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Inter-firm technology transfer: partnership-embedded licensing or standard licensing agreements?

John Hagedoorn, Stefanie Lorenz-Orlean and Hans van Kranenburg

When companies decide to engage in technology transfer through exclusive licensing to other firms, they have two basic options: to use standard licensing contracts or to set-up more elaborate partnership-embedded licensing agreements. We find that broader partnership-embedded licensing agreements are preferred with higher levels of technological sophistication of industries, with greater perceived effectiveness of secrecy as a means of appropriability, and when licensors are smaller than their licensees. Innovative differential between companies, innovative supremacy of the licensor and market and technological overlap between partners appear to have no effect on the preference for a particular form of licensing.

1. Introduction

To the best of our knowledge, this article is the first attempt to analyse the preference of companies for either standard licensing agreements or broader partnership-embedded licensing agreements as they engage in technology transfer with other companies. When companies enter into a licensing agreement, they are subject to a contract or an agreement that regulates the transfer of technology, in which they, as legal entities, give permission or the "right" to another legal entity, such as a company, to manufacture a product or use a service, with the objective of achieving commercial gain, in return for a fee to be paid by the licensee to the licensor. We understand a partnership-embedded licensing agreement to refer to those agreements where companies engage in technology transfer through a licensing agreement that is implanted in a broader agreement, a partnership, which also has other objectives than the single act of transferring technology from one company to the other. In that context, companies combine licensed technology transfer with the sharing of resources or even assets related to any element of the value chain, such as joint R&D, manufacturing, supply, and marketing.

Obviously, companies face a set of completely different issues when they engage in a standard licensing agreement or when they decide to make the licensing agreement part of a broader partnership. In this article, we will consider a number of industry-specific conditions and pair and company-specific settings that we expect to be relevant in explaining under which circumstances firms might opt for technology transfer through either a standard license or a partnership-embedded licensing agreement. The main contingencies that we explore in this study refer to the level of technological sophistication of industries, the regime of appropriability with which companies are confronted, and the inter-firm differences between licensing partners in terms of their size, their innovativeness, their technological bases, and their product markets.

We study a sample of nearly 230 licensing agreements made between US companies in various industries during the 1990s. About 70% of these licensing agreements refer to partnership-embedded licensing, the other 30% are standard licensing contracts. All these licensing agreements are exclusive licenses, restricted to a specific user, a geographic region, a specific length of time, and/or a specific field of use. Most of the agreements are found in a small range of industries such as chemicals, instruments, and electrical and electronic equipment.

2. Hypotheses

The literatures on partnerships (e.g., Contractor and Lorange, 2002; Hagedoorn, 2002; Casciaro, 2003) and licensing (e.g., Anand and Khanna, 2000; Kim, 2005; Kim and Vonortas, 2006) both suggest that the preferences that companies might have for particular organizational modes and the architecture of inter-firm arrangements in the context of technology sharing depends on both environmental conditions, i.e., industry-specific conditions, and partnership and firm-specific conditions. Following these partnership and licensing literatures, we will discuss a set of hypotheses that stipulate the environmental as well as the firm and partnership conditions that might shape the preferences that companies have for standard licensing contracts or partnership-embedded licensing agreements.

When considering contributions that are relevant in the context of understanding the industry conditions that affect technology transfer through standard licensing contracts or partnership-embedded licensing, it becomes clear that the past two decades of empirical research have already generated a substantial body of literature on partnership formation while licensing has clearly attracted somewhat less attention. A relatively large number of contributions (see amongst others Eisenhardt and Schoonhoven, 1996; Dussauge and Garette, 1999; Oster, 1999; Contractor and Lorange, 2002; Hagedoorn, 2002) indicates that the growth in the number of inter-firm partnerships, where companies share resources and assets, is generally associated with so-called high-tech industries. In these high-tech industries, the competitive landscape of companies is determined by technological competences,

R&D activities, learning and flexibility in terms of organization, and innovative output. Partnerships enable companies to learn with and from their partners in a flexible setting where many of the leading companies engage in a multitude of partnerships with different partners. Although partnerships are popular in a large number of industries and they are indeed established in all sectors, across the spectrum from dynamic high-tech industries to more static and technologically less advanced sectors, there is evidence that partnerships are more widespread in high-tech industries. Research by amongst others Dussauge and Garette (1999) and Hagedoorn (2002) indicates that a disproportionate share of these partnerships are made in a limited number of R&D intensive industries, such as pharmaceuticals, electronics, and information technology industries.

Most standard licensing agreements are found to be restricted to single technology transfer, few of them are part of a multiple technology transfer exercise (Anand and Khanna, 2000). Based on a theoretical contribution, Arora and Fosfuri (2003) expect that in industries characterized by homogeneous markets with little product differentiation, companies have a higher preference for licensing; whereas, this preference for licensing decreases in industries where product differentiation is crucial for the competitive positioning of companies.

The above suggests that we can expect some relevant industry differences with regard to the preference that companies have for licensed technology transfer that is either part of a broader arrangement through a partnership or a standard licensing agreement. Given the experience that many companies in technologically sophisticated sectors have with a range of partnerships, we can expect companies in these sectors to routinely consider partnerships as one of the first options, if not the first option, for any act of inter-firm collaboration, including licensing. In addition, the complexity of technologies and the complementarity of innovative inputs in these industries will require intensive collaboration for technology transfer (Hagedoorn, 2002). Both, the prolificy of partnerships and the nature of complex technology transfer, will stimulate companies in technologically sophisticated industries to think of a combination of partnerships and licensing as a first option when they engage in technology transfer with other companies. Partnerships are less "popular" in technologically less sophisticated industries but in these industries standard licenses are a very well-known mechanism for the single transfer of straightforward technologies. Hence, we expect that companies in technologically less sophisticated industries have a disproportionate preference for standard licensing agreements.

> *H1: The higher the level of technological sophistication of industries, the higher the likelihood that companies prefer partnership-embedded licensing to standard licensing contracts.*

So far, there is little research on the possible effect that the degree to which companies can protect their technology might have on their preference for either

partnership-embedded licensing or standard licensing contracts. The empirical analysis of Anand and Khanna (2000) suggests that generally in industries with weaker regimes of appropriability, where patents are considered to offer little or no effective protection, licensing is to be less preferred by companies as the licensee can invent around the technology that is transferred (see also Kim and Vonortas, 2006, for similar results). In these industries with weaker regimes of appropriability, Anand and Khanna (2000) expect that broader inter-firm agreements, such as joint ventures, are more likely to occur as this form of partnership offers companies the possibility to monitor and control their technology transfer partners. They also state that exclusive licensing, which limits technology transfer to a specific user, a geographic region, a specific length of time, and/or a specific field of use, might be preferred when companies operate in the context of a strong regime of appropriability and their technology is well protected through patents.

However, in case the efficiency of the regime of appropriability and the protection of technology in industries is based on secrecy and not on intellectual property rights, the effect of the regime of appropriability might change. Cohen *et al.* (2000) and Arundel (2001) mention that in a large number of industries companies prefer to use secrecy to protect their technology. This suggests that in industries where companies see secrecy as an efficient protection mechanism for their technology, companies might also prefer partnership-embedded licensing agreements to standard licensing contracts. Partnerships allow companies to monitor and control the transfer of their technology in an inter-organizational context, but this monitoring and control of the relationship also enables partners to gradually build up a trusted relationship where confidentiality among partners facilitates the transfer of technology (Gulati, 1999; Ahuja, 2000; Chung *et al.*, 2000; Kale *et al.*, 2000). As secrecy is perceived as an effective mechanism to protect technology and control technology transfer by companies from a range of industries, companies operating in such industries will probably see closer collaboration through partnership-embedded licensing as more effective than market-based, arms-length transactions through standard licensing contracts. In addition, we can point at the role of tacitness in the transfer of technological knowledge in industries where secrecy is an important protection mechanism for innovative activities. Contributions by Braganza *et al.* (1999), Merges (2003), and Torrisi (1998) indicate that industries where companies prefer secrecy to protect their innovative activities are also those sectors where tacit knowledge plays an important role in the transfer of technology. Standard licensing is based on a high degree of transferable codified knowledge but partnership-embedded licensing enables companies to go beyond the transfer of codified knowledge and to communicate additional tacit knowledge in a broader set up of a partnership. Also, as demonstrated by Martin and Salomon (2002) increasing levels of the tacitness of knowledge to be transferred by companies to others, encourage them to

prefer more organizationally complex partnerships to standard licensing contracts. Hence:

> *H2: The stronger the regime of appropriability of industries, in terms of the prevalence of companies for secrecy, the higher the likelihood that companies will prefer partnership-embedded licensing to standard licensing contracts.*

Turning to a number of more firm-specific and partnership-specific dimensions of the preference for standard licensing contracts or partnership-embedded licensing, we shall now first consider the possible effect of the size differential of companies that engage in technology transfer. In this context, we understand size to be an indicator of the market power of a company that refers to its ability to benefit from and to influence the actual process of technology transfer in a licensing agreement, be it of an embedded or a non-embedded nature. As already well established in the industrial organization literature, we expect the size of firms to be an important aspect of market power as larger companies can reap benefits in terms of both economies of scale and scope and bargaining power vis-à-vis smaller firms (Bresnahan, 1989; Cohen and Levin, 1989; Schmalensee, 1989; Freeman and Soete, 1997; Malerba and Orsonigo, 1997; Barla, 2000).

The literature points out that the size of companies participating in partnerships and more in particular the size difference with their partners can play a role in the risk perception of companies during the partnership formation process as well as during the life span of the partnership (Berg *et al.*, 1982; Mytelka, 1991). In general, this literature suggests that this kind of asymmetry in partnerships generates higher risks to the smaller firm. Thus, when companies of different size cooperate in technology transfer, we assume that smaller licensors are running a greater risk of losing control over their technology than larger firms that have more resources to control and monitor their technology transfer. In case a large firm is the licensor to a smaller licensee, it has the resources and organizational capabilities to monitor the licensee. When the larger firm is the licensee, it also can use its resources and organizational capabilities to monitor the agreement and it has no incentive to engage in a more complex arrangement, such as a partnership-embedded licensing agreement.

The literature on licensing does indeed indicate that when companies of different firm size engage in technology licensing agreements, larger firms dominate the agreement due to bargaining asymmetries that affect the terms of the licensing agreement (Caves *et al.*, 1983; Bessy and Brousseau, 1998). Research by Kolmer and Dowling (2004) on licensing practices of large integrated companies and smaller newly established firms in the bio-pharma industry demonstrates some major differences in the licensing strategies of these companies. Large companies appear to prefer to license less crucial technologies to others (see also Caves *et al.*, 1983);

whereas, smaller firms are forced by market conditions, to license technologies related to their core products.

The above suggests not only some interesting differences between companies of dissimilar size, it also implies that is important for smaller companies with valuable technologies, when acting as licensors, to protect their technological competences and to exercise as much control as possible over their technology transfer. This implies that when smaller companies own valuable technologies that qualify them for licensing to larger partners, these smaller licensors should prefer to set up partnerships that act as broader agreements that enable them to monitor and control technology transfer in broader partnerships than through standard licensing contracts. Thus:

> *H3: In the context of firm size differentials, when licensors are smaller than their licensees, licensors prefer partnership-embedded licensing to standard licensing contracts.*

In a somewhat similar vein as with the size differential of firms, we can expect that different innovative capabilities or differences in innovativeness of partners affect their preference for particular forms of licensing. There is always a risk of technology leakage in technology exchange between companies but when the licensor is more advanced in its technological capabilities and it transfers technology to its less developed partner, there is a serious risk of technology leakage as a by-product of the licensing agreement that will upgrade the less developed partner beyond what was intended. It is difficult for companies to make an exact assessment of alternative applications and future uses of the technology that the licensee can exploit to improve its innovative capabilities beyond the improvement stipulated in the licensing agreement (Caves *et al.*, 1983). Hill (1992) refers to this as the risk of second-order diffusion when technological know-how that underlies the licensed technology is "accidentally" transferred. This additional technology may enable the licensee to innovate beyond the licensed technology and use this technology in other products outside the range of the licensing agreement. Partnership-embedded licensing, where companies collaborate on a broader project than the transfer of technology itself, gives more options for a licensor to monitor both its partner and the use of its transferred technology than in case of a standard licensing contract. Hence, we expect that:

> *H4: In the context of innovative differentials between companies, when licensors are more innovative than licensees, licensors prefer partnership-embedded licensing to standard licensing contracts.*

The licensing agreements that are analysed in this article, both partnership-embedded licensing agreements and standard licensing contracts, are restricted to exclusive users, where the geographic regional use, the specific length of time of

usage, and/or the specific field of use are specified in the agreement. This implies that licensors have the option to control the use of their licensed technology by companies that operate in similar product markets or that use a somewhat similar technology base. However, no matter how specified licensing contracts are drafted, they still contain some element of uncertainty. Therefore, even though licensing agreements are clearly less relational than many other forms of inter-firm cooperation, they are still to some degree incomplete contracts as not all contingencies of future and broader use can be foreseen (Hill, 1992; Bessy and Brousseau, 1998; Hagedoorn and Hesen, 2007).

When licensors enter into a technology transfer agreement with partners that are direct competitors, in the sense that they operate in similar product markets or apply similar technologies, they are expected to prefer to arrange this technology transfer through a partnership-embedded licensing agreement. Again, the main motive for this preference is that a partnership-embedded licensing agreement offers more options for a licensor to monitor its partner and the technology transfer than a standard licensing contract. Through partnership-embedded licensing it can avoid second-order diffusion of technological know-how that might enable its partner, with which there is overlap in markets and/or technologies, to use these unintended spill-overs in new or improved products or to upgrade its technology. Hence:

> *H5: The larger the similarity of companies, in terms of market overlap (5a) and technological overlap (5b), the higher the likelihood that companies will prefer partnership-embedded licensing to standard licensing contracts.*

3. Methodology

3.1 Sample and data collection

We test our hypotheses on a sample of licensing agreements taken from the Thomson SDC database, using a binomial logit model (Limdep version 8.0). The sample consists of 228 licensing agreements of which, 28.9% are standard licensing agreements and 71.1% are embedded licensing agreements. Our research covers a 10 years period, from 1990 until the end of 1999.

There are some important features of our sample that have to be discussed briefly. First, we restrict our analysis of licensing agreements, both the partnership-embedded licensing agreements and the standard licensing contracts, to exclusive licensing. Contrary to non-exclusive licenses which are usually unrestricted in terms of users, geographic regions, length of time, and specific fields of use; exclusive licensing agreements refer to specific partners where technology is transferred from one company to another with restricted use. As such these exclusive licensing agreements are expected to be of greater importance to both the licensor and the

licensee then the common non-exclusive licensing agreement. Second, in order to control for the effect of international technology transfer and to counter the effect of the lack of data on non-US companies, we concentrate on licensing agreements made within the domestic US context, i.e., agreements made between two US companies. Third, given the legal ramifications of intellectual property rights and licensing, certainly in an international context, this sample of US domestic licensing agreements has the advantage that these agreements are subject to the same legal system. Fourth, we only analyse agreements made between two companies; a small number of agreements between three or more companies were deleted from our sample. Fifth, due to the lack of some industry indicators for service industries and given the abundance of licensing agreements in manufacturing industries, we only include agreements for manufacturing sectors. Finally, but also critically, the licensing agreements between the pairs of companies in this sample are unique and first combinations of these companies. Based on the information found in the Thomson SDC database, these partners did not engage in earlier licensing agreements or other forms of cooperation with each other during a period of at least 5 years prior to the licensing agreement in this sample. This implies that the preference for a partnership-embedded licensing agreement or an exclusive licensing agreement is not guided by previous or recent contacts between two companies that could be interpreted as joint, routinized, and endogenous search behaviour. On the contrary, the decision to enter into either form of licensing can be seen as a distinctive and strategic decision, made in the context of a first time encounter between the two companies involved in the technology transfer.[1]

To arrive at our sample, we first selected all agreements in the Thomson SDC database that are flagged as licensing agreements and those agreements in which technology transfer and licensing were mentioned in the textual description (deal text). We only considered agreements labelled as completed/signed deals (status: completed/signed). Using the textual description, we also verified whether the Thomson identification of the licensor and licensee were accurate, similar to Anand and Khanna (2000) we found that licensor and licensee are generally correctly identified in the Thomson SDC database. Next, we selected only one-way licensing agreements that are indicated as exclusive licensing agreements, excluding a large number of cross-licensing agreements that are not flagged as such. Within the group of exclusive licensing agreements, we distinguish between partnership-embedded licensing and standard licensing agreements. A partnership-embedded licensing agreement is a licensing agreement that is part of an R&D agreement, marketing agreement, or manufacturing and supply agreement, the latter category contains

[1]Furthermore, during the period 1990–1999, only 16 pairs of companies, i.e., 7% of the sample, have set up any form of subsequent collaboration registered in the Thomson SDC database after their first agreement, of which only 1 pair entered into a third consecutive collaboration agreement with each other.

manufacturing, supply, and original equipment manufacturing/value-added reseller agreements.[2] As indicated in the above, we also only included exclusive licensing agreements that pertain to a US context, implying that the participants are US firms (participant ultimate parent nation code: US, cross border participants: no) and that the licensing agreement refers to the US market (nation code of partnership contains US) as one of the main markets.

Given the selection procedure, as described in the above, most agreements (58%) are found in SIC 28 (chemicals and allied products), followed by 14% in SIC 38 (instruments and related products), and 8% in SIC 36 (electrical and electronic equipment). The remaining agreements are spread over a diverse group of industries. Major companies in the sample are Eli Lilly and Schering-Plough which are involved in 10 licensing agreements each, followed by American Home Products and Bristol-Myers Squibb, each with 7 licensing agreements.

3.2 Measures

The dependent variable, *form of licensing agreement*, refers to the preference for a standard exclusive licensing contract or a partnership-embedded licensing agreement. The dependent variable is coded 0 if the licensing agreement is a standard exclusive licensing contract and 1 if it is a partnership-embedded exclusive licensing agreement, i.e., when the licensing contract is part of a partnership that also covers joint efforts of companies in R&D, manufacturing and supply or marketing.

Level of technological sophistication of an industry (Hypothesis 1) refers to the R&D intensity of the sector in which a licensing agreement (either a standard exclusive licensing or a partnership-embedded exclusive licensing agreement) is found, as indicated by the Thomson SDC database. This measure accounts for the degree to which firms in a particular industry dedicate resources to R&D. It is measured as total R&D expenditures of companies as a percentage of total production (gross output) in an industry. The data refer to US industries and R&D intensity is reported as average of 1991–1997 (OECD, 2001). Conversion tables were used to convert ISIC codes, in which the OECD R&D intensities are categorized, into SIC codes used by Thomson SDC to categorize industries to which licensing agreements refer. This industry R&D intensity indicates the extent to which companies in particular industries devote resources to R&D that generate a continuous flow of newly developed technologies, new products and new processes, representing differences in the sectoral levels of technological sophistication (OECD, 1992, 2001, 2003; Freeman and Soete, 1997; Galan and Sanchez, 2006). As also stated by

[2]Our binary classification (standard licensing versus partnership-embedded licensing) is based on the information found in the Thomson SDC database. Additional analyses with a more fine-grained classification of partnership-embedded licensing agreements, using multinomial logit and ordered logit analyses did not generate meaningful results.

Hatzichronoglou (1997: 146), this "... R&D intensity largely reflects an industry's technological sophistication ...".

The *regime of approproability* of industries is measured as the level of perceived effectiveness of secrecy as an appropriability mechanism in different US industries as reported in Cohen *et al.* (2000). This indicates the degree to which companies in different industries appreciate secrecy as an effective appropriability mechanism for innovation (Hypothesis 2). Using a conversion table, we transformed ISIC codes, in which the regimes of appropriability are reported, into the SIC codes to which both forms of exclusive licensing are assigned in the Thomson SDC database.

Size differential of companies is based on the difference between the numbers of employees for both companies engaged in an agreement (Barla, 2000; Hagedoorn *et al.*, 2005). It is calculated as the logarithmic difference between the number of employees from the licensor and the licensee.[3] Data for this variable were retrieved from Compustat, CorpTech, Dun & Bradstreet's Hoovers, Osiris, and Worldscope and, in a small number of cases, annual reports. For both partners in an agreement, we took employment data from 1 year before the agreement was established.

Innovative differential between licensing partners is measured through patent intensity ratios. See Griliches (1998) for a discussion of patents as a useful indicator of innovation. The patent intensity ratio is based on the total number of US patents issued to companies during 5 years prior to the year when the agreement was established. For each partner in an agreement, we calculated a patent intensity ratio, controlling for firm size as measured by the number of employees. From these individual ratios, we calculated the innovative differential as the difference in patent intensity between the licensor and licensee (Hypothesis 4).[4]

Market overlap of companies is measured by primary 4-digits SIC code overlap between licensor and licensee. Primary SIC codes of companies are reported in the Thomson SDC database. Based on primary 4-digits SIC codes we computed a market overlap dummy, which was set at 1 if the licensor and the licensee are in the same market, as measured by primary 4-digits SIC code, and 0 if they are not (Hypothesis 5a).[5]

Technological overlap is measured by a patent class overlap dummy (Hypothesis 5b). This measure is based on the number of patent classes listed for all US patent applications of both partners in an agreement, during a period of 5 years before a licensing agreement was established. The dummy is 1 if at least one full

[3]In additional analyses, we also measured the size differential in terms of the revenue difference at the pair level. The statistical analysis with revenue-based size differential was performed with a slightly smaller sample ($N = 211$), due to missing values for at least one of the companies in 17 pairs of our overall sample. This analysis led to similar results.

[4]We also used patent intensity ratios and average patent intensity in unreported statistical analyses, this generated similar results.

[5]Measures for market overlap in 2- and 3-digits SIC codes generated similar results.

patent class (nine digits) is the same and 0 if there is no patent class overlap.[6] These data were retrieved from the US Patent and Trademark Office.

We also included a number of control variables. A trend variable *time* is included to control for possible growth in the number of agreements (see e.g., Gulati, 1999) and a gradual change in the distribution between partnership-embedded licensing and exclusive licensing agreements. This trend variable was calculated by assigning a value to each particular year, which reflects the distance to the first year of the period under investigation.

The *average experience* is the log of the count of the total number of licensing agreements accumulated by each pair of companies during a period of 5 years before the agreement (see e.g., Gulati, 1999). This experience refers to all forms of licensing, embedded and non-embedded (i.e., standard) licensing, exclusive and non-exclusive licensing, and cross licensing agreements.

We control for possible industry effects by constructing dummies for the three largest industries in our sample. We include an industry dummy for chemicals and allied products (129 agreements), instruments and related products (30 agreements), and electrical and electronic equipments (18 agreements). The default "industry" refers to the remaining 51 agreements that are scattered across 13 different industries.

4. Results

Table 1 presents the descriptive statistics and Table 2 depicts the correlation matrix for the variables in this study. Correlation is very low for most variables and only moderate (<0.45) for some industry variables, well below the suggested cut-off point of 0.70 (Cohen *et al.*, 2002) indicating that multicollinearity is not a problem. In addition, variance inflated factors (VIF) were calculated by running "artificial" OLS regressions between each independent variable as the "dependent" variable and the remaining independent variables as suggested by Maddala (2000).[7] As all VIF values are smaller than 2, this indicates that there is no multicollinearity between the variables.[8]

Table 3 provides the results for the stepwise logit analysis, where industry and pair-related variables are added to the analysis. An alternative procedure, where each step remains in the analysis as the other variables are added, generated similar results.

[6]An alternative technology overlap measure, based on the number of patent classes, at the three digit level, that licensors and licensees share divided by the total number of patent classes of both companies, generated similar results.

[7]Variance Inflation Factors (*VIFj*) for each such regression are calculated as: $VIF_j = 1/(1 - R_j^2)$, where R_j^2 is the R^2 of the artificial regression with the *j*-th independent variable as a "dependent" variable.

[8]Given the moderate level of correlation between the industry variables, we also ran the regressions without industry dummies which generated similar results as those presented in Table 2.

Table 1 Descriptive statistics (means, sd, minimum, median, and maximum) for all variables ($N = 228$)

Variables	Mean	SD	Minimum	Median	Maximum
Form of licensing agreement	0.71	0.45	0.00	1.00	1.00
Level of technological sophistication	7.89	5.28	0.20	8.60	14.70
Regime of appropriability	50.86	7.59	32.50	53.57	70.69
Size differential	−1.76	4.37	−10.10	−1.94	8.89
Innovative differential	0.01	0.08	−0.33	0.00	0.68
Market overlap	0.13	0.33	0.00	0.00	1.00
Technological overlap	0.15	0.36	0.00	0.00	1.00
Time	5.21	2.46	1.00	5.00	10.00
Average experience	1.22	1.17	−0.69	1.10	3.95
Chemicals and allied products	0.57	0.50	0.00	1.00	1.00
Instruments and related products	0.08	0.27	0.00	0.00	1.00
Electrical and electronic equipment	0.13	0.34	0.00	0.00	1.00

Table 2 Bivariate correlations for all variables, $N = 228$

Variables	1	2	3	4	5	6	7	8	9	10	11
1 Form of licensing agreement											
2 Level of technological sophistication	0.21										
3 Regime of appropriability	0.27	0.21									
4 Size differential	−0.19	−0.08	−0.07								
5 Innovative differential	0.01	0.01	0.12	−0.10							
6 Market overlap	0.13	0.23	0.08	−0.11	−0.06						
7 Technological overlap	0.14	0.14	0.10	−0.00	−0.04	0.06					
8 Time	−0.08	−0.17	−0.11	0.04	−0.03	−0.21	0.07				
9 Average experience	0.11	0.25	−0.01	−0.12	0.06	0.04	0.37	0.11			
10 Chemicals and allied products	0.00	0.38	−0.02	−0.09	−0.03	0.23	0.18	−0.03	0.21		
11 Instruments and related products	−0.03	−0.04	0.10	0.03	0.09	−0.11	−0.13	−0.07	−0.13	−0.33	
12 Electrical and electronic equipment	−0.01	−0.18	−0.05	0.03	−0.02	−0.07	−0.02	0.03	−0.07	−0.44	−0.11

Table 3 Estimation results of binomial logit model predicting the preference of firms for form of licensing agreement (partnership-embedded licensing or standard licensing agreement)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	1.23** (0.47)	−2.48* (1.16)	1.08* (0.50)	−2.34† (1.21)
Level of technological sophistication		0.07† (0.03)		0.07† (0.04)
Regime of appropriability		0.06** (0.02)		0.06** (0.02)
Size differential			−0.10** (0.04)	−0.10** (0.04)
Innovative differential			−0.15 (1.76)	−0.84 (1.82)
Market overlap			0.86 (0.59)	0.61 (0.60)
Technological overlap			0.95† (0.55)	0.80 (0.57)
Time	−0.09 (0.06)	−0.04 (0.06)	−0.07 (0.06)	−0.03 (0.07)
Average experience	0.25† (0.13)	0.19 (0.14)	0.14 (0.15)	0.93 (0.15)
Chemicals and allied products	−0.21 (0.38)	−0.43 (0.42)	−0.46 (0.40)	−0.64 (0.44)
Instruments and related products	−0.29 (0.60)	−0.58 (0.62)	−0.23 (0.61)	−0.52 (0.63)
Electrical and electronic equipment	−0.14 (0.51)	−0.14 (0.52)	−0.24 (0.52)	−0.23 (0.53)
N	228	228	228	228
- Log likelihood	134.5065	124.9702	127.5203	119.7334

Standard errors in parentheses.

†$P<0.10$; *$P<0.05$; **$P<0.01$.

Given the rather unambiguous nature of the results, we will only discuss the results for the full model (model 4). Compared with the other models, the full model has the expected lowest log-likelihood value and it generates a very significant improvement ($P<0.001$) over the base model (model 1) and models 2 and 3.

Turning to the hypotheses testing, we find some clear results for the industry-related hypotheses and some mixed findings for the pair-level hypotheses. Consistent with Hypothesis 1, the higher the level of technological sophistication of industries, in terms of R&D intensity, the more companies operating in these industries prefer partnership-embedded licensing agreements, where technology transfer is part of a broader partnership, to standard exclusive licensing agreements. Also, as suggested by Hypothesis 2, the more companies operate in an industry environment where secrecy is an important dimension of the protection of their innovations and technology, the more they prefer to embed their technology transfer to other companies in a partnership rather than arrange for technology transfer through standard licensing contacts.

The firm or pair level effects on the preference for licensing agreements indicate that only the size differential in pairs of companies seems to have a significant impact

on the preference of these companies. Consistent with Hypothesis 3, the larger the size differentials between partners, when licensors are smaller than their licensees, companies prefer to transfer technology through a licensing agreement that is part of a wider partnership that covers multiple elements of the value chain. However, the other hypotheses did not generate the expected results. We expected that when licensors are more innovative than their licensees, they would be inclined to protect their technology transfer by means of additional control, beyond the protection offered by a contract, through a broader partnership (Hypothesis 4). Our results indicate that neither the innovative differential between partners nor the innovative supremacy of the licensor has an effect on the preference for a particular form of licensing. Also, the degree to which partners are direct competitors as they are operating in similar markets (Hypothesis 5a) or the degree to which their technologies are somewhat similar (Hypothesis 5b) appear to have no impact on the preference for partnership-embedded licensing. Both market overlap and technological overlap have the expected positive sign and technological overlap is even marginally significant in model 3, but we find no significant results in the full model (model 4).

The control variables, time, average experience of partners with a wider range of licensing agreements, and the industry dummies have no effect on the preference for particular forms of licensing. Given some suggestions on the possible effect of the regime of appropriability on the licensing strategy of different companies (Anand and Khanna, 2000), we considered a number of interaction effects of the regime of appropriability with the size of licensors, the innovativeness of licensors, the market overlap of partners and their technological overlap. We also considered the interaction of these variables with experience, because inexperienced firms may be less selective in their choice of partners than more experienced firms. However, these interaction effects turned out to be not significant.

It is also useful to examine marginal effects that show the change in predicted probability associated with changes in the explanatory variables (Greene, 2003). These marginal effects are shown in Table 4. An examination of the marginal effects indicates the direction of the influence of the explanatory variables on the preference of companies for either standard licensing agreements or broader partnership-embedded licensing agreements, as well as their level of significance. The results show that a 1-point increase of the level of technological sophistication increases the probability of broader partnership-embedded licensing agreement with 0.01. Furthermore, an increase in the effectiveness of secrecy increases the probability of broader partnership-embedded licensing agreement with 0.01. The result for the size differential in pairs of companies is also interesting. An increase in the size difference between partners has a negative effect on the probability of broader partnership-embedded licensing agreement. This indicates that when the licensor is smaller than the licensee, the licensor prefers to transfer technology through a licensing agreement that is part of a wider partnership that covers multiple elements of the value chain.

Table 4 Marginal effects on the probability that firms prefer a partnership-embedded licensing agreement or a standard licensing agreement

Variables	Model 1	Model 2	Model 3	Model 4
Constant	0.25** (0.09)	−0.49* (0.24)	0.21* (0.09)	−0.45† (0.24)
Level of technological sophistication		0.01† (0.02)		0.01† (0.01)
Regime of appropriability		0.01** (0.00)		0.01** (0.00)
Size differential			−0.02** (0.01)	−0.02** (0.01)
Innovative differential			−0.03 (0.35)	−0.16 (0.35)
Market overlap			0.14† (0.08)	0.11 (0.09)
Technological overlap			0.16* (0.07)	0.13 (0.81)
Time	−0.02 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)
Average experience	0.05† (0.03)	0.04 (0.03)	0.03 (0.03)	0.02 (0.03)
Chemicals and allied products	−0.04 (0.08)	−0.08 (0.08)	−0.09 (0.08)	−0.12 (0.08)
Instruments and related products	−0.06 (0.13)	−0.13 (0.15)	−0.05 (0.13)	−0.11 (0.14)
Electrical and electronic equipment	−0.30 (0.11)	−0.03 (0.12)	−0.05 (0.11)	−0.05 (0.11)

Standard errors in parentheses.

† $P<0.10$; * $P<0.05$; ** $P<0.01$.

Hence, the evidence of these marginal effects suggests that firms prefer broader partnership-embedded licensing agreements with increasing technological sophistication, increasing importance of secrecy, and the smaller the licensor is compared to its licensee.

5. Discussion and conclusions

Our findings clearly indicate that industry-specific conditions, both in terms of the level of technological sophistication and the regimes of appropriability, have an effect on the preference of companies for technology transfer through either standard licensing contracts or through partnership-embedded licensing. The more industries are characterized as technologically sophisticated and R&D intensive, the higher the preference for partnership-embedded licensing. Such industries where hyper-competition (D'Aveni, 1995), with a combination of product differentiation, large R&D efforts, speedy innovation, and flexibility, affect the competitive positioning of companies are also those sectors where we witness a growth in the number of partnerships (Dussauge and Garette, 1999; Hagedoorn, 2002). Inter-firm partnerships in these technologically sophisticated industries combine multiple technologies of partners that can actually overarch different fields of technology, where companies jointly develop new technologies and new products and processes.

The sharing of technological competences and learning with and from partners are the main goals of partnerships in these industries (Hagedoorn, 2002). As the transfer of multiple and complex technologies is less enhanced by standard licensing agreements (Anand and Khanna, 2000), we submit that in technologically sophisticated industries, where companies have already built up considerable experience with partnerships, licensing of complex technologies is embedded in partnerships to facilitate the collaboration and transfer of technology from one company to the other.

Industries characterized as technologically less sophisticated represent more homogeneous markets with less product differentiation and less emphasis on continuous innovation. It is also in these industries that we find fewer partnerships and less partnership experience of individual companies (Dussauge and Garette, 1999; Hagedoorn, 2002) with more single technology transfer (Anand and Khanna, 2000). As such the need for companies to embed their technology transfer in broader partnerships seems limited. In these industries, technology transfer is also less geared towards complex, multiple technology sourcing, where the tacit nature of knowledge would require a more extended cooperation between licensor and licensee.

When we consider the regime of appropriability of industries, in terms of the degree to which companies use secrecy to protect their innovative input and output (Cohen *et al.*, 2000), our research indicates some interesting findings. When tacit knowledge and confidentiality become important social mechanisms to protect innovation and technological knowledge in industries, the relevance of partnership-embedded technology transfer also increases. Standard licensing contracts are clearly less relational in nature than partnerships (Eisenberg, 2000; Hagedoorn and Hesen, 2007) but even licensing agreements are in principle not 100% complete and as such second-order diffusion (Hill, 1992) remains a risk even in exclusive licensing agreements. Partnership-embedded licensing does offer partners the possibility to create more elaborate cooperation than through a standard licensing contract, yet it also gives them the opportunity to closely monitor technology transfer and partly control their relationship through a partnership.

Looking at the company and pair effects on the preference for standard licensing contracts or partnership-embedded licensing, it appears that the size differential between partners engaging in technology transfer is the only factor that is relevant. Neither the difference in innovative capabilities nor the conflicting interests through overlap in product market combinations or similar technology sourcing seem to be relevant. It is important to note that the form of licensing that this study analyses refers to technology transfer in which companies made an agreement where the technology to be transferred is restricted to one licensee who can use it for a specific geographic region, a specific length of time, and/or a specific application. This suggests that when licensors are more innovative than their licensees, or when both companies operate in similar markets and depend on similar technologies,

companies are probably confident that licensing agreements, regardless of some contractual incompleteness, provide ample safeguards against opportunistic behaviour and second-order diffusion (Caves *et al.*, 1983; Hill, 1992).

Partnership-specific effects are relevant when we consider size differential between companies that engage in technology transfer through licensing. As suggested by our findings, the more partners differ in size, the higher the likelihood that they prefer partnership-embedded licensing agreements to standard licensing contracts. More specifically, when the licensor is the smaller partner, we see that a partnership-embedded licensing agreement is the preferred mode of technology transfer. By definition, the licensor holds the property rights on the technology to be transferred and it probably has the relevant experience and knowledge about how to use the technology, which gives it an information advantage (Caves *et al.*, 1983). However, as indicated in research by Kolmer and Dowling (2004), compared to larger companies, small firms are more inclined, or forced due to lack of financial resources or complementary assets, to license core technologies to other companies. Smaller companies are also engaged in fewer technologies than large companies that tend to be more multi-technology and multidivisional in nature (Freeman and Soete, 1997; Scherer, 1980). This implies that when smaller companies act as licensors it is likely that their technology transfer refers to an activity that is relatively crucial for these companies as their pool of technologies from which to transfer a specific technology is limited (Arora *et al.*, 2001). Even though exclusive licensing contracts limit the scope of the application by the licensee, smaller licensors are limited in their abilities to counter the risk of impacted information and opportunism on part of the licensees. All of this suggests that when licensors are confronted with larger licensing partners, smaller licensors prefer to organize their technology transfer through partnership-embedded licensing agreements that enable them to monitor their partner through a broader partnership set-up over an extended period of time than through a single licensing contract.

In this context, we can also briefly discuss some interesting legal aspects of the preference of companies for partnership-embedded licensing. Given the legally problematic status of pre-contractual liability regarding intellectual property due to the early disclosure of technical information, i.e., prior to the actual technology transfer under a licensing agreement, companies might prefer to engage in partnership-embedded licensing agreements to better monitor and control the agreement from the early start. However, as explained by Merges (2006), when the technology to be transferred is protected by patents, companies are already well-protected by law. Assuming that most of the licensing agreements in our sample are backed by patents, this could explain why companies that engage in technology transfer with companies in similar markets, with technologically overlapping partners, and with less innovative partners are already well-protected and do not have to rely on embedded licensing agreements *per se*. When companies are smaller than their partners, they prefer partnership-embedded licensing which could indicate

that smaller companies might fear that litigation of larger companies is troublesome and time-consuming. If, the licensing agreement would be violated by the larger partner, then monitoring the technology transfer through a partnership-embedded licensing agreement will give more useful information about how, where and to what extent the license is implemented by the partner and which activities take place outside the parameters set by the agreement.

Although, the above suggests a number of interesting findings that clarify under which conditions companies prefer partnership-embedded licensing to standard licensing contract, our research still leaves quite a number of questions unanswered and additional research is required. As already indicated in Section 1, this is, to the best of our knowledge, the very first attempt to analyse the choices that companies make when they consider technology transfer through a standard licensing contract or through a more extended partnership. A number of subjects that warrant further research come to mind. First, our research is based on a limited sample of licensing agreements and further research on an extended sample with a larger number of companies in a more multi-sectoral and international setting will enable us to look at research questions from an international perspective while broadening the picture to a broader range of industries. Second, our data are restricted to a limited number of publicly announced agreements with some information on the content of the agreement. Obviously, we need more information on the motives of firms to arrive at a more complete understanding of the alternative options that they consider. Survey research and case studies can generate further insight into the considerations of companies, asking a much broader set of questions about the motives to engage in technology transfer and its organizational and contractual setting than is possible through database research. Third, a relatively unknown territory for future empirical research is found in the interaction of the legal set-up of various forms of technology transfer, their organizational setting, and the strategic implications of the choices that companies make when they transfer technology to other companies. In addition, future research could consider the actual learning effect for companies through these different forms of licensing. Obviously, these topics for future research also indicate the limitations to our current contribution, in terms of the relatively small sample for US companies, largely limited to a small number of industries, while we addressed only a small number of research questions. Given the exploratory nature of our contribution, we hope that despite some limitations, our work has explored a number of interesting subjects that lay out some of the groundwork for future studies.

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Addresses for correspondence

John Hagedoorn, Department of Organization and Strategy, Faculty of Economics and Business Administration, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands. e-mail: j.hagedoorn@os.unimaas.nl
Stefanie Lorenz-Orlean, Department of Organization and Strategy, Faculty of Economics and Business Administration, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands. e-mail: s.lorenz@os.unimaas.nl
Hans van Kranenburg, Nijmegen School of Management, Institute for Management Research, Radboud University Nijmegen, PO Box 9108, 6500 HK Nijmegen, The Netherlands. e-mail: h.vankranenburg@fm.ru.nl

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