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# PROTECTING INTELLECTUAL PROPERTY IN INTERNATIONAL ALLIANCES: AN EMPIRICAL STUDY

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## Abstract

When firms establish international alliances, they face a difficult question: "How can we promote technology transfer and learning without losing control of valuable intellectual property?" I examine the role of equity in mitigating such "appropriability hazards" in international alliances and find that US firms use equity in alliances with firms from countries with weak intellectual property protection, and rely on contracts (non-equity alliances) when they have confidence in the security of intellectual property rights.

# 1. INTRODUCTION

The last two decades have seen significant changes in the global economy, particularly in the degree of interlinking of firms from an expanding group of industrialized and industrializing countries. Driven by regional economic integration, geographic diffusion of technological capabilities and lingering barriers to high technology trade and investment, international alliances and joint ventures have proliferated. Many of these alliances are formed with the explicit aim of pooling technological resources and leveraging valuable intellectual property. Firms wishing to establish alliances thus face a difficult question: "how can we promote technology transfer and learning in an alliance, without losing control of valuable intellectual property?" This question takes on particular urgency for US firms in alliances with companies from countries with weak intellectual property protection, such as China, India or Brazil; countries which nonetheless hold the promise of potentially high long-term rewards for US firms investing there.

Transaction cost economics (Williamson 1975; 1985; 1996) suggests that the challenge for alliance participants is to create a governance structure that supports the exchange of know-how while safeguarding against the hazards of opportunism. The theory further suggests that one critical safeguard against technology leakage is the establishment of a separately incorporated equity joint venture. The sharing of equity ownership between the partners in such a venture reduces the incentives of either party to cheat on the spirit of the agreement and encourages jointly optimal behavior. In addition, joint managerial control enhances partners' ability to monitor alliance activities.

In this paper, I examine the choice between contract-based alliances (such as licensing and technology sharing agreements) and equity joint ventures. I argue that in situations where leakage of intellectual property is a significant problem, US companies are more likely to choose equity joint ventures over contract-based alliances. The danger of intellectual property leakage, or so-called "appropriability hazards" are predicted to be higher in alliances with firms based in countries with weak intellectual property protection. However, not all transactions or projects are

equally vulnerable to leakage, and so the model of appropriability hazards tested in the empirical analysis also includes transaction-level characteristics, such as the types of activities involved, and the technological and geographic scope of the alliance. Competing explanations of national differences in alliance structure, related to government regulations or aspects of national culture such as trust, are also tested through inclusion of relevant control variables in the estimation.

Strong support for the central hypothesis is observed. Agreements involving firms from countries where intellectual property protection is weaker are more likely to be organized as equity joint ventures, ceteris paribus. There is also some evidence that equity joint ventures are preferred when agreements involve firms from countries with lower levels of societal trust, and when the nature of the transaction is such that there are significant specification and monitoring problems. The study complements and extends previous empirical work by combining transaction-level and country-level data, providing the first large-scale empirical examination of the role of appropriability hazards and national differences in the protection of intellectual property on the governance of international cooperative agreements.

The paper is organized as follows: the transaction cost theory of appropriability hazards and governance of international alliances is developed in Section 2, highlighting the impact of national differences in intellectual property protection. Section 3 surveys the relevant empirical literature and describes potentially competing explanations for cross-national differences in the governance of interfirm alliances. The empirical analysis is described and discussed in Section 4, and Section 5 concludes.

## 2. APPROPRIABILITY HAZARDS IN INTERNATIONAL ALLIANCES.

If a firm holds valuable intellectual property which can best be exploited in combination with assets (either technological or otherwise) held by a firm based in another country, a strategic alliance with the foreign firm is an attractive option. Such an alliance can take many forms, ranging from a simple technology license or other contract-based alliance such as a technology sharing agreement, to the establishment of a separately incorporated equity joint venture. In

choosing among these organizational forms, transaction cost theory suggests that a useful initial question to ask is, "if we rely on a simple contractual arrangement between the two (or more) firms, what problems are likely to arise?"

Writing and executing a reliable simple contract for the use of technology involves a three-stage process: (i) specification of property rights; (ii) monitoring and; (iii) enforcement. A simple contract for the use of a technology must specify, in detail, the property rights involved, i.e. what, precisely, is the asset that is being transferred, what rights of use, modification and/or resale are (and are not) intended in the contract, etc. The ease with which these rights can be specified is largely a function of the type of asset involved. At the most basic level, if the contract is designed to govern the creation rather than the exploitation of technology (as is the case in an R&D contract, for example), specification will inevitably be problematic, as the assets don't exist at the time the contract is written, and technological innovation is a highly uncertain process. However, even for existing assets, specification is not necessarily straightforward. The degree of "tacitness" of know-how is one relevant consideration. Since tacit know-how is, by definition, difficult to articulate, precise specification in a contract of the relevant intellectual property rights is impossible for such know-how (Hennart, 1988). The age of a technology is also an important factor: contracts are more difficult to specify for novel technologies (particularly those embodying a radical change from previous methods) because the buyer and seller will share even less of the tacit know-how associated with its application than is usual for more "routine" innovations (Davidson & McFetridge, 1984).

Specification of property rights is not in itself sufficient to ensure the security of a contract for the use of an asset. If the owner of the intellectual property is to have confidence that the users of the asset will confine their activities to those provided for in a licensing agreement, they must be able to monitor the scope of the activities, and enforce the terms of the agreement. The magnitude of monitoring requirements will again depend on the nature of the technology involved, and the degree of tacitness. Increases in the number of products or technologies included in a contract, or increases in the geographic scope of the transaction will also increase

the difficulty and cost of monitoring all the relevant activities involved in contract execution. Similarly, if contracts are used to govern a project involving multiple firms, monitoring costs will increase with the number of partners involved.

Where a contract for technology transfer can be adequately specified and monitored, the focus shifts to the problem of enforcement in the event that a violation is detected. Enforcement of intellectual property rights in international alliances can be problematic. Imitators "inventing around" patents is an allegedly common problem in some industries (Teece, 1986). Specific provisions of intellectual property laws may also actually limit protection for some technologies. In the US there are no specific exclusions from patent protection, other than "laws of nature," but this is often not the case in other countries, as discussed below.

### 2.1 National Differences in Intellectual Property Protection

When firms attempt to protect technology that they are transferring across national borders, they are faced with a complex variety of legal rules and procedures. Many countries (108 as of 1993) are signatories to the 'Paris Convention for the Protection of Industrial Property,' which requires each contracting country to grant the same protection to foreign nationals as it grants to its own citizens. However, the convention does not specify actual standards of protection, and the level of intellectual property protection varies significantly across countries. Some of these differences are in the types of protection available for various technologies--for instance, in India, product patents are not issued for chemicals, alloys, optical glass, semiconductors and intermetallic compounds (in contrast to most other countries). In addition, some countries require firms to license various patented technologies to local firms (e.g. for drug patents in India and the Philippines), sometimes at very low royalty rates (Mansfield, 1994, p. 10). [1]

Other differences occur in the general rules governing patents: for example, whether a patent holder must work the invention within a specified time limit for it to remain valid, whether the patent application is kept secret until a patent is granted and whether the patent is awarded to

the party who can show that they were the 'first-to-invent' (as in the US) or if it is simply awarded to the 'first-to-file,' i.e. apply, for the patent (as in most other countries). These differences in the patent laws, while often arcane, can have a significant effect on the ease of obtaining a patent, and may have the effect of discriminating against foreign firms. For example, according to a 1993 survey on patent-filing costs in 32 countries, the cost of filing in Japan for foreign applicants was the highest in the world, due to "translation costs and fees charged by "benrishi" (Japanese patent attorneys)" (US General Accounting Office, 1993, p. 34). Furthermore, patent enforcement relies on the general enforcement powers of the courts--where the judicial system is corrupt, or where property rights and contracts are not respected, firms' ability to contract for the use of valuable intellectual property will be compromised.

Ranking countries by the 'strength' of their intellectual property rules is hampered by the multi-dimensionality of protection, and the lack of agreement as to what constitute optimal rules. However, for multinational operations, the similarity of intellectual property rules in the home country and the foreign country where operations are located is an important consideration, as this reduces the liability of "foreignness." Also, from the point of view of a patent holder, "better" intellectual property protection is achieved when property rights are easy to establish, are interpreted broadly and are strictly enforced, with substantial penalties for noncompliance.

### 2.2. Implications for Governance

Most product transactions today involve technology in some form and, in most cases, classical market arrangements (i.e. spot contracts) work well. However, difficulties encountered at any of the three stages of contracting for technology--specification of intellectual property rights, monitoring, or enforcement--will lead to an increase in appropriability hazards, and a move towards more hierarchical forms of organization. For international strategic alliances, this means a move from contract-based alliances such as licensing or technology sharing agreements, to equity joint ventures. The sharing of equity in a joint venture works to mitigate appropriability hazards in several ways: Joint ownership reduces the incentives of either party to cheat on the

letter or spirit of the agreement and encourages jointly optimal behavior. In addition, joint managerial control and shared board membership enhance each partner's ability to monitor alliance activities (Pisano, 1989).

These benefits of equity sharing, or hierarchy, do not come without cost, however. Attenuated incentives mean that the technology may not be exploited in its best use, or to its fullest extent, so equity joint ventures will be reserved for situations where appropriability hazards are more severe. The strength of intellectual property protection is one important factor in the institutional environment for international alliances involving technology transfer. Weak protection of intellectual property will tend to raise the cost of relying on contract-based alliances in relation to equity joint ventures, and will therefore tend to encourage joint ventures for a wider range of transactions, relative to contracts, ceteris paribus.

The ceteris paribus condition is of critical importance in this last statement. As the theoretical discussion suggests, appropriability hazards (and hence governance choice) do not only depend on the legal environment in which an alliance takes place. In addition to concerns about enforcement, the ease of specification and monitoring inherent to the transaction must also be taken into account. Furthermore, if a firm is considering an alliance in an environment of weak protection, it must make two simultaneous decisions: what technology will be shared or transferred and how that transfer will be governed. If the firm responds to weak protection by only undertaking transactions that are easy to specify, monitor and enforce, then this may skew the observed cross-national pattern of alliances. Hence, in empirical analysis, we must simultaneously consider characteristics of the transaction which affect contract specification and monitoring difficulties, along with enforcement issues. We expect that the degree of hierarchical control in alliances with foreign firms will be greater for transactions where specification of property rights is difficult (e.g. where asset creation is involved, or where the know-how is highly tacit) or where monitoring is difficult (e.g. where the technological or geographic scope of the agreement is large, or where multiple partners are involved).

## 3. COMPETING EXPLANATIONS: A REVIEW OF THE LITERATURE

To date there has been little research on the effect of cross-national differences in appropriability regime on the governance of international alliances. However, one recent study (Mansfield, 1994) examines the relationship between intellectual property protection, direct foreign investment (DFI) and technology transfer, (including the composition of DFI), and provides some support for the general contention that the adequacy of intellectual property protection has a significant influence on the organization of international technology transfers. Using a combination of survey data, interview studies and statistical analysis, Mansfield found that the perceived weakness of protection is inversely related to the total amount of US direct investment in a country (even controlling for other economic factors). Furthermore, for those countries where protection is very weak, the survey results suggest that US firms are only willing to transfer technology to equity joint ventures or wholly owned subsidiaries. Thus, for example, the vice president for R&D at a chemical firm is quoted as follows:

> We have no situation where we decided not to transfer advanced technology to a country having weak intellectual property laws solely because of [intellectual property] laws. However...we have transferred our advanced technology only to overseas affiliates or joint ventures where we have a substantial equity position, and therefore a strong voice in management. (ibid, p. 26)

Perhaps the most prominent competing explanations for cross-national differences in the governance of interfirm arrangements are those which rely on some aspect of cultural differences. Granovetter (1985), for example, argues that the social network in which actors are embedded shapes the flows of information between them, and influences the ways in which they interact and do business. Shane (1992) provides some support for this proposition, focusing on the issue of "societal trust." In an analysis of aggregate US licensing activity and direct foreign investment in 33 countries, Scott concludes that US firms prefer more hierarchical arrangements when allying with firms from "less trusting" cultures. For the choice between contract-based alliances and equity joint ventures, this would imply that greater reliance on contract-based alliances will be found in "high trust" cultures.[2]

Turning to other aspects of culture, Kogut and Singh (1988) examine foreign entry into the US market, and analyze the effect of "cultural distance" and "uncertainty avoidance" on the choice between acquisition, wholly owned greenfield investment and joint ventures. They find that the more dissimilar the culture of the investing firm's home nation and the culture in the United States, or the greater the uncertainty avoidance of the investing firm's national culture, the more likely is the firm to choose a joint venture or wholly owned greenfield over an acquisition. Kogut and Singh argue that culture distance increases the relative cost of acquisitions because of difficulties in integrating an already existing foreign management. This argument would suggest that the cost of joint ventures (with their shared management responsibilities) are also raised, relative to contract-based agreements. However, cultural distance may also increase contracting costs related to monitoring and enforcement (due to a lack of familiarity with the relevant aspects of the cultural and legal system), which raises the cost of contracts relative to joint ventures. Uncertainty avoidance may have similarly conflicting effects, and so the impact of these cultural factors on the choice between an equity joint venture and contract-based alliances is ambiguous.

The role of government-imposed foreign investment restrictions in cross-national governance differences is analyzed in Contractor (1990). This study examines the relationship between the proportion of majority versus 50-50 (or minority) affiliates of US firms, and changes in foreign governments' restrictions on US direct investments. Using data from the 1982 Benchmark Survey (US Department of Commerce, 1985), Contractor finds that an across-the-board reduction in foreign investment restrictions in the early 1980s was accompanied by a "small but unequivocal reduction in the share of sales of minority affiliates (as a fraction of all US affiliates) in all but a handful of countries." (p. 72) In a cross-section analysis, Contractor confirms this relationship, and also finds a significant positive relationship between a country's GDP and the presence of minority (versus majority) affiliates of foreign companies. The rationale for this effect is that greater market size increases the host government bargaining power, and since host governments, particularly in developing countries, prefer foreign companies to establish joint ventures with local producers, they use their increased bargaining

power to induce this structure (Kobrin, 1987; Poynter, 1982). Governments rarely have strong preferences between contract-based and equity-based alliances, however, and there are few if any regulations specifically aimed at influencing the choice between these two structures. Thus, we cannot predict the impact, if any, of government regulations on alliance structure.

Other empirical studies examining mode of entry into foreign markets suggest a range of additional country-level explanatory variables. For example, Agarwal and Ramaswami (1992) include measures of "investment risk" (related to economic volatility and government policy) in modeling the choice among various modes of serving a foreign market. Kim and Hwang (1992) also include country-specific measures of political instability and government restrictions, along with a measure of perceived differences between the home and host country with respect to culture, political systems and economic conditions. Unfortunately, the logic underlying the predicted effects of these national differences is not well developed in these and related studies. Take, for example, Kim and Hwang's discussion of the role of "demand uncertainty" in the choice between licensing, joint ventures or wholly-owned subsidiaries.

> When future host country demand for an MNC's product is uncertain... an MNC may be unwilling to invest substantial resources in the country to effectively adjust to oscillating conditions and to enhance its ability to exit the market without incurring substantial sunk costs should demand fail to reach a significant level. Thus, other things being equal, when demand uncertainty is high, MNCs will favor entry modes that involve low resource commitments. (Kim & Hwang, 1992, p. **)

This quote highlights the problem of simultaneity in the choice of the governance and content of transactions, discussed earlier. While Kim and Hwang draw a direct connection between demand uncertainty and entry mode, it is clear that their argument is really about the effect of demand uncertainty on the types of assets that the MNC is willing to put at risk which, in turn, affects the most efficient governance mode. Without including transaction-level variables in the analysis, it is impossible to control for this simultaneity.

The extant literature thus provides us with a variety of potential explanations for cross-national differences in the governance of interfirm alliances, only some of which are consistent with transaction cost reasoning. The central components of these explanations are included in the empirical analysis described below through a set of control variables.

# 4. EMPIRICAL ANALYSIS

## 4.1. Hypotheses

From the discussion in Section 2, we have the following central hypotheses:

H1: The degree of hierarchical control in alliances with foreign firms is inversely related to the strength of intellectual property protection (i.e. the "appropriability regime") in a country, ceteris paribus.

H2: The degree of hierarchical control in alliances with foreign firms will be greater for transactions where specification of property rights is difficult (e.g. where asset creation is involved, or where the know-how is highly tacit)

H3: The degree of hierarchical control in alliances with foreign firms will be greater for transactions where monitoring is difficult (e.g. where the technological or geographic scope of the agreement is large, or where multiple partners are involved)

Restating the first hypothesis, we expect an agreement between a US firm and a firm from a country with a weak appropriability regime to have a higher probability of being organized as an equity joint venture when compared with an alliance involving a firm from a country where the appropriability regime is strong, ceteris paribus. Thus, we have a dichotomous dependent variable, which can take on the following values:

**EQUITY=0** for contractual (non-equity) alliances

**EQUITY=1** for equity joint ventures

## 4.2. Data Source and Measures

The population of interest in this study is horizontal technology transfer alliances linking US and non-US based firms. Contract-based alliances (Equity = 0) include technology licensing and cross-license agreements, second sourcing agreements and technology sharing agreements. Equity joint ventures in the sample (Equity = 1) all involve some product design and/or

manufacture and marketing (i.e. they are not purely engaged in basic R&D). By restricting the sample to agreements involving at least one US-based firm, we can focus attention on the appropriability regime (and other institutional features) of the "foreign" country.

The sample is drawn from the Cooperative Agreements and Technology Indicators (CATI) information system, a relational database covering approximately 10,000 cooperative agreements involving some 3500 different parent companies in many different industries and countries. Cooperative agreements in the CATI database are defined as "common interests between independent industrial partners which are not connected through majority ownership," and all involve some arrangement for technology transfer or joint research (Hagedoorn & Duysters, 1993).

The CATI data is based on systematic examination of secondary reports of alliance formation, primarily during the 1980s. In addition to the organizational form of the alliance, the database includes information on the identity and nationality of the partners, the date of establishment, the type and scope of the transaction involved, and the industry, or technology sector in which the cooperative agreement takes place. Although the database aims at complete coverage of alliances established worldwide, significant omissions and biases in the data are inevitable, particularly with respect to geographic and industrial sectors covered. The CATI originators describe the shortcomings of the data as follows:

> ...skewness in the distribution of modes of cooperation (i.e. an underestimation of the number of customer-supplier relations and licensing agreements, due to under-reporting in published media), ... some geographic - i.e. Anglo Saxon - bias... an underestimation of certain technological fields not belonging to modern core technologies and ... some over representation of large firms. (Hagedoorn & Duysters, 1993, p.1)

They nonetheless have sufficient confidence in the data to use it to illustrate overall trends in inter-firm cooperation (Hagedoorn & Schakenraad, 1990; 1992; 1993a; 1993b). The data limitations are not expected to introduce systematic bias in the current study, where we focus on individual decisions regarding alliance structure. However, where results may be affected, this is noted in the discussion.

### 4.3. Measures

The independent variable of central interest is the "national appropriability regime." While there are several previous studies that attempt to measure the strength of intellectual property protection in various countries and industries, they all suffer from significant shortcomings, particularly in terms of coverage. Some studies, such as Mogee (1989) focus on only one or two industries, while others, like Mansfield (1994) cover many industries but include only a few countries. A 1988 study by the US International Trade Commission surveyed a somewhat broader spectrum of countries, but did not rank countries' intellectual property protection per se; instead US firms were asked to list countries "...in approximate order of importance to you, which you would most like to see adopt fully adequate and effective intellectual property protection." (US International Trade Commission, 1988, quoted in Mansfield, 1994, p. 9). This ranking may differ significantly from actual or perceived levels of intellectual property protection.

The primary measure of the "strength" of intellectual property protection used in the empirical analysis reported here is from Rapp and Rozek (1990). Their index of patent protection is based on:

> ...conformity of each nation's patent laws to the minimum standards proposed in the *Guidelines for Standards for the Protection and Enforcement of Patents* of the US Chamber of Commerce Intellectual Property Task Force. This index...ranks the level of patent protection on a scale of zero to five, where zero is assigned to a nation having no patent protection law at all and five corresponds to nations whose laws are fully consistent with the minimum standards (p. 79)

The "Rapp and Rozek Index" is available for 87 countries, and is thus the most comprehensive available in terms of geography, but it still has limitations: First, as they themselves point out, the index is based primarily on patent laws on the books, and not on their enforcement or implementation. This method may overestimate the effectiveness of protection in some cases. The second limitation is the narrow focus on patents as the primary instrument of intellectual property protection. In some industries, other forms of protection, such as trade secret laws (in biotech, for example) and copyright (in software) may also be important. There may also be significant inter-industry differences in the general effectiveness of legal protection of

intellectual property across industries (Levin, Klevorick, Nelson, & Winter, 1987). If the effect of weak patent protection is concentrated in certain industry segments, it may not be detected using a single aggregate measure. And finally, despite the broad country coverage, there are a few notable exceptions to the Rapp and Rozek study, including Japan, Hong Kong, South Korea and Austria. Since these countries (particularly Japan) account for a significant number of inter-firm agreements with the US, it is important not to exclude them from the analysis. Indices were therefore estimated for the missing countries, based on the Mansfield survey results.[3]

Another way to assess the adequacy of a country's intellectual property protection for foreign participation is to look at foreign companies' "demand" for intellectual property rights, such as patents, in each country. If foreign companies do not have confidence in the intellectual property laws they are less likely to apply for a patent in that country: Not only is the patent application process often complex and time consuming, but the disclosure necessary for patent applications in most countries can potentially *increase* the risk of misappropriation, if patents are routinely denied or inadequately enforced. The World Intellectual Property Organization (WIPO) publishes an annual report of the total number of patents applied for and granted in member countries, which distinguishes between resident and non-resident applicants (WIPO, 1987). Non-resident applications are used as an alternative proxy for appropriability regime in the analysis detailed below.

For hypotheses 2 and 3, which control for simultaneity effects in the choice of the content and governance of the technology transfer, transaction-level variables are included in the analysis. Absent information on the specific technology involved, and the degree of "tacitness" of the relevant know-how, the proxy for specification difficulties is transaction type: Transactions involving product development are more difficult to specify than "pure" production or marketing transactions. Monitoring difficulties are proxied by the technological and geographic scope of the alliance and the number of partners. Sector dummies for biotechnology, information technology and new materials are also included to partially control for industry effects.

In addition to the measures of appropriability regime, several other country-level variables are added to the model, as suggested by the prior empirical studies surveyed in Section 3. The most problematic of these from a measurement perspective is "societal trust." Devising a good country-level measure of trust is a difficult proposition, as previous researchers have found (Shane, 1992). The measure most often used is Hofstede's "power distance" scale. This is one of four "dimensions of culture" devised by Hofstede, and actually represents the extent to which members of a society expect power to be distributed equally within organizations and institutions (Hofstede, 1980). However, power distant societies have also been found to exhibit less interpersonal trust and a greater need for organizational controls on the behavior of individuals (Shane, 1992). And while there are no definitive tests of the validity of power distance as a measure of trust, prior research effectively illustrates the connection between the two constructs (Casson & Nicholas, 1989; Laurent, 1983; Negandhi & Prasad, 1971; Ng, Hossain, Ball, Hayashi, Kim, O'Driscoll, et al., 1982; Williams, Whyte, & Green, 1966). We should therefore expect to observe a positive relationship between the power distance measure for a country (which is an "inverse proxy" for societal trust) and the likelihood that an alliance will be organized as an equity joint venture.

Other country-level control variables included in the model are the following:

- Uncertainty Avoidance: Hofstede's "uncertainty avoidance" scale refers to an "intolerance of ambiguity" (Hofstede, 1980, p. 155) and is associated with reliance on rules, stability in employment and other formal relationships, and a generally high national level of anxiety. As suggested in the discussion of Kogut and Singh (1988), the differential impact of this characteristic on contractual versus equity alliances is ambiguous. It is, however, included as a control variable.
- Cultural Distance: Also following Kogut and Singh, we include a composite index of "cultural distance" (between the US and the country in question). Cultural distance is based on the deviation across each of the four Hofstede dimensions (i.e. power distance, uncertainty

avoidance, individualism and masculinity), corrected for variance differences among the dimensions. Thus, for country j,

$$CD_j = \sum_{i=1-4} \{(I_{i,j}-I_{i,us})^2/V_i\}/4$$

where $I_{i=1-4}$ are the indices of the four cultural dimensions, $V_i$ is the respective variance, and us indicates the United States.

- Investment Restrictions: Regulation of DFI is usually aimed at restricting the level of foreign equity involvement in manufacturing and other operations. The latest comprehensive data available on DFI regulations affecting US firms comes from the 1982 Benchmark Survey of the US Department of Commerce (US Department of Commerce, 1985), which reports the proportion of a country's affiliates that were required to limit the US parent's equity.
- Performance Requirements: This measure also comes from the Benchmark Survey and, like the investment restriction measure above, was included in Contractor's (1990) study. This is a composite measure, comprising the sum of the proportion of all affiliates in a nation who are subject to an export minimum, an import limit and/or a local content minimum.
- Market Size and Growth Rate: Market size and growth rate are likely to affect the quantity rather than the form of foreign direct investment. However, measures of appropriability regime may be highly correlated with market size, so Gross Domestic Product (for 1987) and average annual growth rate of GDP (for 1980-91) are included as additional controls. This data comes from World Bank publications (World Bank, 1987; World Bank, 1993).

For agreements involving more than two partners, and where the non-US partners come from more than a single country, the country-specific variables were calculated as follows: For measures of the appropriability regime, and other features of the institutional environment (i.e. culture and investment regulations), the variable was set to the most "unfavorable" value among the partner countries. The logic here is that an agreement resembles a "chain" of contracts (or equity ties), whose integrity is equal only to that of the weakest link. For "market size" variables

(i.e. GDP and GDP growth), the average value for all of the non-US partner countries was calculated.

Table 1 summarizes the independent variables, showing the variable definitions and expected sign of the estimation coefficient. A positive sign indicates an increase in the likelihood that an alliance will be organized as an equity joint venture, rather than as a contract-based alliance.

### 4.2. Descriptive Statistics

Figure 1 shows the distribution of horizontal production agreements between the US and firms in each of the other countries in the CATI database. There are several points of interest here. First, the concentration of US firms' agreements with firms from just a few countries is striking: almost 40% of the alliances in the sample are between US and Japanese firms, and the top six countries together (Japan, UK, Germany, France, Netherlands and Italy) account for 80% of the total. The "other" category includes Argentina, Australia, Austria, Brazil, Denmark, Finland, Hong Kong, Hungary, India, Ireland, Israel, Libya, Mexico, Norway, New Zealand, Portugal, Singapore, Spain, Taiwan, Thailand, Tunisia, Turkey, USSR, Venezuela and Yugoslavia. Each of this latter group of countries has fewer than ten horizontal technology transfer alliances with US firms recorded in the CATI database. These numbers should of course be treated with some caution, due to the biases discussed earlier. Nonetheless, any serious geographic biases are likely to reflect the European base of data collection and so the position of Japan as the leading partner of US firms is quite significant.

In a total sample of 1407 alliances, 67% are contract-based alliances (i.e. licensing agreements, second-source agreements or technology sharing agreements) and the remaining 33% are organized as equity joint ventures. The dependent variable ("equity") takes a value of zero for contract-based alliances, and a value of 1 for equity joint ventures. Table 2 presents the means, standard deviations and range of the independent variables, along with the total number

of observations available. Missing data explain the variation in this number. Table 3 shows the correlation matrix for the independent variables.

Some of the country-level variables are somewhat correlated, as expected, but none are so high as to present problems for the analysis: Power distance (the proxy for societal trust) is correlated with uncertainty avoidance (0.747) and cultural distance (0.567). Thus countries with lower levels of societal trust (i.e. high power distance score) are also characterized by higher levels of uncertainty avoidance and tend to be those countries which are most culturally dissimilar from the US. Other significantly correlated variables are equity restrictions and performance requirements (0.636), GDP and uncertainty avoidance (0.727) and GDP and GDP growth (0.851).

### 4.3. Results and Discussion

Estimation results are shown in Table 4, and provide strong support for the central hypothesis, that US firms are more likely to organize an alliance as an equity joint venture when the partner is from a country where intellectual property protection is weak (all else being equal). Model 1 includes the Rapp and Rozek index as a proxy for appropriability regime and the transaction-level variables featured in hypotheses 2 and 3, along with the proxy for societal trust (power distance), the other country-level control variables and industry dummies. Model 2 shows the estimation results when foreign patent applications is used in place of the R&R index as a proxy for appropriability regime. The sample size in each case is 1343, which is the number of observations for which information on all the variables collectively is available.

The estimation results from the two models are broadly similar: The coefficient on the proxy for appropriability regime in each model is negative, as hypothesized, and significant at the 1% level. Most of the transaction level variables are also significant and are consistent with results from earlier studies (Self cite, 1995). Design and mixed transactions are more likely to be organized as equity joint ventures than are purely production or marketing transactions, suggesting that specification difficulties lead to the adoption of the joint venture structure, as

hypothesized. The coefficient on mixed transactions is significantly larger than that for design, paralleling Pisano's result, that R&D collaborations in biotechnology involving both R&D and other functions were more likely to use equity links than were "pure" R&D agreements (Pisano, 1989). The hypothesized impact of monitoring difficulties on alliance structure is also observed, as wider technology scope is associated with equity arrangements, with a positive coefficient, significant at the 1% level. However, geographic scope and number of partners both have a negative coefficient, which is contrary to the expected sign, although they are not significant at the 5% level.

The overall predictive power of each model is excellent: the "correct" prediction regarding governance mode is made for 88% of the agreements in the sample, significantly better than a random assignment, which would be expected to be correct for only 56% of the agreements,[4] and also significantly better than simply predicting every outcome as a contractual form (which would be correct 67% of the time).

The evidence on the role of societal trust in governance mode choice is mixed: Power distance (the proxy for trust) has a coefficient with the expected sign in both models, but is only significant (at the 5% level) in model 2. Therefore we can not strongly conclude that lower levels of societal trust are associated with the choice of more hierarchical governance modes. However, we may hypothesize that trust would be a more important variable in cross-national comparisons of domestic alliances: firms in a high societal-trust nation can be expected to rely on less hierarchical modes of governance in their dealings with each other, but this effect may not extend to dealings with foreign firms.

Of the other country-level controls, in model 1, "performance requirements" has a significant (5% level) negative coefficient, as does the level of GDP (although neither are significant in model 2). Neither of these effects have unambiguous explanations, although it is possible that GDP is acting as a proxy for the level of development of the institutional infrastructure (in addition to and separate from the patent protection laws that are measured by the R&R index). This infrastructure, such as the legal system and education level, etc., make

contractual governance more feasible, and so would be expected to shift the observed pattern of governance towards less hierarchical forms. The number of foreign patent applications may also depend on some of these other institutional features, possibly explaining why GDP does not enter as a separately significant factor in model 2.

## 5. CONCLUSION

The empirical analysis reported here provides strong support for the central hypothesis that appropriability hazards are an important factor in US firms' choice of governance mode when they enter into cooperative agreements with foreign firms. Furthermore, the important factors contributing to appropriability hazards appear to operate at two levels: (1) at the transaction level, appropriability hazards are related to the type and scope of the transaction; (2) at the institutional environment level, appropriability hazards depend on the foreign country's intellectual property protection or "appropriability regime," as well as possibly on other aspects of the institutional environment such as the level of societal trust and other legal institutions.

Clearly the choice between equity and non-equity modes is only one relevant consideration in the design of alliances, although apparently an important one. There is additional anecdotal evidence of this pattern: In China, the US firm Xerox refuses to discuss terms for technology transfer until a joint venture is formed (Van Oldenborgh, 1995). Nonetheless, many alliances involve more subtle safeguards. For example, at Fuji-Xerox, a long-running and reputedly successful joint venture between Xerox and Fuji Photo Film in Japan, there have been a variety of evolving mechanisms used to control the flow of technology within the alliance. These include specific restrictions on the location of alliance activities, controlled personnel transfers and the like. Further study is warranted on the role of these organizational features in safeguarding technology and promoting learning in alliances.

## NOTES

[1]The recently completed agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs), part of the Uruguay Round of GATT negotiations, will gradually lead to the elimination of some of these national differences in patent laws. However, the period of phase-in of the relevant changes lasts up to eleven years for the least developed countries, and even then, important exclusions will remain (For details of these prospective changes, see Chaudhry & Walsh, 1995).

[2] The proxy for trust used by Shane is Hofstede's "power distance" index (1980). This proxy, along with other Hofstede national culture indices is also used in the current study, and is discussed in detail in section 4, below.

[3]A complete listing of the Rapp and Rozek index and a comparison with Mansfield measures for the countries represented in the CATI database, including the relevant estimated values, is available from the author on request.

[4] The correct classification rate that would be expected by chance is equal to $a^2+(1-a)^2$, where a is the proportion of joint ventures (or contracts) in the sample.

## REFERENCES


Agarwal, S., & S. Ramaswami. 1992. Choice of foreign market entry mode: Impact of ownership, location and internalization factors. *Journal of International Business Studies,* First Quarter: 1-27.

Casson, M., & S. Nicholas. 1989. *Economics of trust: Explaining differences in organizational structure between the United States and Japan.* Discussion Papers in Economics, 217, University of Reading.

Chaudhry, P.E. and M.G. Walsh. 1995. Intellectual property rights: Changing levels of protection under GATT, NAFTA and the EU. *Columbia Journal of World Business, Summer: 80-91.*

Contractor, F. 1990. Ownership patterns of U.S. joint ventures abroad and the liberalization of foreign government regulations in the 1980s: Evidence from the Benchmark Surveys. *Journal of International Business Studies,* First Quarter: 55-73.

Davidson, W.H. and D.G. McFetridge. 1984. International technology transactions and the theory of the firm. *Journal of Industrial Economics,* 32 (3): 253-264.

Granovetter, M. 1985. Economic action and social structure: A theory of embeddedness. *American Journal of Sociology*, 91: 481-510.

Hagedoorn, J., & G. Duysters. 1993. *The Cooperative Agreements and Technology Indicators CATI Information System.* Unpublished Manuscript, MERIT.

Hagedoorn, J., & J. Schakenraad. 1990. Inter-firm partnerships and co-operative strategies in core technologies. In C. Freeman & L. Soete, editors, *New Explorations in the Economics of Technical Change*. London: Frances Pinter.

_____. 1992. Leading companies and networks of strategic alliances in information technology. *Research Policy*, 21: 163-190.

_____. 1993a. Strategic technology partnering and international corporate strategies. In K. S. Hughes, editor, *European competitiveness* Cambridge, U.K.: Cambridge University Press.

_____. 1993b. Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal*, 14: 371-385.

Hennart, J-F. 1988. A transaction costs theory of equity joint ventures. *Strategic Management Journal*, 9: 361-374.

Hofstede, G. H. 1980. *Culture's consequences: International differences in work-related values..* Beverly Hills, CA: Sage Publications.

Kim, W. C., & P. Hwang. 1992. Global Strategy and multinationals' entry mode choice. *Journal of International Business*, First Quarter: 29-53.

Kobrin, S. J. 1987. Testing the bargaining power hypotheses in the manufacturing sector in developing countries. *International Organization*, Autumn: 609-38.

Kogut, B., & H. Singh. 1988. The effect of national culture on the choice of entry mode. *Journal of International Business Studies*, Fall: 411-432.

Laurent, A. 1983. The cultural diversity of western conceptions of management. *International Studies of Management and Organization*, 13(1-2): 75-96.

Levin, R., A. Klevorick, R. Nelson, & S. Winter. 1987. Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, 3: 783-820.

Mansfield, E. 1994. *Intellectual property protection, foreign direct investment and technology transfer.* Discussion Paper, 19. The World Bank: International Finance Corporation.

Mogee, M. E. 1989. *International trade in chemicals: Intellectual property problems and issues* . Organization for Economic Cooperation and Development.

Negandhi, A., & S. Prasad. 1971. *Comparative management.*. New York: Appleton-Century-Crofts.

Ng, S., A. Hossain, P. Ball, K. Hayashi, S. Kim, M. O'Driscoll, D. Sinha, & K. Yang. 1982. Human Values in nine countries. In R. Rath, H. Asthana, D. Sinha, & J. Sinha, editors, *Diversity and unity in cross-cultural psychology.* Lisse, Netherlands: Swets and Zeitlinger.

Pisano, G. 1989. Using equity participation to support exchange: Evidence from the biotechnology industry. *Journal of Law, Economics and Organization*, V1: 109-26.

Poynter, T. A. 1982. Government intervention in less developed countries: The experience of multinational companies. *Journal of International Business Studies,* Spring/Summer: 9-25.

Rapp, R. & R. Rozek. 1990. Benefits and costs of intellectual property protection in developing countries. *Journal of World Trade*, 24 (2): 75-102.

Shane, S. 1992. *The effect of cultural differences in perceptions of transaction costs on national differences in the preference for licensing.* Unpublished Manuscript, Wharton Business School.

Teece, D. 1986. Profiting from innovation. *Research Policy* , December: 285-305.

U.S. Department of Commerce. 1985. *U.S. direct investment abroad, 1982: The benchmark survey.* Washington, D.C.: U.S. Department of Commerce Publications.

U.S. International Trade Commission. 1988. *Foreign protection of intellectual property rights and the effect on U.S. industry and trade.* Washington D.C.: USITC Publications.

U.S. General Accounting Office. 1993. *Intellectual property Rights: U.S. companies' patent experiences in Japan* . Washington D.C.: GAO/GGD-93-126.

Van Oldenborgh, M. 1995. Court with care. *International Business,* April: 20-22.

Williams, L. K., W.F. Whyte & C.S. Green. 1966. Do cultural differences affect workers' attitudes? *Industrial Relations*, 5: 105-117.

Williamson, O. E. 1975. *Markets and Hierarchies*. New York: Free Press.

_____. 1985. *The Economic Institutions of Capitalism.* New York: Free Press.

_____. 1996. *The Mechanisms of Governance.* New York: Oxford University.

WIPO. 1987. *Industrial property statistics: Publication A.* World Intellectual Property Organization.

## TABLE 1: SUMMARY OF INDEPENDENT VARIABLES

| Variable | Definition | Source | Expected Sign of Coefficient |
|---|---|---|---|
| Rapp and Rozek Index | Index of strength of patent protection in a country, ranging from 0-5. O=negligible patent protection, 5=laws fully consistent with US stds. | (Rapp & Rozek, 1990) | - |
| Foreign Patent Applications | Total number of patent applications filed by nonresidents, 1987. | WIPO | - |
| Transaction Type | Activities covered by agreement: product/process design, production/ marketing or "mixed." | CATI | + |
| Technology Scope | Range of products or technologies covered by agreement | CATI | + |
| Geographic Scope | Geographic scope of alliance: single continent, or worldwide. | CATI | + |
| Number of Partners | Number of firms in alliance | CATI | + |
| Power Distance | Hofstede culture measure: Increasing power distance proxies for decreasing levels of societal trust | Hofstede | + |
| Uncertainty Avoidance | Hofstede culture measure: intolerance for ambiguity | Hofstede | ? |
| Cultural Distance | Composite index, based on Hofstede culture measures (see text for definition) | Hofstede | ? |
| Performance Requirements | Proportion of foreign affiliates subject to import limits and/or local content minimum, 1982. | Benchmark Survey | ? |
| Market Size | 1987 Gross Domestic Product | World Bank | ? |
| Growth Rate | Average annual growth rate of GDP, for 1980-91 | World Bank | ? |
| Industry | CATI technology sectors in which alliance is active -- biotechnology, information technology, new materials and "other" | CATI | ? |

Table 2: Descriptive Statistics for Independent Variables

| | Mean | Standard Deviation | Range | No. of Obs. available |
|---|---|---|---|---|
| Rapp and Rozek Index<br>0=No patent protection laws<br>5=Laws fully consistent with minimum standards | 4.327 | 0.890 | 0-5 | 1396 |
| Foreign Patent Applications 1987 (Number of patent applications filed by non-residents) | 36,874 | 14,425 | 0-58,450 | 1385 |
| Power Distance* | 48.48 | 11.90 | 11-81 | 1350 |
| Uncertainty Avoidance* | 73.94 | 21.49 | 8-104 | 1350 |
| Cultural Distance* | 1.639 | 0.992 | 0.02-4.2 | 1350 |
| Equity Restrictions (1982)<br>Proportion of affiliates required to limit equity | 0.030 | 0.060 | 0-0.51 | 1364 |
| Performance Requirements<br>Proportion of affiliates subject to each of three preformance requirements | 0.017 | 0.035 | 0-0.31 | 1364 |
| Gross Domestic Product 1987 (Billions of US Dollars) | 734.3 | 498.3 | 7-1328 | 1375 |
| Average Annual GDP Growth 1980-91 (percent) | 4.04 | 18.66 | -0.4 - 667 | 1389 |
| Design Transaction Dummy<br>1 = design<br>0 = production or mixed | 0.048 | 0.213 | 0-1 | 1407 |
| Mixed Transaction Dummy<br>1 = mixed<br>0 = production or design | 0.215 | 0.411 | 0-1 | 1407 |
| Technology Scope<br>1 = few or broad range of technologies or products<br>0 = single technology or product | 0.423 | 0.494 | 0-1 | 1407 |
| Geographic Scope<br>1 = Global Operations<br>0 = USA or N. America | 0.217 | 0.412 | 0-1 | 1407 |
| Number of Partners | 2.218 | 0.759 | 2-13 | 1407 |
| Information Technology Dummy | 0.403 | 0.491 | 0-1 | 1407 |
| Biotechnology Dummy | 0.105 | 0.307 | 0-1 | 1407 |
| New Materials Dummy | 0.133 | 0.340 | 0-1 | 1407 |

* See text for definition and description of these variables.

## Table 3: Correlation Matrix for Independent Variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Design Transaction | 1.00 | | | | | | | | | | | | |
| 2. Mixed Transaction | -0.116 | 1.00 | | | | | | | | | | | |
| 3. Technology Scope | 0.014 | 0.293 | 1.00 | | | | | | | | | | |
| 4. Geographic Scope | -0.057 | 0.003 | -0.038 | 1.00 | | | | | | | | | |
| 5. Number of Partners | -0.028 | -0.021 | -0.096 | 0.293 | 1.00 | | | | | | | | |
| 6. R&R Index | -0.007 | 0.056 | -0.040 | 0.121 | -0.023 | 1.00 | | | | | | | |
| 7. Patent Applications | -0.004 | 0.027 | -0.025 | 0.103 | -0.031 | 0.659 | 1.00 | | | | | | |
| 8. Power Distance | 0.013 | -0.035 | 0.370 | -0.020 | 0.146 | -0.490 | -0.208 | 1.00 | | | | | |
| 9. Uncertainty Avoidance | 0.010 | -0.023 | 0.060 | -0.039 | 0.113 | -0.495 | -0.372 | 0.747 | 1.00 | | | | |
| 10. Cultural Distance | 0.023 | -0.035 | 0.052 | -0.101 | 0.087 | -0.639 | -0.624 | 0.567 | 0.738 | 1.00 | | | |
| 11. Equity Restrictions | 0.030 | -0.022 | 0.022 | -0.071 | 0.019 | -0.661 | -0.442 | 0.389 | 0.155 | 0.262 | 1.00 | | |
| 12. Performances Reqs | 0.002 | -0.010 | 0.008 | -0.056 | 0.056 | -0.516 | -0.429 | 0.305 | 0.117 | 0.130 | 0.636 | 1.00 | |
| 13. GDP | 0.002 | -0.048 | 0.073 | -0.098 | -0.052 | -0.593 | -0.228 | 0.432 | 0.727 | 0.667 | 0.140 | -0.107 | 1.00 |
| 14. GDP Growth | 0.008 | -0.052 | 0.076 | -0.139 | -0.052 | -0.760 | -0.457 | 0.390 | 0.551 | 0.655 | 0.357 | 0.115 | 0.851 |

Table 4: Estimation Results, Logit Model

| | 1 | 2 |
|---|---|---|
| Intercept | 2.376* (1.16) | 0.181 (.409) |
| R&R Index | -0.614** (.193) | n/a |
| Foreign Patent Apps (coeff. x $10^4$) | n/a | -0.232** (.055) |
| Power Distance | 0.003 (.007) | 0.016* (.008) |
| Uncertainty Avoidance | -0.0004 (.005) | 0.011* (.005) |
| Cultural Distanc | -0.0002 (.0005) | -0.0005 (.0005) |
| Equity Restrictions | -1.446 (1.66) | -1.138 (1.57) |
| Perf. Requirements | -6.502* (3.17) | -2.814 (2.51) |
| GDP | -0.0005* (.0002) | -0.0002 (.0006) |
| GDP Growth | -0.055 (.102) | -0.030 (.066) |
| Design Transaction | 1.484** (.171) | 1.493** (.171) |
| Mixed Transaction | 2.556** (.127) | 2.577** (.128) |
| Technology Scope | 0.751** (.100) | 0.751** (.101) |
| Geographic Scope | -0.255 (.131) | -0.251 (.132) |
| Number of Partners | -0.117 (.079) | -0.123 (.081) |
| Biotechnology | -0.707** (.196) | -0.794** (.201) |
| Information Technology | -0.574** (.112) | -0.602** (.113) |
| New Materials | -0.023 (.145) | -0.027 (.145) |
| Log of Likelihood Function | -430.2 | -427.5 |
| Chi-Squared | 826.67** | 832.07** |
| Percentage of outcomes predicted correctly | 88.2% | 87.9% |
| Sample Size (n) | 1343 | 1343 |

* $p < 0.05$; ** $p < 0.01$

Figure 1: Number of Horizontal Production Alliances Between US Firms and Firms Based in Other Countries