makes the technology more attractive to potential investors. However, it is not always possible to develop complete commercial products based on the technology, in view of the limitation of available resources and the difficulty of finding partners when the technology is in an initial stage. Many universities do not have the funds that are needed to pay for the development of new products (Kolchinsky, 2004), and firms are best positioned to that work, in case of promising research results. It is because of this that TTUs when searching for partners, in addition to considering a positive attitude towards risk, try to understand how the technology fits with the technological space of the potential partner. Special attention is dedicated to firms that want to substitute or update products, and that want to diversify their range of products.

It is not always possible to license the technology to the firms that are considered the most suitable to develop and commercialized it, because firms may have no interest in the technology, or are not interested on it at that particular time for strategic reasons. TTUs say that when it is not possible to license to the most adequate partner, and because it is better to obtain an agreement than to not obtaining it, then it is preferable to license to the firm that is quicker in manifesting its interest. When other firms, a posteriori, offer more value for the invention, TTUs do not step back and uphold the partnership with the firm they are working with.

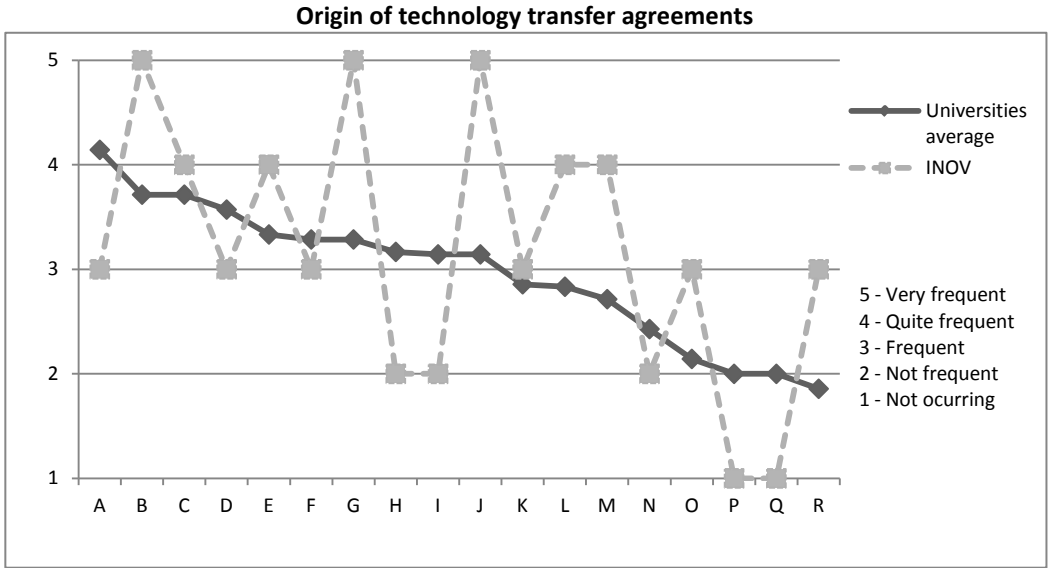
The general perception of a good partner is that it has the competencies to initiate large scale production, it has access to the networks that are necessary to address the relevant markets and, above, all, is a credible partner, that respects deadlines and meets defined targets and that negotiates fairly so that each partner feels that a balanced agreement is reached.

4.2.2 The strategy for technology diffusion

Most license agreements are associated with the contacts and the partnerships of the inventors and TTUs and to the adequate diffusion of the value proposition associated with the invention. Informal networks are valued by the TTUs in this process, which used them to evaluate the technological and market potential of the invention, to obtain funds, to support spin-off creation and to determine the geography of the patent protection. These informal networks are constituted by different agents, economic, technologic, governmental and entrepreneurial.

Based on the information obtaining through the network, the market research, and the acquired experience, it is possible to define a strategy for publicizing the technology in the market using different communication channels. The following graph indicates the frequency of the practices that are behind the origin of the agreements. The contacts with Portuguese firms of national dimension and the knowledge that inventors have of firms are the practices that constitute the more frequent origin of agreements concerning the universities. The contact with firms located in the same region of the university is the practice that has the larger standard deviation, being the most frequent for some universities and not so for others. International contacts made by TTUs seem to be also important.

The origin of certain agreements results from specific requests made by firms concerning technology that is tailor-made according to those requisites. To respond adequately to these requests, many TTUs make regular and comprehensive updates of the scientific and technological supply of the university. These projects are initiated either by the firms, the TTUs or the researchers, and their aim is not only to patent and license, but also to solve specific problems and make advantage of governmental (or other) programs supporting R&D activities.



A-	Contacts with Portuguese firms	K-	Contacts with firms with international dimension
B-	Contacts with firms with national dimension	L-	Contacts with former collaborators working in the target industry
C-	Contacts with firms known by the researchers	M-	Previous license agreements
D-	Contacts with firm from other countries	N-	Public presentations of research results by the researchers
E-	Contacts with large firms	O-	Public presentation of results by the TTUs
F-	Contacts with R&D people from firms via researchers	P-	Contacts with firms that obtained information through patent directories
G-	Existent partnerships between firms and university	Q-	Participation in international fairs
H-	Contacts with small firms	R-	Contacts with firms that obtained the information on the site of the TTU
I-	Contacts with firms that knew about the technology through sites or publications		
J-	Contacts with firms located in the same region		

The most frequent agreement origins for INOV are the contacts with regional firms, the contacts with firms of national dimension and the existing partnerships with industry. The contact with large enterprises, the previous existence of license agreements, the researchers' knowledge of enterprises and the contact with former collaborators working in the target industry are also important for obtaining agreements. INOV interest is to extend its contacts beyond the region. The countries with which there are more agreements are the Portuguese speaking countries, including Macau, but specially Angola, and the countries of Eastern and Mediterranean Europe, including Turkey.

Multiple channels of information diffusion are utilized by the TTUs to publicize the value proposition of the technology which must be a concise and quantitative presentation of the problem (and the reason why the consumer will adopt the solution), the identification of the market, its size, the economic and social benefits for the adopters and its comparison with competing technologies and solutions (Gomes, 2007).

The existence of enterprise centers, incubators and science parks in the proximity of the universities have a positive influence in the number of firms interested in licensing agreements. It is also important to make an integrated management of the units that support entrepreneurial activities and technology transfer, since it improves the relation with researchers and the definition of commercial strategies. TTUs also demonstrated interest in managing their relation with university departments in a more structured way, monitoring the development of projects since its inception.

From the point of view of INOV, there are three options for an effective technology transfer process:

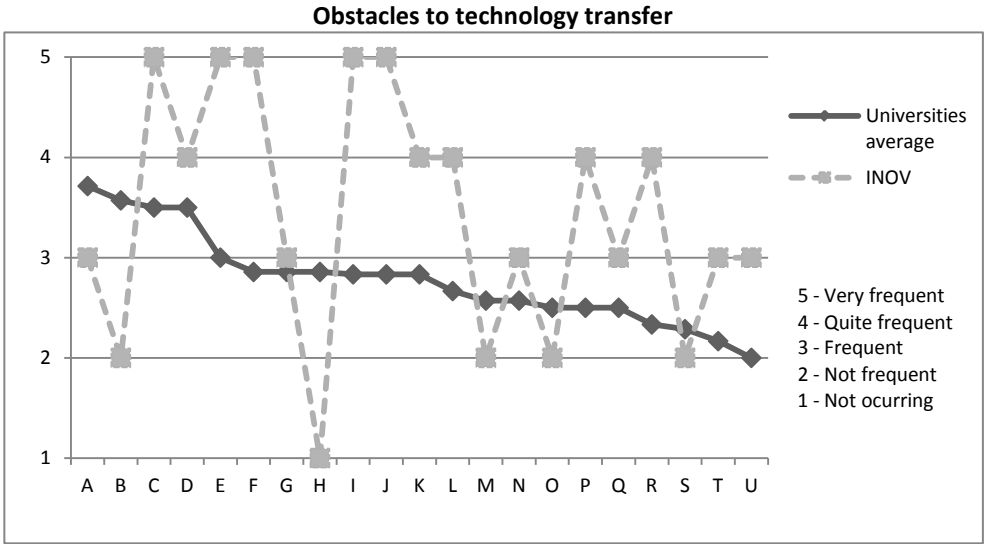
- The inventor creates a new enterprise to commercialize the invention;
- The invention is integrated in a larger product or system and solves a specific problem to a firm;
- The researcher makes an invention to solve a problem to a firm who he works for. In this case, the licensee will be the firm.

The option on which the inventor delegates the responsibility for the commercialization in an external entity is the one that is less likely to succeed. The inventor must try to sell or license himself. The role of inventors in licensing is

essential and it is well acknowledged by the TTUs that their relations of trust with researchers and their informal networks are behind the success and growth of the TTUs. TTUs are not only intermediaries between researches and universities they are a "value shop" that manages a network of actors and technologies, providing support to researchers in the valuation of technology (Stabell and Fjeldstat, 1998).

4.3 Obstacles to technology transfer

According to the responses of the TTUs, presented in the graph below, the most important barriers to licensing are the difficulty of finding a partner with adequate resources and capacities, uncertainty related to commercialization costs, the stage of development of the technology and the longer than expected development periods.



A- Difficulty of finding a partner with adequate resources and capacities	L- Insufficient knowledge of the size, potential an growth rate of the market
B- Uncertainty related to commercialization costs	M- Price of the products derived from the technology
C- Stage of development of the technology insufficient	N- The profit margin
D- Longer than expected development periods	O- Limitations in the geographical extension of the patent protection
E- No marketing capacities	P- Competitive and differentiated advantages of the technology
F- Research and patents with little interest to industry	Q- No collaboration from the research team
G- Payback period	R- Technology description and strength of patent claims
H- Delays in the bureaucratic process	S- Legal difficulties in obtaining the agreement
I- Mismatch between the requisites of the industry and the characteristics of the technology or its application	T- No information on firms
J- Insufficient knowledge of consumer's needs	U- Useful live of the technology
K- Insufficient knowledge of the strengths and weaknesses of competing technologies and products	

The most important barriers for INOV are the stage of development of the technology, no adequate marketing capacities, research and patents with little interest for firms, mismatch between the requirement of the firm and the characteristics of the technology and its applications and no adequate knowledge about the consumer's needs.

Other important barriers to INOV are the longer than expected development periods, insufficient knowledge of the strengths and weaknesses of competing technologies and markets, insufficient knowledge of markets and uncertainty over the competitive advantages and differentiation of the technology.

INOV also refers that the notoriety of the entity that licenses, and the notoriety of the country where the technology comes from, conditions the licensing of technology, noting that Portugal is not known as a producer of technology. However, it refers that in Portuguese speaking countries Portugal is a credible source of technology, and these markets are also mentioned by other TTUs. Again it is referred the importance of offering complete products, whose features are fully demonstrable, and its importance to reduce the

perception of risk from the part of firms and the increase in attractiveness that results.

An obstacle that does not occur in INOV is bureaucratic delays and only one university TTU mentions it as a frequent one. Barriers related to the life cycle of the technology and the research team collaboration are also not important, while the barriers related to pay back period and profit margin are important both to INOV and TTUs, although less important than the ones referred above.

4.4 Evaluation methods

In an initial phase of the evaluation process of an invention, TTUs tend to use quick evaluation methods, based in checklists and production of short reports about the potential market and return of the invention. Later the evaluation is made more in depth, and use of comparable agreements, royalty standards and cash flow projections are used. The more in depth study is initiated by a potential manifestation of interest or by the need to obtain more information to strengthen its presentation to potential investors. In the evaluation process it is necessary to understand the invention, and no one understands it better than the inventor (Di Sante, 2007), and that makes his collaboration essential.

The following graph indicates the activities that are more important according to the perception of the respondents. TTUs consider the analysis and description of the technology, and of its attributes and claims, the identification of new development stages and the definition of an activity plan, the most important activities. Next in importance, is the identification of competing patents, the evaluation of maturity and support in the identification of technology applications. TTUs live from finding commercial applications to the technology and to evaluate their market potential, so it is important that all potential applications be contemplated in the patent application and the level o protection be as wide as possible (Young, 2007).

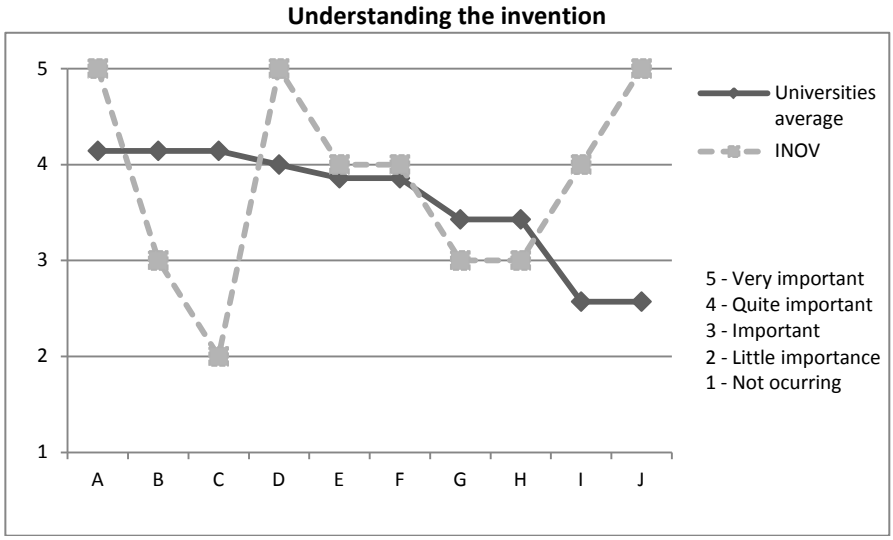
INOV refers that it is important to build applied R&D projects on a clear identification of the targets to be met, what are the applications to be built, what are the target markets and what are the advantages relative to competitors. In this way, research directives can be lead more easily to patents and inventions with potential to generate revenue. The use of patent search, before the start of an R&D project and after its first results, may reduce to half the project duration and bring reduction in costs of about 40% (Smith, 2005).

Identification of competing R&D teams, the probability of alternative technologies show up and the redesign of patents through reverse engineering are also assumed by the TTUs to be important activities. For INOV the redesign of the patent is very important as well as the analysis of alternative technologies.

In this stage of evaluation, it is important to know every aspect of the technology and to clarify all tasks that are necessary to the proof of concept (if not already done) and to obtaining a complete commercial product. The proof of concept is essential to develop products based on the technology. The lack of a proof of concept national fund is a weakness that is remarked by all TTUs.

After all aspects of the invention are understood, and the resources necessary to further development are identified, it follows a stage where the most promising applications and their respective market are identified and studied. Market research is the starting point to understand the relation between the technology, its applications, its market, identifying its final consumers, its needs, its competitors, and the relevant firms and actors, so that an adequate market position is found. It allows the definition of the value proposition and of the marketing strategy. Market research is initiated by the TTUs when research results are communicated and is deepen during the period that is between the registration of the patent and the PCT request or when a manifestation of interest is received.

To obtain data about the invention and on its potential market there are several methods with different levels of depth that can be applied at different times of the evaluation process.



A- Analysis and description of the technology, its attributes and claims B- Identification of new development phases and definition of an activity plan C- Identification of competing patents D- Analysis of the nature of the invention (incremental, disruptive) E- Evaluation of the state of maturity of the technology	F- Analysis of the competitive advantages and differentiated characteristics of the products associated with the technology G- Identification of all technology applications H- Identification of similar and competing R&D teams I- Analysis of the possibility of competing technologies show up J- Evaluation of the possibility of redesign of the patent

The most common methods of evaluation are:

- Pre-defined evaluation models and matrices;
- Comparable license agreements and the observation of royalties practiced in industry;
- Evaluation based on development costs;
- Discounted cash-flow method;
- The 25% rule;
- Real options and Monte Carlo simulation methods;
- Patent auctions

The following sections address the frequency with which these methods are utilized by the respondents to this study.

4.4.1 Pre-defined evaluation models and matrices

Most TTUs use the methods based on checklists and on pre-defined evaluation models and matrices. The *Commercialization Quicklook Assessment* is utilized by three of the seven TTUs. The COAP – *Commercial Opportunities Appraisal Process* and the *Rapidscreen* are utilized by two of the seven TTUs. One of these units has developed its own matrices of evaluation criteria, that group a set of indicators into four categories: the state of development, the innovation potential, the market potential, and the strategic importance of the technology. In the case of INOV, none of these methods is used.

4.4.2 Comparable license agreements and the observation of royalties practiced in industry

The analysis of previous license agreements is used by four TTUs and by INOV. Only two TTUs consider the royalty standards of the industry that is the target of the technology, in order to have a reference on which to base their negotiation.

4.4.3 Evaluation based on development costs

According to the responses given to the questionnaire, evaluation of the development costs and its consideration for the negotiation of a technology transfer agreement is considered, in average, important. However, this importance is contradicted by the literature, and by some of the TTUs, which affirm that the market value always determines the value of the technology, independently of all the costs that the institution incurred. This position is also adopted by INOV, which adds that evaluation based on development costs is only useful to decide on the launch of a project or to evaluate future stages of development.

4.4.4 Discounted cash-flow methods

The discounted cash-flow method is used by four of the seven TTUs, which use this method upon the manifestation of interest on the technology from the part of a firm. INOV does not discard

altogether this method, but they do not use it regularly to evaluate its technologies.

4.4.6 Methods not used by TTUs or by INOV

In this section, tentative explanations for the fact that certain common practices are not used by the respondents will be advanced.

The 25% rule (cf. section 2.4.5) is not used because its application is not well understood, and because there are doubts on whether the value of 25% is adequate, since this value can vary with the rights conceded by the patent and with the development of production and distribution stages of the technology. This rule is based on an average distribution of license agreements, but because each agreement is unique the rule may cast some doubts on its effectiveness (Speser, 2006). However, it may serve as a starting point to negotiation processes.

The real options and Monte Carlo simulation methods are not used because TTUs prefer evaluation methods that are quicker and that allow the inspection of several variables, and not whole scenarios that may affect the profitability of the invention.

Only one TTU is considering the use of patent auctions.

4.5 Types of payment used in licensing agreements

A license agreement creates contractual obligations between the licensor and the licensee, and several modes of payment, that consider several considerations whose nature may be economic, technological, legal or commercial, may be included in the contract.

The graph below indicates that TTUs introduce different modes of payment in license agreements, with different degrees of frequency.

Earned royalties – royalties based on a percentage of sales or utilization of the technology – constitute the widest use mode of payment in the license agreements of TTUs, but involving also other forms of payment. The same can be said about INOV, where this form of payment is quite frequent. The inclusion of a minimum annual payment is also frequently used by TTUs, which define their value based on the business plan. For INOV, this mode is not frequent.

Up-front payments are very frequent for INOV, but less so for the TTUs. These express a concern in assessing the position of the firm and the preoccupation of establishing a mutual relationship, especially when the firms are from the same region of the TTU or when the firm results is established to explore an invention. This preoccupation is also reflected on the frequency of payments established after a period of experimentation and tests (deferred royalty calculation). Some TTUs say that they do not use this mode because it may generate conflicts.

Support payments for scientific and technical services are frequent in license agreements of the TTUs but it is INOV that gives more importance to them, and who utilizes them more, referring that they earn much more revenue with these services than with the royalties over the sales. These services, a mixture of maintenance and technical assistance, also have the advantage of keeping the relationship with the licensee, and the possibility of selling other solutions.

Sublicensing is common with TTUs but INOV does not concede them.

Stage payments or milestone payments are not frequent in INOV, and in the case of the TTUs, although the frequency is higher, they are not used regularly.

Equity participation is not frequent, although some TTUs referred the fact that some universities, through their schools, faculties, or interface institutions, may be adopting this payment mode.

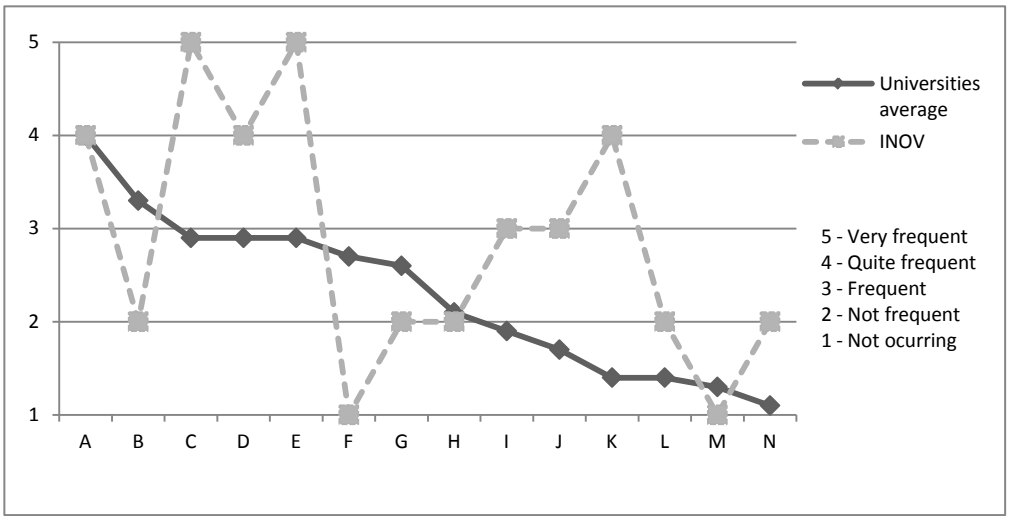
The single lump sum payment is not common in most TTUs, but it is so in two of them, who prefer this mode of payment because it simplifies procedures during the monitoring phase. INOV also refers that this mode is frequently used in its license agreements.

Termination fees are frequently used by INOV, which uses them as a measure of credibility. TTUs do not use this mode frequently.

Fixed fee payments are not frequently used by TTUs but are frequently used by INOV, who develops technologies in the area of information and communication technologies.

Practices that are not frequent or do not occur, either in INOV or in the TTUs, include adjustments to the value of royalties, late payments penalties and option agreements.

Types of payment



A-	Earned royalties or running royalties	H-	Equity payments
B-	Minimum cash payment	I-	Single lump sum payment
C-	Up-front payment	J-	Termination fees or kill fees
D-	Support payments	K-	Fixed fee
E-	Deferred royalty calculation	L-	Royalty adjustments
F-	Sub-licensing payments	M-	Option agreements an option payments
G-	Stage payments or milestone payments	N-	Late payment penalties

4. Earnings distribution within the university

The distribution of revenues obtained through technology licensing agreements is different in each of the respondent universities. The University of Porto, with an allocation of 60% of earnings to inventors, and the University of Minho, with an allocation of 45% of earnings to inventors, are the universities that have a larger number of license agreements, followed by the Technical University of Lisbon, with an allocation of 50% of revenues to the inventors. The University of Beira Interior, with an allocation of 55% of revenues to the inventors, is the University that has the smaller number of patents, but whose number of license agreements is equivalent to those of the more active universities (measured by the number of patents).

The earnings obtained from the license agreements are used mainly to reward the research team that originated the patent and to support the research centre where the invention took place. It is also frequent the utilization of revenues to acquire equipment and materials and to continue to manage its exploration having in view future gains. Revenues are also used in transverse activities, mainly in the management and reinforcement of intellectual property rights and in strategic R&D projects of the university.

Distribution of earnings from license agreements

University	Distribution of earnings
University of Aveiro (Universidade de Aveiro)	40% for inventors 60% for the University (negotiable)
University of Beira Interior (Universidade da Beira Interior)	55% for inventors 45% for the University, of which 25% for the Department or Centre 20% for the Central Executive Services
University of Coimbra (Universidade de Coimbra)	55% for inventors 45% for the University, of which 30% for the Faculty 15% for the Central Executive Services
University of Minho (Universidade do Minho)	45% for inventors 45% for the University, of which 15% for the Department or Centre 15% for the Faculty 15% for the Central Executive Services 10% for remuneration of risk capital (central services)
New University of Lisbon (Universidade Nova de Lisboa)	30% - 55% for inventors, depending on the profitability Remaining for the University, to be distributed by departments, on a case by case manner
University of Porto (Universidade do Porto)	60% for inventors 45% for the University, of which 30% for the Faculty or Department or Centre 10% for the Central Executive Services
Technical University of Lisbon (Universidade Técnica de Lisboa)	50% for inventors 50% for the University

The TTUs are not considered explicitly in the distribution of revenues obtained from license agreements, and the universities have no explicit rules in the case there is the creation of a spin-off firm to exploit research results.

Revenues from license agreements are considered just like any other source of revenue, in INOV. There is not a specific distribution between inventors and institution. However, the salaries are substantially greater than in the universities, and the units to which the inventors are affiliated can have access to more material and human resources.

Conclusion and final remarks

Having in mind the aim of understanding and improving the information and knowledge about methods and strategies of evaluation and licensing of technologies by the universities, this paper formulated a series of research questions that allowed the description and comprehension of technology valuation practices that are used by technology transfer units.

From the obtained empirical results, several conclusions could be reached. The following is a summary of some important ones, grouped according to the main concepts of the paper:

Selectivity in patent protection

- The size of the patent portfolio is not directly related to the number of license agreements;
- Different degrees of selectivity in terms of patent protection are assumed; more selective TTUs prefer to patent by estimating future patent management costs and the probability of finding suitable partners; other are selective only when considering expanding the geographical scope of the patent protection.

Origin of technology transfer agreements

- Informal networks are important in the evaluation of technical and commercial evaluation of the technology, in the identification of suitable partners, in finding financial support, in the support of spin-off firms and in the identification of the geographical scope of patent protection;
- The main origin of technology transfer agreements are Portuguese firms with national dimension and the contacts that inventors have with these firms are very important;
- TTUs seek firms that commercialize similar products;

- Complete and demonstrable products that reduce the perception of risk are very valued by firms;
- Technology communication and diffusion strategies are very important to increase trust and to effectively communicate the value proposition of the technologies.

Obstacles to technology transfer

- Main limitations are associated with the difficulty of finding partners with adequate technological and marketing capacities;
- Cost uncertainty relative to development and commercialization, stage of development of the technology, and time required to obtain products with required specifications are also important obstacles.

Technology evaluation

- Checklists and pre-defined models of evaluation are the most utilized methods of technology evaluation because conclusions on the technology and market potential can be reached in a quick way;
- Use of previous agreements and cash-flows projections are also used when there is the manifestation of interest from the part of a firm.

Payment structure

- The more frequent modes of payment are the running royalties, but other modes are frequently included in the technology transfer agreements, such as the up-front payments and the minimums;
- Payment for scientific and technical support services are an important source of revenue that allow the continuation of the relationship with the licensee.

Distribution of earnings from technology transfer agreements

- Revenues from agreements are used mainly to reward the researcher or research team that produced the invention, and to support the unit to which the inventor or team is affiliated;
- Allocation of revenues to the inventors differs from university to university and range from 30% to 60% of total revenues;
- University rules do not specify the allocation of revenues to the TTUs, nor they specify the distribution of revenues when spin-off firms are created.

It also came clear from these study that there is the need to create a regular communication process between the TTUs so that each unit can be aware of the practices of the others and learn with each other experiences by identifying possible errors and areas where improvements can or should be made, and to establish possible modes of cooperation.

The following research lines are examples of the need to deepen the problematic of technology evaluation and licensing, and address some answered issues that came out of this research.

- Commercialization of inventions in the global market: indexes of geographical market penetration and the cost-benefit relation of license agreements of technology developed by universities;
- Competitive watch and scientific and technological productivity of the university: R&D centers practices and the contribution of TTUs to identify and diffuse research lines and business opportunities, and the valuation of patent portfolios;
- The utility of technological production: the correlation between licensing of technology and its impact in the development, visibility, reputation and social and economic rewards of the research teams.

These research lines create the opportunity to better understand the application of technology evaluation and licensing practices, and to capture the meanings that lie in the evaluation and innovation procedures implemented by technology transfer professionals.

References

Abell, Derek F. (1980). *Defining the Business: The Starting Point of Strategic Planning*. Englewood Cliffs, London: Prentice-Hall.

Agrawal, A. & Henderson, R. (2002). *Putting patents in context: exploring knowledge transfer from MIT*. Management Science, 48(1), 44–60.

Arvanities, S., Kubli, U. Sydow, N. & Worter, M. (2005). *Knowledge and technology transfer (KTT) activities between universities and firms in Switzerland: the main facts*. Swiss Federal Institute of Technology Zurich and Swiss Institute for Business Cycle Research.

Bray, M. & Lee, J (2000). *University revenues from technology transfer: licensing fees versus equity positions*. Journal of Business Venturing.

Chapple, W., A. Lockett, D., Siegel S. & Wright, M. (2005). *Assessing the relative performance of U.K. University technology transfer offices: parametric and non-parametric evidence*. Research Policy, 34(3), 369–384.

Chukumba, C. & Jensen, R. (2005). *University invention, entrepreneurship, and star-ups*. Mimeo

Ciardullo, J. & Evans, B. (2006). Under the gavel: a defence of patent auctions. The Daily Deal. October 23.

CEC (2007). *Improving knowledge transfer between research institutions and industry across Europe: embracing open innovation. Voluntary guidelines for universities and other research institutions to improve their links with industry across Europe.* Communication from the Commission of European Communities COM (2007) 182 Final, SEC(2007) 449.

Collins, S. & Wakoh, H. (2000). *Universities and technology transfer in Japan: recent reforms in historical perspective*. Journal of Technology Transfer, 25(2), 213–222.

Crawford, C. (1987). *New Product Failure Rates: A Reprise. Research Management*, Vol. 30, nº 4, 20-24.

Debackere, K & Veugelers, R. (2005). *The role of academic technology transfer organizations in improving industry science links*. Research Policy, 34(3), 321–342.

Degnan, S. & Horton, C. (1997). *A survey of licensed Royalties*. Les Nouvelles. 91-96.

Di Sante (2007). *The role of the inventor in the technology transfer process*. IN. *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A Krattiger, RT Mahoney, L Nelsen, *et al*.). MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A.

Dodds, J. & Somersalo, S. (2007). *Practical Considerations for the Establishment of a Technology Transfer Office*. IN *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A Krattiger, RT Mahoney, L Nelsen, *et al*.). MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A.

Drews (2004). *Patent License Evaluation*. Practising Law Institute. IPMetrics LLC.

EPO (2008). *Patents up for auctions*. European Patent Office. 8-7-2008.

Feldman, M., Feller, I., Bercovitz, J. & Burton, R. (2002). *Equity and the technology transfer strategies of American Research Universities*. Management Science. 48(1), 105–121.

Franko & Ionescu-Pioggia (2006). *Making the Right Moves. A Practical Guide to Scientific Management for Postdocs and New Faculty*. 2nd edition. Burroughs Wellcome Fund-Howard Hughes Medical Institute.

Friedman, J. Silberman, J. (2003). *University Technology Transfer: Do Incentives, Management, and Location Matter?*. Journal of Technology Transfer, vol 28, 17-30.

Gardiner, G. (1997). Strategies for technology development. Presentation to the board of the Yale Corporation in February.

Gatignon, H., Robertson & Fein, A. (1997). *Incumbent Defence Strategies against New Product Entry*. International Journal of Research in Marketing. Vol. 14, nº 2, 163-176.

Godinho, M., Silva, L & Cartaxo, R. (2008). *Análise da actividade das Oficinas de Transferência de Tecnologia e de Conhecimento (OTIC) e dos Gabinetes de Apoio à Promoção da Propriedade Industrial (GAPI) de âmbito académico*. Lisboa. OTIC da Universidade Técnica da Lisboa.

Gomes, P. (2007). *The Value Proposition*. IN. *Seminário: Techpreneur – Entrepreneurship Trainning*. UNL.

Grandstrand, O. (2006). *Fair and reasonable royalty rate determination. When is the 25% rule applicable?* Les Nouvelles. 179-181.

Granovetter, M. (1973). *The Strength of Weak Ties.* American Journal of Sociology, Vol. 78, 1360-1380.

Gulbrandsen, M. & Smeby, J. (2005). *Industry funding and university professors research performance.* Research Policy, 34(6), 932–950.

Harmon, B., Ardishvili, A., Cardozo, R., Elder, T., Leuthold, J., Parshall, J. (1997). *Mapping the university technology transfer process*. Journal of Business Venturing, 12(6), 423–434.

Howard & Johnson (2001). *Establishing royalty rates in licensing agreements*. CMA Management

Hsu, D. & Bernstein, D. (1997). *Managing the university technology licensing process: Findings from case studies*. *Journal of the Association of University Technology Managers*, 9, 1-33.

Johnson, P. (2007). *Reasonable royalty damages and license structure*. IN Revista Econ One. Economic Theories in Practive. Sacramento, CA.

Kemmerer, J. & Jiaquing, E. (2008). *Profitibility and royalty rates across industries: some preliminary evidence*. Journal of Academy of Business and Economics.

Kim, S. e Blacklock, P. (2009). *Patent Licensing Basics*. RUDEN McCLOSKY. South Florida legal guide.

Kolchinsky, P. (2004). *The entrepreneur's guide to a biotech startup*. Evelexa.com.

Kristoffersson, S & Jonsson, M. (2003). *Evaluation of inventions – reducing time in a DEAR process*. Ekonomiska Institutionen. Linköping.

Lach, S. & Schankerman, M. (2003). *Incentives and Invention in Universities*. NBER Working Papers 9727, National Bureau of Economic Research, Inc.

Leone, M.e Oriani, R. (2007). *The option value of patent licenses*. University of Bologna & Luiss Guido Carli University.

Lockett, A., Wright, M. & Franklin, S. (2003). *Technology transfer and universities spin-out strategies*. Small Business Economics, 20(2), 185–200.

Mansfield, E. & Lee, J. (1996). *The Modern University:Contributor to Industrial Innovation and Recipient of Industrial R&D Support*. Research Policy, Vol 25, No. 7, 1047-1058.

Miles, R., Snow C. & Meyer A. (1978). *Organizational Strategy, Structure and Process*. The Academy of Management Review. Vol. 3, nº 3, 546-562.

Mowery, D. & Nelson R. (1999). *Sources of Industrial Leadership*. Cambridge University Press, New York.

Owen-Smith, J. (2003). *From separate systems to a hybrid order: accumulative advantage across public and private science at research one universities*. Research Policy, 32(6), 1081.

Parr, R. (2007). *Royalty Rates for Licensing Intellectual Property*. John Wiley &Sons. New Jersey.

Poddar, S. e Sinha, U. (2002). *The Role of Fixed Fee and Royalty in Patent Licensing*. National University of Singapore & Indian Statistical Institute.

Powers, J & McDougall, P. (2005). *University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship*. Journal of Business Venturing, 20(3), 291–311.

Pressman, D. (2009). *Patent it yourself. Your step-by-step guide to filing at the U.S. Patent Office*. 14th ed. NOLO. Parker Street. Berkeley.

Ramakrishnan, V., Chen, J. & Balakrishnan, K. (2005). *Effective strategies for marketing biomedical inventions: Lessons learnt from NIH licence leads*. Journal of Medical Marketing Vol. 5, 4 342–352. Henry Stewart Publications, 1745–7904.

Razgaities, R. (2003). *Valuation and Princing of Technology-Based Intellectual Property*. Hoboken, New Jersey. John Wiley & Sons, Inc.

Razgaitis R. (2007). *Pricing the Intellectual Property of Early-Stage Technologies: A Primer of Basic Valuation Tools and Considerations*. IN. *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A Krattiger, RT Mahoney, L Nelsen, *et al*.). MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A.

Saragossi, S. & Potterie, B. (2003). *What patent data reveal about universities: the case of Belgium*. Journal of Technology Transfer, 28(1), 47–51.

Shane, S. (2001). *Technological oportunities and new firm creation*. Management Science, 47(2), 205-220.

Shane, S. (2004). *Academic Entrepreneurship: University Spin-offs and Wealth Creation*. Cheltenham, UK: Edward Elgar.

Shane, S. (2004). *Encouraging university entrepreneurship? The effect of the Bayh-Dole act on university patenting in the United States*. Journal of Business Venturing, 19(1), 127–151.

Siegel, D., Waldman, D. & Link, A. (2003). *Assessing the impact of organizational practices on the productivity of university technology transfer offices: an exploratory study.* Research Policy, 32(1), 27–48.

Smith, H. (2005). *What innovation is – How companies develop operating systems for innovation*. CSC White Paper. European Office of Technology and Innovation.

Soares, I., Moreira, J., Pinho, C., Couto, J. (2007). *Decisões de Investimento. Análise Financeira de Projectos*. Lisboa. Edições Sílabo, Lda.

Speser, S. (2006). *The Art & Transfer of Technology Transfer*. Hoboken, New Jersey. John Wiley & Sons, Inc.

Stabell, C.B. & Fjeldstad, O.D. (1990). *Configuring value for competitive advantage: on chains, shops, and networks*. Strategic management journal, 47-84.

Tansik, D., Dakin, K. & Lindsey, J. (1991). *Technology transfer: Financing and commercializing the high tech productor service from research to roll out*. Chicago, IL: Probus Publishing Company. Springer Netherlands.

Thalhammen-Reyero (2008). *Transfer and Valuation of Biomedical Intellectual Property*. Chapter 22. *IN*. *Taxation and Valuation of Technology: Theory, Practice and the Law*. Horvath and Chiidikoff Editors.

Thursby, J., Jensen, R. & Thursby, M. (2001). *Objectives, characteristics and outcomes of university licensing: a survey of major U.S. Universities*. Journal of Technology Transfer, 26, 59-72.

Thursby, J. G. & M. C. Thursby (2004). *Are faculty critical? Their role in university-industry licensing*. Contemporary Economic Policy, 22, 162–178.

Tornatzky, L., Fleischer, M. (1990), *The Processes of Technological Innovation.* Lexington Books, New York, NY.

UMIP (2005). *Licensing: A Researcher's Guide*. Eversheds LLP and The University of Manchester Intellectual Property Limited.

Wada, T. (2004). *Running royalty and patent citation: the role of management cost in unilateral patent licensing.* National Institute of Science and Technology Policy (NISTEP) & Ministry of Education, Culture, Sports, Science and Technology (MEXT). Gakushuin University, Tokyo, Japan.

Wakee,I (2004). *Starting Global. An Enterprenership-In-Networks Approach*. Ph.D. Dissertation. Febodtuk B. V., Enschede.

WIPO (2004). *Successful technology licensing*. IP Asset Management series.

WIPO/ITC (2005). *Exchanging value: negotiating technology licensing agreements. A training Manual*.

Wood, T. (2004). *Launching patent licensing for an emerging company*. Sixth Annual Seminar on Licensing Intellectual Property. University of Dayton School of Law.

Young, T. (2007). *Establishing a Technology Transfer Office*. IN *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A Krattiger, RT Mahoney, L Nelsen, *et al*.). MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A.