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# Hazards in Transfering Knowledge and Contractual Architecture: The Case of Payment Schemes in Technology Licensing Agreements

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# Hazards in Transferring Knowledge and Contractual Architecture: The Case of Payment Schemes in Technology Licensing Agreements

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*This article provides an empirical assessment of payment schemes implemented in technology licensing agreements. Following a new institutional and resource-based view analysis, we argue that transaction costs evolve with the quality of the protection provided to the licensor by the institutional environment, the nature of the resources exchanged, and the characteristics of partners. We develop propositions and test them using an original source of data (a French governmental database recording international technology transfers). While we observe no clear effect of the institutional environment on the design of payment schemes, our empirical investigations highlight the key role played by the tacit nature of the licensed knowledge. Our results suggest that precise data measuring what is exchanged might shed new light on previous studies focusing only on sector differences. Furthermore, our results also show that ex-post contractual hazards appear to be particularly acute in the case of technology transfers, which explains why the results of previous studies on other classes of transaction are not confirmed. This suggests that different payment scheme strategies should be retained depending on what is actually exchanged by contracting parties.*

*JEL: D82, L14, K33.*
*Key words: royalties, fee, payment schemes, licensing, transaction costs, institutions, intellectual property rights, technology licensing agreements.*

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## INTRODUCTION

In a knowledge-based economy, companies rely on coordination mechanisms to share and transfer knowledge. These mechanisms are essential tools for companies wanting to develop their competences, enhance the value of their cognitive capabilities, or simply access complementary knowledge. As a result, there has been strong development and interest in the contractual and organizational forms that enable the transfer of knowledge. Most of the literature on knowledge sharing agreements, however, focuses on alliances and equity joint ventures (JV) (e.g. Oxley 1997; Hagedoorn 2008), while the practical focus is on another category of agreement: technology licensing agreements (TLAs). There are two reasons for this. First, as we develop later, TLAs are often less visible than alliances and JVs, because firms consider them confidential. Second, an important part of the literature dedicated to technology transfer focuses on the management of knowledge from a resource-based perspective, rather than the securitization of the exchange, the focus of most contract theories and transaction cost economics in particular. Indeed, the analysis reveals the difficulty of sharing and transmitting knowledge, building a common cognitive framework, and elaborating a new set of knowledge. As a consequence, the emphasis falls on the organizational solutions elaborated to articulate the capabilities of firms involved in a joint process of knowledge development, and less attention is devoted to what appears at first to be a simple transfer of knowledge and technology.

At the same time, several scholars (See for example Foss and Klein 2008) debate whether the rules that establish the principles behind the process of sharing and appropriating knowledge elaboration and use will have any impact on the behaviors of the parties involved. This explains why there are recurrent calls for reconciliation between the incentive and knowledge management perspectives of governance. Studying TLAs is a good way to focus on the incentive aspect: the securitization of knowledge transfer is essential to licensing relationships.

Indeed, when patentees choose to license their technology, licensees may take actions that have an adverse impact on the licensors' ability to get return on their R&D investments (e.g. poor quality

control, overstepping territorial restrictions, revelation of private information, etc.). Licensees may also "invent around" and develop innovations that will limit the licensors' ability to retain value from their patents (Scotchmer 1991). Alternatively, after the agreement is signed, licensors may withhold the technical and marketing support licensees need to integrate the technology into their operations effectively, because it is costly and risky for them (Arora 1995). Apart from purely opportunistic behaviors, contractual problems may also arise because of the nature of knowledge and technology transactions (Caves and al. 1983). First, transactions are submitted to the Arrow paradox on trade on information (Arrow 1962). Licensees can be reluctant to pay a fixed fee in advance for a technology they know very little about, especially if they are risk averse and do not know if they will be able to implement it in their own operations. Second, knowledge transfer is an irreversible good, because ex post exclusion is very difficult. Licensees can hardly unlearn the knowledge transferred and their future actions will benefit from the transfer. This might impact on licensors' ability to value their technology and hinder their capability to develop and exploit related innovations.

In this paper we analyze the design of payment schemes, based on an original database of technology licensing agreements. Payments schemes implement risk-sharing rules that impact on both parties' ex-post incentives to ensure the success of the transaction and to comply with their ex-ante commitments. It also influences their incentives to anticipate future transactional failures and contractual hazard. In line with Williamson (1991a), we recognize that the parties take the ex-post performance of an agreement into account when they design it, and we claim that this is an essential issue when transferring knowledge because of the irreversible character of the transfer. Since we are dealing with transaction over knowledge, we are also considering the suggestion drawn from the resource-based view. Indeed, instead of focusing on specific investments, as a transaction cost analysis would suggest, we consider the kind of knowledge that is exchanged by contracting parties (i.e. tacit vs. codified knowledge), suggesting that contractual hazards will depend on this. This paper is therefore a contribution to the dialogue between the resource-based view and the transaction cost approach.

The paper is organized as follows. In the first section, we detail how our findings contribute to the existing literature, then, in section 2, present our theoretical framework and hypothesize about payment schemes in technology licensing contracts. In section 3, we describe our sample and the type of information we rely on. Section 4 gives details on variables used in the empirical tests and the methodology of this study. Section 5 displays econometric results, highlighting the payment formulas implemented in the contracts. Section 6 concludes.

## STATE OF THE ART AND OUR CONTRIBUTION

### Royalties in Technology Licensing Agreements: Previous Literature

The theoretical literature dealing with payment schemes has mainly focused on their determination from an industrial organization perspective, focusing on cost-reducing innovations on oligopolistic markets. It typically considers a market with perfect information, no risk, and where licensors do not compete with their licensees. The results are well established and summarized in Kamien (1992), Reinganaum (1989) and Shapiro (1985). In this framework, auctioning is found to be the best way to rent patent. Indeed, Katz and Shapiro (1986) and Kamien et al. (1986) show that by comparison to a fixed fee an auction increases licencees' opportunity cost.[1] Moreover, royalty is found to be the worst mechanism because it increases marginal costs, preventing the full extraction of the monopolistic rent from the licensees.

However, those theoretical results are not in line with actual licensing practices, where royalties are predominant and often used *with* fixed fees (Contractor 1981; Rostoker 1983), Taylor and Silberston 1973; Bessy and Brousseau 1998). Three lines of arguments were developed to cope with this problem.

1 However, these results depend also on the magnitude of the innovation (see Kamien, Tauman and Zamir 1990).

First, some scholars relaxed the non-competition hypothesis (see for instance Katz and Shapiro 1985; Muto 1993; Marjit 1990; Wang 1998; Kamien and Tauman 2002). The basic idea is that technology licensing enables the marginal cost of licensors' competitors to be manipulated through the royalty rate.[2] In this case it may be optimal for technology holders to use royalties when licensing their technology instead of lump-sum fees, because the indirect gains in market share may overcome the direct loss caused by depressed payments for the technology. This line of argument refers mainly to collusive strategies (MacGee 1966; Shapiro 1985). However, it might ignore some important determinants of payment schemes and it fails to explain the persistence of royalty-based licenses in inter-sector or international technology transfers.

A second way to explain the prevalent use of royalties on the technologies market is to relax the assumption of risk neutrality. According to Bousquet et al. (1998) when a licensee is risk averse, an output-based payment may be used as an insurance mechanism to protect the buyer. It is difficult to test this hypothesis, however, because of the lack of accurate data. The existing empirical investigations take firm size as a proxy for risk aversion. This is problematic since firm size also reflects other factors (Osborn and Baughn 1990). In addition, these researches lead to contradictory evidence in favor of the risk aversion argument.

Finally, some authors have begun to take into account the failures that characterize the market for technologies, relaxing the perfect information hypothesis to solve the paradox.[3] Information asymmetries concern the value of the transferred technique. For example, Gallini and Wright (1990) and Beggs (1992) show how a royalty payment can be used to signal the actual value of the

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2 See Erutku and Richelle (2007) for an exception, extending Kamien and Tauman's (1986) paper by allowing the inventor to design contracts specifying the payment of a fixed fee plus a royalty. See also Sen and Tauman (2007) who analyze the optimal use of fees and royalties as a way to give rights incentives to cost-reducing innovations.

3 For Saracho (2002), the main informational problem lies inside the licensee's firm. More precisely, Saracho shows how complex remuneration schemes for licensee's managers may increase the profitability of royalty-based licenses for the patent holder. As separation of ownership and control is strongly correlated to firm size, testing this theory has the same limitation as risk-based explanations. Moreover, this explanation applies only to a small number of firms, and, to the best we know, has never been emphasized as a major concern for royalty licensing in the literature.

technology to potential users. Additionally, Choi (2001) and Macho-Stadler et al. (1996) point out that royalties may also be used by licensors to deal with moral hazard. Licensors may be motivated to transfer the valuable know-how needed by licensees to implement the technology; this knowledge transfer is non-contractible. A testable implication of this literature is that the use of royalty provisions should be positively correlated to the degree of tacit knowledge transferred, and negatively correlated to the equity links between partners. Macho-Stadler et al. (1996) and Mendi (2005) test these propositions, and we discuss them below.

A striking point in the theoretical explanations we have presented here is that there is no place for ex-post contractual hazards. The choice of payment schemes, once determined, is implemented without any ex-post costs, whereas the descriptive literature on technology licensing has extensively commented on the cost of securing those agreements, which are a major reason for relying on lump-sum fees instead of royalties (Taylor and Silberston 1973). Moreover, Contractor (1981, p. 35) argues: "Royalties are subject to non-performance, default, exchange-conversion, and other risks in the future, whereas lump-sum fees are paid at the agreement inception."

**Our Analytical Framework**

Our analytical framework is clearly based on transaction cost economics and brings to the forefront issues pertaining to the ex-post securitization of contracting parties. However, we also rely on the resource-based view to complement our framework. Indeed, central to this approach is the idea that the firm is essentially a pool of resources and capabilities that are the primary determinants of its strategy and performances (Wernerfelt 1984; Peteraf 1993). Some of those resources— like knowledge exchanged through technology licensing agreements —are intangible. Applying the resource-based view to technology transfer highlights two phenomena. First, technology transfer generates "strategic" hazards, since part of the transmitted knowledge might be the origin of the licensor's strategic advantage. Second, knowledge is difficult to transfer because both licensor and licensee must make efforts to teach and learn. In a context in which mutual trust and relational

networks are insufficient to control potential opportunism and strategic behavior, contractual provisions—in particular payment schemes—could be viewed as mechanisms aimed at generating incentives for both parties to make the effort to transfer and absorb knowledge.[4]

More precisely, we argue that (1) technology licensing agreements are specific agreements aimed at transferring knowledge that forms part of the licensor's competitive advantage; (2) depending on the nature of the knowledge transferred, ex-post contractual hazards might be particularly acute, leading to the choice of a payment scheme strongly influenced by the licensor's ability to secure the transfer. Such an approach leads to a trade-off, explaining the payment schemes observed in technology licensing agreements. On the one hand, licensees prefer to pay royalties rather lump sums because the latter oblige them to make greater efforts in measurement and assessment ex ante, and induce tremendous risks (because of the uncertainty concerning the actual value of the technology, the licensor's willingness to transfer knowledge, and the licensee's ability to implement it efficiently). On the other hand, royalties increase the licensor's vulnerability to the licensee's opportunism. The licensee can refuse to pay for the transferred technology, or lie about intensity of use. Licensors will therefore accept a royalties-based payment if and only if they are able to exclude the licensee from the ability to use the technology ex post, if necessary. This will depend very much on the nature of the technology (the way it is embodied and transferred, its ease of measurement) and the institutional framework ("strength" of IPR, efficiency of contract law and enforcement institutions). This leads us to develop testable hypotheses concerning the way payment schemes should be implemented in technology licensing agreements. Our approach combines two branches of the transaction cost approach (see Williamson 1985). First, by focusing on the contractual control of ex-post misalignment of the contracting parties' behavior, we take the governance approach (Williamson, 1975, 1985, 1996). Second, by pointing out that securitization transactions is pretty much dependent upon the

4 Because moral hazard and opportunism are pushed to the background in the resource-based view (Foss 1996; Eisenhardt and Schoonhoven 1996), this approach does not provide clear propositions about the way contractual provisions might impede contractual hazard. Nonetheless, this approach is useful to characterize the dimensions of knowledge that are difficult to transfer and relevant to our study.

delineation of property rights at the institutional level, by both formal and informal institutions, our approach follows the logic of the "measurement" branch of transaction cost economics (Barzel, 1989).

**Applied Contribution**

To assess the relevance of our propositions, we use a unique and exhaustive French database in which 61,244 international licensing contracts signed by French firms are registered. We built a workable database for our paper by extracting a sub-sample of 553 contracts representative of licensing practices in seven industries.

There is little research based on substantial applied studies that tries to identify firms' actual licensing practices. One of the major reasons for this is the difficulty of accessing information. Most firms consider their TLAs highly confidential. Each individual TLA provides any reader with a lot of detail about the value of a given technology, the complementary resources necessary to implement it efficiently, and the commitments that link industrial partners. TLA portfolios enable analysts to assess accurately the nature and value of any given firm's intellectual assets. Consequently, firms are reluctant to display information about their TLAs.

To our knowledge only a few studies based on statistical methodologies have been performed on payment schemes in technology licensing agreements (Aulakh et al. 1998; Degnan and Horton 1997; Macho-Stadler et al. 1996; Mendi 2005; Vishwasrao 2007). Fewer provide econometric results. Compared to those previous studies, we believe our paper makes a contribution for three main reasons. First, compared to previous empirical studies (Anand and Khanna 2000; Macho and Stadler 1996; Mendi 2005; Vishwasrao 2007), we benefit from detailed data on contract characteristics, the flow of resources that are exchanged between parties, and the context of the transaction, which allow us to disentangle the influence of the environment and transaction features on contractual provisions. Previous papers were not able to do this and often considered the industry as a good proxy for the nature of the resources exchanged (Anand and Khanna 2000). Since, in these studies, specific

institutions might exist at the industry level (e.g. private/self-governance institutions) sector dummies simultaneously proxy transaction features and specificities of the institutional environment. Second, as far as we know, we provide the first empirical study using a transaction cost economics framework combined with a resource-based view to analyze payment schemes in technology licensing agreements. We show that the tacit component of transferred knowledge leads to lump sum fees rather than royalties. These empirical results are not in line with several previous empirical studies, as we discuss later. Third, by applying a transaction costs perspective to a class of contract on which few econometric studies related to this tradition have been performed, we provide not only another empirical test of the theory, but also a test enabling comparisons with studies on other classes of transaction, contributing to a better understanding of the impact of transaction features and contexts on contractual design. For example, Lafontaine (1992) called for such a study to see whether the results obtained on franchise contracts apply to licensing agreements. Our conclusion is that previous results obtained by Lafontaine do not apply in the case of technology transfer because ex-post contractual hazards appear to be particularly acute. The licensee cannot be disciplined by imposing a termination at will clause, as is often the case in franchise contracts (Brickley, Dark, and Weisbach 1991; Brickley 2002). Termination is of no concern to licensees, once they have absorbed the relevant knowledge, because transfers are non-reversible. Due to the inability to deter such opportunistic behavior, license contracts tend to implement a once-and-for-all lump sum payment rather than a pure royalty agreement. Williamson (1991a p. 83) explains this point well and to a certain extent our paper confirms his prediction. Our results suggest that different payment strategies should be retained, depending upon the characteristics of the resources exchanged (appropriability, excludability, etc.).

## PAYMENT SCHEMES IN TECHNOLOGY LICENSING AGREEMENTS: HYPOTHESES

Patents allow their owner to license innovations to other firms. A license contract names the parties involved and gives the particulars of the technology transferred, the duration of the license, and the conditions. It specifies a governance mechanism (supervision mechanism, renegotiations provision,

etc.) and payment scheme (Caves et al. 1983; Bessy and Brousseau 1998). License contracts entail the payment of a license fee *L*, paid only once for the duration of the contract, and royalties on sales *r*. The licensing agreement can implement either, or both.

The transaction cost approach, which puts contractual incompleteness and risk of opportunism at the core of its analysis, suggests that the choice between lump sum and royalty payment schemes should reflect efforts to economize on transaction costs (Williamson 1991b). Lump sum payment gives purchasers an incentive to engage in extensive presale measurement of the exact value of the technology,[5] whereas royalties require greater post-agreement monitoring and enforcement mechanisms. In fact, a royalty payment economizes on the ex-ante cost of measurement, replacing it with the cost of ex-post opportunism.[6]

To advance our analysis and enable more precise and testable propositions, we must identify the determinants of measurement and enforcement costs. Transaction cost economics looks predominantly at the attributes of transactions and the institutional framework—the "shift parameter" (Williamson 1991b; Oxley 1999)—as main determinants of transaction costs.

**The Attributes of the Transaction**

What are the principal dimensions along which transactions differ and have the potential to affect contractual hazards? Following a resource-based view perspective, we argue that the analysis of technology transfers requires consideration of how knowledge is embodied in various formats (the human brain, documents, physical resources, etc.). Transferring knowledge requires the transmission

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5 Ex-ante measurement costs can be socially valuable, as the more efficient licensors are better rewarded. However, in the case of technology transfers, the characteristics of the technology are not affected by licensees' efforts. Measurement by licensees simply redistributes wealth among licensors and from licensors to licensees and results in social waste. Licensors are therefore expected to develop selling practices that limit such measurement costs.

6 Licensees' ex-post failure to pay has no social cost per se. It is mere redistribution. However, it can result in a net social loss if the anticipation of failure to pay changes licensors' actions. Ex ante, licensors have little incitement to provide know-how to licensees. Ex post, they have to dedicate resources to supervise licensees and to retaliate to any opportunistic behavior. Ex-ante and ex-post risks of poor transaction performance and the costs of potential conflicts reduce volume of trade and might even prevent trade from occurring.

of various resources with very diverse properties in terms of rivalry, appropriability and ease of transmission. Transactions have to be considered in terms of the complexity of the transfer (does it require emission and absorption efforts by the parties involved, or is easy to perform?); its reversibility (can licensors exclude licensees from using knowledge ex post, if they longer want to allow them to use it?); and possible opportunism (can licensors confine licensees to the ex-ante forecasted uses of the knowledge transferred?).

Several authors have already discussed the difficulty of transferring knowledge, even within firms (Jensen and Meckling 1991; Szulanski 1996). The level of codification of knowledge appears to be a central element and varies greatly between different technological domains (technological domains are often proxied by industries, e.g. Anand and Khanna, 2000).[7] In those domains where knowledge is highly codified (as opposed to being tacit), intellectual property rights are strong and technology transfers through royalty contracts are easier to secure (since courts can supervise the transfer of knowledge and how it is used).[8] This results in low ex-post transaction costs. On the other hand, in domains where knowledge is tacit, royalty contracts are not easy to secure ex post, and the economy they provided on ex-ante measurement costs may not be justified when compared with the enforcement costs they entail.[9] This leads us to our first proposition:

***Hypothesis 1: The larger the amount of codified knowledge transferred, the more likely contracting parties are to use royalty rates.***

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7 Our data set enables us to assess precisely the intensity of the transfer of both codified and tacit knowledge for each transaction. We can observe each technological domain, while most studies rely on strong assumptions about the nature of knowledge at the industry level (in which contrasting technological domains co-exist most of the time, in terms of codifiability, commonness, etc.).

8 The degree of tacit of knowledge has often been presented as a key factor explaining the internalization of technological exchanges within firms. The main rationale for integration is to cope with the opportunism of the contractual partner (Teece 1986; Osborn and Baughn 1990).

9 The theory gives us no indication of the relative magnitude of ex-ante measurement vs. ex-post enforcement costs generated by the tacit nature of exchanged knowledge. Nevertheless, we can think of many ways for licensors to signal the value of their knowledge. More importantly, we consider long-term agreements (the average contract duration in our sample is eight years). This suggests that it is appropriate to focus on ex-post enforcement issues, considering ex-ante measurement costs effects as secondary.

**Public and Private Institutions**

The institutional framework contributes to the delineation (measure) and enforcement of rights of use over all kinds of economic resources (North 1990). When it comes to the exchange of intangibles (and related level of transaction costs) it is crucial to take into account the impact of the institutional framework on the completeness and strength of these exclusive rights of use. Despite international treaties and conventions, the actual completeness of IPR systems differs significantly from one country to another, as does its impact on the ability of parties to secure knowledge transfer.[10]

In countries where the legal system protects strongly and efficiently against IP infringement, ex-post transaction costs are reduced. Since royalty-based licensing agreements imply rents for licensors over the course of the agreement, it is important for these firms that their knowledge is adequately protected in the countries where their licensees operate. Royalty-based compensation structures are likely to be implemented in countries with strong legal protection. In the absence of adequate legal protection, licensors can either refuse to license their technology, or can minimize uncertainty about IP protection by opting for lump sum compensation to be paid up front.

Hypothesis ***2*****: *The stronger the institutional framework for protecting IP rights, the more likely contracting parties are to use royalty rates.***

Caves et al. (1983) and Bessy and Brousseau (1998) point out, in the case of technology licensing agreements in particular, and Arora and al. (2001) more generally, the imperfections of the IPR system might lead industry participants to implement private institutions and self-governance mechanisms to secure property rights. By providing the means to share information on participants' behavior within an industry, contributing to building a reputation mechanism, providing alternative capabilities for dispute resolution, etc., they increase the likelihood of compliance with commitments.

10 Alternatively we could consider how national differences in levels of trust impact perceptions of transaction costs (Shane 1994). We focus our analysis IPR differences but acknowledge that institutional differences (formal and informal institutions) can be more broadly defined.

Thus, contractual design should also depend upon the specificities of the institutional environment at the industry level.

Hypothesis ***3*: *The use of royalties in technology licensing agreements should vary from one industry to another, reflecting the different strengths of institutions that secure transactions at the industry level.***[11]

To sum up, the probability of TLAs implementing royalties should (1) increase when property rights are efficiently enforced, when contract law is well designed and efficiently enforced, and when private institutions/self-regulation contribute to secure transactions at the industry level; and they should (2) decrease when the transmitted knowledge tends to be tacit.

It should be noted that our propositions contrast with the predictions of the principal-agent and adverse selection models, viewing royalty rates as a useful tool for infusing proper incentive where tacit knowledge is concerned (cf. Macho Stadler et al. 1996;[12] Choi 2001), or for signalling good technologies (Gallini and Wright 1990, Beggs 1992). These views are correct as long as the institutional framework is supposed perfect enough to enforce the contracts based on royalty payments.

11 This proposition might seem general and imprecise. However, contrary to previous empirical studies (for example, Anand and Khanna 2000), which relied on sector dummies to grasp both the nature of the exchanged resources in the industry and the nature of industry-level institutions, we have precise data on the characteristics of the knowledge exchanged by contracting parties. We are therefore confident that our sector dummies reflect in large part differences in the institutional environment at the industry level.

12 As we will argue later, our results are also different because we rely on more precise data about what is actually exchanged among firms. For instance, Macho-Stadler et al. (1996) highlighted a positive relationship between the implementation of royalties and the transmission of know-how. The latter could, however, be an imperfect proxy of the transmission of tacit knowledge only. We maintain that the intensity of transfer of both tacit and codified knowledge has to be taken into account to analyze the impact of the nature of the transaction on the contract mechanism. This should be assessed through the description of the whole set of resources transferred between licensor and licensee.

## THE DATABASE

### The Sample

Firms incorporated in France, even if they are subsidiaries of foreign firms, are requested to fill all their international TLAs at the French Patent Office.[13] The database we use draws from this obligation. It includes 61,244 contracts (including TLAs, copyright licensing agreements, technical assistance commitments, patent sales, etc.) signed between 1904 and 1998. As a first approach we decided to focus on the contracts that were still in force over the period 1994–8 and generated financial transfers over that period (2,798 TLAs). Our aim was to perform extended data and econometric analyses on a representative sample of these 2,798 contracts. This is a labor-intensive task, since the contracts have to be read and codified before any analytic processing. Indeed, while we have access to the complete and actual wording of the contracts, only a part of the information on them is computerized.

The present paper is therefore based on a sample of 553 contracts[14] from seven different industries (see Table 1). The seven industries were selected because they are associated with contrasted licensing practices (in terms of both willingness to license and contractual practices).

(Table 1 ABOUT HERE)

Thanks to the contract and the administrative registration form that a French firm must complete when registering a contract, we have extensive information that encompasses information on the French firm, contractual provisions, and details of the resources exchanged.[15]

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13 "French firm" means that the firm is incorporated in France. However, the firm can be a subsidiary of a foreign firm. This is the case with 27% of the French firms in our sample.

14 This sample is representative of the diversity of licensing practices, since we are interested in explaining the diversity of TLAs. Its structure does not reflect the structure of the mother population of contracts since some types of contract are more frequent than others, and since TLAs are more frequent in some industries than in others.

15 Partner size has been checked using the Kompass database.

**Major Features of the Analyzed Sample of TLAs**

In this section, we present some descriptive statistics about the sample. They demonstrate that it is not too biased even though it relies on a relatively small set of contracts.[16] Moreover, they enable us to confirm some general characteristics of TLAs that were previously highlighted, especially by Caves et al. (1983) and Bessy and Brousseau (1998).

In 50% of the 553 processed contracts, the French partner is the licensor. The French firm is therefore the licensee in 50% of the cases. In 21.5% of the contracts the agreements are between firms belonging to the same group (with at least a minority shareholding relationship). In 24.4% of the cases, the two companies had contractual relationships before the signature of the contracts studied.

As Arora (1995) and Bessy and Brousseau (1998) point out, technology and knowledge transfers often require the exchange of many resources in addition to the right to use a license. Table 2 illustrates this. Note that in the domestic appliances industry and agriculture (mostly seeds) the intensity of transfers is far below the mean. $\chi^2$ tests confirm that the types of resources exchanged vary across industries. This is obviously linked to various degrees of knowledge codification, and more generally to the fact that knowledge is embodied in various formats in the various technical fields.

This is also because the difficulty of performing and securing the transfer of knowledge varies across industries. The bundling of knowledge to other resources (such as the right to use a trademark, basic products or services) is a way of securing these transfers. In 17.5% of the contracts, there is an

16 Because of the difficulty of accessing contractual information and the cost of building a data set out of written contracts, in other empirical studies contractual samples tend to be small in size. For instance, Davies (1977) investigated 26 cases; Davies (1992) 204 cases; Macho-Stadler et al. (1996) 240 cases; Aulakh et al. (1998) 110 cases; Chi and Roehl (1997) 93 cases; Bessy and Brousseau (1998) 46 cases; Brousseau et al. (2007) 213 cases.

obligation for the licensee to buy products or services from the licensor. Bundling is frequent in the chemical and pharmaceutical industries, but scarce in the domestic appliance industry.[17]

(Table 2 ABOUT HERE)

Another way of securing technology transfers is to barter through the mutual exchange of intangibles (and sometimes tangibles). With bartering, the licensee is liable to provide the licensor with some types of resources. There is a reciprocity requirement in some of our contracts (22.8%); however, with the exception of technical test results, they are a minority. This is because we selected a sample of contacts implementing payment mechanisms, while barter, by definition, tends to exclude payment.

## ECONOMETRIC TEST

### Explained Variables

In our database, 63% of our 553 licensing contracts are based on royalties only*;* 8% are based on lump sum payments only. The remaining portion is characterized by a combination of lump sum and royalty payments. As we pointed out in the introduction, royalties are the rule rather than the exception. Several variables have been created to test our propositions concerning payment schemes in license contracts.

We analyze the choice of payment scheme as a discrete choice between pure royalty payments, lump sum payments and a combination of the two. We created the variable **ROYALTIES** as a dichotomic variable equal to 1 if the contract is based on royalties only, and equal to zero if the contract is based on lump sum payments or a combination of lump sum and royalty payments. We also created variable **LS/RLS/PR** that is equal to zero if the contract implements a single lump sum payment, 1 if a two-part tariff is implemented, and 2 if only royalties are paid. This enables us to perform ordered probit tests to take into account the fact that payment schemes are not a dichotomic choice but more likely a

17 While bounded sales in the case of TLAs are tolerated under the US antitrust regulations implemented in 1989 (Intellectual Property Antitrust Protection Act), the EU antitrust regulation has strictly forbidden it since 1995.

continuous choice in which pure royalty contracts and pure lump sum contracts are only two polar forms of a more continuous choice.

**Explaining Variables**

*Exchanged Resources*

We begin by contrasting the resources exchanged depending on whether they entail the transfer of tacit or codified knowledge. In order to distinguish the tacit and codified components of the transfer, two separate variables are implemented.

Variable **COD** (for codified knowledge) is an indicator taking into account whether the contract covers model transfers, plans and red-book transfers, development and test data, commercial and marketing data. All these resources enable an outsider to check the reality of the transfer. Transfers are verifiable, and the circulation and the use of the related knowledge can be (to a certain extent) controlled ex post.

Variable **TACIT** (for tacit knowledge) is an indicator taking into account whether the contract covers consultancy services and technical assistance, training, personnel delegation, accounting, management and marketing methods. This classification might appear subjective and is not immune to criticism. There are several problems about the way to evaluate the kind of knowledge that is transferred through contracts. Firstly, we do not consider a level for each resource. For example, a contract with few know-how transfers is rated the same as a contract with several. We do not have any intensity indicator for each tacit or codified item. A second problem is that the theory does not clearly state whether all resources should be regarded as equally important (i.e., with a unit rating) or as independent of each other. We might have expected a different weighting for each resource in the definition of tacit knowledge, but the theory tells us nothing on this point. For this reason we chose a simple operational definition of our variable (each kind of resource rated), and refinements are possible. We tried several specifications for these variables, and the results reported in the next section

appear to be robust to minor changes in those definitions. To test for reliability, we applied the Cronbach alphas for the scales with the recommended 0.7 used roughly as a cut-off. Reliability was 0.76 for the TACIT construct, and 0.50 for the COD one. The low score of the COD variable is not as challenging as it first appears. Indeed, we have to keep in mind that codified resources are often substitutable means of transfering information, whereas tacit components are more often used in a complementary way to transfer knowledge. Since degrees of freedom are not a problem in our data, we could have incorporated each of the factors that make up these variables in estimates to see whether the results are being driven by a specific component. However, because of multicolinearity problems, such estimates did not give us any clarification about the main driving components.

We expect the variable COD to impact positively on the likelihood of implementing royalties, while increasing degrees of tacit knowledge should lead to lump sum payments. The Pearson correlation coefficient between TACIT and COD is important and positive (51.8%). It is also significant (1/1000 level). As we noted earlier, this result supports the necessity to include both TACIT and COD variables in our estimations.

*Public Institutions*

To assess the impact of the institutional environment, three features must be taken into account: the law of reference of the agreement, the nationality of the licensee (the IP law in the licensee's country of origin is the one that counts), and the nationality of non-French partners.

Nominally, the law of reference used in the contract should be the one taken into account. However, this is open to discussion, since the law of reference in question is the contractual law, not the IP law. To grasp the extent to which the IP regime impacts on the contractual arrangement, we have to deal with the nationality of the licensee. The patent law of the licensee's country of origin will apply in the last resort. However, in many cases, the final appeal court for the arrangement is a private body (such as the arbitration courts of an international chamber of commerce). In these cases, the nationality of the partner matters because the judiciary authorities of the country where the company is incorporated

will be in charge of guaranteeing the enforcement of the arbitration sentence. This reasoning is also followed by Aulakh et al. (1998).

We use a composite index to measure the strength of IPR. There are many indexes but they all face two serious limitations. First, scores are usually based on the laws in force at a single point in time. They do not take into account changes and amendments to the laws or the performance of judicial institutions or patent offices that may have occurred over the period in which our contracts were signed.[18] Second, while many indexes try to evaluate the strength of IPRs, they do not take into account the way they are enforced ex post. However, with those indexes we expect to evaluate the presence of public institutions that may affect contract structure.

We focus our attention on the indexes computed by Ginarte and Park (1997). Using five components of the patent laws (extent of coverage, membership in international agreements, provisions for loss of protection, enforcement mechanisms, duration of protection), Ginarte and Park propose an index of patent rights for 110 countries for the period 1960–90. The way IPRs are effectively enforced is not taken into account; but at a first glance, this index can be considered a good proxy of the quality or strength of institutional protection. Therefore, we built two variables with this indicator. The first reflects the level of IPR protection in the country of the non-French partner (**GINARTREF**); the second assesses the IPR protection in the licensee's country, and by extension the legal protection of the patent (**GINARTREP**).[19]

*Private Institutions*

As Arora (1995) points out, inter-sectoral technology transfers often lead to greater asymmetrical information with licensees less familiar with the traded technology. Moreover, some research highlighted the role of sectoral institutions (like engineers' networks) as a way of sharing knowledge

18 Contracts in our sample were signed between 1969 and 1998, with more than 85% signed between 1986 and 1998. We then have to find a temporal index.
19 The test performed with the proxy of patent nationality uses only 551 contracts, because the Ginarte and Park indexes for Comoro and Yugoslavia are not available.

between companies, thus reducing the information problem (e.g. von Hippel 1988). Bessy and Brousseau (1998) and Kim and Vonortas (2006) point out that in addition to facilitated transfers, the repetition of exchanges within an industry can lead to the emergence of private institutions that secure those transfers. Arora and Fosfuri (2002) illustrate the emergence of formal organizations and informal norms framing the exchanges of knowledge (and resulting in a market for technologies) in the chemical industry.

We are not aware of any index computed to grasp the involvement of private institutions in technology licensing agreements. To capture their impact we created **sector dummies.** Of course, such indicators are not precise enough and might reflect intersectoral differences not linked to private institutions/self-governance. For example, Anand and Khanna (2000) use sector dummies to grasp what kinds of resources are exchanged between sectors. Because we benefit from a precise measure of what is exchanged, we are confident that sector dummies in our own econometric analysis will reflect other differences across industries, and possibly the specificities of the relevant institutions in each sector. However, they also reflect the potential homogeneity of knowledge. In the consumer electronic industry, for instance, most firms are at the frontier of research and have very similar capabilities, which is not the case in many other industries.

*Other Relevant Factors*

Other factors, impacting on trust, negotiation power and common knowledge between parties might also affect payment strategy in TLAs. We consider them as control variables, without any clear prediction of the role they should play in the willingness of the contracting parties to implement royalties.

When companies sign repeated contracts together, we might expect them to be in a committed cooperative relationship and to develop common frames and references reducing the cognitive distance between them. This might be especially true between partners in different countries that are therefore (initially) cognitively distant. Contractual securitization might therefore be less relevant than

(bilateral) reputation. Furthermore, the building of common frames and references might ease the transfer of knowledge. Consequently, we created the variable **PREVIOUS-CONTRACT** taking the existence of previous contracts between the parties into account. We expect that previous contracting will increase the trust and common knowledge between parties and might then affect the way they implement payment schemes.

The size of licensee is an important matter for choosing the proper payment formulae. Many scholars explain that large companies have fewer capital constraints and are less risk averse (Montalvo and Yafeh 1994). Large licensees could be less reluctant than small firms to pay a lump sum at the beginning of a deal. On the other hand, large firms facing smaller ones might benefit from stronger bargaining power. Large licensees, all else being equal, are therefore more able than smaller ones to impose its first best solutions in terms of payment scheme on the licensor; this will a royalty scheme (as compared to a lump sum) because the licensee shares the implementation and exploitation risks of the licensor. To check for these possible impacts, we created the **SIZEE** variable that grasps the size of the licensee.

When a licensor enters into a technology transfer agreement with a partner that is a direct competitor—in the sense that it operates in similar product markets or relies on similar technologies—it seeks to avoid unintended spillovers that might empower its partner. A resource-based view analysis suggests that the licensor should opt for a licensing agreement that would help it to monitor carefully both partner and transfer. To account for this effect, we created variable **ID-SECTOR**, taking value 1 if the contracting parties belong to the same sector.

When contracting parties develop complementary resources, it signals a symmetric partnership that might underscore strategic considerations in inter-firm collaboration (Hagedoorn et al. 2008). Furthermore, such reciprocity might also provide a balancing of contractual hazards through the exchange of mutual "hostages" (Williamson 1985). The existence of such complementary generates a high degree of interdependency and therefore, a lower risk of mutual exploitation. Following this idea,

we created variable **RECIPROCITY** that is ranked between 1and 4, depending on whether the contract covers license transfers, data transfers, brand-name or model transfers and input transfers from licensee to licensor.

Among subsidiaries belonging to the same company, or between a subsidiary and its mother company, the securitization of exchanged property rights should play a lesser role in the design of contractual agreements.[20] Consequently, we created the variable **CAP-LINK** to take into account the existence of equity links between licensor and licensee.

Contracting parties might also implement geographical restrictions. Such contractual safeguards reduce the risks borne by the licensor, because it confines the negative impact of the licensee's potentially opportunistic behavior. However, it only does so to the extent that this contractual provision is enforceable ex post. To control for the potential effects of geographical restrictions on implemented payment schemes, we created the variable **RESGEO**.

All variables are summarized in Table 3.

(TABLE 3 ABOUT HERE)

## THE ECONOMETRIC RESULTS

Results are presented in Tables 4 and 5. We first consider the choice whether or not to include royalty payments in TLAs by estimating a probit model looking at pure royalties payments vs. other kinds of payment. Results are given in Table 4. Nevertheless, it is natural to consider payment schemes as more complex discrete organizational choices. That is why we also performed ordered probit estimates to analyze the pure lump sum payments choice vs. the pure royalty and mixed payments

20 Moreover, within a group, bringing profits back to the mother firm's country is a crucial question, and licensing royalties are a good way of performing that type of transfer.

choices. Results are given in Table 5. The two kinds of estimates lead us to the same results. We can therefore consider the ordered probit test relatively robust.[21]

(Tables 4 and 5 ABOUT HERE)

As expected, our main result is that the remuneration regime is sensitive to the nature of the resources transferred: Transferring codified knowledge increases the recourse to royalties, while logically transmitting tacit knowledge raises the probability of implementing lump sump payments. This result is robust, whatever the estimates (probit or ordered probit). It is also robust to different specifications, including or excluding institutional indicators (our GANARTEF and GINARTEP variables) and sector dummies, and focusing or not on the subsample of French licensors. This result goes against the more usual incentive-focused explanations and confirms the relevance of a theoretical framework taking into consideration ex-post transaction costs to predict payment scheme in TLAs. Incidentally, it raises a lot of questions about previous empirical tests in this area. Indeed, previous empirical literature that tests agency propositions usually relies on unreliable proxies of the transferred resources (see the discussion in Macho-Stadler et al. 1996, fn 12); sometimes measuring such resources by using sector dummies (Anand and Khanna 2000) and concluding that royalty payments are a way to motivate licensors to transfer tacit resources. Our results suggest that this is misleading. Disentangling resources exchanged and differences in the environment across sectors leads to different results.

The institutional indexes provide only limited results. The Ginarte and Park indicators are never significant when applied to the nationality of the non-French partner. They sometimes have a weak significance when they grasp the nationality of the licensee, but this impact is very sensitive to the type of estimation performed (probit or ordered probit). We have to admit that the impact of the institutional environment is difficult to grasp because it is difficult to benefit from relevant proxies to assess the quality of the environment. It is difficult to identify relevant methods to "measure" the

21 The explained variable is effectively ordered. If this were not the case, we would expect a multinomial probit to be more satisfying. Results do not change dramatically when using a multinomial rather than an ordered probit.

features of the legal frameworks, and to draw objective assessment of the institutional environment. This is obviously due to the fact that many dimensions have to be taken into account (various features of various laws, diverse characteristics of the enforcement institutions, etc.). Single-dimension indexes are therefore strongly biased and probably only adapted to very specific types of studies. Brousseau and Sattin (2007) discuss these problems extensively and suggest an alternative methodology—based on licensing agreement databases like the one we draw on here—to compute relevant indexes of the "quality" or "strength" of IPR protection.[22]

Our sector dummies, used as crude variables to grasp private institutions (and other relevant environmental characteristics) at the sector level, appear to explain the way contracts are designed. This is not a surprise. Such indicators already proved significant in previous studies. What is interesting in our study is that the introduction of such indicators does not change the results and does not appear as crucial in explaining contractual choices, even if they are jointly significant.

There are further interesting results. Additional variables indeed play a role. More precisely, we observe that equity links, previous contracts between partners, and the fact that the partners belong to the same industry increase the use of royalty rates in agreements. This suggests that those elements reduce the threat of ex-post opportunism and allow partners to put the emphasis on ex-ante incentives to transfer knowledge. Furthermore, the size of the licensee, as well as the existence of reciprocal exchange and the use of geographical restriction in agreements are also significant and increase the use of lump sum payments in agreements. Such results suggest that those elements play a role in the

22 In this paper, differences of quality across institutional frameworks are measured by comparing the design of contracts implemented in different institutional contexts. The insight is that differences in the quality of the institutional environment should be taken into account when drafting the contract. When it is possible to control for all the other variables (features of the transaction, specificity or the relationship among the parties, etc.), the measured variations between two contracts implemented in different institutional contexts should reflect differences across institutional frameworks. This reasoning has been relied on in labour econometrics since Oaxaca's pioneering work (Oaxaca 1973) assessing racial or sexual discrimination. Brousseau and Sattin examine a set of licensing agreements set up in different institutional contexts. More precisely, they assess how the contractual choices that are made in one country would have been affected if they had arisen in another institutional environment.

licensee's willingness to accept lump sum payments; the first two, because they are linked to weaker liquidity constraints; the third because exclusivity provides the licensee with expectations of monopoly profits.

### ENDOGENEITY ISSUES

One of the strengths of our study is that we had access to very detailed contract data. But relying only on data contained in the contracts raises troubling methodological questions about endogeneity issues. It could be argued that the source of endogeneity might be the correlation between explanatory variables that are contractual provisions (TACIT and COD) and the error term, because of characteristics of the contracting parties (operators' characteristics) and the contracts (regional characteristics) that are omitted.

The endogeneity of contract clauses has one main dimension in our case. Indeed, there is an ex-ante self-selection problem, in that the contracting parties may select specific clauses according to their (sometimes unobservable) characteristics or those of the projects. For example, the decision to transfer codified or tacit knowledge could be induced by the licensor's anticipation of potential renegotiations and of the licensee's perceived renegotiation skills. Conversely, geographical restriction guarantees might be included as a means of making risky licensing agreements attractive to licensees. Thus, the problem we need to tackle is how to assess the real effect of the kind of knowledge exchanged on the payment schemes implemented in the contracts. To do this, we need to find suitable instruments. The source of endogeneity is the correlation between explanatory variables (i.e. the kind of knowledge exchanged) and the error term. Regional unobserved factors are technology or policy related, while operator-specific factors relate to renegotiating (and similar) skills.

To address this problem, we follow Guasch et al.'s (2008) methodology to develop a set of instruments that are correlated with the kind of knowledge exchanged between parties, but not with the above-unobserved effect. The instruments for our two kinds of transferred knowledge (i.e., COD and TACIT) consist of the average prevalence, at the time of contracting, of the same kind of

knowledge exchange in the same sector and in different countries (Instrument 1) and in different sectors and different countries (Instrument 2). The correlation between the choice of a specific kind of knowledge exchanged for a project in a specific sector of a given country through Instrument 1 is independent of country-specific aspects. Similarly, this choice is only correlated to Instrument2 through aspects independent of both country- and sector- (and operator-) specific effects. First stage estimates are given in the Appendix.

Furthermore, we test for the exogeneity of the variables under scrutiny, using the two-stage conditional maximum likelihood procedure (2SCML) developed by Rivers and Vuong (1988) This approach simply consists of running the standard probit estimation augmented by the residuals of the first stage estimations (see also Wooldridge, 2002).[23] Indeed, endogeneity problem appears to be an issue only in the French licensors' sub-sample when considering the choice of codified knowledge exchanged between parties (Probit (7) Table 4 and Ordered Probit (7) Table 5). Thus, exogeneity tests increase our confidence in our results and the fact that the kind of knowledge exchanged is largely exogenous.

## DISCUSSION

Our results contrast sharply with the few previous existing empirical studies on the topic (Anand and Kahnna 2001; Macho-Stadler et al. 1986; Mendi 2005) and raise questions about their robustness. Compared to Anand and Kahnna (2001) and Macho-Stadler et al. (1986), we believe our results differ essentially because our data are more precise than theirs, especially in the way resources exchanged are measured.

23 Although 2SCML was described and applied initially to probit analysis, the extension to ordered probit used here is straightforward.

Mendi (2005) suggests an alternative explanation that would be consistent with our results. He argues that contracting parties might choose payment schemes in TLAs to avoid early termination of the relationship. Following this argument, there should be a positive relationship between contract duration and the probability of the parties including variable payments. Our results, as presented in Tables 4 and 5, cannot corroborate or refute this theory, since we did not try to test the influence of all other contractual provisions to avoid endogeneity problems. Hoever, to test Mendi's insight we ran the same tests, focusing as he did on the whole sample and recent contracts, but using our explanatory variables, once again measuring more precisely what is actually transferred in the agreements. Results are showed in Table 6 and do not change our main results. Duration does not appear to be a major driving factor in contractual choices.[24] This reinforces our confidence in the robustness of our results. At the same time, it has to be pointed out that estimating contract duration is very difficult in the context of technology licensing. Indeed, licenses are usually granted for the whole duration of the patent, which is extremely imprecise information because licenses can be granted at different stages in the patent lifecycle. Moreover, in many industries, the pace of innovation means that patented technologies become obsolete long before patent expiry, making the TLA obsolete as well.

(Table 6 ABOUT HERE)

## CONCLUSION

In this paper we rely on a transaction cost framework to analyze payment schemes in TLAs. However, we combine it with the resource-based view to take into consideration the peculiar nature of the object of the transaction—knowledge. Our results suggest that payment schemes in TLAs may be explained by the willingness of the parties to economize on contract enforcement costs, and highlight the complex impact of the tacit nature of transferred resources on payment formulae. More precisely, the more tacit the transferred resources are, the more contracts rely on lump sum payments.

24 Indeed, contract duration should be considered as potentially endogenous. Mendi's paper did not examine this issue; the results in Table 6 were obtained using Mendi's methodology.

Previous results obtained in other kinds of exchanges, for example, Lafontaine (1992) on franchising, do not apply because ex-post contractual hazards appear to be particularly acute where technology transfers are concerned. More precisely, the licensee cannot be disciplined by imposing a termination at will clause, as is often the case in franchise contracts (Brickley et al. 1991; Brickley 2002). Termination is of no concern to licensees; once they have acquired the relevant knowledge transfer is non-reversible. Accordingly, lacking a deterrent effect, license contracts will take the form of a one-off, lump sum rather than a royalty agreement. This point is in line with transaction economics predictions (Williamson 1991a p. 83).

While innovative, our results are to a certain extent frail and should be confirmed through further study. First, we ignored potentially important interactions and qualifications of other contract provisions that can alter their nominal meaning. A given contractual provision might be implemented because of the introduction of another. For example, licensors might be inclined toward a royalty scheme if they can implement a complex governance structure to secure the transfer of their knowledge. The interdependency between contractual provisions is rarely studied. As far as we can see, there seems to be no correlation between payment schemes and other contractual provisions—but such issues merit further study. Second, we cannot be sure that our national institutional variables alone correctly capture the impact of the institutional framework. A better assessment of the impact of institutions is dependent upon the development of new types of indicator able to "measure" the quality and the various features of the institutional environment at a micro level. As we pointed out earlier, the design of such indexes has to take into account many diverse sets of rules and enforcement mechanisms. The computing of such indexes requires extended access to a wide range of information. The complexity of measuring institutions is reinforced when we consider private and informal institutions. Relevant indexes to "measure" the features of the institutional environment will have to be both pluri-dimensional and computed at several levels (national legal systems and industry self-regulatory frameworks). The task is wide-ranging and difficult. However, this should lead to a better

understanding of the impact of various institutional features on contractual provisions. This better understanding would be useful for the design of technological strategies and industrial policies.

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**Tables**

**Table 1: The Sample***

| Industry Name | Total number of contracts in the data base | % of payments made by French firms in 1997 | % of payments received by French firms in 1997 | Number of contracts in the sample | % of the sample |
|---|---|---|---|---|---|
| Mechanical Machines and Tools (05) | 150 | 6.46 | 1.41 | 101 | 18.26 |
| Automobiles and Terrestrial Transportation Material (07) | 93 | 4.09 | 9.03 | 40 | 7.23 |
| Electrical Appliances and Machines (08) | 72 | 1.62 | 1.37 | 34 | 6.15 |
| Basic Chemicals (10) | 119 | 6.94 | 4.25 | 58 | 10.49 |
| Pharmaceutical Products (12) | 474 | 39.55 | 37.16 | 117 | 21.16 |
| Domestic Appliances and Domestic Equipment.(20) | 54 | 0.22 | 12.54 | 31 | 5.61 |
| Agriculture, Fishing, Forestry (30) | 298 | 3.03 | 0.94 | 35 | 16.4 |
| Other (22 industries) | 1315 | 38.03 | 33.23 | 77 | 13.92 |
| TOTAL | 2798 | 100.00 | 100.00 | 553 | 100.00 |

*The sample is constituted of 553 technology licensing contracts randomly chosen from a larger database constituted of 2,798 licensing contracts concerning eight different industries. The table gives information concerning the number of contracts for each industry as well as the percentage of royalty payments made by French firms (when the licensee is French) and received by French firms (when the licensor is French).

**Table 2: Transfers to the Licensee Performed Through TLAs[#]**

(in % of 553 contracts; Industry codes in columns are given in Table 1)

| *Transfer to the licensee in addition to the right to use a patent* | **Whole sample** | *05* | *07* | *08* | *10* | *12* | *20* | *30* | $\chi^2$ |
|---|---|---|---|---|---|---|---|---|---|
| User Rights Over Other IPRs | | | | | | | | | |
| *Trademark* | **26.2** | *25.7* | *12.5* | *14.7* | *19.0* | *47.0* | *22.6* | *23.3* | 37.1*** |
| *Model* | **11.0** | *12.9* | *30.0* | *20.6* | *5.2* | *5.2* | *6.4* | *1.3* | 36.9*** |
| *Know-how* | **60.4** | *63.3* | *82.5* | *67.6* | *75.9* | *73.5* | *16.1* | *16.8* | 113.1*** |
| Codified and Embodied Knowledge | | | | | | | | | |
| *Plans, Red Books* | **50.5** | *61.3* | *70.0* | *58.8* | *74.1* | *52.1* | *19.3* | *5.2* | 101.2*** |
| *Development and Test Data* | **28.7** | *21.7* | *30.0* | *26.5* | *50.0* | *39.3* | *9.7* | *24.7* | 31.3*** |
| *Commercial and Marketing Data* | **11.6** | *9.9* | *20.0* | *20.5* | *10.4* | *14.3* | *6.4* | *3.9* | 12.1* |
| Tacit Knowledge | | | | | | | | | |
| *Consultancy Services, Technical Assistance* | **40.5** | *56.4* | *55.0* | *61.8* | *56.9* | *29.9* | *22.6* | *7.8* | 71.6*** |
| *Training* | **28.7** | *36.6* | *50.0* | *52.9* | *53.4* | *8.5* | *6.4* | *2.6* | 102.4*** |
| *Personnel Delegation* | **28.2** | *36.6* | *37.5* | *47.1* | *48.2* | *8.5* | *9.7* | *3.9* | 88.1*** |
| *Accounting, Management and Marketing Methods* | **9.4** | *14.8* | *15.0* | *2.9* | *3.4* | *11.1* | *3.2* | *0.0* | 22.0** |
| *Other* | | | | | | | | | |
| *Prototypes, Biological Material* | **34.4** | *23.8* | *32.5* | *29.1* | *32.6* | *35.9* | *12.9* | *80.5* | 97.1*** |
| *Products and Services (Regular Input)* | **28.9** | *10.9* | *15.0* | *32.3* | *20.7* | *60.0* | *16.1* | *48.0* | 77.7*** |

***: Dependency hypothesis is accepted at the threshold of 1 P.1000; **: OF 1 P.100*; OF 5 P.100

**#** The table gives information about the kind of resources exchanged in our TLA sample. $\chi^2$ indicates whether observed means differ significantly across different industries.

## Table 3: Definition of The Explaining Variables

| Variable | Definition | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| COD | Variable ranked between 1-4 depending on whether the contract covers model transfers; plans and red book transfers; development and test data; commercial and marketing data | 553 | 1.02 | 1.02 | 0 | 4 |
| TACIT | Variable ranked betwenn 1-4 depending on whether the contract covers consultancy services and technical assistance; training; personnel delegation; accounting, management and marketing methods | 553 | 1.07 | 1.28 | 0 | 4 |
| RECIPROCITY | Variable ranked between 1-4, depending on whether the contract covers licence transfers, data transfers, brand-name or model transfers and input transfers from the licensee to the licensor | 553 | .25 | .52 | 0 | 4 |
| CAP-LINK | Dichotomic variable equal to unity if the contract concerns two parties with capital links | 553 | .22 | .41 | 0 | 1 |
| PREV-CONTRACT | Dichotomic variable equal to unity if previous contracts between the parties exist | 553 | .24 | .43 | 0 | 1 |
| ID-SECTOR | Dichotomic variable equal to unity if the licensee and the licensor operate in the same sector | 553 | .52 | .50 | 0 | 1 |
| RESGEO | Dichotomic variable equal to unity if there is some geographical restriction in the contract | 553 | .13 | .33 | 0 | 1 |
| SIZEE | Dichotomic variable equal to unity if the licensee employs more than 500 workers | 553 | .48 | .50 | 0 | 1 |
| GINARTEF | Ginarte and Park index for the country of the non-French partner | 551 | 3.81 | .61 | .33 | 4.86 |
| GINARTEP | Ginarte and Park index for the country of the patent | 551 | 3.77 | .51 | .33 | 4.86 |

**Table 4: The Payment Formulae Explanation:**

**Pure Royalties vs. Lump Sum Payments**

**(Royalties = 1, Others = 0)**

| Explaining Variables | Probit (1) | Probit (2) | Probit (3) | Probit (4) | Probit (5) | Probit (6) | Probit (7) |
|---|---|---|---|---|---|---|---|
| | Royalties | Royalties | Royalties | Royalties | Royalties | Royalties | Royalties |
| TACIT | -0.194*** (0.057) | -0.198*** (0.058) | -0.185** (0.058) | -0.181** (0.062) | -0.169** (0.062) | -0.196* (0.096) | -0.189* (0.096) |
| COD | 0.199** (0.074) | 0.197** (0.074) | 0.203** (0.075) | 0.238** (0.078) | 0.242** (0.079) | 0.277* (0.116) | 0.287* (0.117) |
| RECIPROCITY | -0.229+ (0.121) | -0.212+ (0.124) | -0.244* (0.123) | -0.253* (0.129) | -0.280* (0.128) | -0.546* (0.230) | -0.579* (0.231) |
| CAP-LINK | 1.184*** (0.178) | 1.199*** (0.180) | 1.183*** (0.180) | 1.320*** (0.190) | 1.300*** (0.189) | 1.677*** (0.355) | 1.629*** (0.351) |
| PREV-CONTRACTS | 0.477** (0.150) | 0.496** (0.152) | 0.485** (0.151) | 0.522*** (0.159) | 0.506** (0.157) | 0.230 (0.241) | 0.222 (0.241) |
| SECT-ID | 0.395** (0.124) | 0.411** (0.126) | 0.436*** (0.126) | 0.402** (0.135) | 0.426** (0.135) | 0.426* (0.191) | 0.460* (0.193) |
| RESGEO | -1.129*** (0.197) | -1.192*** (0.203) | -1.195*** (0.203) | -1.150*** (0.216) | -1.152*** (0.216) | -1.226*** (0.320) | -1.245*** (0.322) |
| SIZEE | -0.423*** (0.119) | -0.405*** (0.119) | -0.407*** (0.120) | -0.207 (0.134) | -0.210 (0.134) | -0.123 (0.191) | -0.109 (0.191) |
| GINARTEF | | -0.035 (0.100) | | -0.041 (0.105) | | 0.075 (0.132) | |
| GINARTEP | | | 0.161 (0.120) | | 0.156 (0.126) | | 0.218 (0.140) |
| SECTORAL DUMMIES | *No* | *No* | *No* | *Yes* | *Yes* | *Yes* | *Yes* |
| CONSTANT | 0.065 (0.114) | 0.175 (0.397) | -0.580 (0.479) | -0.206 (0.440) | -0.971+ (0.526) | -0.712 (0.576) | -1.276* (0.608) |
| SAMPLE | *Whole* | *Whole* | *Whole* | *Whole* | *Whole* | *French Licensors* | *French Licensors* |
| Log Likelihood | -302.67 | -299.8 | -298.9 | -286.45 | -285.82 | -157.10 | -155.8 |
| McFadden R2 | 0.19 | 0.20 | 0.21 | 0.24 | 0.24 | 0.24 | 0.25 |
| Observations | 553 | 551 | 551 | 551 | 551 | 275 | 275 |
| Rivers Vuong test p-value / COD | - | - | - | 0.88 | 0.52 | 0.22 | $0.08^{+}$ |
| Rivers Vuong test p-value / TACIT | - | - | - | 0.14 | 0.94 | 0.61 | 0.66 |

*Robust standard errors are given in brackets. *** denotes significance at 1‰ level; **denotes significance at 1% level; * denotes significance at 5% level; + denotes significance at 10% level*

**Table 5: The Payment Formulae Explanation:**

**Pure Royalties vs. Payments with Royalties (Mix) vs. Pure Lump Sum Payment (LS)**

**(LS = 0, Mix = 1, Royalties = 2)**

| Explaining Variables | Ordered Probit (1) | Ordered Probit (2) | Ordered Probit (3) | Ordered Probit (4) | Ordered Probit (5) | Ordered Probit (6) | Ordered Probit (7) |
|---|---|---|---|---|---|---|---|
| | Roy/Mix/LS | Roy/Mix/LS | Roy/Mix/LS | Roy/Mix/LS | Roy/Mix/LS | Roy/Mix/LS | Roy/Mix/LS |
| TACIT | -0.172*** (0.050) | -0.170*** (0.051) | -0.161** (0.051) | -0.129* (0.054) | -0.122* (0.054) | -0.179* (0.084) | -0.174* (0.084) |
| COD | 0.163* (0.068) | 0.161* (0.068) | 0.171* (0.068) | 0.194** (0.072) | 0.201** (0.072) | 0.210* (0.106) | 0.218* (0.106) |
| RECIPROCITY | -0.255* (0.110) | -0.255* (0.112) | -0.281* (0.111) | -0.307** (0.116) | -0.328** (0.116) | -0.407* (0.194) | -0.434* (0.195) |
| CAP-LINK | 1.180*** (0.171) | 1.183*** (0.172) | 1.175*** (0.172) | 1.326*** (0.180) | 1.313*** (0.179) | 1.683*** (0.314) | 1.647*** (0.312) |
| PREV-CONTRACTS | 0.462*** (0.139) | 0.469*** (0.140) | 0.467*** (0.139) | 0.495*** (0.145) | 0.490*** (0.145) | 0.277 (0.212) | 0.272 (0.212) |
| SECT-ID | 0.363** (0.113) | 0.385*** (0.114) | 0.409*** (0.115) | 0.330** (0.122) | 0.352** (0.122) | 0.356* (0.170) | 0.386* (0.171) |
| RESGEO | -1.113*** (0.158) | -1.149*** (0.160) | -1.160*** (0.160) | -1.067*** (0.171) | -1.078*** (0.172) | -1.199*** (0.248) | -1.218*** (0.249) |
| SIZEE | -0.365*** (0.107) | -0.352** (0.108) | -0.352** (0.108) | -0.175 (0.119) | -0.176 (0.120) | -0.119 (0.166) | -0.108 (0.167) |
| GINARTEF | | 0.025 (0.090) | | 0.023 (0.093) | | 0.094 (0.116) | |
| GINARTEP | | | 0.203+ (0.105) | | 0.198+ (0.108) | | 0.209+ (0.120) |
| SECTORAL DUMMIES | *No* | *No* | *No* | *Yes* | *Yes* | *Yes* | *Yes* |
| CONSTANT | 2.15*** (0.23) | 2.72*** (-0.82) | 1.19+ (0.75) | 2.28* (1.29) | 1.43 (1.23) | 1.87+ (0.97) | 0.85 (0.90) |
| SAMPLE | *Whole* | *Whole* | *Whole* | *Whole* | *Whole* | *French Licensors* | *French Licensors* |
| Log Likelihood | -418.28 | -415.51 | -413.65 | -399.13 | -397.54 | -208.12 | -207.71 |
| McFadden $R^2$ | 0.17 | 0.17 | 0.18 | 0.20 | 0.21 | 0.21 | 0.21 |
| Observations | 553 | 551 | 551 | 551 | 551 | 275 | 275 |
| Rivers Vuong Test p-value / COD | - | - | - | 0.99 | 0.41 | 0.21 | $0.08^{+}$ |
| Rivers Vuong Test p-value / TACIT | - | - | - | 0.17 | 0.84 | 0.47 | 0.85 |

*Robust standard errors are given in brackets. *** denotes significance at 1‰ level; **denotes significance at 1% level; * denotes significance at 5% level; + denotes significance at 10% level*

**Table 6: The Payment Formulae Explanation:**

**The Role of Contract Duration**

| Explaining Variables | Logit (8) | Logit (9) | Logit (10) | Logit (11) |
|---|---|---|---|---|
| | Fixed Payment | Fixed Payment | Fixed Payment | Fixed Payment |
| TACIT | 0.247+<br>(0.142) | 1.074*<br>(0.528) | 0.412**<br>(0.150) | 1.299+<br>(0.664) |
| COD | -0.603***<br>(0.172) | -1.893**<br>(0.640) | -0.607**<br>(0.200) | -2.241***<br>(0.603) |
| RECIPROCITY | 0.333<br>(0.322) | 2.131+<br>(1.105) | -0.008<br>(0.377) | 4.455*<br>(2.127) |
| CAP-LINK | -2.492***<br>(0.517) | -2.095+<br>(1.175) | -2.980***<br>(0.614) | 1.109<br>(1.934) |
| PREV-CONTRACTS | -0.593+<br>(0.343) | -1.124<br>(1.128) | -0.557<br>(0.389) | -2.913<br>(2.093) |
| SECT-ID | -0.432<br>(0.325) | 0.772<br>(0.791) | -0.542<br>(0.353) | 1.092<br>(0.918) |
| RESGEO | 2.388***<br>(0.549) | | 2.209***<br>(0.539) | |
| SIZEE | -0.041<br>(0.294) | 1.196<br>(1.048) | 0.009<br>(0.330) | -0.211<br>(1.383) |
| DURATION | 0.015<br>(0.036) | 0.114<br>(0.107) | 0.027<br>(0.044) | -0.157<br>(0.187) |
| SECTORAL DUMMIES | *Yes**** | *No* | *Yes**** | *Yes**** |
| COUNTRY DUMMIES | *Yes**** | *No* | *Yes**** | *No* |
| CONSTANT | 2.874<br>(1.887) | -0.662<br>(1.364) | 2.588<br>(2.112) | 0.748<br>(2.135) |
| SAMPLE | *Whole* | Signed after 1994 | Contract duration more than 4 years | Signed after 1994 and Contract duration more than 4 years |
| Log Likelihood | -169.564 | -23.338 | -135.269 | -14.683 |
| Pseudo $R^2$ | 0.31 | 0.29 | 0.35 | 0.39 |
| Observations | 361 | 48 | 303 | 35 |

*Robust standard errors are given in brackets. *** denotes significance at 1‰ level; **denotes significance at % level; * denotes significance at 5% level; + denotes significance at 10% level*

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**Appendix A: First Stage Estimations**

| Explaining Variables | OLS | OLS | OLS | OLS |
|---|---|---|---|---|
| | COD | TACIT | COD | TACIT |
| RECIPROCITY | 0.443*** (0.069) | -0.114 (0.090) | 0.418*** (0.111) | -0.316* (0.137) |
| CAP-LINK | -0.008 (0.093) | 0.440*** (0.115) | 0.058 (0.144) | 0.531** (0.171) |
| PREV-CONTRACTS | 0.259** (0.084) | -0.065 (0.106) | 0.155 (0.124) | 0.181 (0.149) |
| SECT-ID | 0.283*** (0.075) | -0.242* (0.095) | 0.328** (0.105) | -0.367** (0.126) |
| RESGEO | -0.158 (0.109) | 0.511*** (0.135) | -0.163 (0.139) | 0.707*** (0.162) |
| SIZEE | 0.006 (0.072) | -0.016 (0.088) | -0.059 (0.099) | 0.039 (0.118) |
| GINARTEP | -0.063 (0.070) | -0.218* (0.087) | -0.064 (0.074) | -0.172+ (0.088) |
| INSTRUMENT1-COD | 0.382*** (0.109) | | 0.453** (0.142) | |
| INSTRUMENT2-COD | -0.391** (0.134) | | -0.354* (0.177) | |
| INSTRUMENT1-TACIT | | 0.413*** (0.079) | | 0.438*** (0.106) |
| INSTRUMENT2-TACIT | | -0.401*** (0.118) | | -0.461** (0.159) |
| CONSTANT | 0.565* (0.285) | 1.309*** (0.351) | 0.492 (0.307) | 1.226*** (0.361) |
| SAMPLE | *Whole* | *Whole* | *French Licensors* | *French Licensors* |
| R2 | 0.372 | 0.370 | 0.377 | 0.446 |
| Observations | 551 | 551 | 275 | 275 |