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1. Introduction

In the age of globalization, knowledge is one of a firm's key resources to achieve sustainable economic growth. But not only is a broad repository of valuable knowledge of importance but also an effective value appropriation strategy. The need for the latter is rooted in the intangible nature of knowledge. Arrow (1962; 1971) was the first to recognize and investigate this intangible nature of knowledge-based resources and how it affects the distribution of economic rents between resource owner and other players in a market economy.

Prior to a market transaction, the seller of a knowledge asset must first convince potential buyers from the value of his or her offer by communicating its content. However, this content is the main, or most often even the only, value driver of explicit knowledge. If this pre-transaction transfer can be realized at close to zero marginal cost, it will simultaneously satisfy a potential buyer's need and further impede any subsequent market transaction. For decades, economists have analyzed this underlying problem of the information paradox (Arrow, 1971; Winter, 2006).

[1] An earlier version of this paper has been presented at the 66th Annual Meeting of the Academy of Management 2006 in Atlanta, Georgia. The authors thank two anonymous reviewers for their helpful comments.

Complex contracts are among the solutions offered to overcome this essential problem. In case of innovations, licensing agreements are one type of performance-oriented contracts used to exploit the value embedded in technical knowledge (Teece, 1986). Licensing activities have motivated a large body of literature covering topics like reasons for (Arora and Fosfuri, 2003; Mottner and Johnson, 2000; Saracho, 2002) and results of (Arrow, 1962; Rockett, 1990) granting licenses, profit maximizing licensing strategies (Fosfuri, 2006; Kamien and Tauman, 2002; Katz and Shapiro, 1986; Poddar and Sinha, 2004), ways to distribute the value created between licensor and licensee (Kamien and Tauman, 1986), timing of licensing (before or after developing a technology) (Gallini, 1984; Gallini and Winter, 1985; Shapiro, 1985) and the types of innovations that are transferred (Arora, 1995; Katz and Shapiro, 1985).

One stream of research analyzes in detail the information given by licensing agreements. Major contributions have been made by Taylor et al. (1973), Caves et al. (1983), Rostoker (1983), Contractor (1981; 1985) Macho-Stadler et al. (1996), Aulakh et al. (1998), Bessy et al. (1998). Anand et al. (2000) and Nagaoka et al. (2006). So far, most of the research carried out in this field has been focused on describing the different features of licensing agreements. This paper particularly contributes to research by investigating the relationship between the financial value of a licensing agreement and its content. Thereby, we answer the following research questions: (1) Does an effective market mechanism for technical knowledge exist? and (2) Which contractual terms drive the value of a licensing agreement?

2. Theoretical Background

2.1. Exploiting knowledge through licensing

2.1.1. Knowledge: Content and types

Licensing agreements are one specific class of contracts used to exploit technological knowledge in collaboration with an external partner. Understanding the essential role that licensing agreements play in the process of generating value out of knowledge assets requires in a first step to analyze content and features of these assets. As for the first, the existing body of literature shows a variety of different approaches to describe the content of knowledge. However, economic theory still lacks a precise and commonly accepted definition. Some economic theorists analyze knowledge following the ideas of epistemology, the branch of philosophy investigating concept, origin and reliability of knowledge (Nonaka and Takeuchi, 1995; Spender, 1996).[2] Other economic thinkers argue that knowledge is just 'the state of knowing' (Machlup, 1980:56) or 'that which is known' (Grant, 1996:110). Today, it is widely recognized that 'knowledge is grounded on information' (Caldwell, 1975:570) which is interpreted by the knowing entity (Huber, 1991) and, following Plato's justified belief approach, assumed (Nonaka, 1994) or proofed (Liebeskind, 1996) to be true.

One approach to reduce the diversity of knowledge definitions is an analysis along the following two dimensions: (1) time and (2) type. With regard to the general economic transformation process we can either interpret knowledge as an input factor or as output of corporate processes and, thus, as a corporate asset (Barney, 1991; Itami and Roehl,

[2] This philosophical discussion can be traced back to Aristotle and Plato and has been resumed throughout the centuries by various thinkers like e.g. René Descartes, John Locke, Immanuel Kant, Jon Dewey and Gilbert Ryle.

1987; Quinn, 1992; Teece, 1998) that exists at a specific point in time. Or, applying a more dynamic view, as a facilitator in the production process emphasizing the supportive role of knowledge and its potential to increase efficiency in the process of combining different inputs (Arrow and Hahn, 1971; Penrose, 1959; Spender, 1996).

The elements of the second dimension, type, are explicit and implicit knowledge. This split can be traced back to Polanyi (1966) who coined the term of tacit knowing. He bases his ideas on the observation of the limited ability of human beings to fully express verbally all what they do know. Citing several experiments conducted by Lazarus and McCleary (1949; 1951), Polanyi argues that some parts of human knowledge are connected by a functional relationship of which the knowing individual is not fully aware. Or, in more popular words, the quintessence of tacit knowing consists of the observation that individuals do know more than they can tell (Polanyi, 1966).

Scholars have taken up this idea by defining tacit knowledge as a superordinate concept for all those parts of knowledge that cannot be fully expressed, defined or codified.[3] This economic interpretation of the tacit nature of knowledge has been further shaped in contrast to explicit knowledge.[4] The explicitness of knowledge enables the knowing individual to codify[5], formalize and systematize knowledge. In turn, this process of standardization facilitates both, transferability and protection of knowledge using

[3] However, although the wording seems comparably, differences do exist regarding the meaning of both concepts. While Polanyi assumes that tacit knowing only exists if the individual is unaware of its very existence and that concentrating and focusing on tacit knowing lead to its destruction, economic theorists in general interpret tacit knowledge as being inexpressible and hence difficult to transfer voluntarily or involuntarily (Nelson et al., 1982). They allow one to be aware of one's tacit knowledge but at the same time to be unable to articulate it.

[4] Synonyms for this dichotomy are codified and uncodified (Choi and Lee, 1997; Teece, 1998), objective and subjective, prepositional and personal, declarative and procedural (Grant, 1996; Kakabadse, et al., 2001; Nahapiet and Ghoshal, 1998; Winter, 1987), internal and external (Zack, 1999) or alienable and non-alienable (Brynjolfsson, 1994; Foss, 2002) knowledge.

[5] In this context, codification refers to the possibility to compress knowledge into a specific, standardized expression which can be understood by everyone who is acquainted with this way of expression (Boisot and Child, 1988)

intellectual property rights (IPRs) (Mudambi and Navarra, 2004; Nonaka and Takeuchi, 1995; Teece, 1998).

Explicit knowledge is a public good (Arrow, 1962; Dyer and Nobeoka, 2000; Grant, 2002; Kogut and Zander, 1993; Machlup, 1980; Martin and Salomon, 2003). Once communicated, the resource owner can neither fully control access to nor consumption of this resource. In addition, non rivalry in consumption does exist (Arrow, 1962; Ba, et al., 2001; Grant, 1996). Consequently, the value potential embedded in this resource cannot be fully appropriated by the resource owner in the absence of any additional appropriation strategies (Arrow, 1962).

Contrary to the public character of explicit knowledge, tacit knowledge is of completely private nature. This property affects the transferability diametrically to the case of explicit knowledge. It is not easily visible, expressible and therefore only transferable to a limited extent (Nonaka, 1991; 1994; Nonaka and Takeuchi, 1995). A shift from one individual to another is slowly, costly and uncertain (Arora, 1995; Grant, 1996; Kogut and Zander, 1992; Nelson and Winter, 1982; Teece, 1977). The only ways to transfer tacit knowledge are teaching (Penrose, 1959; Winter, 1987) or imitating the actions which are performed using tacit knowledge (Polanyi, 1958, 1966; Teece, 1986).

2.1.2. Purpose of licensing contracts

According to Teece (1986) and his classical work on profiting from innovations, licensing agreements are particular advantageous under a strong appropriability regime and in the presence of complementary assets. However, if the subject of contract is an innovation or other technical knowledge then these contracts hold a danger of opportunistic behavior on both sides. Bessy and Brousseau (1998) further emphasize

that a knowledge transfer can induce the creation of new knowledge that in turn can substitute or devalue the knowledge originally transferred. Due to these limitations, complex contractual agreements are needed in order to exploit the economic potential of knowledge in the marketplace.

One major advantage of licensing agreements is that they can deal with any type of knowledge. They can be used to transfer not only explicit knowledge in the form of IPRs or documents like manuals, blueprints or technical handbooks but also tacit components through offering technical assistance and educational services (Anand and Khanna, 2000; Arora, 1995).

The primary objective of a licensing agreement is to define the specific rights and duties of both contracting parties. Based on this agreement, the licensor transfers his or her property rights of the subject of the contract to the licensee for a specific period of time in exchange for some sort of compensation (Manfroy, 2002; Sullivan, 1996). In contrast to a contract of sale, the licensor or knowledge owner retains title to the property and only temporarily allows the licensee to exercise a well defined bundle of owner specific rights (Contractor, 1985).

By granting licenses for explicit knowledge, licensors can overcome appropriabilty problems. First of all, this reduces its public nature. Furthermore, if they do not grant an exclusive license, licensors can take advantage of the feature of non rivalry in consumption. This allows multiple transactions of the same knowledge content with different licensees. In the case of tacit knowledge, licensing agreements are one way to control knowledge flows between licensor and licensee.

For licensees one major advantage of this flexible nature of licensing contracts is that they can avoid the risk of being sued for infringing property rights related to explicit

knowledge and with the same contract can profit from implicit or tacit components of knowledge.

Although neither content nor structure of licensing agreements are legally defined, several recurring features can be found in each contract (Bryer, 1999; Contractor, 1985; Merwin and Warner, 1996) allowing a comparison and statistical analyses of its content. All licensing agreements contain information about the identities of the participating firms, subject of the contract, purpose of the contract, number and characteristics of rights granted, compensation provisions and expected lifetime.

2.2. The life cycle of a licensing contract: A two stage model

We can split the entire lifetime of an agreement into two consecutive stages. The first stage, the negotiation period, comprises a series of meetings during which licensor and licensee discuss the specific features of the licensing agreement. Like any other market transaction, this period is characterized by a series of negotiations and compromises. If both parties eventually agree, they will draft a licensing agreement to come in force at the effective date (end of stage one, start date for stage two).

During the second stage (contract period), the licensor may use the subject of contract as defined in the agreement. In a world with deterministic outcomes, licensor and licensee ex ante know what future holds and what costs and benefits are associated with this agreement. However, in reality both contracting parties face a high degree of uncertainty regarding the economic and legal consequences of their decisions. Especially in an economic surrounding like the electronics industry where we observe a rapid technology development of cumulative technologies that are protected by extensive, overlapping patent portfolios (Grindley and Teece, 1997; Reitzig, 2004) and

hardly predictable customer behavior, drafting and entering appropriate licensing agreements is a key factor for sustainable economic success.

Therefore, we assume that both parties try to reduce this multifaceted uncertainty by choosing appropriate contractual terms. During the negotiation period it is most important for them (1) to achieve a common understanding about the subject of contract, (2) to clearly define which rights are transferred and (3) to decide about the features of these rights. With regard to the unknown future, the parties must implement contractual clauses that define not only (1) the duration and (2) termination of the contract but also (3) how the licensee shall compensate the licensor for the transfer of rights.

2.3. Stage one: Negotiation period

Before and during the negotiation period, both parties form expectations about the strategic and economic value that results from a possible licensing contract. A successful outcome of any negotiation requires that their expectations coincide, at least partially. Since each party also takes into consideration the value expectations of the opposite party and since all expectations are based on a set of assumptions, licensee and licensor will estimate not only single values but entire value ranges for the respective technology.

Following the model of Contractor (1985), we identify borders of each value range based on expected costs and benefits.

Insert Figure 1 about here

2.3.1. Negotiation period: Licensor's perspective

The transfer of technological knowledge is costly (Teece, 1977). These transfer costs define the minimum acceptable value from the licensor's perspective. They comprise e.g. costs for delivering explicit knowledge like documents, manuals or patents and costs for transferring implicit knowledge induced by teaching licensee's engineers and offering support and ongoing assistance over the entire duration of the agreement. If the purpose of the contract is to penetrate a foreign market or if an exclusive license is granted, than opportunity costs have to be added in order to estimate a threshold value since the choice of licensing as form of market entry theoretically rules the possibilities for export or foreign direct investment out (Contractor, 1981). In the case of granting an exclusive license, opportunity costs arise since the licensor is bound by the contract not to grant this specific license to other potential licensees.

The maximum value from the licensor's perspective equals either the sum of transfer costs, opportunity costs and the present value of all cash flows the licensor expects the licensee to obtain over the lifespan of the agreement (A1) or the sum of transfer costs, opportunity costs and the present value of all costs, the licensor expects the licensee to incur in order to obtain the respective technology elsewhere (A2). As for the latter, we agree with Farok Contractors argumentation but for the former we suggest that for both, licensee and licensor, not only the present value of future cash flows is of importance but also the degree, to which both, licensor and licensee, expect an appropriation of these cash flows.

2.3.2. Negotiation period: Licensee's perspective

From a licensee's perspective, the most favorable contract would grant a license free of charge. However, since both parties have entered a negotiation process, the licensee will form expectations about licensor's transfer costs and take these into consideration in assessing a minimum value for the respective technology. The maximum costs the licensee will be willing to accept depend on the options available to get access to this technology. If we assume that the licensee wishes to bridge a technological gap through licensing and to exploit the economic potential of the respective technology, the maximum value equals the sum of the discounted incremental profits or cost savings that can be yielded by using this technology (B4). This has been the predominant motivation for the sample of licensing contracts analyzed in this paper. However, value expectations can be driven by other factors as well. Instead of asking for a license, the licensee could also set up an own R&D project to either develop a similar technology or to invent around the licensor's patents (B3). Alternatively, the licensee could try to find a similar technology offered by a different licensor in order to substitute the negotiated technology (B2). If the licensee requires a permission to use a specific technology only to avoid an infringement process, a fourth option includes calculating a net present value of the costs for such a litigation process (B1). These costs do not consist of expenses for legal advice and costs of the proceedings only. Since the patent owner can obtain a preliminary injunction against any further value exploitation activities conducted by the infringing party, costs of lost sales and earnings must also be taken into account (Grudziecki and Michel, 2002).

If the expected value ranges of licensor and licensee overlap, a successful signing of the contract seems to be likely. The contractual features then mirror the expectations of

both, licensor and licensee as well as their individual bargaining power. We recognize that the latter can hardly be measured reliably. But since these agreements are negotiated by experts led more by clear interests and less by emotions, we assume that the contracts we investigate are 'wise agreements' (Fisher and Ury, 1982) that meet the interests of both parties, allow for a fair solution of conflicting interests and are durable.

2.4. Stage two: Contract period

2.4.1. Contract period: Duration and termination

The compensation provisions answer the question how the licensee shall compensate the licensor during the contract period. But before the parties can decide about this specific feature, they must first agree upon a clear definition of the lifetime of the agreement. If the contract deals with patents, it usually terminates at the expiry date of the last patent. For the electronics industry, Taylor and Silberston (1973) report that, as the subject of contract in most cases also comprises unprotected know how, licensor and licensee define a shorter period and implement prolongation clauses. If both contracting parties fail to give notice by a certain predefined date that they do not wish to extend the duration of the term then these clauses automatically extent the validity of the agreement. In contrast to this prolongation, both parties can also define situations in which one party can void the contract. These termination rules matter in case that one party infringes a substantial condition of the agreement.

2.4.2. Contract period: Compensation provisions

Empirical results show a considerable variety of compensation provisions (Aulakh, et al., 1998; Bessy and Brousseau, 1998; Merwin and Warner, 1996). Apart from lump

sum payments, the most common means to determine license fees are recurring amount payments and royalty rates. Royalty rates can either be defined as an absolute amount to be paid on a per unit base or as a percentage of sales volume or more precisely of the net selling price[6]. In addition, a royalty rate either remains stable (flat royalty) or changes with regard to the development of the royalty base. In the latter case, licensor and licensee agree upon a schedule defining the adjustments of the royalty rate to be made if the base, e.g. the sales volume or the number of units sold, exceeds predefined thresholds. Finally, recurring amount payments are either due after the completion of different steps in an overall process (e.g. product development) or at predefined future dates. In our sample we find three main compensation mechanisms: (1) a fix component comprising lump sum and (2) recurring amount payments and (3) a variable component, consisting of a schedule of declining royalty rates.

If both parties agree upon a running royalty rate then the licensor's revenue (royalty income) is directly linked to the exploitation of the respective technology by the licensee (Cho, 1988). From the perspective of the licensor, the financial value of a license therefore depends not only on the economic potential, or more precisely on the stream of profits the licensee generates by exploiting these rights, but also on the degree to which he or she can appropriate a satisfying part of this stream via the compensation formula. Therefore, the transaction value of a license agreement $V(L_0)$ from the licensor's perspective at time t = 0 is given by:

$$V(L_0) = \left[\sum_{t=1}^{T} \frac{V(r_b)_t * rr_t}{(1+c)^t} + \sum_{t=1}^{T} \frac{RA_t}{(1+c)^t} + LS_0 \right] * \varphi_0 \qquad (1)$$

[6] This price is usually calculated as the price of contract products charged to customers after allowing deductions for value-added tax, costs for packing, transport and insurance, applicable import-export and excise duties, returns and trade discounts. Besides these two bases, royalty rates might also be defined as percentage of the gross margin or the profit before or after taxes (Perlitz, 1980).

with $V(r_b)_t$ as value of the royalty base in t, rr_t as royalty rate in t, RA_t as recurring amount payments in t, LS_0 as lump sum payment in period 0, c as cost of capital and T as duration of the agreement. φ_0 denotes an appropriability factor which determines the extent to which the licensor can appropriate the value calculated by the compensation formula.

In addition to this financial value, both parties might agree upon a reciprocal exchange of knowledge or patents. From the perspective of each party, such a cross-license (Taylor and Silberston, 1973:116) creates the advantage to avoid development costs for a complementary technology and allows an earlier introduction of a product based on each partners' technology. But at the same time this also provokes the creation of substitutes for the products of each partner (Fershtman and Kamien, 1992). Moreover, cross-licensing might foster collusive behavior of both parties since it either increases (in the case of imperfect substitutes) the probability of a market entry (Eswaran, 1993) and/or enables each party to directly influence the pricing or distribution strategy of the respective partner (Shapiro, 1985).

2.5. Hypotheses

2.5.1. Hypotheses: Negotiation period

The overall aim of a licensing agreement is to determine the rights and duties of both parties. In general, we can identify four classes of property rights (Alchian and Demsetz, 1973; Coase, 1960; Demsetz, 1967) that can be licensed. A licensee can obtain the right (1) to use, (2) consume and (3) obtain income from and (4) to alienate attributes of the subject of contract. Attributes comprise all different operation modes and application areas of this resource (Foss and Foss, 2005). Since a contract is one of

the primary sources of information in case of any legal proceedings and provides the basis for a successful business relationship, it must not only cover all important aspects of subsequent transactions but must also be written in a clear and precise style (Ramsay, 2002).

Of course, multiple formulations can be used to express the rights granted. The right to use is reflected in a licensing agreement by giving the permission to utilize the subject of contract as defined in the agreement. In contrast to this, granting rights to produce or manufacture specific goods based on the traded technology corresponds to the right of the licensee to exploit this technology within the production process in every way that might seem suitable, thus to consume this technology in order to produce a specific output. The granting of rights to market or sell products and services enables the licensee to obtain income from the attributes of this technology, whereas the right to sublicense qualifies to generate profits from selling and, thus, alienating the respective technology.

The impact of these different classes of rights derives from the fact that they do not only determine the size of the market in which the licensee can operate but also the means by which he or she can penetrate this market. Furthermore, by a precise and extensive specification of the license, licensee and licensor can reduce uncertainty regarding the rights granted. Based on these reflections we hypothesize:

Hypothesis 1: The more rights are granted, the higher the transaction value will be.

A clear and precise formulation of the rights granted requires in first step to create a common understanding of concepts that describe specific rights and duties. Therefore,

every contract contains one section in which definitions of key contractual terms, like 'contracting products' or 'transferred rights', are given.

On the one hand, introducing definitions for key contractual terms allows a clearly arranged description of the license. On the other hand, an extensive definition of these terms again reduces uncertainty during the negotiation period and facilitates an efficient problem solving process in case of any future problems between the contracting parties Thus, we assume:

Hypothesis 2: The degree of accuracy applied to define contractual terms increases the transaction value.

Having exclusive access to important resources is vital for achieving and securing competitive advantages (Barney, 1991). The highest offer a licensor can make is the grant of an exclusive license to a third party. Since this decision narrows the window of opportunity for the licensor and chancels the possibility of profiting from the feature of non rivalry in consumption opportunity costs arise. In presence of an efficient market mechanism, these additional costs increase the licensor's threshold (Merwin and Warner, 1996). Therefore we hypothesize:

Hypothesis 3: The decision for an exclusive license increases the transaction value.

2.5.2. Hypotheses: Contract period

Based on an analysis of 46 contracts, Bessy and Brousseau (1998) identify five different kinds of licensing agreements. One distinguishing feature between these five classes is the existence of contractual terms referring to cross-licenses. In one class, Bessy and

Brousseau (1998) refer to as 'development technology licenses', no other compensation mechanisms are implemented besides a pure cross-license. In the case of cross-licensing agreements licensor and licensee may not only consider technology primarily as a source of future revenue but as a currency or a bargaining chip to be used during the negotiation process in order to achieve their individual objectives (McEvily, et al., 2004; Nickerson, 1996). In view of these considerations, we interpret the existence of contractual terms referring to cross-licenses as an equal mean to compensate the licensor and, therefore, assume:

Hypothesis 4: Cross-licensing clauses negatively affects transaction value.

Based on their analysis of the semiconductor and electronics industry, Grindley and Teece (1997) distinguish two types of (cross-) licensing contracts: They identify a capture model, that entitles the licensee to use all the patents within a technology field not only during the license period but until they expire. In contrast to this, if both parties agree on a fixed period licensing model, the contract is only valid over a predefined life span. In order to prolong this kind of agreement both parties must enter renegotiations. Grindely and Teece (1997) state that the latter facilitates more flexibility since licensor and licensee can periodically adjust the agreement to reflect environmental and technological changes.

If both parties agree on a renewal clause, then the existing contract will be automatically renewed after a specific time span and changes of contractual features require a renegotiation of the entire contract. Thus, we argue that renewal clauses reduce flexibility and hypothesize:

Hypothesis 5: Renewal clauses negatively affect transaction value.

Another source for uncertainty is the probability that the existing contract is incomplete since both parties either do not take all possible future circumstances into account or that it is to costly to design a contract that reflects all the relevant scenarios in sufficient detail (Brynjolfsson, 1994). If contracts are of incomplete nature, problems may arise such as the unwillingness to fulfill specific contractual duties (Rabin, 1993). In the absence of precise stipulations, these problems can only be solved by costly trials. Therefore, both parties agree upon termination clauses that allow them to react by canceling the respective contract if the environment or their individual situation is changing in an unforeseen way. Therefore, we assume:

Hypothesis 6: The degree of accuracy applied to define termination rules increases the transaction value.

3. Empirical results

3.1. Data collection and transformation

To test our hypotheses, we have collected 191 single licensing agreements which we obtained from various companies active in the electronics industry by personal contact. To ensure a high degree of comparability within the sample, we defined five selection criteria to be met by each contract. First, the contract must have been negotiated by a member of a company wide licensing department. The existence of a licensing department, either being independent or being part of a company wide legal department is required in order to assure that value exploitation via licensing out activities is intended to happen on a regular base. Second, both parties of the contract must have been legally unrelated on the signing date. This criterion is essential for analyzing

market transactions at arm's length only and to avoid including intra-firm licensing agreements that define internal transfer prices and aim at reducing tax payments on a company level (Kopits, 1976). Third, subject of the contract must either be technological knowledge in explicit form (like e.g. a single patent or patent portfolio) or in implicit, thus tacit form (like e.g. training or services). Fourth, we only included contracts that were used to transfer technological knowledge in exchange for (financial) payments in combination with granting cross-licenses or financial payments only. We excluded every single pure cross-licensing agreement. Fifth, the licensor's predominant aim must be to commercialize the value potential embedded in the respective technology. We did not include cases in which licensing agreements served other purposes, e.g. supporting an internationalization strategy.

We carefully read all contracts and coded them following the model of Srnka and Koeszegi (2007) for transforming qualitative information into quantitative data. This model consists of five separate stages. The first two stages comprise (1) collection and (2) transcription of qualitative data. If the data are already available in written from (as it is the case for licensing agreements) these two stages can be omitted. However, most important in these initial stages of the transformation process is to create and ensure a sufficient degree of comparability within the sample. One major concern here is to deal with language differences. Due to semantic differences and cultural phenomena, comparing documents written in different languages may lead to misinterpretations which in turn prevent the construction of a comparable dataset. In view of this and since the majority of contracts is written in English, we exclude any licensing agreement composed in another language. This reexamination process led to a sample size of 141 contracts.

Stage three (unitization) and four (categorization) focus on defining appropriate units of analysis and on structuring and condensing data. For our sample we take advantage of the fact that several recurring features and a comparable structure can be found in each contract (e.g. the identities of the participating firms, subject of the contract, purpose of the contract, number and characteristics of rights granted, compensation provisions and time frame). Since we had access to the full text version of the documents we decided for stage five (coding) to code any common aspect of the contracts. Of course, this implies devoting a considerable amount of time to coding and consistency checks. On the one hand, such a comprehensive analysis allows an in depth analysis of contractual features but, given a predefined time span for data collection, at the same time also limits the number of contracts that can be coded.

3.2. Variables

3.2.1. Dependent variable

In order to calculate the dependent variable 'transaction value', we compute in a first step the value of the fix component by summing up the amount for lump sum payments and the net present value of recurring payments. In a second step we then add the net present value of the variable payments based on the royalty schedule defined in the contract. In a third step we calculate the total value of the licensing agreement as sum of both the fix and variable component. Since compensation formulas are defined in two currencies (Euro and US-Dollar) we convert the total Euro values into a corresponding amount of US-Dollar by multiplying the calculated transaction value by the interbank exchange rate effective on the signing date. We assume that both contractual parties

either build future expectations about exchange risk on a naïve no change forecast or apply hedging strategies to avoid currency risks.

As discussed above, compensation formulas comprise four main elements: (1) lump sum payments, (2) recurring amount payments, (3) royalty rate payments and (4) cross-licenses. We find all these elements and combinations of them in our sample: The great majority of cases (84.5%) uses lump sum payments either as sole compensation mechanism (31.0%) or in combination with royalty rates (26.1%), recurring amount payments (4.2%) or cross-licensing agreements (23.2%).

For the remaining contracts (15.5%) licensee and licensor agree upon more than two compensation mechanisms like lump sum, recurring amount and royalty rate (1.4%), lump sum, royalty rate and cross-license (10.6%), lump sum, recurring amount and cross-license (2.8%), and a combination of all four payment schemes (0.7%).

3.2.2. Independent variables

For testing our hypotheses, we define six variables. The definition of the license is measured as number of words used for the description of the license. We assume a positive relationship between the number of words used to describe the license and the rights actually transferred. Of course, this implies that the number of words is not increased by negative formulations like geographic (or technological) restrictions. We find such restrictive clauses in a quarter of contracts (25.4%). In order to create a comparable sample, we carefully read through all contracts and create a ‘net position’ of this variable by subtracting the number of words used to express restrictions from the total number of words used for describing the license.

We apply the same method of counting and do similar calculations for two other variables. The degree of accuracy in defining key contractual terms equals the number of words used for describing definitions of key contractual terms. We arrive at the degree of accuracy for the definition of termination rules by adding up number of words used for defining situations in which one party can void the agreement. We measure contractual terms referring to cross-licenses, renewal options and exclusive rights as dummy variables.

3.3. Sample description

Table 1 summarizes the main characteristics of our sample The contracts we investigated are used to transfer Intellectual property rights (Patent applications, single patents, patent portfolios and copyrights) and property rights for inventions, software, software documentation, know how and hardware.

Insert Table 1 about here

If the subject of contract comprises more than just one item (e.g. patent portfolio and know how) we count the number of entries for each variable separately. As can be easily seen, intellectual property rights play an important role (84.2% of all entries are related to at least one IPR category). In fact, more then half of the number of entries (52.0%) are connected to a transfer of a portfolio of patents. Furthermore, an analysis of the type of rights granted reveals that, in the majority of cases, licensors refuse to grant the right to sublicense the subject of contract. We find contractual clauses for exclusive rights in nearly one quarter of all contracts (22.5%). The earliest date on which licensor

and licensee acceded to a licensing agreement was in 1970. However, the majority of contracts was signed between 1991 and 2000 (47.2%) and 2001 and 2005 (45.8%). This reflects the increasing willingness of companies to extract value from their intellectual assets that we can observe since the late 1980s (Manfroy, 2002).

A final look at geographical restrictions reveals that approximately three fourth (74.6%) of all contracts contain no explicit geographic restriction and that the rights are granted worldwide. Caves et al. (1983) find geographic restrictions in about one third (34%) of the contracts they investigated and Taylor and Silberston (1973) report that of 29 companies that replied to their question about restrictive provisions, 25 state that they explicitly or implicitly limit the markets in which a product can be sold. Interviews with different managers, responsible for the contracts in our sample revealed the fact that a precise formulation of geographical restrictions is often not required. On the one hand, patent licenses already define the geographical extend in which the licensee can operate (please recall the predominance of IPR as subject of contract). On the other hand, the absence of an explicit formulation of such restrictions can be motivated by the aim to avoid costly renegotiations that occur in case of extending the geographical scope of patent protection after the signing of the contract.

3.4. Multivariate analysis

Table 2 shows the results of ordinary lest square regressions for four models with standardized coefficients (beta) and t-values in parentheses. We used SPSS© for testing hypotheses and examined the main underlying assumptions of all the statistical tests of hypotheses but found no major violations. In particular, to check for multicollinearity

we computed variance inflation factors (for all variables below 2.7) and condition indices (for all variables below 5.0).

We begin with a simple model that tests the impact of the breadth of rights granted, the degree of accuracy applied for defining key contractual terms and the exclusivity of rights. For each or the following four models we add one additional variable. The final model (IV) then comprises all variables.

Insert Table 2 about here

A first look at the result of the full specified model IV ($R^2_{adj.}$ 0.28, $p < 0.01$) shows that we find strong support for hypothesis 1. The breadth of rights granted has a positive and significant ($p < 0.01$) effect on the value of a licensing agreement. We can also observe a positive and significant ($p < 0.05$) relationship between the degree of accuracy applied for defining key contractual terms and the dependent variable. Furthermore, statistical analyses reveal a negative and significant relationship between the value of a licensing agreement and the degree of accuracy applied for defining termination rules ($p < 0.01$) and the existence of prolongation clauses ($p < 0.05$).

4. Discussion

Following our theoretical model, we first discuss the results for the variables of the negotiation period and then proceed with an analysis of our findings for the contract period.

The confirmation of the first two hypotheses strongly supports the idea of a highly effective market mechanism. In general, an effective market transaction requires that the

traded goods exhibit a sufficient degree of homogeneity that allows a deduction of values and prices through comparative analyses. In fact, this criterion of homogeneity comprises two important aspects. First, we may expect a positive correlation between the quantity or significance of qualitative features of a good and its price. Second, homogeneity implies that market participants share a common understanding about the good's nature and its features. In an active and open market where homogenous goods are frequently traded between unrelated market participants and in the absence of market power of one or a few of these participants, market prices therefore serve as good indicators for the value of traded goods. In fact, this basic function of the price system first of all enables any transaction (Hayek, 1945).

For intangible assets in general and knowledge assets in particular the hypothesis of an existence of an active market is often rejected. However, we can observe first attempts to establish active markets for specific intangible assets like e.g. auctions for patents and patent portfolios. In this case, market participants try to take advantage of the fact that an invention must meet several fundamental and procedural requirements defined by national patent laws in order to qualify for patent protection. The strong harmonization of different national patent laws during the last decades (Jaffe, 2000) facilitates a certain degree of comparability of different patent rights and thus ensures a minimum level of homogeneity.

Despite this remarkable progress, we cannot yet identify an active market for all kinds of intangible goods. But this does not necessarily imply that these assets can not be traded at all. Rather does the singularity of a knowledge asset rooted in its intangible nature and related appropriation problems call for highly skilled knowledge workers

(Drucker, 1991) using meta-knowledge[7] for evaluating the subject of contract. These experts do not only enable any transfer of knowledge through licensing agreements but can also guarantee a considerable level of quality regarding the technology valuation process.

In view of our results for hypothesis one, we may conclude that they are successful in establishing a positive relationship between the breadth of rights the licensor grants and the financial value of a contract during the negotiation period. Thus, in the absence of an open and active market, valuation by experts is an appropriate strategy to assess the value for a knowledge asset.

We receive further support for this idea from the significant result for hypothesis 2. A reduction of uncertainty by clarifying key contractual terms seems not only possible but also valuable. In view of the legal rights and means of a patent holder and based on the wish to reduce the probability of incomplete contracts and costly trials, an extensive definition of these terms reduces uncertainty during the negotiation period. In the light of the results for hypothesis 1 and 2 we may therefore further conclude that by reducing uncertainty an increase in the quality of an agreement is possible but not at zero costs.

But if agreements are costly not only uncertainty will be reduced but also licensee's propensity to act opportunistically will diminish, since he or she then faces a similar situation the licensor does before signing an agreement. Therefore, these findings can also contribute to the debate about the best ways to protect knowledge. Means to protect knowledge do not consist of IPRs only but also comprise secrecy (Arora, 1997; Arundel, 2001; Cohen, et al., 2000) or selecting an appropriate organizational structure (Spender, 1996) that (1) decreases incentives for opportunistic behavior, (2) increases

[7] Meta knowledge can be defined as knowledge used in order to asses value and reliability of knowledge as resource (Kakabadse, et al., 2001; Spender, 1996).

the scope of control over employees and (3) reduces their mobility (Liebeskind, 1996). If we do not concentrate on the protection of knowledge only but more generally on the successful exploitation of knowledge based advantages then we also have to consider first mover advantages (Nelson, 1990) resulting from implementing a lead time strategy and from riding down the experience curve (Winter, 1987).

The overall aim of all these protective means is to bypass the threats resulting from the information paradox by either limiting the number of knowledge recipients (e.g. secrecy) or by reducing the time period over which knowledge is valuable to others (e.g. lead time). The signing of costly licensing agreements can be one mean to reduce the number of knowledge recipients since licensors do not transfer knowledge only but simultaneously create the need or wish on the licensee's side to keep this knowledge private.

If we look at the results for selected contractual features, like the exclusivity of rights granted (hypothesis three) and the decision to grant cross licenses (hypothesis four), we find for the first a small and negative, though insignificant relationship. Thus, based on our sample, we cannot confirm hypothesis three. However, this negative relationship is in line with previous empirical results. Kim and Vorontas (2004) show that the complexity of a given technology negatively affects the tendency to grant exclusive licenses. In industries like the electronics industry in which complex technologies are used, IPRs are weaker and harder to enforce then in industries with discrete technologies. In fact, patent owners in this industry report a lower reliance on protecting technology through IPRs (Cohen, et al., 2000; Mansfield, 1986). But if IPRs are weak then offering and granting exclusive rights might be less favorable than in other industries with less complex technologies.

This weakness of IPRs in the electronics industry can also explain cross-licensing activities. Based on the results for hypothesis four, we cannot confirm the idea of a cross-license as substitute for monetary payments. Anand and Khanna (2000) argue that due to this weakness companies working in this industry exhibit in general a higher tendency to grant cross-licenses. Since weak IPRs induce substantial imitation and inventing around activities by competitors, cross-licensing agreements might be an efficient contracting mechanism in order to avoid costs for reengineering (Anand and Khanna, 2000) and expensive infringement trials. Although empirical results indicate that costs for imitating existing and protected technology are comparatively low in electronics,[8] the probability of litigation including an unfavorable court decision can motivate cross-licensing (Ordover, 1991).

Grindley and Tecce (1997) report that in cumulative industries like electronics, innovations are strongly interconnected. They further argue that this dependency creates mutually blocking patent portfolios leading to a 'Mexican standoff' (Grindley and Teece, 1997p. 11). In such a situation one major objective is to receive freedom to operate in a certain technology field. Grindley and Nickerson (1996) state that cross-licensing terms are used in order to solve this mutual blockade. Therefore, granting cross-licenses can rather be interpreted as a precondition to be met before entering negotiations then as a significant value driver. Clearly, granting-cross licenses might also be a first step in order to establish a close cooperation form between licensee and licensor. Again, in this case, the prior goal of a licensing agreement would not be to generate profits by exploiting the economic potential of a respective technology but to establish a faithful cooperation between both parties. Thus, we may view the of granting

[8] According to Mansfield, Schwartz & Wagner (1981: 913) and Levin, Klevorick, Nelson & Winter (1987: 811), patents generally raise imitation costs by 7 to 15 percentage points.

cross-licenses rather as a strategic device to deal with the specific features of the underlying technological complexity and to improve the relationship between both contracting parties then as a compensation mechanism.

For the negotiation period, we might summarize that two indicators describing the content and range of the rights transferred have a positive and significant impact on transaction values.

Turning to the results for the variables of the contract period, the negative and significant relationship between the existence of prolongation clauses and the value of an agreement seems to support our idea that licensor and licensee wish to maintain a high degree of flexibility. Although we can imagine situations in which the one party (e.g. licensor) would profit from an extension of the contract at the expense of the second party, this result implies that both parties create negative expectations regarding the future profitability of their present decisions. Two reasons can explain these pessimistic expectations. First, given the predominance of IPRs as subject of transfer in our sample, one important aspect can be that the quality, thus the value, of a patent is not proven until it has been found valid through an infringement trial (Sherry and Teece, 2004). Second, in a world of rapid technological progress, it is in general difficult to create reliable and consistent expectations about how a present decision affects the economic situation of the contracting party in the future.

Based on the statistical analyses of our sample we cannot confirm hypothesis six. In fact, transaction values decrease with an increase in the degree of accuracy for defining termination rules. This implies that both contracting parties cannot fully rule out uncertainties during the contracting period. Additional support for this idea comes from

Bessy and Brousseau (1998) who argue that uncertainty is reflected in the application of an average royalty fee level. In order to determine whether the royalty rates in our sample differ from average royalty rates, we compared these with royalty rates published by Taylor and Silberston (1973) Contractor (1981), Parr (1995) and Battersby and Grimes (2006) and found no significant differences.

Therefore, we may conclude that due to uncertainty and limited information (Caves, et al., 1983) not only about the technology but also about the behavior of each party and the economic consequences of this behavior, licensor and licensee will create prudent expectations and consequently underestimate the economic potential embedded in the licensed technology during the contract period. Additionally, each agreement can be, like any other contract, subject to moral hazard problems. In the case of knowledge transfer, Bessy and Brousseau (1998) argue that it might be nearly impossible to create ex ante incentive schemes or to implement supervision mechanisms in order to avoid or resolve hidden action problems.

5. Conclusions and further research

Our analysis of licensing agreements shows that an effective market mechanism for technology transfer does exist. The prices for property rights of knowledge are correlated with the breadth of rights granted. However, due to the intangible nature of knowledge and in combination with market players that might act opportunistically, licensing agreements are not only used to exploit the economic potential of knowledge, but also as complex and strategic means to reduce uncertainty.

Our results indicate that licensor and licensee deal with two different kinds of uncertainty. The first type of uncertainty we refer to as uncertainty during the negotiation period can be reduced by choosing appropriate contractual terms. Dealing with the second type – uncertainty during the contract period – seems to be more challenging.

Prior studies have already revealed certain cross-industry differences in licensing contracts. Since cross-licenses play a major role in the electronics industry, it would be interesting to analyze how results will change if this research setting is applied to another industry. Furthermore, the value significance of single property rights might differ with regard to the economic possibilities that are linked to these rights. Ultimately, the value of knowledge depends on generating profits from its application and exploitation. Therefore, it is of particular interest which product-, technology- and costumer-related factors drive the value of knowledge.

Figure 1: Value ranges and the life cycle of a licensing agreement

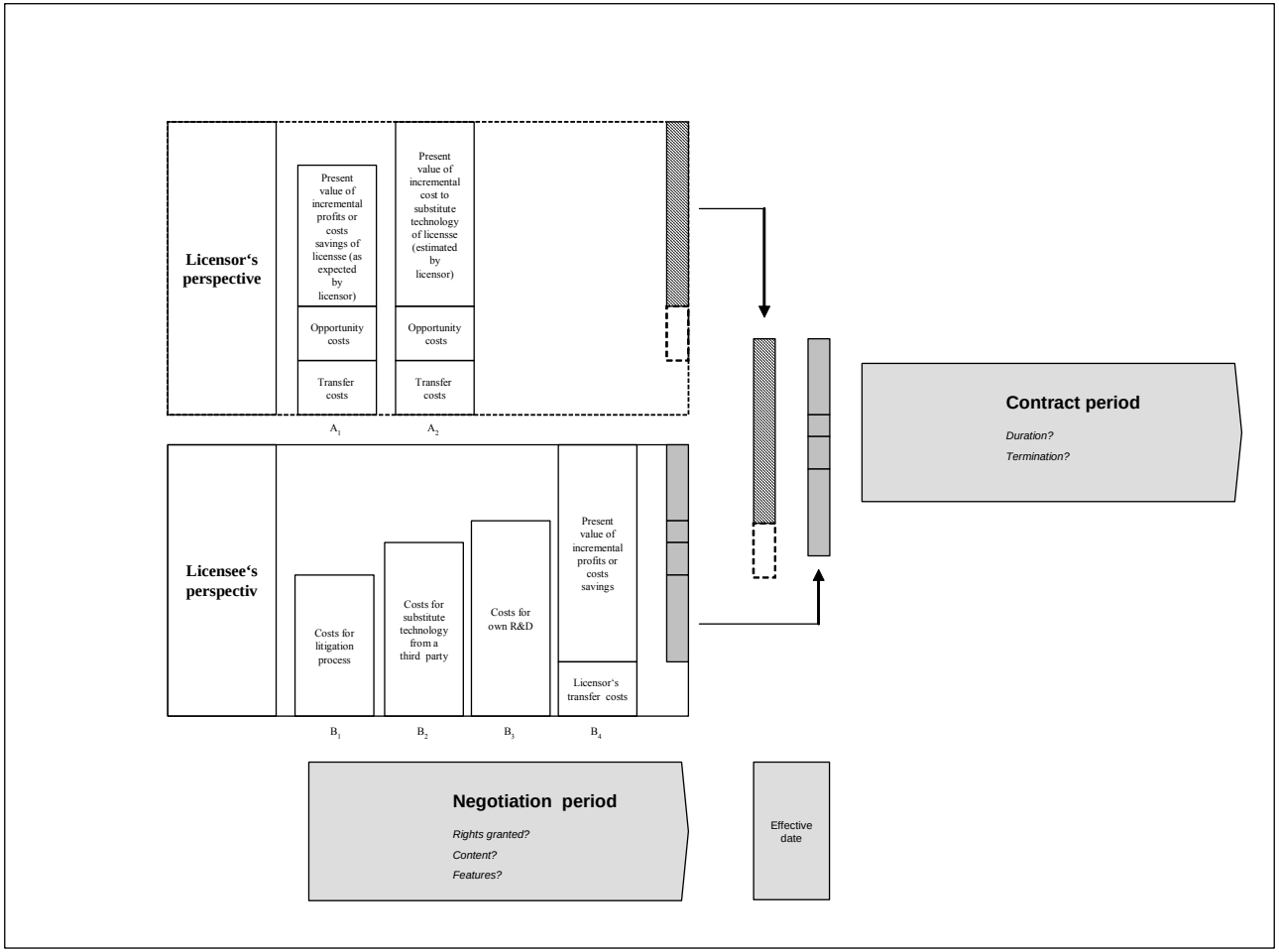

Table 1: Descriptive statistics

Descriptives		# Words	Mean	Std. Devi.
Subject of the contract*		Full text	2,666	1,913
Intellectual Property Rights	84.2%	Preamble	299	364
Patent	15.2%	Defintions	387	491
Patentportfolio	52.0%	License description	262	340
Patent application	15.8%	Compensation formula	275	281
Copyright	1.2%	Termination rules	176	213
Invention	15.8%			
Know How	3.5%			
Software	10.5%			
Software documentation	1.2%			
Hardware	0.6%			
Rights granted*				
Right to produce	31.9%			
Right to use	28.2%			
Right to trade	31.6%			
Right to sublicense	8.4%			
Exclusivity	22.5%			
Technology Flow back requirement	2.1%			
Year of Signing				
1970 - 1980	0.7%			
1981 - 1990	6.3%			
1991 - 2000	47.2%			
2001 - 2005	45.8%			
Geographical extend				
Worldwide	74.6%			
Non worldwide	25.4%			

* Number of entries per class divided by the total number of entries in the sample

Table 2: Results from regression analysis

Variable	Model I		Model II		Model III		Model IV	
(Constant)	0.00		0.00		0.00		0.00	
	(-1.203)		(-1.355)		(-0.365)		(-0.303)	
Definition of license	0.42	***	0.41	***	0.40	***	0.44	***
	(4.814)		(4.539)		(4.588)		(4.97)	
Definition of key contractual terms	0.12		0.07		0.23	*	0.24	**
	(1.345)		(0.689)		(1.936)		(2.031)	
Exclusivity of rights (0/1)	0.00		-0.02		-0.03		-0.04	
	(0.05)		(-0.23)		(-0.32)		(-0.474)	
Cross license (0/1)			0.10		0.10		0.11	
			(1.058)		(1.031)		(1.196)	
Termination					-0.25	**	-0.26	***
					(-2.573)		(-2.653)	
Prolongation / Renewal option (0/1)							-0.16	**
							(-2.061)	
N	141		141		141		141	
F Value	15.29	***	11.75	***	11.11	***	10.19	***
R2	0.249		0.256		0.290		0.312	
R2 adj.	0.233		0.234		0.264		0.281	
Delta R2 adj.			0.001		0.030		0.017	

Beta values
(t-values)

*** p < .01
** p < .05
* p < .10

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