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CONTRACTING FOR THE TRANSFER OF TECHNOLOGY
WITHIN MULTINATIONAL CORPORATIONS:
EMPIRICAL EVIDENCE FROM SPAIN

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Abstract

This article analyzes a sample of contracts that includes contracts for the transfer of technology to Spanish subsidiaries in 1991. First, know-how is more likely transmitted within multinationals than between unrelated firms, highlighting the key role of multinationals in the diffusion of tacit knowledge. The determinants of scheduled payments are also studied, to find, among other things, that multinationals adjust scheduled payments depending on differences in taxes between the source and host countries.

Keywords: contract, technology, multinationals.

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Introduction

Several studies have found that the international diffusion of technology has a positive impact on productivity and, ultimately, growth in the country that acquires foreign technology. Keller (2004) provides a survey of research in this field. Multinational firms play a key role in the diffusion process as carriers of technology across national borders. Indeed, the data show that most international trade in disembodied technology is made within multinational corporations. For instance, the US Bureau of Economic Analysis reports that, in 2003, US receipts and payments related to international trade in disembodied technology amounted to 48 and 20 billion dollars, respectively, and that 75% of all technology exports and 80% of all technology imports were transactions between affiliated parties, i.e. parent firms and their foreign subsidiaries. This paper provides empirical evidence on contractual arrangements between affiliated parties for the international transmission of technology.

Some previous studies point to the role of multinationals in technology diffusion. Hejazi and Safarian (1999) find that FDI has a positive impact on host-country total factor productivity in a sample of OECD countries. Kogut and Zander (1993) argue that multinational firms specialize in the internal transfer of knowledge, especially tacit knowledge. Empirical studies on various aspects of international technology transfer by multinationals include Teece (1977), Contractor (1981), and Gupta and Govindarajan (2000). However, empirical evidence on the terms of internal technology transfers is very limited, due to the scarcity of appropriate data. Among the few studies that use contract-level data, Anand and Khanna (2000) use data from Securities Data Corporation to find inter-industry differences in contract terms, although they do not have access to data on scheduled payments. Macho-Stadler et al. (1996) use a sample drawn from the same database as used in this paper to test for the importance of the transfer of know-how on the likelihood of including royalty payments. Aulakh et al. (1998) empirically analyze the choice of scheduled payments, whether fixed or variable. The authors find that licensor involvement is higher in variable payments contracts, and that better protection of intellectual property rights and a more favorable economic environment in the host country

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increase the likelihood of royalties being used. Additionally, they find that royalties are typically associated with technologies that are either in the growth stage or mature. However, none of these articles makes a distinction between transfers among affiliated and unaffiliated firms.

This paper contributes to the literature on multinational corporations precisely by providing empirical evidence on agreements between affiliated firms to transfer technology across national boundaries. It analyzes a sample of contracts for the transfer of technology to Spanish firms in 1991, the same sample that was used in Mendi (2005). The sample includes both affiliated and unaffiliated transactions, although in this paper we focus mostly on the former. A contract is classified as affiliated if there are ownership linkages between the contracting parties. Specifically, a transfer is affiliated if the foreign licensor is either the parent firm of the Spanish affiliate, or the licensor is a foreign affiliate whose parent firm is the same as that of the Spanish affiliate. Some contracts in the database include the transfer of ownership of the technology, while others are licensing contracts¹. In the remainder of the paper, only the terms licensor and licensee will appear, even though in some cases, when ownership is transferred, they refer to seller and buyer, respectively.

The main findings of this paper can be classified into three categories: differences between affiliated and unaffiliated transactions in the type of technology that is transferred; determinants of the type of payments in affiliated transfers; and determinants of the royalty rate, also within affiliated contracts. Concerning the type of technology that is transacted, the likelihood of transferring know-how is significantly higher among affiliated parties than among unaffiliated parties. By contrast, there is no such difference in the case of transfers of codified knowledge. This finding highlights the important role of multinationals in the transfer of knowledge across national borders, especially tacit knowledge, and points to the presence of important costs of the transfer of tacit knowledge between unaffiliated parties. Regarding the type of payments that the parties agree on, it is found that affiliated transfers typically schedule variable payments, and rarely include fixed payments. Furthermore, contracts that stipulate a longer duration will more likely include variable payments than shorter contracts. Another result is that closer commercial ties between the licensor's country and Spain increase the likelihood of scheduling fixed payments. Finally, duration has a positive impact on the royalty rate, whereas higher corporate taxes in the licensor's country and more intense commercial ties between Spain and the licensor's country reduce the royalty rate.

The rest of the paper is organized as follows: Section 2 discusses the testable hypothesis generated by alternative explanations for the contractual terms of international technology transfers. Section 3 describes the database from which the sample used in the empirical section was drawn. Section 4 presents and discusses the empirical evidence. And finally, Section 5 summarizes the main conclusions.

Affiliated technology transfer contracts

This section briefly discusses the predictions of alternative explanations for the observed characteristics of contracts for the transfer of technology, presenting the hypotheses to be tested in Section 4. These predictions refer to the kind of technology most likely to be transferred internally, and to scheduled payments.

¹ In only 3 of the 73 affiliated contracts did the Spanish firm acquire ownership of the technology. That is why in this paper we use the terms licensor and licensee.

Regarding whether there are differences between affiliated and unaffiliated transfers in the type of technology to be transferred, Kogut and Zander (1993) provide a clear, testable hypothesis. The authors argue that the multinational corporation appears because it is more efficient as an organizational vehicle to transfer knowledge abroad. They point to a specialization of multinationals in the international transfer of tacit knowledge, for which it is more difficult to write contracts than for codified knowledge. A testable hypothesis is thus that affiliation increases the likelihood of know-how being transferred. This effect is a consequence of both the specialization of multinationals in the transfer of this type of knowledge across national borders and of the difficulties that unaffiliated parties have in writing contracts for the transfer of tacit knowledge. A second empirical implication of this article is that no such effect should be observed in the case of transfers of codified knowledge, such as patents.

Moral hazard has been identified as one potential determinant of scheduled payments in technology transfer contracts. This problem could appear both on the licensor's and on the licensee's side, as first identified in Arrow (1969). The licensee has an incentive to renege on payments once it knows about the technology, and the licensor has incentives to transfer second-best technology once the agreement has been reached. This problem is more acute whenever know-how is to be transferred. This is because, on the one hand, know-how is tacit knowledge, which makes it much harder to describe and thus to write a contract to transfer it; and on the other, know-how does not benefit from legal protection against imitation as patents do.

Choi (2001) is an example of a model based on moral hazard to explain scheduled payments in these contracts. In this article, a double-sided moral hazard model is presented in which fixed and variable payments are used to provide both parties with the right incentives to carry out transaction-specific investments. In unaffiliated transfers, the party which puts most effort into successful implementation of the technology is made the residual claimant. Thus, if the licensor's effort is greater than the licensee's, it is more likely that variable payments will be used; and if the licensee's effort is relatively more important, fixed payments will arise. By contrast, affiliated transfers are assumed to be free from moral hazard, and the prediction is that only fixed payments will be observed, since including royalties distorts the licensee's output choice. Thus, the testable implications of this class of models are that most affiliated transfers generate fixed payments, not royalty payments, and that the transfer of know-how between two affiliated firms should have no significant effect on scheduled payments. A statistically significant effect would indicate the presence of moral hazard problems between a parent firm and its foreign affiliate or between two affiliates. This result could be interpreted as an indicator of the difficulties that multinational firms have in finding and dealing with local agents for their foreign subsidiaries.

Asymmetric information on the technology type has also been a candidate to explain scheduled payments. It refers to one of the parties having better transaction-specific information than the other. Asymmetric information could be on the licensor's side, since the licensor knows more about the technology to be transacted than the licensee. In this line, Gallini and Wright (1990) present a model in which royalty payments are used to signal high-quality technology. Unfortunately, the database does not contain enough information to test the implications of these models of asymmetric information on the licensor's side. However, asymmetric information can also be on the licensee's side, since the licensee is better acquainted with the local market. In this case, one prediction is that contracts where the licensor has better information about the conditions of the host country increase the likelihood of fixed payments. In the empirical tests, the measure of asymmetric information on host country conditions will be commercial ties between the source and host countries: closer ties are assumed to indicate less asymmetric information.

From another perspective, asymmetric information also plays a role in the monitoring of the licensee's behavior. In order for variable payments to be a feasible mechanism to transfer revenue back to the parent firm, output and prices must be observable. If it is difficult for the parent firm to observe these variables, then it will most likely opt for a fixed-payments contract. Thus, a testable hypothesis is that lower ties between the two firms' countries would reduce the likelihood of the parties' including variable payments, and increase that of their including fixed payments. If such effect is found, it will again suggest the existence of moral hazard problems within multinational corporations, where local agents search for their own benefit, ignoring the goal of aggregate profit maximization. Scheduled payments would then be used to realign the incentives of local agents with those of the parent firm.

The sharing of risk has also been a candidate explanation for the type of payments observed in these contracts; see, for instance, Allen and Lueck (1999) or Bousquet et al. (1998). In this case, the prediction is that, assuming that the licensor is risk-neutral, the more risk-averse the licensee is, the more likely the parties will include variable payments in the agreement. The measure of risk aversion used in this study is the size of the licensee, measured by its sales in the year previous to the agreement. Thus, if risk aversion is an important determinant for scheduled payments, then the licensee's size should increase the likelihood of variable payments and reduce the likelihood of fixed payments being included. A negative relationship between size and the likelihood of setting variable payments is also consistent with an explanation of scheduled payments based on the licensee being cash constrained. If the licensee's cash holdings are correlated with size, then contracts signed by smaller licensees will more likely include variable payments instead of fixed payments.

Another concern of the parties, which could affect scheduled payments, is avoiding early termination of the relationship. Klein (1996) argues that if scheduled payments differ substantially from the actual value of the technology, one of the two parties might be interested in early termination. The loss from premature termination increases the longer the relationship was initially scheduled to last. Variable payments, by better adjusting payments to the actual value of the technology, reduce the likelihood of early termination and, therefore, the prediction is of a positive relationship between contract duration and the probability of inclusion of variable payments. Indeed, Mendi (2005), using observations of unaffiliated contracts, finds that the effect of contract duration on the likelihood of scheduling variable payments for the first year is positive, consistent with this argument.

However, it is reasonable to expect the effect of duration to be present only within unaffiliated contracts. In these transactions, the linkages between licensor and licensee are likely to be confined to the observed transfer of technology. Thus, the parties have greater incentives to adjust the contract terms to avoid early termination of the relationship. By contrast, the relationship between affiliated parties is, by its nature, a permanent one, and therefore it is less likely to disappear because of the difference between scheduled payments and the true value of the technology, or because of the licensee being cash constrained. Affiliated firms have access to more mechanisms to solve these problems than unaffiliated parties. The prediction, therefore, is that contract duration has no effect on scheduled payments within affiliated contracts.

Finally, another potential explanation for the type of payments chosen is differences in corporate taxes between the licensor and the licensee's country. Tax considerations may be especially relevant in the case of multinational corporations, which have potentially more freedom and greater incentives than unrelated firms to manipulate the parent and subsidiary's profits so as to minimize tax payments. Variable payments are better suited to this purpose, since raising or lowering the royalty rate automatically transfers profits from the subsidiary to the parent, or vice versa. Therefore, if differences in corporate

tax regimes are an important determinant of payments, then affiliated transactions should include a higher proportion of variable payments contracts. Furthermore, there should be significant differences in the likelihood of observing royalty payments, depending on differences in corporate tax rates between the countries of the licensor and the licensee. If corporate taxes are higher in the licensor's country, there is an incentive to lower the royalty rate, so as to keep profits in the licensee's country, where taxes are lower. Thus, the prediction is that the higher the corporate taxes in the licensor's country, the lower the royalty rate.

The data

This section presents the data to be used in the empirical analysis in Section 4, describing the variables included and providing summary statistics. It also presents some stylized facts on scheduled payments included in the contracts.

The population of contracts, described in Pérez (1996), is 5,168 contracts signed in 1991 by Spanish firms with the purpose of importing technology. The sample of 212 contracts used in Mendi (2005) includes both affiliated and unaffiliated transfers of technology, although the focus in that article was the unaffiliated subsample. The subsample of affiliated contracts contains 73 observations. As specified above, a contract is classified as affiliated if it is signed either by a foreign parent and its Spanish subsidiary or by a Spanish subsidiary and a foreign subsidiary of the same parent firm. A Spanish firm is considered to be a subsidiary of a foreign firm if the latter holds at least 50% of the Spanish firm's equity. Equity participation is reported by the Spanish firm, which allows for classification of contracts into affiliated and unaffiliated.

The sample could be collected because, up to 1992, whenever a Spanish firm imported technology, it had to file a form with the Spanish Ministry of Industry, describing the terms of the agreement. Filing of the forms ceased in 1992 because such control was no longer allowed by the European Union. The forms that were filed with the Ministry are stored in the archives of the Spanish Ministry of Industry. The sample was collected by manually copying the data contained in a random selection of forms. The fact that the Ministry had no classification system for the forms suggests no sample selection arising from the sampling procedure.

Among the features of the imported technology to be described in the form, the licensee had to indicate the following items: whether a patent and/or know-how was being transferred, whether technology was of a product and/or of a process type, and whether the licensee obtained ownership of the technology. Additionally, the Spanish firm had to report whether it carried out R&D, the industry of the licensor and of the licensee, the licensor's country, and its own sales in the year prior to the agreement.

Especially valuable is the information on scheduled payments for the initial five years of the agreement. The Spanish firm had to report an estimation of future payments, if applicable, to be made in those periods, distinguishing between fixed and variable payments, and reporting the royalty rate whenever variable payments were scheduled. Since variable payments are based on future sales, and therefore subject to estimation errors, this study only uses the royalty rate and indicators of the presence of fixed and/or variable payments.

In some cases, the Spanish firm attached to the form a copy of the contract. Whenever the contract was available, other clauses were observable, such as whether or not

the licensee had any exclusive territory, or duration of the contract. Since very few contracts were attached to the forms, only the duration variable will be used in the analysis. Duration can sometimes be inferred, even if the contract is not available. In fact, whenever the contract was included, the duration variable just takes the value expressed in the contract. If the actual contract is not observable, the duration variable has been constructed by observing what is the last period for which the parties agree on payments to be made.

1. The sample. Summary statistics

Table 1 presents summary statistics of the variables that are observed in the subsample of affiliated contracts, which contains 73 observations. 19 of these contracts were signed by two subsidiaries of the same parent firm, one of them located in Spain, and the other abroad. The remaining 54 contracts were agreements between a foreign parent firm and its Spanish affiliate.

Most variables are dichotomous, taking only two possible values: zero or one. This is because most information contained in the forms is qualitative, since the licensee, who filed the form, indicated whether or not the transaction had a given feature. Table 1 presents summary statistics of the variables observed in the subsample of affiliated transfers.

Table 1. Summary statistics of the sample

Variable	Min	Max	Mean	Std. Dev.
<i>FP</i>	0	1	0.342	0.478
<i>VPI</i>	0	1	0.753	0.434
<i>Roy1</i>	0.5	15	4.553	3.069
<i>R&D</i>	0	1	0.425	0.498
<i>Subs</i>	0	1	0.74	0.442
<i>Pat</i>	0	1	0.315	0.468
<i>KH</i>	0	1	0.781	0.417
<i>Pcs</i>	0	1	0.479	0.503
<i>Dura</i>	1	15	3.984	2.723
<i>Taxes</i>	-1.1	3.7	-0.179	1.244
<i>ln(imp)</i>	-0.821	2.815	2.114	0.831
<i>EU</i>	0	1	0.685	0.468
<i>ln(sal)</i>	2.198	11.99	7.505	1.931

FP appears on the first row; it is a dichotomous variable that indicates whether or not fixed payments have been scheduled for any of the initial five years of the agreement. The percentage of affiliated contracts that ever stipulate fixed payments is only 34%. *VPI* is an indicator of the contract stipulating variable payments to be made in the first year of the agreement. The mean of this variable implies that over 75% of the contracts schedule royalties for the first year. As will be shown below, the likelihood of including royalty payments is increasing along the life of the contract, which means that the first year is the period that has the smallest probability of including variable payments.

Roy1 is the royalty rate, as a percentage of the licensee's sales, also in the first year of the agreement. The mean of this variable has been calculated conditional on the contract specifying variable payments being made in the first year. The average royalty rate for the first year is 4.5%, although there is a considerable dispersion in the observed royalty rates.

As will be observed in Table 2 below, royalty rates are fairly constant along the life of the contract.

Subs takes the value one if the Spanish firm is a subsidiary of the licensor, and zero otherwise. *R&D* is another dichotomous variable, an indicator of the licensee performing R&D activities, although there are no data on what percentage of sales is devoted to R&D. Roughly 50% of the licensees in the sample carried out R&D. Regarding technology type, *Pat* takes the value one if the technology to be transferred mentioned a patent, and zero otherwise. Only 30% of the contracts stipulated the transfer of patented technology. *KH* is a dichotomous variable that indicates the transfer of know-how. Most affiliated transfers of technology, almost 80%, include the transmission of tacit knowledge. *Pat* and *KH* are not exclusive categories; indeed, in 16 contracts, the transfer of patented technology together with the transfer of know-how is observed. *Pcs*, reported next, is an indicator of the technology being of a process type. The licensee had to classify the technology into one of three possible categories: product, process, or product and process. *Pcs* takes a value one if the technology fell into the process category, and zero otherwise. Slightly less than half of the contracts stipulated transfer of a process technology.

Next is contract duration, *Dura*, defined as the expected length of the relationship at the time of signing the contract. Notice that this refers to ex-ante duration, which could differ from the actual duration of the relationship, if there is premature termination or if the parties decide to extend the relationship. In the sample, the average contract duration is slightly below four years. *Taxes* is a measure of the difference in corporate tax pressure between the licensor's country and Spain. It is a three-year moving average of the difference, between the licensor's country and Spain, in the ratio of corporate tax revenues to GDP in 1990, taken from OECD (2005). A positive value of this variable indicates that corporate taxes in the licensor's country were higher than in Spain in 1990.

Regarding the country in which the licensor is established, the mean of the *EU* variable indicates that 70% of all licensors were located in European Union countries, as can be seen in the next row. *ln(imp)* measures the logarithm of the percentage of Spanish imports coming from the licensor's country in 1990. The average of this variable is 8%. Finally, there is information on the licensee's size, measured by its sales in the year prior to signing the contract. In this paper, the variable to be used is *ln(sal)*, the logarithm of sales, expressed in million pesetas. The mean of this variable is 2.198 and, thus, the average licensee reported sales of 1,817 million pesetas in 1990, which was the year previous to the agreement².

2. Scheduled payments

Due to the scarcity of data on the kind of payments affiliated parties agree on when transferring technology, reported scheduled payments for the initial five years of the relationship are of special interest. Table 2 reproduces panel C of Table II in Mendi (2005), which shows the percentage of affiliated contracts that stipulate fixed payments only, royalty payments only, or mixed payments (fixed plus variable) for the initial five years of the relationship. Notice that the total number of contracts diminishes as we consider more advanced periods, since there are some contracts whose duration is shorter than five years.

² The exchange rate of the Spanish peseta to the US dollar in 1990 was 102 pesetas per dollar.

Table 2. Scheduled payments for the initial five years of the relationship

Year	FP only (%)	VP only (%)	Mixed (%)	Total	Average royalty
First	24.7	65.8	9.6	73	4.55
Second	13.3	81.7	5.0	60	4.54
Third	13.2	81.1	5.7	53	4.24
Fourth	9.1	86.4	4.5	44	4.33
Fifth	9.3	86.0	4.7	43	4.39

Most affiliated contracts stipulate royalty payments, even in the first year of the contract. The proportion of variable payments contracts increases as more advanced periods are considered. Fixed payments, if present, are typically made early on, later giving way to variable payments only. Indeed, most contracts that schedule fixed payments for the first year switch to only royalty payments in the second year of the contract; no contract that includes variable payments in a given period switches to fixed payments later on. As pointed out in Mendi (2005), this feature was also present in the subsample of unaffiliated transfers. The average royalty rate in contracts that schedule variable payments is roughly constant along the life of the contract.

Empirical evidence

This section presents and discusses the results of some empirical tests using the sample of contracts. First, a comparison will be made between affiliated and unaffiliated contracts, searching for differences between the two subsamples in the type of technology to be transferred, and in contract terms. Then, the affiliated subsample is analyzed to search for the determinants of whether scheduled payments are fixed and/or variable, and of the size of the royalty rate. The goal is to shed light on whether there are significant differences between affiliated and unaffiliated transfers, and on the factors shaping scheduled payments in affiliated transfers.

1. Affiliated and unaffiliated contracts

The search for differences between affiliated and unaffiliated transactions is done by testing whether there are statistically significant differences between the two subsamples in the means of the observed variables, using t-ratio tests. The results of these tests are displayed in Table 3.

Table 3. Tests for differences in means between affiliated and unaffiliated subsamples

Variable	Unaffil.	Affil.	t-test	Signif.
<i>FP</i>	0.626	0.342	4.060	0.000
<i>VPI</i>	0.619	0.753	-1.980	0.049
<i>RoyI</i>	5.090	4.553	0.714	0.477
<i>Pat</i>	0.245	0.315	-1.100	0.274
<i>KH</i>	0.520	0.780	-3.836	0.000
<i>R&D</i>	0.597	0.425	2.415	0.017
<i>Pcs</i>	0.468	0.479	-0.163	0.871
<i>Dura</i>	4.414	3.984	0.643	0.521
<i>Taxes</i>	-0.2	-0.179	-0.12	0.905
<i>ln(imp)</i>	1.846	2.114	-1.917	0.057
<i>EU</i>	0.554	0.685	-1.855	0.065
<i>ln(sal)</i>	7.548	7.505	0.121	0.904

While there are no significant differences between the two subsamples in the size of the royalty rate, conditional on variable payments being present, the tests show that variable payments are more likely to be observed in affiliated transactions. There are several explanations consistent with this finding. First, if it is likely that the licensee will appropriate the technology and renege on future payments, the licensor will demand a fixed payment in order to secure revenues and avoid the risk of expropriation of its technology. Additionally, monitoring the licensee's operations is more difficult and costly in the case of unaffiliated transactions, which may prevent variable payment schemes from being implemented in this type of transfers. These moral hazard problems are less likely to occur among affiliated parties, giving rise to a positive relationship between affiliation and variable payments. Also consistent with this positive effect is a greater willingness of the parent firm to share risk with its foreign subsidiaries than with unaffiliated parties.

The positive correlation between affiliation and variable payments is also consistent with differences in corporate taxes being an important determinant of scheduled payments. The high dispersion of royalty rates, as reported in Table 1, is also in line with this argument, although in order for this to be a satisfactory explanation, the dispersion should reflect differences between countries' corporate tax rates. Further evidence on the role of taxes in the determination of scheduled payments will be presented below. There are no significant differences between the affiliated and the unaffiliated subsamples with respect to the *Taxes* variable.

The other remarkable difference is that it is much more likely for know-how to be included in an affiliated transfer than in an unaffiliated transfer. This difference is statistically significant, as can be seen in the fifth row of Table 3. Conversely, there is no significant difference between the two subsamples as regards the likelihood of transferring a patent. These findings are confirmed by the results given in Table 4. The first column of Table 4 reports estimated marginal effects in a Probit model where the dependent variable is *Pat*, the indicator of patented technology being transferred. In the second column, the dependent variable is *KH*, the indicator of the transfer of know-how. In both cases, the regressors include industry dummies, size, technology being of a process type, contract

duration, the logarithm of imports from the source country, and indicators of the licensee performing R&D and the transaction being affiliated.

Table 4. Likelihood of transfer of patents and know-how

Variable	Patent	Know-how
<i>Link</i>	0.025 (0.073)	0.269 *** (0.077)
<i>R&D</i>	0.012 (0.074)	-0.041 (0.093)
<i>Pcs</i>	-0.242 *** (0.066)	0.172 * (0.088)
<i>Dura</i>	-0.008 (0.009)	0.03 ** (0.013)
<i>ln(imp)</i>	-0.013 (0.032)	0.021 (0,04)
<i>ln(sal)</i>	0.013 (0.016)	-0.022 (0.02)
Industry dummies	Yes	Yes
Log-likelihood	-75.965	-88.509
Sample size	165	165

Standard errors in brackets, below estimated marginal effects.

*** indicates significant at the 99% level (two-tailed test).

** indicates significant at the 95% level (two-tailed test).

* indicates significant at the 90% level (two-tailed test).

The coefficient of interest is that on *Link*, the indicator of the transaction being affiliated. While in the first column it is not statistically significant, in the second it is positive and statistically significant at the 99% level. This means that tacit knowledge, but not codified knowledge, is more likely to be transferred in-house. This result is consistent with Kogut and Zander's (1993) finding that the less codifiable and harder to teach technology is, the more likely it is to be transferred internally.

The much greater proportion of affiliated contracts that include the transfer of know-how also suggests that unaffiliated parties are more likely to fail to reach agreement on the transfer of tacit knowledge. This creates significant differences between the type of technology that is transferred in-house and the type that is transferred in arm's-length transactions. The preferred channel for the transmission of tacit technology is internal, whereas technology types that are codifiable and therefore easier to write contracts for are also transferred to unaffiliated parties. Know-how often refers to firm-specific procedures, routines and knowledge, requiring a much greater effort on the licensor's side and adaptation by the licensee for its correct implementation.

It could be argued that this result calls for legal protection against imitation of tacit knowledge, since this kind of protection would make it easier for know-how to be transferred not only internally but also in arm's-length transactions. However, this argument is probably flawed. First, Mendi (2005) did not find a significant effect of the transfer of know-how on scheduled payments in unaffiliated transfers. If the lack of legal protection were an important issue when transferring know-how, unaffiliated parties to a contract would modify their scheduled payments to mitigate moral hazard problems. However, this is not observed in the data. Second, the main problem when transferring know-how might not be appropriability hazards, but the greater costs of its transfer to an unaffiliated party. Unaffiliated parties are likely to lack the organizational design or the experience needed for successful implementation of the tacit technology. Furthermore, correct implementation may often require a greater involvement on the licensor's side, as the technology is not codifiable. This may be the real reason why know-how is more likely to be transferred in-house, and why legal protection against imitation would have only a marginal effect in facilitating international trade in tacit knowledge.

Regarding other characteristics to be observed in Table 3, there are no differences between affiliated and unaffiliated firms in size, contract duration, or likelihood of transferring process technology. Unaffiliated firms are more likely to carry out R&D than affiliates, with the difference being statistically significant. There also seem to be differences concerning the licensor's country. There is a statistically significant difference between the proportion of affiliated and unaffiliated licensors that are established in European Union countries. This is confirmed by the significant difference of the same sign in the logarithm of imports variable.

This positive relationship between affiliation and commercial ties between Spain and the licensor's country points to the existence of complementarities between direct investment and trade. Trade provides more accurate information not only on the conditions of domestic demand, but also on the legal framework, or culture, that may facilitate the establishing of subsidiaries. Therefore, a benefit of economic integration among countries – for instance, by removing barriers to trade or introducing a common currency– is the fostering of trade in goods, which allows firms to acquire information on foreign markets more quickly. If this information helps in setting up foreign subsidiaries, which are the preferred channels for the transmission of know-how, then the removal of barriers to trade fosters the international transfer of know-how through increased foreign direct investment.

2. Choice of payment types

This subsection studies the factors that affect the type of payments to be made, whether fixed or variable. The subject is the choice between fixed and variable payments, not the size of the payment itself. Therefore, the dependent variables are dichotomous, indicating whether or not each payment type is present. It is assumed that the decision to include fixed payments is made simultaneously to that of including variable payments. For this reason, a bivariate Probit model is estimated (see Maddala, 1983). This model includes two equations, whose error terms can be correlated.

In the first equation, the dependent variable is an indicator of the presence of fixed payments at any time during the life of the contract. This is equivalent to an indicator of the presence of fixed payments in the first year of the agreement, since no contract that does not schedule fixed payments for the first year does so for subsequent years. In the second equation, the dependent variable is an indicator of the presence of royalty rates being scheduled for the first year of the agreement. Recall that the likelihood of a period including variable payments increases the more advanced the period is.

The regressors used in the estimation of the bivariate Probit model are indicators of the transfer of know-how and whether the technology is of a process type. Additional regressors are: duration, the difference between corporate taxes as a percentage of GDP in Spain and in the licensor's country, the logarithm of imports from the licensor's country, and the logarithm of the licensee's sales. This specification does not include industry dummies because their inclusion would make the Wald statistic insignificant. In unreported regressions, it was verified that no industry dummy was statistically significant and that the signs and statistical significance of the other regressors remained the same. Once the dependent variables and the regressors have been included in the specification, the latent variables are modeled as:

$$\begin{aligned} X_{1i} &= \beta_{11}KH_i + \beta_{12}Pcs_i + \beta_{13}Dura_i + \beta_{14} \ln(imp)_i + \beta_{15} \ln(sal)_i + \varepsilon_{1i} \\ X_{2i} &= \beta_{21}KH_i + \beta_{22}Pcs_i + \beta_{23}Dura_i + \beta_{24} \ln(imp)_i + \beta_{25} \ln(sal)_i + \varepsilon_{2i} \end{aligned} \quad (1)$$

where the distribution of the vector that contains the error terms is

$$(\varepsilon_{1i}, \varepsilon_{2i})' \sim N \left[0, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right] \quad (2)$$

The variables that are actually observed are

$$\begin{aligned} FP_i &= 1(X_{1i} \geq 0) \\ VP_i &= 1(X_{2i} \geq 0) \end{aligned} \quad (3)$$

where $1(\cdot)$ is the indicator function, which takes the value one if the latent variable is non-negative. Table 5 reports maximum likelihood estimates of the coefficients in the bivariate Probit model. There are two specifications that have been estimated. The difference between them is the inclusion in the second specification of the *Subs* variable, the indicator of the contract being a transfer between a parent firm and its subsidiary. This variable is included to control for constant differences between these two types of transactions. The number of observations actually employed in the regression is 51. The reduction in the number of observations relative to the total sample size is due to the fact that the duration variable is not available for some contracts.

Table 5. Bivariate Probit of the presence of fixed and variable payments

Variable	Specification 1		Specification 2	
	FP	VP	FP	VP
<i>Subs</i>			0.156 (0.534)	-0.065 (0.607)
<i>KH</i>	-0.559 (0.504)	0.792 (0.509)	-0.572 (0.524)	0.749 (0.625)
<i>Pcs</i>	0.996 ** (0.418)	-0.791 * (0.445)	1.005 ** (0.421)	-0.785 * (0.447)
<i>Dura</i>	-0.199 ** (0.086)	0.372 *** (0.125)	-0.203 * (0.087)	0.378 *** (0.130)
<i>ln(imp)</i>	0.430 * (0.262)	-0.578 ** (0.282)	0.404 (0.274)	-0.565 * (0.299)
<i>ln(sal)</i>	-0.092 (0.077)	0.078 (0.076)	-0.098 (0.080)	0.082 (0.079)
Log-likelihood	-31.854		-31.801	
Sample size	51		51	

Standard errors in brackets, below estimated coefficients.
 *** indicates significant at the 99% level (two-tailed test).
 ** indicates significant at the 95% level (two-tailed test).
 * indicates significant at the 90% level (two-tailed test).

The coefficients on *KH* are not statistically significant in either specification. This result complements that in Mendi (2005), where no evidence of any effect of the transfer of know-how on scheduled payments using the subsample of unaffiliated contracts was found. Hence, moral hazard does not seem to be an important determinant of payments for the transfer of technology, either in affiliated or in unaffiliated transfers. If moral hazard was an important factor shaping payments, then the transfer of know-how should have an influence on observed payments. The reason is that the transfer of tacit knowledge is more likely to generate moral hazard problems than the transfer of codified knowledge.

However, the transfer of know-how is more often observed in affiliated transfers, as seen in Tables 3 and 4. This suggests that the effect of the transfer of tacit knowledge may not be on payments, but on the likelihood of the parties' actually reaching an agreement for the transfer of this type of technology. The statistically significant effect of affiliation on the likelihood of transfer of know-how, but not of patented technology, points to important problems in transferring this kind of knowledge to unaffiliated parties. Internal transfer appears to be the preferred method of technology diffusion if technology is of a tacit type, as confirmed by the data.

Pcs increases the likelihood of including fixed payments and reduces that of including variable payments in the first year of the relationship. These effects are statistically significant in both specifications. Typically, the sources of uncertainty in process technologies are technical, as opposed to demand fluctuations in the case of new products. A process is likely to have been experimented by the parent firm in the source

country, which reduces uncertainty. By contrast, in the case of a new product, even if it has been present in the source country for a number of years, its introduction into a new market is often more problematic than the transfer of a process technology. The effect of the transfer of process technology is similar to that found in Mendi (2005).

The present database also allows us to estimate the effect of duration on scheduled payments. In unaffiliated contracts, as found in Mendi (2005), expected duration of the contract increased the likelihood of the parties' including variable payments in the first year of the life of the contract, and reduced the likelihood of the parties' choosing fixed payments. In the affiliated subsample, the effects of duration have the same signs as in the unaffiliated subsample, and are also highly statistically significant. The sizes and signs of the coefficients on duration and their statistical significance are robust to the inclusion of the *Subs* variable, as can be seen by comparing the reported estimates of the coefficients in specifications 1 and 2.

It was argued for the case of the unaffiliated subsample that duration had a positive effect on the likelihood of including variable payments because the parties wanted to avoid early termination of the relationship: if the relationship was scheduled to last for longer, then both parties have more to lose if it is prematurely ended. The effect of duration on scheduled payments is surprising and suggests a greater than expected degree of independence of Spanish subsidiaries from their foreign parents.

In the first specification, the logarithm of imports variable is positively correlated with the likelihood of fixed payments and negatively with the likelihood of variable payments being scheduled for the first year of the agreement, both effects being statistically significant. However, the positive effect of $\ln(\text{imp})$ on the likelihood of including fixed payments loses its statistical significance in the second specification, where the fixed effect of the transfer being between a parent firm and its subsidiary is controlled for. These effects imply that multinational firms that are established in countries with less intense commercial ties with Spain are more likely to schedule variable payments and less likely to schedule fixed payments in their technology transfers to Spanish affiliates. Thus, for subsidiaries of firms located in countries with less intense commercial ties, the effect of uncertainty on the condition of the Spanish market dominates the increased difficulty in monitoring the activities of a Spanish subsidiary.

The last variable to be considered is the size of the Spanish subsidiary, measured as the logarithm of its sales in the year previous to the signing of the agreement. In unaffiliated transfers, Mendi (2005) finds that the larger the licensee, the higher the likelihood of fixed payments and the lower the likelihood of variable payments, both effects being consistent with explanations based on risk sharing and cash constraints on the licensee's side. However, when analyzing affiliated transfers, the effects of size on the probability of including fixed and variable payments are not statistically significant in either specification. These results suggest that neither cash constraints nor risk sharing play a key role in choosing the kind of payments in affiliated technology transfers.

3. Choice of royalty rate

The last empirical analysis in this article is to determine what influences the royalty rate, as a percentage of sales, scheduled for the first year of the contract. The focus is on the royalty rate in the first year because, since contracts have different durations, it yields the maximum number of observations. Furthermore, the royalty rate is found to remain fairly constant over time.

Since the distribution of the first-year royalty rate is truncated at zero, the estimation method employed is a Tobit model. The set of regressors includes industry dummies, the transfer of know-how, contract duration, differences in corporate taxes, an indicator of the technology being of a process type, the logarithm of the proportion of Spanish imports coming from the licensor's country, and the logarithm of the licensee's sales. The specification is thus as follows:

$$Roy_i = \beta_0 + \sum_{j=1}^3 \beta_j Ind_{j,i} + \beta_4 KH_i + \beta_5 Pcs_i + \beta_6 Dura_i + \beta_7 Taxes_i + \beta_8 \ln(imp)_i + \beta_9 \ln(sal)_i + \varepsilon_i \quad (3)$$

where Ind_j for $j = \{1,2,3\}$ are licensee industry dummies³. These three industry dummies have been included because there could be inter-industry differences in royalty rates, and because the LR test remains significant even after including these additional variables. The sample size is 50 and the dependent variable takes a zero value 15 times. Table 6 reports the estimated coefficients in the Tobit model, considering two specifications. The first specification includes the $\ln(imp)$ variable, whereas in the second, this variable has been replaced by the EU variable.

Table 6. Determination of the royalty rate in the first year of the agreement

Variable	Specification 1	Specification 2
<i>Subs</i>	0.869 (1.225)	0.975 (1.203)
<i>KH</i>	0.294 (1.309)	0.12 (1.282)
<i>Pcs</i>	-0.962 * (1.135)	-0.13 (1.137)
<i>Dura</i>	0.588 *** (0.21)	0.711 *** (0.206)
<i>Taxes</i>	-1.185 ** (0.573)	-1.527 *** (0.521)
<i>ln(imp)</i>	-1.813 *** (0.573)	
<i>EU</i>		-3.844 *** (1.105)
<i>ln(sal)</i>	-0.198 (0.324)	-0.17 (0.318)
<i>Constant</i>	5.339 (3.636)	2.294 (3.377)
Industry dummies	Yes	Yes
Log-likelihood	-99.211	-98.341
Sample size	50	50

Standard errors in brackets, below estimated coefficients.
 *** indicates significant at the 99% level (two-tailed test).
 ** indicates significant at the 95% level (two-tailed test).
 * indicates significant at the 90% level (two-tailed test).

³ Three industry dummies have been included: the first corresponds to Energy, Minerals and Chemicals, the second to Metal Transformation, and the last one to Other Manufacturing and Construction.

It can be seen immediately that, in both specifications, duration has a positive, statistically significant effect on the size of the royalty rate. This effect is in line with that found in Table 5. Therefore, a longer contract duration not only increases the likelihood of the parties' scheduling variable payments from the first period, but also gives greater weight to variable payments. Again, this result points to affiliated parties' concern to avoid early termination of the relationship.

The transfer of know-how has a statistically insignificant effect on the royalty rate, similar to the insignificant effect found in Table 5. This is also interpreted to indicate that moral hazard models are not a good explanation for observed payments in technology transfer contracts. Now, the effect of *Pcs* on the royalty rate is less clear than in the determination of the type of payments to be made. In the first specification, the effect is negative and statistically significant at the 90% level, whereas in the second specification, the effect is negative, but statistically insignificant. The effect of the licensee's size is negative, although statistically insignificant in both specifications.

In addition to the insignificant effect of the transfer of know-how, two interesting results emanate from Table 6. First, $\ln(\text{imp})$ has a negative, statistically significant effect on the royalty rate in the first specification. Consistent with this finding, in specification 2, in which the logarithm of imports variable is replaced by an indicator of the licensor's country being a EU member state, the effect is also negative and statistically significant. This can be interpreted in the same way as the coefficient on $\ln(\text{imp})$ in Table 5. The quality of the licensor's information about conditions in the domestic market seems to be an important factor shaping scheduled payments. Closer commercial ties between the licensor and the licensee's countries provide better information on the Spanish market, which reduces uncertainty for the licensor. That makes it easier to estimate the actual value of the technology applied to the Spanish market, leading to wider use of fixed payments.

As pointed out above, differences in corporate taxes between the licensor and the licensee's countries can also influence scheduled payments. The coefficient on *Taxes* is consistent with this hypothesis. The negative, statistically significant coefficient means that if corporate taxes are higher in the licensor's country, the share of profits transferred back to the licensor is smaller. Thus, we find that affiliated transfers are more likely to use variable payments, which are more suitable for controlling the amount of revenues transferred back to the source country. Additionally, the royalty rate seems to be sensitive to differences in corporate taxes between the source country and Spain. These two pieces of evidence suggest that one of the main concerns in affiliated transfers is to minimize total tax payments.

Finally, although industry dummies have been included, they turn out not to be statistically significant. If there were important inter-industry differences in risk, and risk sharing were an important factor in shaping scheduled payments, statistically significant industry dummies should have been found.

Conclusions

This paper has analyzed a sample of contracts that includes contracts for the transfer of technology to Spanish subsidiaries by foreign affiliated firms. First, comparing affiliated with unaffiliated transactions, there are substantial differences in the type of scheduled payments: while few affiliated transfers include fixed payments, in unaffiliated transactions this type of payments is very likely to be included. Analysis of the two subsamples also reveals important differences in the type of technology that is transferred. In affiliated transfers, the proportion of contracts that include the transfer of know-how is much higher than in unaffiliated transfers. No such effect is observed in the transfer of

codified knowledge, such as patents, where the difference is not statistically significant. This suggests that tacit knowledge is more efficiently transferred within multinationals rather than in arm's-length transactions. This finding supports the argument presented in Kogut and Zander (1993) that multinational firms specialize in the transmission of technology. The transfer of tacit knowledge to an unaffiliated firm seems to be problematic, and internal transactions are the preferred transmission method.

Also related to the transfer of tacit knowledge is the finding that the transmission of know-how does not affect scheduled payments within affiliated transactions. This is interpreted as evidence against moral hazard shaping scheduled payments. What seems to be occurring is that the cost of transferring know-how to an unaffiliated party is too high, lowering the proportion of unaffiliated contracts that provide for the transfer of know-how, compared to affiliated transfers. Thus, the evidence suggests that the real effect of the transfer of know-how is on the likelihood of the transfer actually taking place, not on scheduled payments.

The results highlight the important role of multinationals in the international transmission of tacit knowledge. Whereas there seems to be a more efficient market for patented technology, the transmission of know-how still suffers from the problems first pointed out in Caves et al. (1983), which make know-how transfer to unaffiliated parties difficult. Thus, an implication of this study for public policy is that, in industries whose technology has a significant tacit component, policies aimed at fostering direct investment from abroad will have a positive effect on productivity in the host country, via increased competition of local incumbent firms with subsidiaries of foreign firms, simply through knowledge spillovers. The precise mechanism by which the host country's productivity increases remains to be determined.

Regarding other determinants of scheduled payments in affiliated transactions, one of the most surprising results is that duration increases the likelihood of the parties' including variable payments from the very first year of the agreement. This result was also obtained in Mendi (2005), using the subsample of unaffiliated transfers. In that article, the finding was interpreted as showing that the parties had an interest in preventing early termination of the relationship. However, the effect was not expected to be found in affiliated contracts. This suggests that transfers between affiliated parties are not as free from problems as the Economics literature often assumes, probably due to the need to find and deal with local agents to run foreign affiliates.

The empirical analysis also reveals that if the parent firm is established in a country with close commercial ties with Spain, any contracts it signs with its subsidiaries will be, on the one hand, less likely to include variable payments in the first period and, on the other, more likely to stipulate lower royalty rates. This result is interpreted as indicating that the licensor's information about domestic market conditions is relevant to its choice of the kind of payments to be made. Closer commercial ties imply that the licensor has better information, which translates into a more accurate estimation of the actual value, in the Spanish market, of the technology to be transferred, allowing for the scheduling of fixed fees instead of variable payments.

Finally, there is also evidence on the effect of cross-country corporate tax differences on scheduled payments. The evidence obtained in this paper suggests that multinational firms set their payment schemes so as to minimize total tax payments. They do this by adjusting the royalty rate. Governments can take advantage of the fact that multinationals are sensitive to corporate tax levels to attract foreign direct investment, which is found to bring with it technology, especially tacit technology, which has a positive effect on productivity and growth in the host country.

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