Explaining the Remuneration Structure of Patent Licenses

Maria Isabella Leone and Raffaele Oriani

LUISS Guido Carli University of Rome (Italy)

mleone@luiss.it

roriani@luiss.it

ABSTRACT

The design of an appropriate remuneration structure is one of the crucial aspects of patent license negotiation. However, with few exceptions, literature about licensing has paid scarce attention to the determinants of the contractual remuneration structure. Moreover, the licensee's perspective has been often neglected. The aim of this paper is to shed new light on the variables affecting the upfront fee that the licensee is willing to pay to enter the license. Consistently with real options theory, we consider the initial fee paid by the licensee analogous to the premium of an option to commercialize the patented technology in the future. As such, the upfront fee should be positively affected by market uncertainty and technological potential. We empirically test our hypotheses on an original sample of 124 patent licenses, finding support to our hypotheses.

Keywords: Patents, Licensing, Upfront fee, Uncertainty, Real options

Introduction

The recent diffusion of markets for technology - virtual spaces where innovations are exchanged in the form of intellectual property rights, products and services - (Arora, Fosfuri and Gambardella, 2001; Rivette and Kline, 2000) confirms the current shift of firms to more open models of innovation based on collaboration and external sourcing of knowledge. The growth of these markets has been mainly driven by the increasing employment of licensing agreements for the transfer of technological knowledge among firms, mostly operating in high-tech industries (Grindley and Teece, 1997; Rivette and Kline, 1999; Annand and Khanna, 2000; Gu and Lev, 2001; Arora et al., 2001; Arora and Fosfuri, 2003; Vonortas, 2003; Kim and Vonortas, 2006). Among all kinds, patent licenses represent the largest part of this technology trade both in terms of volume of transactions and revenues that have skyrocketed from only 15 billion of dollars annually some decades ago to more than 100 billion of dollars today (Kline, 2003; Chesbrough, 2003; Litchtenthaler, 2007).

Carefully accounting for both the financial and non-financial terms associated to any license agreement is then very relevant, as licensing becomes an integral part of firms´ business strategy in the new competitive landscape. In this respect the contractual scheme of licenses (including, for instance, the exclusivity clause as well as all the components of the remuneration structure) plays a very important role in determining the distribution of value accruing to the licensee and the licensor. From the licensor's perspective, it affects the stream of revenues that are potentially generated by the exploitation of the licensed patents by the buyer firm; from the licensee's perspective, instead, it concerns the overall costs (upfront and fixed fee, development costs, royalties) and constraints/conditions that (un)directly affects the exploitation of the licensed patents and that in turn are strongly related to the licensee's business model. For this reason, the achievement of a satisfactory agreement is not an easy task. As revealed by the annual surveys of the Licensing Executive Society (US and Canada), in fact, one of the main problems in licensing negotiations is the difficulty to reach mutually acceptable financial and non-financial contractual terms between the licensor and the licensee. Also, whenever licensing agreements are reached the same evidence is suggestive of an increasing level of buyer's remorse about contract features (Cockburn, 2007; Razgaitis, 2004, 2005, 2006). In recognition of that, the aim of our paper is to contribute to the theoretical and empirical literature explaining the determinants of the remuneration structure of licensing agreements.

Over the last decades relevant advances have been made in the understanding of the optimal contract design of licensing agreements. The tradeoff between fixed and variable payments has been centre-stage in the theoretical literature applying game theory modeling. Early works tended to emphasize that "*licensing by means of a fixed fee is superior to licensing by means of a royalty for both the inventor and consumers*" (Kamien and Tauman, 1984: 472, Kats and Shapiro, 1986). However, drawing on the empirical evidence provided by Taylor and Silberston (1973) showing the existence of mixed contracts (fixed fee plus royalties), subsequent theoretical works have attempt to find new explanations that justify the use of royalties, albeit they imply a distortion of the marginal costs borne by the licensee. Competition in the downstream market (e.g. Kats and Shapiro, 1985), signaling in presence of information asymmetries (e.g. Gallini and Wright, 1990), liquidity constraints of the licensee (Contractor, 1981), risk sharing under cost and demand uncertainty (e.g. Bousquet, Cremer, Ivaldi and Wolkowics, 1998), double-side moral hazard problem (e.g. Choi, 2001) between licensor and licensee are the most relevant reasons provided.

The extant literature on patent licenses presents three major gaps that our paper attempts to fill. First, previous works are only focused on explaining the choice between different forms of payment (fixed fee versus royalty) while neglecting the important issue of the level of these components that substantially affects the distribution of value accrued to both parties. Second, the undertaken perspective generally reflects that of the patent-holder/licensor that wants to maximize his revenues (e.g. Kaumien and Tauman, 1984, Erutku and Richelle, 2007) by deciding to whom and how many firms license-out. Indeed, the under-investigation of the licensee's point of view is a common trait of the literature about licensing. With only few exceptions providing insights on the licensee behavior (e.g. Caves, Crookell and Killing, 1983; Atuehene-Gima, 1993; Cesaroni, 2004), the *licensing dilemma* (Fosfuri, 2006) of the licensor - whether a potential licensor should produce the innovation itself or license the innovation to other firms has been generally overemphasized so far[1]. Third, the majority of these works don't provide any empirical support to the theoretical predictions formulated. To the best of our knowledge, in fact, only Macho, Martinez and Perez (1996) and very recently Vishwasrao (2007) building on prior literature findings, tested their hypotheses about the determinants affecting the forms of licensing payment (lump sum fee, royalty, royalty and fee)

[1] The recent attemp of Gambardella and Giarratana (2007) to include in the model explaining the probability of licensing the situation in which a potential licensee demands the technology based on her flow of revenues, represents a relevant contribution, although partial, to take the demand-side of markets for technology into account.

on the bases of sample of transactions between Spanish and foreign firms and Indian and foreign firms, respectively.

Based on these considerations, in this paper we contribute to answer to our research question in several ways. Theoretically, we first explicitly focus on the determinants of the remuneration structure of patent licenses (form and amount), and in particular on the role of the upfront fee from the licensee's perspective. Aiming at this, we combine the insights of two theoretical approaches: agency and real options theory. Agency theory has been extensively employed for the analysis of other forms of sharing contracts like franchising generally based on a mix between a certain level of up-front payment and royalty rate (e.g., Bhattacharyya and Lafontaine, 1995; Brickley, 2002; Lafontaine, 1992; Lafontaine and Shaw, 1999, Vazquez, 2005). Risk sharing and double-moral hazard argumentations are introduced to explain the amount of the different components of the franchising remuneration structure. Real options theory, instead, has been increasingly employed to formally recognize and assess the value of flexibility for investments with very uncertain returns, such as patents (Pitkethly, 2006; Reitzig, 2006; Ziedonis, 2007). Within this framework, it is possible to investigate the level of flexibility associated to the exploitation of the licensed patents that affects the licensee's willingness to pay a certain amount of up-front payment.

Empirically, we rely on an original dataset of 124 patent licenses[2] that have been concluded from 1983 till 2000. The relevance of our database is threefold. First, its evidence is cross-industries and allow for more generalization of our findings; second differently from other studies based on licensing dataset, it reports detailed information on licensed patents (e.g. citations, IPC classes and so on) which are relevant also for the model specification; third it records values for the remuneration structure and other contractual provisions included in the text of license, whenever available and undisclosed.

The paper is organized as follows. In the next section we briefly analyse the main features of patent licenses. We emphasize the role of flexibility in these contracts from the licensee's viewpoint. Also we describe the main characteristics of the remuneration and contractual structure of licensing agreements, like the exclusivity and the geographic scope. In the Theoretical framework section, starting from the main contributions provided by agency theory we enrich our theoretical framework of reference with the introduction of the real

---

[2] **The Financial Valuation Group (FVG)** is one of the leading business valuation consulting and litigation service firms in North America. (http://www.fvginternational.com/index.html, accessed June 2007).

option reasoning. We define our hypothesis accordingly. The description of the methodology for the empirical analysis follows. In the results section we highlight our findings that support our hypothesis and that are extensively discussed in the Discussion and Conclusion section.

Remuneration structure of patent licenses

Contractual terms of patent licenses

By definition, a license is a "*permission granted by and IPR holder, the licensor, to another legal entity (person or company) the licensee, to make use of, sell or otherwise benefit from the underlying* IPR *under certain restrictive conditions*" (Grandstrand, 1999: 414). Although IPR encompasses patents copyrights, trademarks and trade secrets, licensing represents the leading mechanism in trading patents (Arora & Ceccagnoli, 2004; Arora & Fosfuri, 2003; Chesbrough, 2003). Specifically, patent licenses entitle the licensee (technology buyer) to use the patent rights and thus to exploit the underlying technology in exchange for a defined royalty rate or a defined level of fixed fees or the mix of both. A simplified sketch of the remuneration structure of a patent licensing contract is provided in Figure 1.

Insert Figure 1 about here

The graphic shows the asymmetric condition of the licensor and the licensee before the start, during and after the end of any licensing contract. The licensor's stream of revenues stems from the flow of royalties and fees periodically paid by the technology buyer. Instead, the payment and revenue structure of the licensee is more articulated. After the initial payment (up-front payment, down payment or initial fee), the licensee is given the right to fully exploit the licensed patent and thus she starts to produce and sell her products. In order to do that, the licensee sustains a certain amount of operating costs. Besides these costs, the licensee also has to periodically paid royalties (generally set as a percentage of sales) as a compensation for the use of the licensed patent.

Along with the two common elements represented in Figure 1 (royalties and upfront fee), there are other many possible modes of payment that can be combined and that represent sources of additional profits and costs for the licensor and the licensee, respectively. Some of them directly affect the distribution of value accruing to the licensee and the licensor. Among them, the most significant are minimum annual royalties and milestone payments, which are fixed cash payments due on each anniversary of the license or upon the crossing of some milestone events, respectively. As such, they stand as a guarantee of the commitment of the licensee to use her best efforts to bring the licensed technology to market and to continue to a best-efforts marketing program for the licensed technology throughout the life of the license agreement. However, not all licenses include such a provision in the text of the contract. This means that the degrees of freedom for the licensee are even stronger. In fact, according to the conventions established by the contractual practice, only the up-front fee, conceived as that payment that precedes the commercial exploitation by the buyer (sometimes called *commitment fee*), is unconditional. (Razgaitis, 2003: 19).

There are several examples at hand that can be found in the real markets for technology confirming this occurrence. For instance, Exactech Inc., a group active in the Drugs, Cosmetics & Health Care Industry, for the rights to use some patents developed by the University of Florida paid the licensor an initial license fee of $6,000. Based on this license agreement, the company was required to pay royalties on the net sales of the licensed products, if (and only if) and when the patented technology was commercially exploited by the company. However, "*to date, the Company has only utilized the University patents in connection with product research and development and accordingly, the Company has paid no royalties to the University [yet]*"[3]**.** Seemingly, the Korean Dong Kook Steel[4] after some years from the signing of the license with Titan Technology Inc. did not report any sale of any products from the plants that it had built up based on the licensed technologies. Thus no royalty was paid to the licensor.

Even accounting for these other elements that affect the value distribution between the licensor and the licensee, the majority of contracts observed empirically are more complex and sophisticated. Indeed, as recently shown by Anand & Khanna (2000) and Bessy, Brousseau & Saussier (2002), real licensing agreements include several different clauses that are meant to detail the circumstances under which the licensee can make use of the licensed

[3] Information drawn by the Company Form:S-1/A that has been filed in 5/13/1996, as available online at http://sec.edgar-online.com/1996/05/13/00/0000950170-96-000189/Section11.asp, as retrieved in January 2008.

[4] http://sec.edgar-online.com/1998/10/26/08/0001008878-98-000043/Section2.asp

technology. Territorial restriction and exclusivity clauses are the most relevant and common examples. The former establishes the boundaries of the licensee's field of action in terms of number of countries in which she is allowed to exploit the licensed technology. The latter, instead, refers to the right grant to the licensee to be the exclusive user of the licensed technology in a particular market. In other words this clause affects the level of competition which the licensee will face in the product market.

Finally, the value of a license as perceived by the licensee is affected by two other primary features of the contract: the duration and the scope. The duration of a license is equal to the number of years the licensee is allowed to exploit the licensed patents. The scope of the license, instead, reflects the overall set of technologies, IPRs and know-how that are exchanged in the transaction. Sometimes, in fact, patent licenses might involve specific provisions of technical assistance or supply of know-how from the licensor, generally upon or right after the payment of the initial fee by the licensee.

<u>The choice of the contractual form: fixed fee vs. royalties</u>

With the first extensive evidence on the diffusion of licensing agreements in the US, UK and Canada markets as collected by Taylor and Silbertson (1974) and Caves, Crookell and Killing (1984), a relevant subset of theoretical investigation has been stimulated with the intent to address the relevant topic of the so-called *Optimal Contract Design* of licensing agreements. Starting out with Kaumien and Tauman (1984), industrial organizational economists have investigated the choice between fixed fee and royalty based contract applying game theory modelling. The focal and starting point of Kaumien and Tauman's argumentation is the analysis of how much profit an inventor may realize by selling his technology through licensing depending on the nature of the market, the nature of the licensed technology and the contractual scheme employed to sell it to one or more external firms (Kaumien and Tauman, 1986). The primary assumptions are complete information, no uncertainty and the absence of competing innovations. The overall outcome of the three-stage game suggests that "*licensing by means of a fixed fee is superior to licensing by means of a royalty for both the inventor and consumers*" (Kamien and Tauman, 1984: 472). In addition, since the object of investigation is the patent license the results are interpreted as suggestive of the private value of a patent from the inventor's perspective.

As indicated by Kamien and Tauman (1992), many variants of their model have been developed so far. The common trait of these attempts has been to provide new explanations that justify the use of royalties given that they imply a distortion of the marginal costs borne by the licensee. Aiming at this, they shift their focus from the exclusive interest of the patentee/inventor to the implications of the mutual relationship between licensee and licensor on the remuneration structure of licensing agreements. According to the strategic argumentation provided by Kats and Shapiro (1985), the licensor may decide to use royalties to restrict the level of output which potential licensees may be committed to in the downstream market. Royalties have the effect to reduce the level of competition so that the level of industry profit arises and the licensor maximizes the amount of revenues that he can extract. This is true also if the licensor and the licensee are competitors in the downstream market and the licensed innovation is not drastic. Instead, if the licensee is a monopolistic producer the licensor would prefer a fixed fee as a best way to extract rents and profits form the license.

The second main rationale explaining the inclusion of royalty in the license contract is the presence of information asymmetries between the licensee and the licensor. On the one hand, the patentee may be more aware of the value of the licensed technology since he is the developer (Gallini and Wright, 1990); on the other hand, the licensee may be more conscious of the potential of this technology in the downstream market where she already operates[5] (Beggs, 1992). In this signaling game the contract become the mean to signal the value of the licensed technology and to induce the licensee or the licensor to accept the offer, respectively. In this respect, royalties over perform lump sum payments since they are due only after the real potential of the technology has been reveled. Additionally, Beggs (1992) provided seminal insights about the level of royalty rate employed in negotiations. According to the empirical evidence found by Taylor and Silbertson (1973), he found that royalty rate increases in presence of inelastic demand and decreases with the level of output.

Another reason explaining the presence of royalties is introduced by Bousquet, Cremer, Ivaldi and Wolkowicz (1998). They focused their analysis on the role played by uncertainty in justifying royalties as a risk-sharing device. In their setting, the demand for a new technology is uncertain and the licensor and the licensee don't have perfect information about the potential cost-reduction of the licensed patent. They found that demand and cost

[5] This is typical the case whenever the licensor is an individual or the licensee is a foreign subsidiary or independent firm that has better information about her local markets where the licensed product will be launched (Beggs, 1992; Vishwasrao, 1994; Choi, 2001).

uncertainty associated to the exploitation of the technology may induce the parties to agree on a "*state-contingent royalty*" rather than on just a fixed fee. According to the authors (1998:542-543) "[u]*nder uncertainty, royalties continue to have an output distortion effect. However, they also provide a measure of insurance.* […] *The optimal contract strikes the right balance between the positive and negative effects of royalties*". Their analysis also contributed to the understanding of the different type of royalty (ad valorem and per unit) that may be included in the contractual scheme and they may be alternatively preferred depending on which kind of uncertainty parties have to face (demand and cost uncertainly, respectively).

Very recently Vishwasrao (2007), in the attempts to review the prior literature findings, provided the first extensive empirical evidence of a number of hypothesis about some factors affecting the characteristic of the optima licensing contract in terms of different forms of payments (lump sum fee, royalty, royalty and fee) included. The paper used an original dataset of foreign technology transactions involving Indian manufacturing firms between 1989 and 1993. He introduced a new reason to explain the decision to include royalties in the contractual scheme of payment. According to him, when licensor's reputation is at stake, royalties outperform lump sum payments since the licensor has the necessity to make sure that the licensee is committed to the development and commercialization of the licensed technologies. However, in order to avoid the distortion effect implies by royalties, the licensor may decide to have an equity stake on the licensee firm. Equity participation performs the same risk-sharing function as royalties. It allows the licensor to control the licensee while providing a stream of revenues in the form of dividends accrued to the licensor.

Theoretical framework and hypotheses

Agency problems in patent licensing

According to Eisenhardt (1989:59) "*overall the domain of agency theory is relationship that mirror the basic agency structure of a principal and an agent who are engaged in cooperative behaviour but have different goals and differing attitudes towards risks*". As such, Agency theory is concerned with determining the most efficient contract governing the principal-agent relationship. It aims at resolving the two main problems that arise in agency relation: the *agency problem* and *risk-sharing*. The first one occurs because cooperating parties have different goals and task to perform during the time-span of the relationship. Risk sharing, instead, arises when principal and agent have different attitudes toward risk. Agency modelling may be applied to a great variety of relationships and most frequently to organization phenomena.

Theoretical explanations for profit and revenues sharing transactions, like franchising, have been generally developed within the framework of reference of the agency theory. Three are basically the models that have been developed[6] to formulate predictions on the optimal level of royalty rate and up-front payment of these contracts. We refer to pure risk-sharing models, one-sided moral-hazards models and two-sided moral hazards models (e.g. Bhattacharyya and Lafontaine, 1995). According to the mainstream, the basic idea is that the remuneration structure is construed as resolving namely the risk-sharing and the agency problem between parties. In the double-sided moral hazards setting, the starting point of the analysis is the recognition of the possibility of mutual cheating between the franchisor and the franchisee. The franchisees can have the incentive to free-ride on the brand name and other inputs provided by the franchisors, while franchisors can have incentives to reduce the quality of the inputs because some of the benefits will accrue to franchisees. The existence of royalties provides an incentive to both franchisors and franchisees to produce a greater effort through the mechanism of revenue sharing. The royalty rate will increase/decrease the more important the franchisor/franchisee inputs and the harder it is to monitor the franchisor/franchisee behaviour (Lafontaine, 1992).

Although the problem of double-sided moral hazard has been extensively analyzed to explain the franchise contracts (Bhattacharyya and Lafontaine, 1995; Brickley, 2002; Lafontaine, 1992; Lafontaine and Shaw, 1999; Lal, 1990), it can be extended to other contracts based on profit or revenue sharing, including licenses (Bhattacharyya & Lafontaine, 1995). Patent licenses involve an agency relationship since the licensor and the licensee generally are motivated by different aims and their actions could not be supervised without bearing high monitoring costs on both sides. As already advance, the licensor tends to maximize his stream of revenues by taking advantage of the potential licensing opportunities and committing as low as an effort possible; the licensee instead tends to minimize her financial exposure while maximize amount of knowledge acquired and the sales coming from

[6] See Lafontaine (1992) for an exhaustive review of the literature.

the commercialization of licensed patents.

Some authors have instigated the effect of moral hazard in patent licensing agreements (e.g. Arora, 1996; Macho-Stadler et al. 1996; Choi, 2001; Mendi, 2003). By relaxing the assumption of completely codified knowledge (in the form of patents), these works analyse the problem of moral hazards implied by the process of technology transfer. According to Arora (1996), on the one hand, licensor may sell her technology without providing the required know-how to exploit it. On the other hand, the licensee, given the possibility of moral hazard on the part of the licensor, could reduce its effort in product development and commercialization until that the technology has been fully transferred. He concluded assessing the complementary role of know-how and patents in resolving the agency problem among parties. That is, the more is the know-how transferred with patented technologies the higher is the probability that licensee would understand and integrate that technology and that licensing would be successful. Vice versa, the higher is the part of technology protected by patents, the higher is the probability the licensing involving also technological know-how may avoid opportunistic behavior by both parties.

Macho-Stadler et al (1996) found that contracts for the transmission of know-how will typically include royalty payments. According to them (1996:53) "[r]*oyalties raise the licensor's incentives to transfer the best current know-how*" which is crucial for the recipient firms to fully assimilate the licensed technology. In this particular case the emphasis is on the moral hazard on the licensor's side. Choi (2001), instead, argued that in presence of costly input related to the effort provided by both parties to transfer and absorb the licensed technology, technology transfer are susceptible to the moral hazard problems. According the fundamental prediction of the double-moral hazard models employed in the franchising literature (e.g. Brickley, 2002), he suggested (2001:254) "*a higher royalty rate induces more effort by the licensor since a lower cost for the licensee (in terms of knowledge absorption) implies a higher royalty income for the licensor*". The optimal royalty rate is then chosen to maximize the trade-off between the outcome contraction effect and the incentive effect.

The models dealing with the problem of double-sided moral hazard in the franchising context have generally assumed that the remuneration structure of the contract (upfront fee and royalties) is negotiated in two steps (e.g., Brickley, 2002; Lafontaine, 1992; Lafontaine & Shaw, 1999). At the first step, an *optimum royalty rate* (r^*) is determined to minimize agency problems and maximize the total value of the contract, subject to the parties' incentives. At the second step, the upfront fee, F, is negotiated. At this step the problem is that after fixing r^*, some downstream profits are left to the franchisee. The upfront fee has then the role of transferring these profits from the franchisee to the franchisors, becoming the real profit sharing parameter. In other words, the determination of the upfront fee establishes how much of the total downstream profit generated by the contract will accrue to franchisors and how much will accrue to franchisee. Under the extreme assumption that the franchisee is kept at his reservation utility levels, the upfront fee will extract all the franchisee's downstream profits.

In this framework, the upfront fee negatively depends on the royalty rate since a higher royalty rate reduces, ceteris paribus, the potential downstream profits of the franchisee. Moreover, the optimal royalty rate is an exogenous variable in the determination of the upfront fee since it is determined at a previous step to address the agency problems. In this paper, we extend this theoretical framework to patent licenses. However, differently from most of the cited literature, we will not assume that the all the downstream profits will be transferred to the licensor through the upfront fee (i.e., the licensee is kept at her reservation utility). The upfront fee is assumed to be object of negotiation and will depend on the licensee's willingness to pay to enter the licensing contract. Accordingly, in the next paragraph we discuss the determinants of the upfront fee.

<u>Patent licenses and real options</u>

When determining the upfront fee within the licensee's perspective, the peculiar nature of the licensing contract has to be considered. As already advanced, given their structure, patent licenses can be seen as options from the licensee's perspective. In fact, when entering a licensing contract, the licensee pays an initial fee (premium to buy the option) to acquire the right (option) to develop and commercialize the technology protected by the patent. However, in most cases the licensee has not the obligation to produce and sell the products or the services based on the licensed technology. This is an important form of flexibility.

Following real options theory, the licensing contract is then analogous to a financial call option (see also Table 1). As a call option provides its owner with the right but not the obligation to buy an underlying financial asset at a predetermined strike price before a given maturity date, the licensing contract provides the licensee with the opportunity, but not the obligation, to acquire the NPV of the cash flows from the commercialization of the patented technology (underlying asset) paying a development and industrialization cost (strike price) at some time before the license term (maturity). Similarly to the underlying asset of a financial option, the NPV is subject to volatility over time, stemming from different sources of uncertainty.

Insert Table 1 about here

The initial fee paid to enter the licensing contract is then a critical variable for real options theory, since it should reflect the option valuation by the licensee. Following financial options literature (Black & Scholes, 1973), the initial fee paid by the licenses (*F*), analogous to the premium paid to acquire a call option, can be expressed as a function of the following variables:

$$F = f\ [NPV, I, \sigma, n, r_f] \qquad [1]$$

Where:

NPV = NPV of cash flows from technology commercialization

I = Development and industrialization cost required for technology commercialization

σ = Volatility of NPV

n = Duration of the license

r_f = Risk-free interest rate

Assuming for the sake of simplicity no further investment after product commercialization and constant annual sales over the licensing period, based on the previous description of the economic structure of a patent license, the NPV can be expressed as follows:

$$NPV = \left[S\left(1 - opc - r^{*}\right)\right] a \neg i \qquad [2]$$

Where:

S = Annual sales from the licensed patent

opc = Incidence of operating costs on sales

r^* = Royalty rate

$a_{n\neg i}$ = Rent factor for n years and discount rate i

i = discount rate (different from r_f)

Based on the proposed model (expressions [1] and [2]), F positively depends on NPV and then it is affected by the NPV determinants. Moreover, F is positively influenced by the license term (maturity of the option) and risk-free interest rate.

The most interesting role within real options theory is, however, plaid by volatility. A fundamental prediction of the theory is that the option value increases with volatility. This is because the downside is limited (premium paid for the option), whereas the upside has not an upper bound (e.g., Kulatilaka & Perotti, 1998; McGrath, 1997). If the licensee uses real options based model to determine how much she should pay to enter the license, we should then expect F to increase with volatility.

In order to analyze the effect of volatility on F, we isolate the sources of uncertainty that affects volatility. We decompose uncertainty into the market and technological domains, as done by previous studies on real options (e.g., Anand, Oriani & Vassolo, 2007; MacMillan & McGrath, 2002; Oriani & Sobrero, 2008). Market uncertainty refers to the volatility of the potential demand for the patented technology. Uncertainty in the technology domain concerns the technical and manufacturing performance and feasibility of the patented technology (Huchzermeier & Loch, 2001; Ziedonis, 2007). In particular, newer and more radical technologies, while having a higher probability of failure, will also have a higher upside potential (Ziedonis, 2007).

Based on that, we expect the following:

Hypothesis 1. The initial fee of a patent license increases with the degree of market uncertainty

Hypothesis 2. The initial fee of a patent license increases with the degree of technological potential

Method

<u>Data and sample</u>

In order to test our hypotheses we defined a research design based on license and patent data. We started from the Financial Valuation Group Intellectual Property (FVGIP) database developed by the Financial Valuation Group (FVG)[7] with the aim to conduct empirical research on intellectual property. This database is a compilation of intellectual property transactions gleaned from publicly available documents. Three primary criteria have been employed by FVG to select the transactions into the database: 1) each license had to involve the exchange of an IPR explicitly; 2) the transaction had been closed; 3) a certain payment structure was agreed upon by the parties, even if those monetary amounts were not disclosed (Financial Valuation Group, 2007). As such, this database records licensing agreements concluded from the 1970s to the present, including approximately 40 fields of information. The dataset provides data on the document source, the date of the event and the source in which it was filed, the names of the licensor and the licensee, their respective SIC and NAICS industry codes with a qualitative description of industries, the type of agreement, a brief synopsis of the transaction, a detailed description of the remuneration structure, and the identification number (IDNO) of patents involved in the transaction whenever available.

Initially the data contained 1,052 technology agreements, including only "patent" and "technology" transactions, as such identified in the database, for the period 1970-2001. Among these we were able to find the original document (License Agreement) or some references in other company filings (e.g. S1, 8K, 10K) from the Security Exchanged Commission (SEC) website for about 600 licenses. The reason is twofold. First of all, not all the available documents are online anymore. Second, with respect to licensing agreements *per se,* the undesirable drop is due to the strategic relevance and sensitive nature of information included in these contracts which parties are very reluctant to disclose (OECD, 2005; Cockburn, 2007).For the same reason, in only 101 cases the FVGIP database records the USPTO identification number (PATENTNO) of the patents involved. Thus, in order to

[7] **The Financial Valuation Group (FVG)** is one of the leading business valuation consulting and litigation service firms in North America. (http://www.fvginternational.com/index.html, accessed June 2007).

verify whether a real exchange of patents had been executed in the remaining licenses and to exactly identify them through their IDNO, we went through all the documents. This procedure enabled us to find directly the desired information or, whenever impossible, to get that by browsing the USPTO dataset according to the information available in the text of the contracts (e.g., the application number or the title of the issued patents included in the description of the transaction). In specific cases, it was possible to find the patents by searching for the name of the assignee in the same database in the focal year together with the keywords provided in the description of the licensed technology. As a result we were able to obtain the relevant information for 301 patent license agreements. In addition, given the specific purpose of our analysis – according to which licensing is indeed considered as a mechanism to access external technology – we only included in our final sample those transactions that had been filed as (pure) licensing or assignment agreements. We then excluded all other transactions that refer to collaboration or settlement agreements, cross-licensing, technology purchases and plans of merger. After that, we came up with a final sample of 227 licenses involving almost 900 USPTO patents exchanged among licensor and licensee firms. In order to collect all relevant statistics on each licensed patent (e.g., number of citations made and received, claims, technological classes, and so on) we matched our database with the National Bureau of Economic Research (NBER) dataset (Hall, Jaffe & Trajtenberg, 2002) and its 2002 update.

The same screening activity of license documents allowed us to better understand the remuneration structure which parties had agree upon. Specifically, by reading the original documents, we were able to make a distinction between licenses that did not involve upfront payments and those that included this form of payment in their remuneration structures. Among them, we also identified those that omitted this value for reasons of confidentiality[8].

Out of 227 observations, we relied on a subset of 124 for the analysis. The reason for this drop is threefold. First, we could not include those upfront payments that were not disclosed (15). Second, we preferred to omit those contracts without upfront fee (60) because they represent a distinct contractual form (Gallini and Wright, 1990; Bousquet, 1998; Vishwasrao, 2007). Third, we had to drop those observations with missing values (28) in the remaining variables included in the analysis.

8 These licenses report the following standardized statement "Confidential Information Omitted and Filed Separately with the Security Exchange Commission. Asterisks denote such Omissions"

Our analysis rests on industry level data. We made use of the value added variable found in the OECD STAN database as a measure of economic activity. Accordingly, we were able to extract data from all OECD countries plus Japan and Korea. We observed 15 different combinations of geographical areas (countries/continents) involved in these licenses. For each combination, we calculated the average and volatility of the growth rate within five years from the license at the industry level based on the ISIC codes.[9]

Model Specification

Dependent variable. According to the model proposed, we needed the initial licensing fee as dependent variable, which we considered analogous to the premium paid by the licensee to buy a call option. To do so, we relied on the data on the license remuneration structures. The measure of the amount of the initial fee paid in U.S. dollars by the licensee is available at the level of each licensing contract examined in this study and included in the final sub sample. Since this variable does not follow a normal distribution, as required by the OLS regression model, we took the natural logarithm of the values in order to achieve a better approximation of this distribution.

Explanatory Variables. Market uncertainty. Market uncertainty refers to the potential demand for the licensed technology. An often used measured of market uncertainty is the volatility of the expected demand for the technology underlying the patent license. Thus, consistently with previous research, we measured such variable as the standard deviation of the market growth rate from year t-*5* to year t (the year of the license).[10]

Technological potential. Technological potential is related to the technical and manufacturing feasibility of the patented technology, which ultimately affects its commercial potential (Huchzermerier & Loch, 2001; Ziedonis, 2007). This may depend on how much

[9] Since our sample is based on SIC codes, which describe the industries in which licensees and licensors are active, it was necessary to get the corresponding values of the industry data according to this standard. Also,the FVGIP database does not record the SICs of each transaction, but only the qualitative description of the industry involved. Thus we first found the match of this description among those available for the licensees and licensors of our initial sample. This allowed us to get the corresponding SIC for each license. Once we get this information we were ready to match our file with the OECD data-file by the means of the ISIC-SIC correspondence table.

[10] As already discussed, this measure has been created on the bases of a very complex process of data gathering and integration. We indeed aggregate the level of economic activity for each countries involved in the license (geographical areas) at the industry level. Specifically we computed the standard deviation of the market growth over the previous five years within the time of license characterizing the industry involved in the license. By this way we were able to assess the overall uncertainty involved in the license according to the geographical scope and industry of it.

distant the licensed technology is from the commercialization stage. Accordingly, following previous studies (Lanjouw & Shankerman, 2001; Ziedonis; 2007), we measured this variable using the number of backward citations contained in the USPTO patents to previous USPTO patents. Each patent cites previous patent that represent the state of the art at the moment of the patent grant. The number of backward citations is a measure of the newness or radicalness of the patented technology. The idea is that when there is less prior art to be cited, there is higher technological uncertainty and the commercial potential of the technology is higher (Ziedonis, 2007). In order to get this information, we merged our dataset with the NBER dataset. Since technological potential increases when the number of backward citations decreases, we calculated our measure multiplying the number of backward citations by -1. When the license involved the exchange of more than one patent, we calculated the mean of this variable in order to account for the average technological potential associated to the overall set of patents licensed.

Control variables. In our model we control for several characteristics of the contract, the patents, the parties and the industry. As concerns the contractual terms, the most relevant negotiation issue that rises before the conclusion of a license refers to the level of the royalty rate the licensee will be required to pay to the licensor at each anniversary of the license. The common base for the calculation of the annual royalties is the annual amount of net sales regarding the licensed products. According to our model (expression [2]), this variable negatively affects the initial licensing fee since it reduces the NPV of the future cash flows. We measured such a variable as the percentage royalty rate reported in each licensing agreement. We also control for the *license term*. This variable should positively affect the value of the patent license for two reasons. First, a longer license allows the licensee to increase the profits from the licensed patents (Parr and Sullivan, 1996). Second, the license term increases the option value of the patent license (see expression [1]). *License term* is computed as the residual number of years the license will be in force. The value of the contract should also be affected by the *exclusivity clause*. Exclusive license allows the licensee to exploit the licensed technologies without bearing the competition of other licensees in the market. Its effect on the initial fee is not clear a priori. In fact, the traditional view of patent licensing holds that licensee prefers an exclusive license to get the maximum outcome from the licensed patent (Parr and Sullivan, 1996). Nevertheless, more recently, some authors have pointed out that licensee firms might want to be licensed openly in order to "…*prevent, or at least retard, the commercial development of inventions in a particular area*" (Agrawal and Garlappi, 2007: 2). This is the case of those companies whishing to sponsor particular laboratories – research institution and university- that require to be licensed on a non-exclusive basis only in order to purposely affect the incentives of other – competitive- firms to embark on technological trajectories that are not favourable to them. We control for this effect including a dummy equal to 1 and 0 otherwise. Since some licenses include more than one patent, we include a measure of *license scope*, calculated as the number of the patents involved in the transactions[11]. Another important measure that could affect the value of the license is its geographic scope. The fist measure employed accounted for the number of different geographic areas involved in each license. However, since countries may differ substantially in size and relevance, we decided only to keep in the regression the information suggesting that the license has been granted *worldwide*. For this purpose, we created a dummy that is equal to one if the license is worldwide, 0 otherwise.

As concerns the patents involved in the transaction, studies on patent valuation based on patent data (e.g., Harhoff, Scherer & Vopel, 2003; Reitzig, 2004; Trajtenberg, 1990) have shown that *patent quality* can be proxied by the number of forward citations the target patent has received since its grant to date. Since this is a relative measure of such value, depending on how far is the time of its grant from our point of observation, we control for this value by counting the number of citations received to the date of the license and then observed by the parties. As already anticipated, since some licenses involve more than one patent, we calculate the mean value of this variable.

As concerns the industry characteristics, the effect of the industry growth rate is controlled for. According to Fosfuri (2006), an increasing market growth may dump the rent dissipation effect for the licensor – the propensity to license out her technologies would be greater, other things being equal - since the competition in that market would be less fierce. From the point of view of the licensee, this implies higher expected cash flows from the license.

Consistently with the calculation of market uncertainty, we computed the average growth rate of the license industry output over the last five years. In order to account for the appropriability regime and the effectiveness of patent protection and transactions (Kim & Vonortas, 2006), we created a dummy called chemical that is equal to 1 if the license SIC

[11] The fact that the licensee includes more than one patent may not imply that these patents can be exploited separately depending on the licensee convenience. It may depend on the fact that licensed products are more or less complex and therefore more or less difficult to be commercialized.

correspond to the chemical and pharmaceutical sectors, 0 otherwise. It reflects the same rationale as that made by Cohen, Nelson and Walsh (2000) between complex and discrete product industries, however it poses more emphasis on "discrete" industries that by definition experience an higher level of intellectual property appropriability (Cohen et al., 2000; Cohen, Goto, Nagata & Walsh, 2002; Kim & Vonortas, 2006).

A further set of controls is related to parties involved in the transactions. First, we control for *information asymmetries*, which could be an important factor in the determination of the remuneration structure (Gallini & Wright, 1990). For this purpose we generated a dummy that identify whether the licensee's and the licensor's core business (4digit-SIC code) is the same. The dummy sic_corresp instead account for a correspondence between the licensee´s SIC code (at the 4digit level) and license SIC code (at the 4digit level). It is another measure of the level of information of the licensee about the licensed technology. And it may be suggestive of the capability of the licensee to assess the value of the licensed technology before. Finally, we accounted for the influence of the identity and nature of the licensor on the initial fee building two dummy variables. The first one is equal to 1 if the licensor is a *non-profit organization* – University, University or Public Research Foundations –, 0 otherwise. The second variable is 1 if she is an *individual* (generally, the inventor), 0 otherwise.

Descriptive statistics and Correlations

In Table 2 we report descriptive statistics for each variables included in the equation we estimated. Some interesting points are worth being mentioned. First, the scope of license that reflects the number of patents involved in each transaction sets its mean at around 4. This value is relatively low if compared to the maximum that is 41. This implies that the majority of licenses exchange few patents, generally only one. The distribution is considerably right skewed. Second, the values associated to the term of the license are also very interesting. They show that the average duration of a license is 16 years. Patent value captures the number of citations received by the licensed patents until the time of license conclusion – this measure would represent the value of patent as perceived by the licensee. A standard deviation of 11 suggests that licensed patents differ very much in their perceived value. The most valued licensed patent records an average of 77 citations. The same reasoning applies also for our independent variable called Technological Potential that exhibits substantial dispersion ranging from -191 to -1.

Insert TABLE 2 about here

Table 3 shows bivariate correlations among all variables included in the regression analysis. From the analysis of this table no serious problems of multicollinearity should emerge.

Insert TABLE 3 about here

Results

In order to test our hypothses on the effect of market uncertainty and technological potential we run OLS regressions against the log of the initial licensing fee against market uncertainty, technological potential and the other control variables. We employed a step-wise procedure by inserting one explanatory variable at a time. By so doing we run 4 different model that are described in Table 4.

Insert TABLE 4 about here

Model 1 holds all the control variables. In model 2 and 3 we introduced the market uncertainty and technological potential respectively. Model 4, is titled the full model and includes the two independent variables and all the controls.

Model 1 confirms that several characteristics of the licensing contracts significantly affect the initial licensing fee. As expected, the initial fee is negatively related to the royalty rate, which supports the assumption that upfront fee is negotiated after a royalty rate has been set, and positively related to the number of licensed patents (license scope) and the license term. The latter one is always significant at a 5% level. Moreover, exclusive licenses have lower initial fees. It is also interesting to notice that the licensing fees required by individuals are significantly lower than those required by firms. The coefficient is statistically significant at the 10% level, suggesting a lower negotiating power of individual licensors.

Considering market uncertainty, we find support for hypothesis 1, stating that the initial fee of a patent license increases with the degree of market uncertainty. The coefficient is statistically significant at a 5% in the full model while it is significant at the 1% level in model 2. In models 3 and 4, we also find support for hypothesis 2, claiming that the initial fee of a patent license increases with the degree of technological potential. However, the level of significance of the technological potential variable dropped to a 10% level in model 4 providing weaker support for hypothesis 2.

Conclusion

Patent licensing in the market for technology is increasingly used. However, at the same time there is also substantial evidence of considerable impediments hindering the mathcing of licensees and licensors. According to the recent empirical evidence collected by the annual Survey of the Licensing Executive Society, the difficulties to reach mutually accettable financial as well as non financial terms represent the main reasons for the failure of negotiations. For this reason, the design of an appropriate remuneration structure is one of the crucial aspects of patent license negotiation.

In recognition of that, in this paper we aimed to shed new light on the remuneration structure of patent licenses. Literature on licensing and market for technologies has paid scarce attention to this issue so far. Few works have provided empirical evidence on the contractual structure of licensing, mainly because of the complexity of licensing agreements (Anand & Khanna 2000; Bessy et al., 2002; Vishwasrao, 2007).

The contribution of the paper is threefold. First, in the attempt to explain the remuneration structure of patent licenses, we have enriched the insights provided by the agency theory with the innovative framework provided by the real option theory. Second, focusing on the licensee´s perspective – which has generally been underinvestigated in the licensing and markets for technology literature – we have argued that patent licenses provide the licensee with a flexibility of use that has not been accounted for so far. In practice, licensing activity witnesses several cases in which the licensee, after having paid the initial licensing fee, decides not to use the patent and not to pay the royalties due on the net sales of the licensed products. For this reason, we argued that the initial upfront fee can be assimilated to the option premium paid by the licensee to acquire the right (option) to develop and commercialize the technology protected by the patent. Third, we tested our hypotheses based on real options theory on an original cross-industry sample of 124 patent licenses.

Our estimations provided several interesting results. First, the remuneration structure of patent licenses (and in particular, the upfront fee) seems to be affected by uncertainty in the market and technological domains. Licensees are willing to pay more to enter a licensing contract in presence of greater market uncertainty and higher technological potential. This result supports a real options view of the determination of the upfront fee. Second, our estimations, after controlling for the most relevant contractual provisions of the licensing agreement, support the relevance of some contractual clauses, such as exclusivity, from the licensee viewpoint. Overall, these results pave the way for a further investigation of the determinants of the licensing overall contractual structures and thus for a better understanding of the functioning of markets for technology.

This study has also several limitations. First, following a consolidated stream of literature, we assumed the royalties to be exogenously determined. We recognize, however, the need to estimate upfront and royalties simultaneously to check for potential endogeneity issues. This requires an effort to find valid instruments for royalties, which has been problematic in the literature examining the remuneration structure of franchising (Lafontaine, 1992; Lafontaine and Shaw, 1999).

Second, we have not included in our analysis all those cases in which the upfront payment is equal to zero. This choice was due to the fact that the licenses without upfront are generally recognized as a distinct contractual form (Bousquet et al., 1998; Gallini and Wright, 1990; Vishwasrao, 2007). This may raise a potential issue of selection biases, which could be taken into account (e.g., through a Heckman selection model). By accounting for that we will be able to rely on a larger dataset providing a more robust analysis and more insightful results.

Third, licensing agreements are complex contracts. Reading all the contracts included in our sample helped us to codify several contractual terms and control for them in our empirical analysis. However, some contractual, which could be relevant for the negotiation process, provisions could have been not included in the analysis.

Notwithstanding these limitations, we believe that investigating the determinants of the remuneration structure of patent licenses within a new theoretical framework and embracing the licensee's perspective can offer an important theoretical and empirical contribution, opening new opportunities for future research on these contracts and their role in technology transfer.

References

Adner, R. & Levinthal, D.A. 2004. What is not a real option: Considering boundaries for the application of real options to business strategy, ***Academy of Management Review***, 29: 74-85

Agrawal, A. K. & Garlappi, L. 2007. Public Sector Science and the Strategy of the Commons, ***Economics of Innovation and New Technology***, forthcoming

Agrawal, D.& Lal R. 1995. Contractual Arrangements in Franchising: An Empirical Investigation, ***Journal of Marketing Research***, 32(2): 213-221

Anand, B.N. & Khanna, T. 2000. The Structure of Licensing Contracts, ***The Journal of Industrial Economics***, 48(1): 103-135

Anand, J., Oriani, R. & Vassolo, R. 2007. Managing a Portfolio of Real Options, ***Advances in Strategic Management,*** 24, in press

Arora, A. & Ceccagnoli, M. 2004. ***Patent Protection, Complementary Assets, and Firm's Incentives fro Technology Licensing.*** Working Paper, December

Arora, A. & Fosfuri, A. 2003. Licensing the Market for Technology, ***Journal of Economic Behaviour & Organization***, 52: 277-295

Arora, A., Fosfuri, A. & Gambardella, A. 2001. ***Markets for Technology***. Cambridge, MA: The MIT Press

Athreye, S. & Cantwell, J. 2007. Creating competition? Globalization and the emergence of new technology producers, ***Research Policy***, 36: 209-226

Atuahene-Gima, K. & Patterson, P. 1993. Managerial Perceptions of Technology Licensing as an Alternative to Internal R&D in New Product Development: an empirical investigation, ***R&D Management***, 23(4): 327-336

Beggs, A. W. 1992. The Licensing of Patents Under Asymmetric Information, ***International Journal of Industrial Organization***, 10: 171-191.

Bessy, C., Brousseau, E. & Saussier, S. 2002. ***The Diversity of Technology Licensing Agreements***. Working Paper, Université de Paris 1, June

Bhattacharyya, S. & Lafontaine, N. 1995. Double-sided moral hazard and the nature of share contracts, ***RAND Journal of Economics***, 26(4): 761-781

Black, F. & Scholes, M. 1973. The Pricing of Options and Corporate Liabilities, ***The Journal of Political Economy***, 81: 637-654

Bousquet, A., Cremer, H., Ivaldi, H. & Wolkowicz, M. 1998. Risk sharing in licensing, ***International Journal of Industrial Organization***, 16(5): 535-554

Brickley, J.A. 2002. Royalty Rates and Upfront Fees in Share Contracts: Evidence from Franchising, ***The Journal of Law, Economics & Organization***, 18(2): 511-535

Caves, R., Crookell, H. & and Killing, P. 198. The Imperfect Market for Technology Licenses, ***Oxford Bulletin of Economics & Statistics***, 45: 249-67

Cesaroni, F. 2004. Technological outsourcing and product diversification: do markets for technology affect firms' strategies?, ***Resaerch Policy***, 33: 1547-1564

Chesbrough, H. 2003. ***Open Innovation The New Imperative for Creating and Profiting from Technology***. Harvard Business School Press. Boston, Massachusetts

Chesbrough, H. 2003. The Era of Open Innovation, ***Sloan Management Review***, Summer: 35-41

Chi, T. & Levitas, E. 2007. ***An Examination of Options Embedded in a Firm´s Patents: The Value of Dispersion in Citations***. Working Paper.

Choi, J.P. 2001. Technology Transfer with moral hazard, ***International Journal of Industrial Organization*****,** 19: 249-66.

Cockburn, I.M. 2007. ***Is the Market for Technology Working? Obstacles to Licensing Inventions, and Ways to Licensing Inventions, and Ways to Reduce Them.*** Paper prepared for the Conference on Economics of Technology Policy, Monte Verità, June

Cohen, W., Goto, A., Nagata, A., Nelson, R. & Walsh, J. 2002. R&D spillovers, patents and incentives to innovate in Japan and the United States, ***Resaerch Policy***, 31:1349-1367

Cohen, W., Nelson, R. & Walsh, J. 2000. ***Protecting their Intellectual Assets: Appropriability Conditions and Why Manufacturing Firms Patent (or not)***. NBER Working Paper, N. 7552

Cohen, W.M., Nelson, R.R. & Walsh, J. 2000. ***Protecting their Intellectual Assets: Appropriability Conditions and Why Manufacturing Firms Patent (or not)***. NBER Working Paper, N. 7552

Eisenhardt, K. M. 1989. Agency theory: An assessment and review, ***Academy of Management Review***, 14(1): 57 - 74.

Erutku, C. & Richelle, Y. 2007. Optimal Licensing Contracts and the Value of a Patent, ***Journal of Economics & Management Strategy***, Vol. 16, No. 2: 407-436.

Financial Valuation Group 2007. The FVG IP database, www.fvginternational.com/ipdatabase.

Folta, T. B. & O'Brien, J P. 2004. Entry in the Presence of Dueling Options, ***Strategic Management Journal***, 25(2): 121-138

Fosfuri A. 2006. The Licensing Dilemma: Understanding the Determinants and the Rate of Technology Licensing, ***Strategic Management Journal***, 27: 1141-1158

Gallini, N. & Wright B. 1990. Technology transfer under asymmetric information, ***Journal of Economics***, 21(1): 147-160

Gambardella, A., Harhoff, D.& Verspagen, B. 2005. ***The Value of Patents***. Working paper, April

Gans, J. & Stern, S. 2003. The product market and the market for "ideas": commercialization strategies for technology entrepreneurs, ***Research Policy***, 32: 333-350

Granstrand, O. 1999. ***The Economics and Management of Intellectual Property***. Cheltenham, UK: Edward Elgar Publishing

Grindley, P.C. & Teece, D.J. 1997. Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics, ***California Management Review***, 39(2): 8-41

Gu, F. & Lev, B. 2004. The Information Content of Royalty Income, ***Accounting Horizons***, 18(1): 1-12

Hall, B.H., Jaffe, A. B. & Trajtenberg, M. 2002. ***The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools***. NBER Working Paper Series

Harhoff, D., Scherer, F. & Vopel, K. 1999. Citations, family size, opposition and the value of patent rights, Research ***Policy***, 32: 1343–1363

Harhoff, D., Sherer, M. & Vopel, K. 2003. Citations, Family Size and, Opposition and the Value of Patent Rights-Evidence from Germany, ***Research Policy***, 32: 1343-1363

Huchzermeier, A. & Loch, C. H. 2001. Project Management under Risk: Using the Real Option Approach to Evaluate Flexibility in R&D, ***Management Science***, 47: 85-101

Japan Institute of Invention and Innovation (JIII). 2003. ***Survey on Patent Valuation System In Patent Licensing Market***, Tokyo

Japan Institute of Invention and Innovation (JIII). 2004. ***Survey on Verification and Evaluation of Patent Valuation System Based on Patent Licensing Contracts***, Tokyo

Jensen, R. & Thursby, M. 2001. Proofs and Prototype for Sale: The Tale of University Licensing, ***American Economic Review***, 91: 240-259

Kamien, M. I. & Tauman, Y. 1984 The Private Value of a Patent: A Game Theoretic Analysis, ***Journal of Economics.***

Kamiyama, S., Sheehan, J. & Martinez, C. 2006. ***Valuation and Exploitation of Intellectual Property***. OECD STI Working Paper 2006/5, June

Katz, M.L. & Shapiro, C. 1985. Technology Adoption in the Presence of Network Externalities, ***Journal of Political Economy***, 94(4): 822-841

Katz, M.L. & Shapiro, C. 1986. How to license intangible Property, ***The Quarterly Journal of Economics***, 3: 567-589.

Kim, YJ. & Vonortas, N.S. 2006. Determinants of Inter-firm Technology Licensing: The Case of Licensors, ***Managerial and Decision Economics,*** 27: 235-249

Kline, D. 2003. Sharing the Corporate Crown Jewels*,* ***MIT Sloan management review***, Vol. 44, Nº 3: 89-93.

Kogut, B. & Kulatilaka, N. 1994. Options Thinking and Platform Investments: Investing in Opportunities, ***California Management Review***, 36(2): 52-71

Kulatilaka, N. & Perrotti, C. 1998. Strategic Growth Options, ***Management Science***, 44(8): 1021-1031

Lafontaine, F. & Shaw, L.S. 1999. The Dynamics of Franchise Contracting: Evidence from Panel Data, ***Journal of Political Economy***, 107(5): 1041-1080

Lafontaine, F. 1992. Agency theory and franchising: some empirical results, ***RAND Journal of Economics***, 2: 263-283

Lander, D. M. & Pinches, G. E. 1998. Challenges to the Practical Implementation of Modelling and Valuing Real Options, ***Quarterly Review of Economics and Finance***, 38: 537-567

Lanjouw, J.O. & Schankerman, M. 2001. Characteristics of Patent Litigation: A Window on Competition, ***The RAND Journal of Economics***, 31 (1): 129-151

Li, Y., James, B., Madhavan, R., Mahoney, J.M. & Mahoney, J. T. 2005. ***Real Options: Taking Stock and Locking Ahead***. Working paper, May

Lichtenthaler, U. & Ernst, H. 2007. Developing reputation to overcome the imperfections in the markets for knowledge, ***Research Policy***, 36: 37-55

Lichtenthaler, U. 2007. The Drivers of Technology Licensing: An Industry Comparison. ***California Management Review,*** 49: 67–89.

Macho-Stadler, I., X. Martínez-Guiralt and Pérez-Castrillo, D. 1996. The Role Of Information

In Licensing Contract Design, ***Research Policy***, 25: 43-57.

MacMillan, I. C., & McGrath, R. G. 2002. Crafting R&D project portfolios, ***Research Technology Management***, 45: 48-60

Marco, A.C. 2005. The option value of patent litigation: Theory and evidence, ***Review of Financial Economics***, 14: 323-2351

McGrath, R. G. & Nerkar, A. 2004. Real Options Reasoning and New Look at the R&D Investment Strategies of Pharmaceutical Firms, ***Strategic Management Journal***, 25(1): 1-21

McGrath, R. G. 1997. A Real Options Logic for Initiating Technology Positioning Investments, ***Academy of Management Review***, 22(1): 13-30

Mendi, P. 2007. Trade in disembodied technology and total factor productivity in OECD countries, ***Research Policy***, 36: 121-133

Mendi. P. 2002. *The Structure of Payments in technology Transfer Contracts: Evidence From Spain*, Working Paper, Department of Economics, Universidad de Navarra.

Miller, L. & Bertus, M. 2005. License valuation in the aerospace industry: A real option approach, ***Review of Financial Economics***, 14: 225-239

Myers, S.C. 1977. Determinants of Corporate Borrowing, ***Journal of Financial Economics***, 5(2): 147-175

Oriani, R. & Sobrero, M. 2008. Uncertainty and the Market Valuation of R&D within a Real Options Logic, ***Strategic Management Journal***, *forthcoming*

Pakes, A. & Schankerman, M. 1984. ***The rate of obsolescence of patents, research gestation***

Pakes, A. 1986. Patents as Options: Some Estimates of the Value of Holding European Patent Stocks, ***Econometrica***, 54(4): 755-784

Parr, R. L. & Sullivan, P. H. 1996. ***Technology Licensing: Corporate Strategies for Maximizing Value***. New York: John Wiley & Sons

Pennings, E. & Lint , O. 1997. The option value of advanced R & D, ***European Journal of Operational Research***, 103(1): 83-94(12)

Perlitz, M., Peske T. & Schrank R. 1999. Real Options Valuations: the New Frontier in R&D Project Evaluation?, ***R&D Management***, 29 (3): 255-269

Pitkethly, M. 2006. Patent Valuation and Real Options. In Bosworth D., Webster E. (Eds.), ***The Management of Intellectual Property***. Cheltenham: Edward Elgar

Razgaitis, R. 2003. ***Valuation and Pricing of Technology-based Intellectual Property***. Hoboken, NJ: Wiley

Razgaitis, R. 2004. U.S./Canadian Licensing in 2003: Survey Results, ***Journal of the Licensing Executives Society***, 39(4): 139-151

Reitzig, M. 2004. Strategic Management of Intellectual Property, ***MIT Sloan Management Review***, 45 (3): 35-40

Reitzig, M. 2006. ***Valuing Patents and Patent Portfolios from a Corporate Perspective: Theoretical Considerations, Applied Needs and Future Challenges***. In Bosworth D., Webster E. (eds.), The Management of Intellectual Property, Cheltenham: Edward Elgar

Rivette, K. & Kline, D. 2000. Discovering New Value in Intellectual Property, ***Harvard Business Review***, January-February: 55-66

Rockett, K. E. 1990. The quality of licensed technology, ***International Journal of Industrial Organization***, 8: 559-574

Schwartz, E. & Moon, M. 2000. Evaluating Research and Development Investments. In M. Brennan & L. Trigeorgis, (Eds.), ***Project Flexibility, Agency, and Product Market Competition: New Developments in the Theory and Application of Real Options***. New York, NY: Oxford University Press

Shapiro, C. 1985. Patent Licensing and R&D Rivalry, ***The American Economic Review***, 75(2): 25-30

Sheehan, J., Martinez, C. & Guellec, D. 2004. Understanding Business Patenting and Licensing: Results of a Survey, ***Patent Innovation and Economic Performance***, 4: 1-89

Taylor, C. T. & Silberston, A. 1973. ***The economic impact of the patent system: A study of the British experience***. Cambridge: University Press.

Trajtenberg, M 1990. A penny for your quotes: patent citations and the value of innovations, ***RAND Journal of Economics***, 21: 172-187

Trigeorgis, L. 1996. ***Real Options: Managerial Flexibility and Strategy in Resource Allocations***. Cambridge, MA: MIT Press

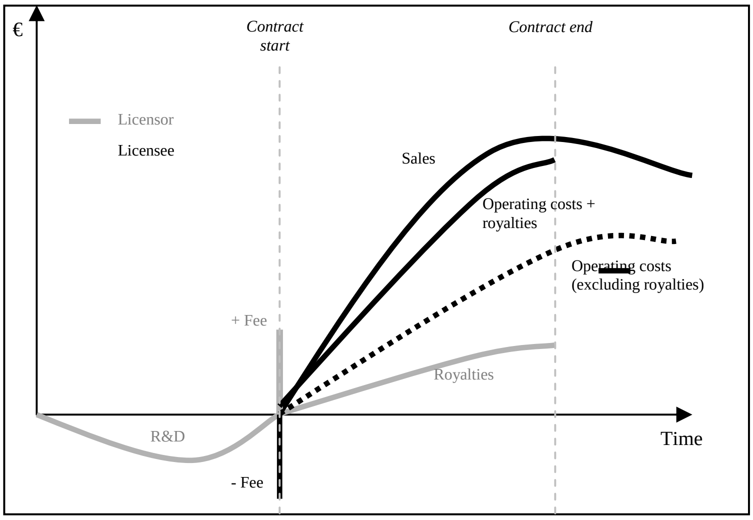
Vishwasrao, S. 2007. Royalties vs. fees: How do firms pay for foreign technology?, ***International Journal of Industrial Organization***, 25(4): 741-759

Vonortas, N.S. 2003. ***Technology Licensing***, Final Report, The George Washington University

Ziedonis, A. A. 2007. Real Options in Technology Licensing, ***Management Science***, 53: 1618-1633

FIGURE 1

The payment structure of a patent licensing contract



Source: Granstrand (1999)

TABLE 1

Analogy between a patent license and a call option

Call option	Patent license
Financial asset	NPV of cash flows (NPV)
Strike price	Development cost (I)
Volatility of the financial asset	Volatility of NPV
Maturity	License term (n)
Risk-free interest rate	Risk-free interest rate
Premium paid to buy the option	Upfront fee

TABLE 2

Descriptive Statistics of all the variables (N=124)

	Mean	S.D.	Min	Max
Upfront	12,15	2,49	4,61	18,42
Market Uncertainty	0,04	0,02	0	0,27
Technological Potential	-15,35	22,34	-191,4	-1
Patent Value	6,26	10,94	0	77,33
Royalty Rate	3,01	3,95	0	22
License Scope	3,93	5,93	1	41
Licensed Term	15,89	9,89	1	99
Exclusive	0,63	0,48	0	1
Worldwide	0,6	0,49	0	1
Business Proximity - Licensor vs Licensee	0,32	0,47	0	1
Business Proximity - License vs Licensee	0,74	0,44	0	1
Non Profit Licensor	0,11	0,31	0	1
Licensor Individual	0,15	0,36	0	1
Market Growth rate	0,03	0,02	-0,03	0,13
Chemicals Industry	0,21	0,41	0	1

TABLE 3

Correlation Matrix (N=124)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Upfront														
2. Market Uncertainty	**0,17**													
3. Technological Potential	0,05	0,12												
4. Patent Value	0,12	0,03	**-0,2**											
5. Royalty Rate	**-0,22**	-0,04	**-0,31**	-0,12										
6. License Scope	0,11	-0,03	**-0,46**	**0,33**	0,05									
7. Licensed Term	0,13	0,02	-0,05	-0,12	0,01	0,03								
8. Exclusive	**-0,26**	0,06	0,12	**-0,14**	-0,08	-0,09	0,12							
9. Worldwide	**-0,18**	-0,08	0,04	0,01	-0,08	0,12	0,05	**0,31**						
10. Business Proximity - Licens	**0,18**	0,07	-0,02	0,12	0,03	-0,01	0,01	-0,09	-0,13					
11. Business Proximity - Licens	0,06	0,11	-0,05	-0,06	-0,02	0,02	-0,06	-0,02	-0,04	**0,28**				
12. Non Profit Licensor	**-0,19**	-0,03	0,1	**-0,16**	0,02	-0,08	0,06	**0,17**	0,1	**-0,24**	0,01			
13. Licensor Individual	**-0,23**	0,03	0,08	**-0,13**	0	-0,06	0,01	0,12	-0,01	**-0,15**	**0,13**	**-0,14**		
14. Market Growth rate	-0,06	**0,24**	0,07	0,08	-0,06	**0,15**	0,06	**0,2**	**0,45**	**-0,16**	0	-0,03	0,04	
15. Chemicals Industry	0,11	0,06	0,12	0,01	-0,01	-0,11	0,03	**0,14**	-0,01	-0,04	0,03	0,07	-0,12	-0,04

Note: Correation coeffieicnts in bold are significant at a 5% level.

TABLE 4

Determinants of Upfront payment. Results from rebust OLS regressions.

	Control Model	Market Uncertainty Model	Technological Potential Model	Full Model
Market Uncertainty		16,339 ***		13,909 **
		[5.596]		[5.316]
Technological Potential			0,025 *	0,022 *
			[0.013]	[0.013]
Patent Value	-0,005	-0,007	-0,001	-0,003
	[0.018]	[0.018]	[0.017]	[0.017]
Royalty Rate	-0,146 *	-0,151 **	-0,143 *	-0,147 **
	[0.076]	[0.075]	[0.074]	[0.074]
License Scope	0,019	0,02	0,079	0,074
	[0.061]	[0.061]	[0.053]	[0.054]
Licensed Term	0,041 **	0,04 *	0,043 **	0,042 **
	[0.021]	[0.021]	[0.020]	[0.020]
Exclusive	-1,139 **	-1,196 **	-1,125 **	-1,175 **
	[0.514]	[0.505]	[0.500]	[0.493]
Worldwide	-0,604	-0,528	-0,657	-0,587
	[0.578]	[0.567]	[0.580]	[0.573]
Business Proximity - Licensor vs Licensee	0,483	0,402	0,417	0,354
	[0.563]	[0.562]	[0.559]	[0.559]
Business Proximity - License vs Licensee	0,395	0,326	0,431	0,368
	[0.446]	[0.441]	[0.446]	[0.445]
Non Profit Licensor	-0,777	-0,733	-0,776	-0,739
	[0.848]	[0.822]	[0.834]	[0.813]
Licensor Individual	-1,05 **	-0,98 *	-0,948 *	-0,898 *
	[0.500]	[0.499]	[0.527]	[0.523]
Market Growth rate	12,799	11,711	9,514	8,905
	[18.562]	[17.405]	[17.737]	[16.776]
Chemicals Industry	0,312	0,27	0,27	0,238
	[0.479]	[0.477]	[0.491]	[0.488]
Constant	12,28 ***	11,697 ***	12,477 ***	11,962 ***
	[0.710]	[0.739]	[0.712]	[0.742]
Number of observations	124	124	124	124
R-Square	0,227	0,25	0,261	0,278
Adj. R-Square	0,144	0,162	0,174	0,185
F-test	5,015 ***	5,847 ***	5,191 ***	6,128 ***

*: p<0.1, **: p<0.05, ***: p<0.01. Standard errors are repoted in brackets