



# Intellectual property rights and the governance of international R&D partnerships

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## Abstract

This paper studies the degree to which country differences in intellectual property rights protection affect the choice of companies for a particular mode of international inter-firm R&D partnering. It focuses on the preference of companies for either an equity joint venture or a contractual partnership. We find that international differences in intellectual property rights protection are a significant factor: with less secure protection, firms choose R&D joint ventures rather than contractual partnerships. The level of technological change in industries has an inverse effect on the preference for international R&D joint ventures.

*Journal of International Business Studies* (2005) 36, 175–186.  
doi:10.1057/palgrave.jibs.8400122

**Keywords:** international partnerships; intellectual property rights protection; R&D

## Introduction

This paper studies the effect of different regimes of intellectual property rights protection on the preference of companies for particular forms of international inter-firm R&D partnership. It particularly looks at the choice for either equity-based international R&D joint ventures or contractual international R&D partnerships. In this context, we shall pay attention to a number of specific issues that refer to the international differences in intellectual property rights protection and the role that technological change might play in all of this.

This contribution builds on a small number of previous studies, such as Pisano (1989) and Oxley (1999). Pisano's (1989) study was considering mainly intellectual property rights protection and the preference for particular forms of inter-firm partnership in the US biotechnology industry. His study suggests that companies prefer equity-based partnerships to contractual agreements when they are confronted with higher levels of specific knowledge transfer, when uncertainty surrounding partnerships increases, and when small-number bargaining conditions create risk. Oxley's (1999) seminal study on a somewhat similar set of questions presented an analysis of the choice between equity and contractual partnerships from the perspective of US companies within a limited number of high-tech sectors. Her study indicates that in international partnerships established during the 1980s both the nature of the actual transactions within a partnership and the 'quality' of the institutional environment for intellectual property rights protection

Received: 26 February 2003  
Revised: 18 August 2004  
Accepted: 30 August 2004  
Online publication date: 9 December 2004

affect the preference for equity or contractual partnerships. When US companies were partnering companies from countries with weaker intellectual property rights protection standards, they preferred to enter into an equity-based partnership rather than engage in a contractual agreement.

Following directions for further study mentioned in Oxley (1999), we shall analyse intellectual property rights protection and the preference of companies for particular forms of international partnerships for a wider range of industries and for companies from a large number of countries. We study over 2000 international partnerships set up by nearly 2000 companies from 53 countries. Our analysis will concentrate on a specific group of inter-firm partnerships, that is, international R&D partnerships, because in these joint R&D activities the protection of intellectual property rights is more crucial than in other forms of partnering such as standard customer-supplier relationships, second-sourcing or joint marketing agreements (Teece, 1986; Osborn and Baughn, 1990; Dussauge and Garrette, 1999).

Our research focuses on the period from the mid 1970s to the end of the 1990s when intellectual property rights protection, and in particular patent-related property rights protection, appeared to still diverge substantially between many countries at different levels of economic and technological development. Also, during that period many companies were still building up experience in international R&D partnering with companies from countries from a less developed intellectual property rights regime. As such, each of these new partnerships can be seen as a crucial strategic decision. In that sense, our contribution can highlight a number of important aspects of the international strategic behaviour of companies and their choices with regard to the form of international inter-firm partnering in the context of intellectual property rights protection.

In the following section, we shall develop a small set of hypotheses and some basic theoretical understanding of relevant phenomena. The subsequent section discusses our sample, data collection, and the variables that we shall analyse. After the presentation of the results, we shall discuss these results separately and draw some major conclusions with an outline of future research.

### Theory and hypotheses

In terms of organisational and legal features, the various inter-firm partnerships that share R&D

activities fall into two basic forms of governance: equity-based joint ventures and contractual R&D partnerships (Hagedoorn, 2002). Joint ventures are separate organisational units created and controlled by two or more parent companies. Within the spectrum of 'hybrids' between markets and hierarchies, joint ventures represent a relatively high level of hierarchical control, as parent companies share formal control over the joint venture through equity sharing (Harrigan, 1985; Williamson, 1996). In general, the ownership structure of joint ventures is determined by equity participation through the *ex ante* allocation of ownership shares to the parent companies. This generates a governance structure where the sponsoring companies can monitor the activities of the joint venture as they are represented on the board of directors. This equity sharing is also expected to align the motivation of the partners, creating mutual interests, which reduces the possibilities for opportunistic behaviour by partners (Pisano, 1989; Oxley, 1997). R&D joint ventures are examples of these semi-autonomous operating ventures that perform R&D and a number of other functions, usually extending their other activities into production, marketing and various services (Dussauge and Garrette, 1999; Hagedoorn, 2002).

Contractual R&D partnerships, such as joint R&D pacts and joint development agreements, cover common R&D activities of two or more companies on a project or programme basis. Such undertakings imply the temporary sharing of some R&D resources in R&D projects or R&D programmes for which companies agree on the shared input of human resources, technologies, laboratories and equipment. Compared with R&D joint ventures, contractual R&D partnerships are, owing to their intended temporary nature and their lack of equity sharing and organisational control, characterised by a lower level of hierarchical control (Oxley, 1999; Hagedoorn, 2002).

Given the fact that it is by definition impossible to contractually specify all concrete results of joint R&D in advance, while there is also no administrative and organisational control based on equity, these contractual R&D partnerships are to be seen as clear examples of incomplete contracts. More specifically, the incomplete nature of these contractual R&D arrangements is the result of two types of *ex ante* information deficiency that are affected by the uncertainty surrounding R&D. First, it is often extremely difficult, if not impossible, to anticipate the exact nature and extent of future

knowledge or to assess the potential of further application of this future knowledge, which is generated through cooperative R&D projects. The speed of technological development and the constant changes in R&D activities in many R&D-intensive sectors of industry add to the uncertainty regarding the assessment of the value of future knowledge (Freeman and Soete, 1997). Second, there is usually some degree of asymmetry in the knowledge capabilities of these partners because the sharing of identical capabilities would only generate some economies of scale but no economies of scope. This asymmetry in the context of the sharing and developing of information based on proprietary and tacit knowledge also implies that companies do not have a precise *ex ante* understanding of the value of the joint knowledge base of the partners to the extent that it can be written into a contract (Chi and Roehl, 1997).

#### **The preference for equity joint ventures or contractual partnerships**

The literature on the choice that companies make with regard to the governance structure of joint activities, such as equity joint ventures and contractual partnerships, focuses on three main topics: the monitoring of the actual collaboration, the enforcement of contractual terms, and the adequate specification of property rights (Pisano, 1989; Williamson, 1996; Oxley, 1999). Our understanding of the difficulties that companies might face with monitoring joint activities and enforcing contractual terms related to property rights suggests that the more relevant these difficulties are, the more likely it is that companies will prefer a more hierarchical mode of shared governance that increases their actual control, that is, control through a joint venture. Moreover, if inter-firm partnerships involve the exchange of technology, which is by definition the case when companies jointly undertake R&D, there is a chance of involuntary knowledge and technology leakage, indicating serious appropriability hazards (Teece, 1986; Oxley, 1997). *Ceteris paribus*, the higher the appropriability hazards in inter-firm partnering, the more companies will prefer the joint venture mode.

These particular aspects of decision-making with regard to the mode of governance for inter-firm collaboration seem highly relevant for understanding international R&D partnerships. As discussed in the above, joint R&D is by definition an uncertain activity for which it is very difficult, if not impossible, to define *ex ante* both the complete

results and their implications for future activities. Costs can be estimated for the short term, but the larger the R&D programme, and the longer its time horizon, the more difficult it will be to give an accurate estimate. Monitoring of R&D activities is possible but, in the case of international R&D partnering, the international nature of collaboration only adds to the uncertain nature of the activity. In international R&D cooperation the appropriability hazards could, owing to a lack of familiarity with circumstances in other countries, be even larger than in domestic inter-firm R&D partnering. Also, the enforcement of contractual terms for international R&D partnering depends largely on the specific legal system that regulates such partnerships. It is well known that there are large international differences in contract law, and the actual enforcement of such laws is even non-existent in many countries (Ginarte and Park, 1997; Varsakelis, 2001). Most relevant in the current context are the international differences in intellectual property rights protection. In general, the literature suggests that the more economically developed countries are, the more they have established a legal system that enforces contract law, and the stronger is their intellectual property rights protection (Marron and Steel, 2000; Varsakelis, 2001).

The above suggests a number of important questions with respect to the preference of companies for international R&D joint ventures or international contractual R&D partnerships in the context of:

- (1) international differences in intellectual property rights protection;
- (2) the role of technological change in their competitive environment.

In the following sections, these questions regarding some specifics of the governance of R&D partnering will be discussed further in a differentiated international and sectoral setting. Given the emphasis on the role of intellectual property rights protection and the appropriability hazard of knowledge leakage to partners, the hypotheses are formulated from the perspective of the company (partner) with its headquarters in the country with the higher level of intellectual property rights protection.

#### **The effect of international differences in intellectual property rights protection**

Countries show considerable differences with regard to important aspects of intellectual property

rights protection, such as the efficiency with which property rights can be established by those seeking legal protection. Other major differences refer to the broadness of the interpretation of property rights and the actual enforcement of property rights protection by the authorities. These international differences in intellectual property rights protection are most clearly demonstrated for patents. Ginarte and Park (1997) analyse these international differences in terms of five major categories of patent rights protection:

- (1) the extent of coverage, that is, the patentability of inventions in major patent classes;
- (2) the participation of a country in international agreements;
- (3) the provisions for loss of protection;
- (4) the legal enforcement mechanisms;
- (5) the duration of protection for a patent.

In general, the more economically developed a country is, the higher it scores on these dimensions of intellectual property rights protection (Rapp and Rozek, 1990; Ginarte and Park, 1997; Marron and Steel, 2000; Primo Braga *et al.*, 2000; Varsakelis, 2001). The level of intellectual property rights protection in a country is also an important predictor for its attraction of foreign direct investment (Dunning, 1993; Ferrantino, 1993; Lee and Mansfield, 1996; Seyoum, 1996; Mille, 1997; Saggi, 2000; Smarzynska, 2002) and international trade (Ferrantino, 1993; Fink and Primo Braga, 1999).

The effective protection of intellectual property rights through patent laws and related measures reduces the risk for companies when they engage in various international activities that demand foreign direct investment, extensive and long-term trading relationships or international inter-firm partnering. Essentially, any international transaction with a company from a country with a well-established intellectual property rights regime is less likely to be subject to substantial appropriation hazards than transactions with companies from countries that offer little or no protection (Lee and Mansfield, 1996). Given the moral hazard in joint R&D, where, as discussed in the above, there is always the risk of unanticipated knowledge leakage, intellectual property rights protection in international R&D partnerships can be expected to be even more relevant than in most other international transactions and investments. Therefore, the strength of intellectual property rights protection in particular countries is expected to be an important institutional and environmental factor in the

choices that companies make when they engage in international R&D partnerships (Muralidharan and Phatak, 1999).<sup>1</sup>

Companies from a domestic environment characterised by substantial intellectual property rights protection are confronted with higher appropriability hazards and potentially subsequent costs when they engage in contractual agreements with companies from countries with relatively poorer conditions of intellectual property rights protection. Equity joint ventures are expected to be reserved for circumstances with such greater appropriability hazards because they offer managerial and organisational control and increase the possibilities for adequate monitoring and oversight (Teece, 1986; Oxley, 1999). This implies that companies from countries with relatively well-developed systems of intellectual property rights protection will, owing to increased appropriability hazards, prefer to form equity-based R&D partnerships rather than contractual R&D partnerships with companies from countries with less developed systems of intellectual property rights protection. Hence:

**H1:** The preference of a company for hierarchical control in an international R&D partnership is inversely related to the level of intellectual property rights protection in the home country of its partner.

### The effect of sectoral technological change

Contributions by Harrigan and Newman (1990), Ciborra (1991), Eisenhardt and Schoonhoven (1996), Gomes-Casseres (1996), Oster (1999) and Hagedoorn and Duysters (2002) suggest that, in general, inter-firm partnerships are associated with sectors of industry where learning and flexibility are important features of the competitive landscape. Under these conditions, companies learn from a variety of partners in a flexible setting of temporary partnerships. Link and Bauer (1989), Mytelka (1991), Dussauge and Garrette (1999) and Hagedoorn (2002) indicate that many of these partnerships are concentrated in a limited number of mainly R&D-intensive industries.

A related body of literature suggests that the level of technological change in industries might influence the preferred form of governance for partnering by companies. According to Harrigan (1985, 1988), rapid technological change in industries induces the formation of somewhat informal forms of partnering such as non-equity, contractual

partnerships. Osborn and Baughn (1990) suggest that the technological instability of industrial sectors is a crucial factor in explaining different patterns for joint ventures and contractual partnerships. Yu and Tang (1992) emphasise that stable sectoral environments favour joint venturing as the main form of inter-firm partnering, whereas unstable sectoral environments lead to a preference for contractual arrangements. Auster (1987) and Hagedoorn and Narula (1996) found that companies involved in international partnerships preferred contractual agreements to equity-based partnerships as the technology involved became more sophisticated.

Although these contributions differ with respect to their theoretical backgrounds, major research questions and the actual indicators used in research, a general picture emerges from this literature. Contractual agreements are particularly preferred in high-tech industries, that is, sectors with high levels of technological change, whereas joint ventures play a role of disproportionate importance in other industries. We expect similar patterns for joint ventures and contractual alliances in international R&D partnering. This implies that the form of governance for international R&D partnering, as chosen by companies, is probably also affected by the level of technological change in the industry in which their international R&D partnering takes place. Thus:

**H2:** The preference of a company for hierarchical control in an international R&D partnership is inversely related to the level of technological change in the sector of industry in which an international R&D partnership is established.

## Research methods

### Sample and data collection

We shall analyse a sample of 2005 international R&D partnerships, taken from the MERIT-CATI databank. These 2005 partnerships are sponsored by 1956 companies from 53 countries. Of these international R&D partnerships, 35% are joint ventures and 65% are contractual R&D partnerships.

The MERIT-CATI databank contains information on thousands of technology-related inter-firm partnerships in various sectors, ranging from high-technology sectors such as pharmaceutical biotechnology to less technology-intensive sectors such as food and beverages. Various sources from

the international financial and specialised technical press were consulted to systematically collect information on inter-firm partnerships. Within the databank there is information on each partnership, and some information on companies participating in these partnerships. Partnerships are defined as mutual interests between independent companies that are not linked through majority ownership. Agreements formed between companies and governmental or academic institutions are generally not included in the database unless they involve at least two commercial companies. The current CATI database records only those partnerships that involve some form of jointly undertaken R&D. Information is collected primarily on joint ventures with R&D activities and contractual R&D partnerships such as R&D pacts and joint development agreements. Other types of agreement such as production and marketing partnerships are not included. In other words, this material is related primarily to R&D collaboration and technology development, that is, those partnerships for which a combined innovative activity is at least part of the agreement (see also Hagedoorn, 2002).

Our research covers the period 1975–1999. The international R&D partnerships formed between the pairs of companies in this sample are unique and first combinations, adding to the crucial nature of their choice for a particular governance structure for an R&D partnership.

### Dependent variable

Our hypotheses associate the differences in the regime of intellectual property rights protection in the home countries of partnering companies and the sectoral level of technological change with the governance structure of R&D partnerships, that is, the preference for an equity R&D joint venture or a contractual R&D partnership. The dependent variable represents the choice of the governance structure for each R&D partnership from the perspective of the partner from the country with the highest level of intellectual property rights protection. This dependent variable, *R&D partnership*, is coded 1 if the partnership is organised as an equity joint venture and 0 if the partnership is organised as a contractual partnership.

### Independent variables

The ratio that measures the difference in intellectual property rights protection in the home countries of partnering companies, *international IPR ratio*, indicates the basic international

dissimilarities in intellectual property rights protection (Hypothesis 1). The measure of country differences in the intellectual property rights protection index is based on the information found in Ginarte and Park (1997) and additional data provided by Walter Park. As already explained in the above, their index refers to a number of major categories for patent rights protection. Previous research indicates that the level of patent protection appears to be a good indication of the more general level of intellectual property rights protection (Marron and Steel, 2000; Ostergard, 2000). Ginarte and Park (1997) provide an index of patent rights protection with 5-year intervals for a large number of countries.

For our analysis, the relevant indexes refer to the years 1975, 1980, 1985, 1990 and 1995. We shall relate each R&D partnership and the countries of the sponsoring companies to the first year of the interval given for these patent rights protection indexes. For instance, all partnerships found in the year 1977 refer to the patent rights protection indexes for the earlier year 1975. It turned out that taking the later year for which patent rights protection indexes are available, in this case 1980, does not have a significant effect on the measurement of this variable. In the actual statistical analysis, we shall apply ratios for the indexes of patent rights protection to measure the difference in the intellectual property rights protection of the home countries of both partners. Given the positive values of ratios, where differentials indicate the degree to which the intellectual property rights protection in the home country of the partner are weaker, the actual measurement of this ratio was transferred to a negative value in order to interpret the findings in the context of the expected inverse relationship mentioned in Hypothesis 1.

The variable for *sectoral technological change* (Hypothesis 2) measures the average R&D intensity of sectors of industry during the 1980s and 1990s as given in various OECD publications. This R&D intensity indicates the degree to which companies in industries devote resources to R&D that generate a continuous flow of newly developed technologies, new products and new processes, representing differences in the degree of sectoral technological change (OECD, 1992; Freeman and Soete, 1997). R&D intensities measure the R&D expenditures as a percentage of output, ranging for instance from 22.7 for aerospace and defence to 0.8 in food and beverages (OECD, 1992). We recoded the OECD

classification of industries to the industry categories found in the MERIT-CATI database.

### Control variables

Consistent with prior research on international partnerships, we included a number of control variables for the specific characteristics of the two companies in each international R&D partnership and for some general characteristics of the countries from which partners originate. The literature indicates that the size of companies and their size differences might play a role in the partnership formation process of companies (Berg *et al.*, 1982; Harrigan, 1988; Mytelka, 1991; Hagedoorn and Schakenraad, 1994; Oxley, 1997; Hagedoorn and Duysters, 2002). However, the empirical findings from these studies appear to be somewhat inconclusive. The variable *size ratio* indicates the actual difference in size between the partnering companies. The size of each company is measured in US\$ million sales for the year the partnership was established. Information on the size of companies was accessed through well-known databases such as Amadeus, Compustat, Disclosure, Securities Data and Worldscope.

The experience of companies with setting up partnerships is known to affect their partnering behaviour positively (e.g. Ring and van de Ven, 1992; Gulati, 1995; Barkema *et al.*, 1997; Dyer and Singh, 1998). The variable *average experience* measures the average of a simple count of previous partnerships for the two companies in the R&D partnership (Oxley, 1999). The variable *ratio of total experience* indicates the degree to which companies in a partnership differ in their actual experience with setting up inter-firm R&D partnerships. It is calculated as the count of the previous partnerships made by the company from the country with the higher level of intellectual property rights protection divided by the count of the previous partnership made by its partner. Both control variables for experience count the number of all relevant R&D partnerships of both companies, found in the MERIT-CATI database, established since 1970 but prior to the specific international R&D partnership formed between the two companies.

The formation of R&D partnerships can also be influenced by the difference in innovative capabilities of companies, where larger differences indicate that the 'leading' company would prefer to form an equity partnership to have more control in order to reduce appropriability hazards (Teece, 1986; Oxley, 1999). The *ratio of patenting* expresses the degree to

which companies have similar or dissimilar strengths in innovative capabilities. The actual measurement is the number of patents that companies have obtained during a 5-year period prior to their R&D partnership, while controlling for size differences. Data on patents are taken from the US Patent and Trademark Office database (US Department of Commerce). Although these US data could imply a bias in favour of US companies and against non-US firms, the patent literature suggests several reasons for choosing US patent data (e.g. Patel and Pavitt, 1991). Frequently mentioned are the importance of the US market, the genuine patent protection offered by US authorities, and the level of technological sophistication of the US market, which makes it almost compulsory for non-US companies to file patents in the USA.

We included two more or less standard control variables from the international business literature that characterise differences between the countries from which companies in an international R&D partnership originate. For *cultural distance* we have used the well-known Kogut and Singh (1988) index of cultural differences between countries, based on Hofstede (1980). The *ratio of the openness of the economy* refers to the ratio between two countries in their share of total trade (exports plus imports) to real GDP per capita (Summers and Heston, 1991). For each of these country-based variables, we expect that larger ratios might positively affect the choice for equity R&D partnerships because these dissimilarities imply a certain degree of unfamiliarity for first-time collaborators. Finally, we include a trend variable, *time*, to account for a possible growth in the total number of R&D partnerships over time and a gradual change in the distribution of equity R&D partnerships and contractual partnerships (Hagedoorn and van Kranenburg, 2003).

This trend variable was calculated by assigning a value to each specific year, corresponding to the 'distance' to the first year of the period under investigation, that is, 1975.

## Results

Table 1 presents the descriptive statistics and the correlation matrix for the variables in this study.

Table 2 provides the results of a stepwise logit analysis. Given the unambiguous nature of the results for the various models, we shall discuss only the results for the full model (model 4). Compared with the other models, this full model has the expected lowest log-likelihood value. Turning to the hypothesis testing, it is clear that the results demonstrate strong support for the hypotheses. Consistent with Hypothesis 1, the results indicate that the preference of companies for hierarchical control, through a joint venture mode for international R&D partnering, is inversely related to the strength of intellectual property rights protection in the home country of their partner. We also predicted that the level of technological change in an industry would have an inverse effect on the preference of companies for hierarchical control in international R&D partnerships (Hypothesis 2). Our results do indicate that there is a significant negative effect, which suggests that establishing international R&D partnerships in industries characterised by higher levels of technological change decreases the likelihood that these partnerships will take the form of equity joint ventures.

As for the effects of the control variables, it turns out that the variables for the size ratio, both experience variables and the ratio of the openness of the economy, have an insignificant impact on the choice for equity or contractual R&D partnerships. Apparently, size differentials do not affect the

**Table 1** Descriptive statistics (means and standard deviations (s.d.)) and bivariate correlations for all variables,  $N=2005$

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9
1 Dependent variable	0.35	0.48									
2 International IPR ratio	-1.24	0.63	-0.084								
3 Sectoral technological change	8.74	5.28	-0.307	0.056							
4 Size ratio	270.21	7410.52	-0.024	0.005	0.006						
5 Average experience	18.33	39.70	-0.043	0.030	0.052	-0.004					
6 Ratio of total experience	7.71	22.59	-0.006	-0.036	0.053	0.027	0.127				
7 Ratio of patenting	172.52	594.46	0.061	-0.026	-0.017	0.010	0.065	0.223			
8 Cultural distance	1.57	1.36	0.073	0.005	-0.059	-0.029	0.279	0.089	-0.033		
9 Ratio of openness of the economy	0.84	0.76	0.014	0.006	0.022	0.013	0.030	0.078	-0.042	0.300	
10 Time	15.24	6.33	0.150	-0.029	0.183	0.045	0.184	0.150	-0.021	-0.088	-0.047

**Table 2** Estimation results of binomial logit analysis

<i>Variable</i>	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>
Constant	1.1011*** (0.1417)	-0.0073 (0.2939)	1.7088*** (0.1617)	0.8690*** (0.3184)
International IPR ratio		-0.9502*** (0.2225)		-0.7046*** (0.2323)
Sectoral technological change			-0.0999*** (0.0090)	-0.0970*** (0.0091)
Size ratio	-0.0003 (0.0005)	-0.0003 (0.0004)	-0.0003 (0.0004)	-0.0002 (0.0004)
Average experience	-0.0007 (0.0011)	-0.0004 (0.0012)	0.0001 (0.0013)	0.0005 (0.0015)
Ratio of total experience	0.0045 (0.0028)	-0.0035 (0.0029)	0.0052* (0.0030)	0.0046 (0.0030)
Ratio of patenting	0.0002** (0.0001)	0.0001* (0.0001)	0.0002** (0.0001)	0.0002* (0.0001)
Cultural distance	0.0840** (0.0366)	0.0895** (0.0375)	0.0544 (0.0395)	0.0616 (0.0404)
Ratio of openness of the economy	-0.0403 (0.0616)	-0.0333 (0.0622)	-0.0122 (0.0658)	-0.0115 (0.0666)
Time	-0.1235*** (0.0092)	-0.1270*** (0.0093)	-0.1078*** (0.0097)	-0.1111*** (0.0099)
<i>N</i>	2005	2005	2005	2005
Log likelihood	-1308.948	-1293.150	-1183.111	-1173.955

Standard errors in parentheses.

 \*Significant at  $p < 0.10$ ; \*\*significant at  $p < 0.05$ ; \*\*\*significant at  $p < 0.01$ .

particular choice that companies have to make for the form of an R&D partnership. We also found no effect of the experience that companies have with setting up partnerships on the structure of their international partnership. The variables indicating the degree to which companies differ with regard to the openness of the economy in their home country and the cultural distance between partners also do not seem to affect their choice for any particular form of international R&D partnering.

The other control variables do have a significant effect on the preference for a particular form of governance of international R&D partnerships. We found a positive, significant effect for the degree to which companies have dissimilar strengths in innovative capabilities, indicating that, with increasing differentials in these capabilities, companies appear to prefer R&D joint ventures. Also, the negative time trend shows that there is a clear general tendency to gradually change to a preference for contractual R&D partnerships.

In addition to the variables applied in the above, we used a set of complementary variables such as various measures for political risk in home countries of partners and the patenting intensity of the home countries of partners. These variables were highly correlated with the intellectual property rights protection in countries, and consequently they were dropped from the analysis (see also Oxley, 1999; Sampson, 2004). We also analysed the role of nominal differences for ratio-based variables, and we applied log-transformed measures of these nominal differences in order to control for

very large dissimilarities between partners. Both exercises led to similar results.

## Discussion

The above demonstrates that intellectual property rights protection is an important aspect in the decision-making regarding international inter-firm R&D partnering. Admittedly, intellectual property rights protection refers to a wider group of intellectual properties than just patents. However, the international differences in the efficiency of patent protection, the broadness of patent protection, and the actual enforcement of patent laws (Ginarte and Park, 1997) do indicate a general intellectual property rights protection climate in a country (Marron and Steel, 2000; Ostergard, 2000). Apparently, companies do realise that in that context international R&D partnerships can create serious appropriability hazards unless the necessary precautions are taken (Teece, 1986; Oxley, 1997). International R&D partnerships appear to carry all the flags that caution companies, in particular if they are dealing with first-time encounters with foreign partners. These precautions can be taken by creating equity-based control in setting up separate organisational entities, that is, joint ventures, which allow for continuous monitoring of the joint R&D activities. This monitoring is possible because usually each sponsor is, based on its equity participation, represented in the management of the joint venture. An important finding of this study is that international differences or similarities in intellectual property rights protection seem to



affect the preference for contractual or equity-based inter-firm R&D partnerships.

The emphasis in this study on R&D partnerships highlights an important aspect of the appropriability hazards of shared activities, that is, the possible leakage of knowledge. R&D partnerships are, given the complementary nature of most partnerships, characterised by information asymmetry that increases the potential risk of knowledge leakage (Chi and Roehl, 1997; Hagedoorn, 2002). International differences in intellectual property rights protection seem to also indicate major differences in country levels of technological capabilities (Rapp and Rozek, 1990; Ginarte and Park, 1997; Primo Braga *et al.*, 2000). This implies that, apart from the fundamentally intrinsic uncertainty of R&D, international cooperation without adequate safeguards to counter involuntary knowledge transfer would further increase the uncertainty that already surrounds the outcome of joint R&D. Joint ventures provide better protection and monitoring than incomplete contracting through R&D pacts and joint development agreements. Support for this particular aspect of our understanding of the preference for particular forms of governance is also found in the positive effect of differences in innovative capabilities in pairs of companies on their preference for equity-based international R&D partnerships.

Important aspects of the above confirm some findings in previous research by Oxley (1997) and Sampson (2004). However, our contribution also demonstrates that the relationship between international intellectual property rights protection and the preference for particular forms of governance of inter-firm partnering is of a general nature. Our research shows that this relationship is relevant not only for understanding the behaviour of US companies and their choices with regard to organising their international R&D partnerships. It also extends to companies from a large variety of other countries that are confronted with asymmetries in intellectual property rights protection. Our findings also demonstrate that these insights are not only relevant for a small number of high-tech industries but also that they appear appropriate across-the-board of a wider range of industries. Furthermore, although a large number of countries partially closed the gap in intellectual property rights protection regimes in the context of Trade Related Aspects of Intellectual Property Rights (TRIPS) of the Uruguay Round of the GATT negotiations, major differences in intellectual property rights

protection are still in effect. In that context, our results indicate that the relationship between international intellectual property rights protection and the preference for particular forms of governance of inter-firm partnering was still valid at the end of the 1990s.

The level of technological change in sectors of industry also affects the preference of companies for particular modes of governance for international R&D partnering. The more industries are characterised by intensive R&D and technological changes that create a constant flow of new products and new processes, the more flexibility and organisational change appear to be relevant for companies in those industries (Harrigan, 1988; Oster, 1999). In particular, contractual R&D partnerships play a major role in attempts made by companies to answer the need for organisational flexibility as they are constantly adjusting to frequent technological changes while monitoring new technologies and introducing crucial innovations themselves (Gomes-Casseres, 1996; Dussauge and Garrette, 1999; Oster, 1999). This does not apply only to domestic partnerships; sectoral technological changes also affect the preference for particular modes of governance of international R&D partnerships. The findings of this study confirm previous studies that suggest that joint ventures are preferred in stable environments with relatively little technological change, whereas flexible, short-term contractual partnerships are preferred in dynamic environments characterised by higher levels of technological change (Osborn and Baughn, 1990; Hagedoorn, 2002).

Although not a central topic in our research, the results for some variables are relevant for understanding some important questions regarding the bearing of transaction or firm-level characteristics on the type of partnership. Findings by Oxley (1997) indicate that firm-level attributes such as size (differences), experience with setting up partnerships, innovativeness of companies and the industry in which a partnership operates would have no effect on the form of inter-firm partnerships. Our research does indeed indicate similar findings for size differentials between partners and their experience with inter-firm partnering. However, differences in the innovativeness of partnering companies and their sectoral technological settings clearly play a role in our analysis. This indicates that, in the context of international R&D partnering, firm-level characteristics crucial to the specific aim of this group of partnerships, that is,

the sharing and joint undertaking of R&D, are important aspects to be considered when contemplating the mode of governance for R&D partnerships. The larger the differential between the innovative capabilities of partners, the more the 'leading' company will search for protection of these capabilities by means of equity joint ventures.

The finding that, contrary to some other studies, the experience with previous partnerships does not have a significant effect on the governance of international R&D partnerships can largely be explained by the specific historical situation with regard to R&D partnering. The number of R&D partnerships did not really grow until the latter part of the period under investigation, which implies that most companies were able to build up substantial experience only towards the end of the period. In addition to this, it appears that companies might realise that experience as such can help them assess a new situation, but a new R&D partnership with a company from a less developed IPR regime warrants a careful consideration of control issues in international R&D partnerships.

### Conclusions

International differences in intellectual property rights protection are a significant factor for companies to consider when engaging in international R&D partnerships. When companies find themselves in an environment with less secure intellectual property rights protection, they tend to choose equity-based R&D joint ventures rather than contractual partnerships. The level of technological change in industries has an inverse effect on the preference for international R&D joint ventures. International contractual R&D agreements, characterised by organisational flexibility, are preferred in R&D-intensive and innovative industries.

Although this study does reveal some very important aspects of intellectual property rights protection and international R&D partnering, it still has certain limitations that indicate an agenda for future research. First of all, there is still a clear

need for further studies based on larger samples than the one used in this study. The current sample is already larger, referring to a longer and more recent period, and also more differentiated in terms of industries and countries than the samples in other studies. Nevertheless, future studies could focus on a larger variety of forms of inter-firm partnering, an even larger group of countries and a more disaggregated sample of industries. Second, other forms of intellectual property rights protection than patent protection, such as copyright and software protection, seem to have become important since the early 1990s. A combination of a study of recent developments in other forms of intellectual property rights protection with recent trends and patterns in inter-firm partnering could generate additional insight into the management of external knowledge transfer in an international context. Third, a better understanding of the actual transfer of knowledge in international partnerships could benefit from research using a wider range of detailed firm-level indicators, a better comprehension of sectoral characteristics, and more sophisticated country-level measures than those currently available.

### Acknowledgements

We thank John Cantwell, Nicolai Foss, Bo Nielsen, Joann Oxley, two anonymous referees of this journal, and participants at seminars at the National University of Singapore, Maastricht University, the Academy of International Business, Stockholm, July 2004, and the Academy of Management, New Orleans, August 2004, for valuable feedback on earlier versions of this paper. We are particularly grateful to Walter Park for providing additional data on international intellectual property rights protection.

### Notes

<sup>1</sup>As suggested by one of the reviewers, taxation, subsidies, governmental protection and other institutional factors might also have some effect on the organizational and contractual choices that companies make.

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*Accepted by Nicolai Juul Foss, Departmental Editor, 30 August 2004. This paper has been with the authors for two revisions.*