OPPORTUNISM, INTERACTIVE LEARNING AND THE ORGANIZATIONAL FORM OF STRATEGIC ALLIANCES*

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Abstract

This paper focuses on the choice of the organizational form of strategic alliances. I survey arguments suggested by transaction cost economics and other contractual perspectives on the theory of the firm, according to which such choice mainly depends on the transaction cost economizing properties of different forms. I propose additional considerations inspired by competence-based theories of the firm which emphasize the role of interactive learning in shaping firms' decisions. In the empirical section, I analyze a sample composed of 271 equity joint ventures and non equity bilateral and unilateral agreements concluded in the period 1983-'86 by 67 North American, European and Japanese enterprises out of the world's largest firms in Information Technology industries. In accordance with the results of previous studies informed by transaction cost economics, the estimates of a multinomial logit model provide evidence that firms tend to resort to equity forms to govern complex transactions. On the contrary, bilateral contractual modes are more likely when collaborations have a technological component. More importantly, the form of alliances proves to be dependent upon the technological capabilities of partner firms, with the probability that a technological collaboration be a joint venture decreasing with the degree of overlapping of firms' patterns of technological specialization.

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2. Introduction

From the second half of the '80s, in the economic and managerial literature there has been growing interest in strategic alliances between firms, partly as a result of the availability of large data set such as the CATI database set up at MERIT (see Hagedoorn 1991). Theoretical and empirical studies have focused on various issues, among which the following ones figure prominently: the factors that lead firms to establish cooperative agreements (Marity and Smiley 1982, Link and Bauer 1987, Arora and Gambardella 1990 and 1994, Colombo 1995); the choice of joint ventures as opposed to acquisitions and establishment of autonomous subsidiaries, especially as a mechanism to enter into foreign markets (Balakrishna and Koza 1993, Hennart and Reddy 1997 and 1998, Mutinelli and Piscitello 1998); the mutual relations between external collaborations notably in the technological sphere, and firms' internal R&D investments (Berg *et al.* 1982, Pisano 1990, Kleinknecht and Reijnen 1992, Arora and Gambardella 1994, Colombo and Garrone 1996 and 1998a, Veugelers 1997); and the implications of collaborative arrangements for market structure and industrial policy, with special emphasis being placed on R&D consortia.[1]

On the contrary, less attention has been devoted to the organizational form of strategic alliances. An exception is given by a few empirical studies, mainly inspired by the transaction cost economics (TCE) paradigm (see Williamson 1975 and 1985) and other contractual approaches. Such studies (see Pisano 1989, Gulati 1995, Garcia Canal 1996, Oxley 1997) generally analyze the choice between equity forms (*i.e.* joint ventures and acquisitions of minority shareholdings) and contractual (*i.e.* non equity) arrangements, such as licenses, customer-supplier relations, joint collaborations in research, marketing or distribution, and adopt the view that firms resort to equity agreements in order to economize on transaction costs when there is a non negligible risk of opportunism, but not so much as to mandate hierarchical internalization.

In this paper, I try to go beyond the contractual perspective on the organizational form of strategic alliances and to integrate it with considerations inspired by competence-based theories of the firm, which emphasize the role of alliances as learning-oriented, capability-building devices. I also provide new empirical evidence based on the estimates of a multinomial logit model on the use of equity joint ventures and non equity unilateral agreements as opposed to

[1] A reach stream of the industrial organization literature has pointed out that collaborative arrangements may serve the purpose of internalizing the externality associated with R&D spillovers, with positive implications for social welfare. See for instance Katz and Ordover (1990). For a review of such studies see De Bondt (1996). For a view on this issue informed by heterodox theories of the firm, see Jorde and Teece (1990).

contractual bilateral arrangements on the part of a sample composed of 67 out of the world's largest enterprises in Information Technology (IT) sectors. The findings of the empirical analysis confirm some of the arguments of TCE; in particular, complex relations are found to be prevalently governed through equity forms. They also illustrate some shortcomings of the approaches based on a contractual perspective on the theory of the firm. Notably, when collaborations have a technological component bilateral contractual modes turn out to be more likely than both equity joint ventures and unilateral quasi-market arrangements. In addition, empirical support is provided for the role played by interactive learning and firms' distinctive capabilities in the choice of the governance mode of alliances: the probability that a technological collaboration be a joint venture rather than a bilateral contractual form is shown to decrease with the degree of overlapping of firms' patterns of technological specialization. In this sense, the results of this paper are complementary to recent empirical works on the relation between the establishment of alliances and the evolution of firms' competencies (Mowery *et al.* 1996 and 1998, Cantwell and Colombo 1997).

The paper is organized as follows. In section 2 I briefly survey the arguments on the governance mode of alliances that are associated with TCE and other contractual theories, and contrast them with a competence-based view which emphasizes the role of interactive learning in influencing firms' decisions. In par. 3 the data set is presented. In par. 4 the econometric model is specified, the theoretical hypotheses suggested by the various approaches are illustrated, the explanatory variables are described in detail, and expectations as to the signs of such variables are discussed. Par. 5 contains the empirical findings. In par. 6 some summarizing remarks conclude the paper.

2. The contractual and competence perspectives on the organizational form of strategic alliances

2.1. The transaction cost economics paradigm

With a few exceptions, previous studies which have addressed firms' decisions as to the organizational form of strategic alliances have adhered to the TCE paradigm. TCE regards cooperative relations as «hybrid» forms in the institutional continuum from markets to hierarchies. They are expected to be the governance mode of choice for exchanges characterized by intermediate transaction costs, when contracting hazards prevent use of arm's-length relations but are not severe enough to require hierarchical integration (Williamson 1991). The main characteristic of the various organizational forms to which TCE draws attention is their different

performance in reducing transaction costs. In this respect, the usual distinction is between quasi-market contractual arrangements and quasi-hierarchical equity relations, with more hierarchical forms being chosen when transaction costs are relatively higher (see for instance Pisano 1989).

The transaction cost economizing properties of equity agreements, and joint ventures in particular, deserve a closer look. First, joint ownership is instrumental to aligning partners' incentives, thus reducing the threat of opportunistic behavior. Second, in equity agreements resources must be committed *ex-ante*, as this is the basis for the allocation of ownership rights; hence, there is no possibility for one party to renege opportunistically on its promises. Third, residual rights of control are jointly exercised by the partners through a formal administrative unit; this is generally regarded as a more efficient monitoring mechanism than those provided by non equity arrangements (Kogut 1988). Such benefits must be weighted against the additional costs of equity relations. First, on top of the costs of negotiating and drafting an agreement, there are the costs required by the set up and running of a new firm.[2] As a substantial fraction of such costs is sunk, the exit costs incurred if the venture is terminated are higher than in contractual relations. Second, as is highlighted by the strategic management literature (see Harrigan 1988, Osborn and Baughn 1990), shared ownership-shared control arrangements may be rather cumbersome to manage, reducing the speed with which firms react to unpredictable contingencies.

In accordance with the arguments illustrated above, the TCE literature has drawn attention to two situations where joint ventures (and minority acquisitions) are expected to outperform contractual forms. First, *complex* transactions are more likely to be governed through equity forms, due to the superior monitoring and incentive aligning properties of such forms. This claim is supported by robust empirical evidence: the larger the number of partners, the broader the product and/or technology scope, and the wider the functional activities covered by an alliance, the higher the likelihood of the alliance being a joint venture or more generally an equity arrangement (Pisano 1989, Garcia Canal 1996, Oxley 1997). Second, when relations between firms are aimed at developing or transferring *tacit know how*, firms will allegedly turn to equity arrangements as substantial relation-specific investments in human capital are required to support relations of this kind. Such argument especially applies to joint R&D collaborations due to the high uncertainty inherent in such activities. However, the findings relating to this latter issue are not entirely in line with the predictions of TCE. For one thing, large scale cross-sectoral

[2] Such costs are due to the need to move facilities and personnel, to adjust parent firms' organizations, to create a new formalized managerial hierarchy, and to reconcile different management styles. They usually are negligible in acquisitions of minority interests.

analyses show that the share of equity forms out of the total number of alliances is smaller in high-tech industries than in more mature industrial settings.[3] In accordance with such pattern, Osborn and Baughn (1990) find a significantly negative correlation between use of joint ventures and the technological intensity of industries, measured by the R&D to sales ratio. In addition, the results as to the implications for the form of alliances of the intention of partners to conduct joint R&D or to undertake other technology related activities are mixed. Pisano (1989) shows that in accordance with TCE, in biotechnology the likelihood that equity forms be used is significantly higher in cooperative agreements which involve R&D than in other agreements (including technology transfer agreements). Similar results are obtained by Osborne and Baughn (1990) and Gulati (1995). Oxley (1997) highlights that the probability of using more hierarchical governance modes is higher in alliances that cover product and/or process design activities; however, her sample does not include R&D collaborations. Garcia Canal (1996) instead finds that the presence of a R&D component significantly decreases the likelihood of an agreement being a joint venture.

2.2. Other contractual perspectives

The point has been made by studies in the managerial literature inspired by game theory or sociological approaches that experience of previous alliances can engender *trust* between firms and reduce transaction costs (see Parkhe 1993, Gulati 1995). On the one hand, previously established alliances provide partners with mutual hostages, rendering use of more hierarchical mechanisms less compelling. On the other hand, through ongoing interactions firms learn about each other; this makes their mutual behavior more predictable, thus again reducing the need for safeguard mechanisms. Gulati (1995) provides evidence that trust substitutes for use of equity forms in strategic alliances. He shows that the likelihood of choosing a joint venture as opposed to a contractual form decreases with the number of prior alliances established by partners with each other. Nevertheless, such result is not confirmed by subsequent studies (see Garcia Canal 1996, Oxley 1997). A major problem of such empirical analyses is that the «*ceteris paribus*» condition may not be respected. Actually, the presence of prior linkages between firms is likely to influence both the form and the *content* of subsequent alliances. If partners have a better knowledge of each other and become confident of their mutual trustworthiness, they may engage in more ambitious collaborations. Everything else being equal, these demand for more robust

[3] Data from the CATI database shown in Hagedoorn and Narula (1996) highlight that in the period 1980-'93, the share of joint ventures out of the total number of agreements in high-tech industries such as biotechnology, computers, microelectronics, software, aviation and defense was comprised between 16% and 23%, a substantially lower value

(*i.e.* quasi-hierarchical) governance structures. In addition, as was said earlier, joint ventures have higher termination costs than contractual relations, due to the partially unrecoverable nature of the investments involved in their establishment. In order to be willing to enter such arrangements, firms need assurance of the reliability and competence of partners so as to reduce risks of failure. Hence, joint ventures will be more likely if partners already have experience of successful collaborations between each other.

The fact that joint ventures entail higher irreversible commitments than non equity relations has another important implication. The game-theoretic literature (see for instance Parkhe 1993) argues that as more is at stake in a joint venture, opportunism is discouraged to a larger extent than in a contractual relation. This comes on top of the superior monitoring properties of equity forms, which are highlighted by TCE. Nonetheless, there are circumstances under which uncertainty is so radical that monitoring partners' behavior is difficult independently of the organizational form of an alliance. This especially applies to collaborations aimed at exploring the opportunities offered by a new technology. In such settings firms lack both relevant internal expertise and external benchmarks; as opportunism cannot be detected, aversion towards making the unrecoverable investments required by a joint venture may lead firms to opt for a more flexible contractual arrangement.

Lastly, a few comments on the mainstream industrial organization literature are in order. Surprisingly enough, such literature has been almost silent on the form of strategic alliances. An exception is Tao and Wu's (1996) game-theoretic incomplete contract model, which addresses the question of whether joint R&D should be conducted in a joint venture or a non equity agreement. They argue that in an equity joint venture, innovations are owned by the venture; with contractual arrangements firms instead get free access to the innovations. Under such assumptions, they show that when partners compete in the same downstream business, joint ventures are favored; if they are in different industries, the governance mode makes no difference. Examination of a sample of R&D collaborations reported in the financial press provides (limited) support to the arguments of the authors.

2.3. Competence-based theories and the role of interactive learning

According to competence-based theories, the organization of economic activities is shaped by the differential ability of different economic institutions to support the development and acquisition of knowledge so as to promote innovation and dynamic efficiency. In this

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than the cross-sectoral average (30%). The same shares were as high as 50% in the automotive industry and 63% in food and beverage.

perspective, it is contended that cooperative inter-firm relations often outperform arm's-length transactions and hierarchical arrangements (both internal development and acquisitions) in coordinating and combining the distinctive capabilities possessed by different firms.[4] First, it generally is very difficult for any firm to autonomously reproduce the distinctive capabilities possessed by another firm.[5] Second, in a world of «true» uncertainty (in the sense of Knight 1921), the services of firms' core competencies are untradeable, as there is no way to agree on the value of what basically are idiosyncratic judgements and opinions (Hodgson 1998). For the same reason, the market for corporate control is a quite inefficient mechanism to have access to them.

Even though the competence-based literature has so far devoted insufficient attention to the organizational form of alliances, I claim that arguments inspired by that literature help shed new lights into such issue. For this purpose, a distinction has firstly to be made between agreements which allow a firm to gain access to the services of the distinctive capabilities possessed by another firm and alliances which are aimed at developing *new capabilities*. In the former case, the choice typically is between equity agreements and non equity *unilateral* quasi-market collaborations, such as licenses, technology transfer agreements, and supply relations. The collaboration is efficiency-driven: its objective is to provide access to partners' competencies (and other specialized resources) in a cost-economizing way. TCE and the capability approach offer mutually consistent explanations, with the emphasis being placed on transaction and production costs, respectively. On the contrary, *interactive learning* is the focal concern of exploration-oriented, capability-building alliances. In this latter case, the collaboration primarily serves the purpose of allowing firms to compare and combine their own cognitive frames with those of the partners, thus capturing «economies of cognitive scope» (Lundvall 1988, Nooteboom 1992). Such agreements quite often relate to R&D and other technology intensive activities, and are more often found in the early stages of an industry life cycle (see for instance Colombo and Garrone 1998b). The organizational form is generally confined to equity joint

[4] In a similar vein, see the pioneering contribution by Richardson (1972, p. 889). In the remainder I will use the terms «distinctive capabilities» and «core competencies» as synonyms. Distinctive capabilities are defined as a firm's ability to select, mobilize and use other tangible and intangible assets, including the skills of the individual employees, to perform tasks in a unique way (Prahalad and Hamel 1990). They express what a firm is able to do better than other firms and are the main source of competitive advantage. On these and related issues see Foss (1996), Hodgson (1994) and (1998), Kogut and Zander (1992), Langlois and Foss (1998), Langlois and Robertson (1995), Loasby (1998), Teece and Pisano (1994), Teece *et al.* (1997). Among the antecedents, see Penrose (1959).

[5] Even in a mutually agreed upon transfer of capabilities, the recipient firm must be equipped with adequate absorptive capacity (Cohen and Levinthal 1989) in order for the transfer to take place successfully. In any case, substantial relation-specific investments relating to explaining, teaching, training, and learning are needed to support the transfer process (see Langlois 1992).

ventures and contractual *bilateral* joint collaborations, as the need for intense interaction between the partners is incompatible with use of quasi-market agreements. The capability approach is especially suitable to explaining the organizational form of this latter type of alliances. Namely, a fundamental difference between equity joint venture and non equity bilateral governance modes which has gone quite unremarked in the literature on this topic, resides in their different effectiveness as a learning device.[6]

A joint venture is a new autonomous jointly owned organizational unit, with its own facilities and its own personnel most of which usually comes from partner firms. Due to location in the same premises and under the same organizational entity, contacts between individuals are more intimate and occur on a more regular basis than with a contractual relation. This creates an environment that facilitates mutual understanding among partners, promotes exchange of context-specific experience and tacit know how, and favors the development of a common language and a shared vision. In other words, in supporting interactive learning, a joint venture enjoys the production cost advantages of a more cohesive, durable and integrated quasi-hierarchical institution. In addition, as Madhook (1998) has pointed out, the partners of a collaboration can sustain learning processes through relation-specific investments that create efficient communication channels between them. They usually involve the establishment of new organizational structures and procedures (e.g. creation of joint cross-functional teams, exchange of personnel over an extended period of time) and often require substantial, partially irreversible modifications in partner firms' own organization (e.g. closure of some units, reassignment of responsibility for some activities). In order to limit the associated transaction costs, partners will preferably resort to equity forms.

Nevertheless, it is important to realize that whether and to what extent equity forms are critical in sustaining collaborative activities aimed at developing new competencies do depend on the underlying features of the relation and the characteristics of partner firms. Among such factors the *ease of learning* from each other figures prominently. In turn this is partly determined by the characteristics of the collection of distinctive capabilities with which partner firms are equipped. If firms have different histories and backgrounds and have developed specialized competencies in different though complementary areas (e.g. capabilities in different technological fields), mutual learning will be difficult, everything else being equal, due to the different knowledge bases of firms and the large cognitive distance between them (Nooteboom

[6] A partial exception is represented by the literature on the mutual relations between the evolution of firms' capabilities and the establishment of cooperative relations. See Mowery *et al.* (1996) and (1998), Cantwell and Colombo (1997).

1996). Under such circumstances the need arises for more robust mechanisms to support interaction: firms are likely to resort to equity governance modes. On the contrary, if firms have overlapping knowledge bases and already share a common vision, their capacity to absorb, interpret, and process knowledge produced by the partners of a collaborative relation and to combine partners' capabilities with their own ones so as to generate synergistic gains, is definitely greater. In this latter case, the higher set up and administrative costs of equity forms are not justified. Recourse to such forms may even be detrimental to mutual learning processes, as the overhead of a formalized organization may excessively reduce variety of perception and interpretation, thus killing the ability to generate novelty and innovation.[7]

3. The data

The data on alliances used in this paper are provided by the ARPA database developed at Politecnico di Milano. ARPA surveyed agreements in Information Technology industries (*i.e.*, semiconductor, data processing, and telecommunications) over the 1980-'86 period. Information contained in ARPA was gathered from the international financial press, technical magazines and specialist studies. Coverage of local sources of information for all three most developed areas (US, Europe and Japan) allowed to control for geographic biases in a quite satisfactory way. ARPA covers a total of 2,014 cooperative agreements; they involve 1,574 partners, that belong to 1,177 different autonomous entities. As to governance modes, equity agreements (mainly joint ventures), non equity joint collaborations and licenses are the most prominent categories, with a 29.2%, 24.6% and 20.8% share respectively.[8]

In this paper, I consider equity joint ventures, non equity joint (*i.e.* bilateral) collaborations and non equity quasi-market (*i.e.* unilateral) agreements involving only firms that belong to a sample composed of 67 large North American, European and Japanese industrial groups out of the largest 150 ones in the world IT industries. For reasons which will be explained later, I confine attention to alliances concluded between 1983 and 1986. Selection of the firms was based on two criteria. First, data were needed on firm-specific characteristics (e.g. size, profits, degree of internationalization, R&D expenses. See section 4.3 and Table 1 for a detailed description) over the entire period under consideration. Such data were obtained from various sources: specialized magazines such as Datamation and Electronic Business, sector studies

[7] It is important to emphasize that the fact that firms have divergent knowledge bases may also make difficult the unilateral transfer of given resources and capabilities due to the lack of absorptive capacity by the recipient firm. Hence, if firms have very differentiated areas of specialization, they may well resort to equity modes to govern also efficiency-driven capability-exploiting alliances.

[8] For a more detailed description of the ARPA database see Cainarca *et al.* (1992).

(Benn Electronic File Directory and Gartner Group Top 100 Almanac), firms' annual reports and other directories (such as the Japan Company Handbook). Considerable effort was devoted to checking the coherence of the various sources. Availability of such data restricted the sample to 100 firms (see Colombo 1995). Second, I obtained access to the dataset on the patent activity in the US of the world's largest firms during the period 1969-'95 set up at the University of Reading. The Reading dataset includes information on 784 firms which account for over 46% of all patents granted in the US between 1969 and 1995. Each patent is assigned to one of 56 technological sectors according to the type of technological activity with which it is primarily associated. Out of the 100 above mentioned firms, 67 were comprised in the Reading database.

The final sample can be regarded as representative of the world's largest firms in IT industries. It is composed of 34 North American, 20 European and 13 Japanese enterprises. In my view, coverage of all three areas of the «triad» represents a significant improvement with respect to previous empirical studies on the issue at hand. In the period 1983-'86 ARPA has surveyed 278 alliances between the sample firms. Equity joint ventures, non equity bilateral collaborations, non equity unilateral arrangements and acquisitions of a minority interest accounted for 19.4%, 30.9%, 47.1% and 2.5%, respectively. Due to a «small number» problem, this latter category was excluded from the empirical analysis.

4. The econometric model

4.1. The specification of the model

The empirical analysis is based on the estimates of a multinomial logit model. Its purpose is to explain what factors influence the relative probability that a collaboration be governed through an equity joint venture (EJOV), a non equity unilateral form (NEQMA), or a non equity bilateral form (NEJC).

The model is specified as follows (see Greene 1991). Let us consider a cooperative relation *i* between two or more firms (i=1,….,271). For the sake of simplicity, let us code with 0, 1 and 2 the choice of a NEJC, an EJOV, and a NEQMA, respectively. Let V_i^j be the benefits accruing to partner firms if organizational form *j* is chosen (j=0,1,2). V_i^j will depend on the characteristics of both the collaboration and the partners. In accordance with the arguments illustrated in section 2, such characteristics include: a) the complexity of the collaboration, described by the vector of variables **COMPL**; b) a variable (TECH) indicating whether the collaboration has a technological component or not; c) a vector of variables (**SECT**) that distinguish whether the partners of the collaboration compete in the same sector(s) or not; d) partners' experience of prior collaborations, both in general (EXPALL) and between each other

(PREALL); e) a variable (CTS) capturing how similar partners' collections of distinctive technological capabilities are; and f) a vector $\mathbf{X}_i$ reflecting other firm-specific characteristics.[9] For reasons which will be evident later (see sections 4.2 and 4.3), I assume:

$$V_i^j = \beta_0^j + \boldsymbol{\beta_1^{j'}}\cdot\mathbf{COMPL}_i + \beta_2^j\cdot PREALL_i + \beta_3^j\cdot EXPALL_i + \boldsymbol{\beta_4^{j'}}\cdot\mathbf{SECT}_i + \beta_5^j\cdot TECH_i + \beta_6^j\cdot TECH_i\cdot CTS_i + \beta_7^j\cdot CTS_i + \boldsymbol{\beta_8^{j'}}\cdot\mathbf{X}_i + u_i^j \qquad j=0,1,2, \qquad [1]$$

with u_i^j (j=0,1,2) being the error terms. Furthermore, let us assume that the organizational form j chosen by partner firms from the choice set J is the one yielding the maximum expected benefits. Let d_i^j (j=0,1,2) be a random variable that equals 1 if alternative j is chosen and 0 if it is not. It results:

$$d_i^j=1 \text{ if } V_i^j>V_i^k,\ \forall k\neq j; \text{ otherwise } d_i^j=0, \qquad j=0,1,2.$$

As is usual in this kind of settings, the assumption is made that the disturbances u_i^j are independently and identically distributed with Weibull distribution. Then, the model for the choice of the organizational form is:

$$\text{Prob}\,(d_i^j=1) = \exp(\beta_0^j + \boldsymbol{\beta_1^{j'}}\cdot\mathbf{COMPL}_i + \beta_2^j\cdot PREALL_i + \beta_3^j\cdot EXPALL_i + \boldsymbol{\beta_4^{j'}}\cdot\mathbf{SECT}_i + \beta_5^j\cdot TECH_i + \beta_6^j\cdot TECH_i\cdot CTS_i + \beta_7^j\cdot CTS_i + \boldsymbol{\beta_8^{j'}}\cdot\mathbf{X}_i) \,/\, \sum_j \exp(\beta_0^j + \boldsymbol{\beta_1^{j'}}\cdot\mathbf{COMPL}_i + \beta_2^j\cdot PREALL_i + \beta_3^j\cdot EXPALL_i + \boldsymbol{\beta_4^{j'}}\cdot\mathbf{SECT}_i + \beta_5^j\cdot TECH_i + \beta_6^j\cdot TECH_i\cdot CTS_i + \beta_7^j\cdot CTS_i + \boldsymbol{\beta_8^{j'}}\cdot\mathbf{X}_i) \quad j=0,1,2. \qquad [2]$$

In order for model [2] to be identified, the coefficients of one of the alternatives have to be set to 0. With no loss of generality, I set $\beta_k^0=0$, k=1,….,8; that is, the NEJC category was taken as the baseline in the econometric estimates. Model [2] was then estimated by maximum likelihood using the following log-likelihood function:

$$L = \sum_i \sum_j d_i^j \cdot \ln \text{Prob}\,(d_i^j=1)\ . \qquad [3]$$

4.2. The theoretical hypotheses

The aim of this section is to briefly synthesize the theoretical hypotheses which I am going to test through the econometric estimates. Additional details on such hypotheses will be given in the next section when the explanatory variables of the econometric model will be illustrated in detail. The literature with which the various hypotheses can be associated is also mentioned.

H_1 (TCE): complex transactions are generally governed through EJOVs due to the need to reduce transaction costs ($\boldsymbol{\beta_1^{EJOV}}>0$).

[9] Illustration of the proxies used in the econometric estimates is postponed to section 4.3.

H_2 (game-theoretic managerial literature and sociological approaches): in so far as trust is created between firms through previous collaborations, opportunistic behavior is deterred; this renders use of EJOVs less necessary ($\beta_2^{EJOV}<0$).

H_3 (contractual approaches): firms that have cumulated greater experience in establishing and managing alliances have superior capabilities in monitoring partners' behavior; *ceteris paribus*, they are less likely to resort to EJOVs ($\beta_3^{EJOV}<0$).

H_4 (industrial organization literature): when partner firms compete in the same industry, EJOVs are more likely than NEJCs, as they allow a more precise definition of the property rights related to innovations discovered by the venture ($\boldsymbol{\beta_4^{EJOV}}>0$).

H_5 (TCE): alliances involving R&D and other technological activities are more frequently governed through EJOVs due to the higher uncertainty associated with such activities and the greater vulnerability to opportunism ($\beta_5^{EJOV}>0$).

H_6 (competence-based theories): alliances involving R&D and other technological activities are more frequently governed through NEJCs as opposed to EJOVs, as partners' aversion towards making unrecoverable commitments under conditions of radical uncertainty leads them to choose a more flexible contractual form. The desire to maintain greater variety of approaches so as to favor an exploration-oriented attitude reinforces such tendency ($\beta_5^{EJOV}<0$).

H_7 (competence-based theories): as R&D and other technology-related alliances are often aimed at creating new capabilities, NEJCs are more likely than NEQMAs due to their superior performances in promoting interactive learning among partners ($\beta_5^{NEQMA}<0$).

H_8 (competence-based theories): in R&D and other technology-related alliances, the balance between EJOVs and NEJCs also depends upon the ease of learning between partners. If partners have overlapping knowledge bases resulting from similar patterns of technological specialization, learning from each other is quite easy; under such circumstances they will preferably resort to NEJCs (see *H_6*). On the contrary, if they specialize in different technological fields and have very differentiated capabilities, the need arises for more robust governance modes to support exchange of knowledge and reduce cognitive distances; in this case, use of EJOVs will be favored ($\beta_6^{EJOV}+\beta_7^{EJOV}<0$).

H_9 (competence-based theories): in alliances focused on production and/or marketing, partners' collections of technological capabilities do not affect the choice of the organizational form ($\beta_7^{EJOV}=0$, $\beta_7^{NEQMA}=0$).

4.3. The independent variables of the model

As was suggested in section 4.1, the independent variables can be subdivided into five categories (see Table 1 for definitions).

The first group includes variables which reflect the complexity of transactions. I considered the number of partners (NPARTNERS), the number of functional activities involved in a collaborative relation (NFCONTENTS), with a distinction being made between technological activities, production, and marketing and distribution, the geographic scope captured by the number of geographical areas (*i.e.* North America, Europe and Japan) to which the partners belong (NGEOAREAS), and the sectoral scope. As to this latter aspect, the dummy variable SPECTASK equals 1 if a cooperation has a unique specific task and 0 if it has a broadly defined sectoral scope or it embraces a variety of narrowly defined tasks.[10] In accordance with Hypothesis H_1, I expect a positive impact of NPARTNERS, NFCONTENTS and NGEOAREAS on the likelihood of a relation being an equity joint venture, due to the need for more hierarchical forms to govern complex transactions; for the same reason, I predict a negative sign for SPECTASK. In addition, note that licenses account for the overwhelming majority of non equity quasi-market agreements. Since they represent a typical mechanism to enter into foreign markets, I also expect a positive correlation between NGEOAREAS and the choice of a non equity unilateral arrangement as opposed to a bilateral one.

The second category is composed of variables which intend to capture the «shadow of the past» effect. PREALL is defined as the ratio between the number of prior alliances that link the partners of a given collaboration to each other and were concluded in the previous three years[11] and the maximum number of possible linkages between them. Such number increases with the number N of firms in the alliance as N(N-1)/2.[12] According to the contention of game theoretic and sociological contributions (Hypotheses H_2), the estimated coefficients of PREALL in the EJOV estimates should be negative. A similar reasoning applies to EXPALL, which is defined as the average number of previous agreements established by the partners of an alliance with both firms that are included in the sample and firms which do not belong to it. As more expert firms

[10] An example of the former category is provided by a cooperative agreement confined to dynamic random access memories (DRAM); examples of the latter category are given by a collaboration in semiconductor and by one that embraces DRAM and microprocessors.

[11] As data on alliances are available from 1980, this is the reason why in this study attention is confined to the analysis of the form of alliances that were established by sample firms after 1982.

[12] I also calculated an additional dummy variable (ALLALL) which is set to 1 if *all* partners of the alliance under scrutiny were involved in one or more collaborations in the previous three years The estimates obtained when ALLALL replaces PREALL do not substantially differ from those that will be presented in section 5. They are available from the author upon request.

should be able to monitor the behavior of their partners more effectively, they would preferably resort to non equity forms (Hypothesis H_3).[13] Nonetheless, as was pointed out in section. 2.2, one should acknowledge that the underlying content of a newly established alliance may be influenced by the «shadow of the past» in a way which is not entirely reflected by other explanatory variables. If the threat of opportunism is reduced, partners may turn to more ambitious, large-scale collaborative ventures; with everything else being equal, this would increase the probability that an equity form be chosen. In addition, firms may be willing to enter into arrangements as costly as an equity joint venture only if they are confident about partners' competence and trustworthiness. Such argument implies that recourse to equity forms is more likely if firms have prior experience of successful collaborations between each other. Failure to take into due account the above mentioned effects may lead to mixed results as to the signs of PREALL and EXPALL.

The third group of variables considers the influence that the sectors to which partner firms belong exert upon the choice of the organizational form of a collaboration. More precisely, two dummy variables were defined. MAINSECT is set to 1 when all partners in a given relation have the same primary sector of activity, with a distinction being made between semiconductor, data processing, and telecommunications.[14] COMMONSECT equals 1 if the following conditions apply: a) all partners are in one or more common sectors and b) MAINSECT is equal to 0. In accordance with Hypothesis H_4, the sign of the coefficient of MAINSECT (and possibly COMMONSECT) in the EJOV estimates should be positive.[15]

The fourth group of variables includes only the TECH dummy. Such variable distinguishes collaborations which involve R&D and/or design and/or engineering components from other ventures which concentrate on production, marketing and distribution, or both. TCE suggests a positive effect of such variable on the relative probability of resorting to an equity joint venture as opposed to a contractual bilateral relation (Hypothesis H_5). However, when uncertainty is radical, aversion towards commitment of non recoverable investments and the desire to preserve an exploration-oriented approach may lead firms to choose a more flexible,

[13] I am aware of the likely collinearity between this variable and time. However, I also share Oxley's (1997) view that such variable nicely reflects the growth of the alliance-related experience of the sample firms over the '80s.

[14] Actually, the main sector of activity is defined as the sector out of the three considered in this study which accounts for the largest share of a firm's turnover.

[15] Actually, the argument of Tao and Wu (1996) is based on the allocation of property rights on innovations discovered in the course of a collaboration. Properly speaking, it applies mainly to collaborations involving joint R&D. Accordingly, I also checked for the presence of an interactive effect between MAINSECT (and COMMONSECT) and TECH. The empirical results, which are not shown here, do not substantially differ from the ones which will be presented in section 5. They are available from the author upon request.

less hierarchical form, with opposite implications as to the sign of the coefficient of TECH (Hypothesis H_6). As regards non equity quasi-market arrangements, competence-base theories suggest that such forms are a rather inefficient learning device, even though they may be instrumental to transferring codified and component-embodied knowledge. Hence, I predict a negative coefficient for TECH also in the estimates relating to this category of agreements (Hypothesis H_7).

In view of the objectives of the present paper, the fifth category deserves special attention. It also includes just one variable (CTS) which aims to capture similarity of technological capabilities among partner firms. CTS is defined as follows (see Cantwell and Barrera 1996, Cantwell and Colombo 1997). Let RTA_{ij} be the revealed technological advantage of firm *i* in technological class *j*. Denoting by P_{ij} the number of US patents granted to firm *i* in technological field *j* over the period 1969-'95, RTA_{ij} is given by the following expression:

$$RTA_{ij} = (P_{ij}/\Sigma_j P_{ij}) / (\Sigma_i P_{ij}/\Sigma_{ij} P_{ij}) .$$

Only 31 technological fields associated with IT sectors were considered. In other words, RTA_{ij} coincides with the ratio of the share accounted for by a given technological class out of the number of US patents in IT granted to the firm under consideration, to the share of the same technological class out of the total number of US patents in IT granted to all sample firms. RTA_{ij} varies around one, with values greater than one suggesting that a firm is comparatively specialized in the activity in question. I then calculated the Pearson's correlation coefficient r_{ik} between the RTA distributions of any pairwise combination of firms *i* and *k* across the 31 technological fields. Such index measures the (positive or negative) correlation between the patterns of technological specialization of firms, as were reflected in the RTA values; it can then be regarded as a proxy of the degree of overlapping of the technological capabilities of firms. The value of CTS for a given alliance is given by the average value of r_{ik} calculated across all pairs of firms *i* and *k* involved in the alliance.

I claim that ease of learning from each other is greater for firms with similar patterns of technological specialization. Consequently, as is stated by Hypothesis H_8, when a collaboration includes R&D and other technology-based activities (*i.e.* TECH equals 1) and is thus likely to be oriented towards the development of *new* capabilities, I expect a negative impact of CTS upon the probability of firms resorting to an equity joint venture as opposed to a contractual bilateral form.[16] Instead, CTS should not exhibit any discriminating power for productive and commercial

[16] As CTS is calculated over the period 1969-'95, endogeneity problems may arise. In other words, the choice of the governance mode of alliances may influence the subsequent evolution of firms' capabilities. My decision not to limit

alliances (that is when TECH equals 0), as such alliances more often are instrumental to gaining access in a cost effective way to the services of partners' *existing* capabilities and interactive learning plays a minor role (Hypothesis H_9). I also expect CTS not to have any significant effect in the NEQMA estimates. In fact, in addition to hindering interactive learning processes, lack of an overlapping knowledge base may also be a serious impediment to quasi-market arrangements aimed at unilateral transfer of knowledge, due to the absence of an adequate absorptive capacity by the recipient firm.

Furthermore, I introduced into the model a series of firm-specific control variables. SIZE, INTERNAT, ROS, R&D, DIVERS, and SCOPE measure average size, given by the average value of the turnover of the partners of an alliance in the year in which the alliance was established (in US $ at 1980 prices), degree of internationalization, proxied by the share of total sales realized in foreign markets, returns on sales, R&D to sales ratio and diversification (in general and within the IT industries, respectively; in both case the Utton diversification index was used).[17] SIZEGAP is the ratio between the value of the turnover of the smallest firm in a given alliance and that of the largest firm; it is greater than zero and smaller than 1, with values near 1 indicating alliances between rather similarly sized firms. INTERDIFF, ROSDIFF and R&DDIFF are given by the largest difference of degree of internationalization, returns on sales and R&D intensity between partner firms. DIVERSDIFF and SCOPEDIFF reflect differences in diversification patterns between firms; both of them were calculated as the ratio of the difference between the largest and the smallest values taken by the Utton index in a collaboration to the sum of such values. For all these variables but SIZEGAP, larger values are associated with greater structural and behavioral differences between the parties of an alliance. Lastly, TIME indicates the year in which an alliance was concluded; it controls for time-specific patterns.

Table 2 exhibits descriptive statistics of the explanatory variables. In Table 3 the mean value of such variables is calculated for each of the three categories of alliances under scrutiny. Even though such figures should be interpreted with caution due to possible collinearity problems, they give some preliminary, quite interesting indications. In accordance with TCE,

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myself to the 1969-'79 period in calculating CTS was mainly determined by the desire to avoid «small numbers» problems. Note however that a preliminary investigation showed that the patterns of technological specialization of sample firms are quite stable over time (on this topic see also Patel and Pavitt 1995 and 1997). In addition, the findings of previous studies on the impact of the governance mode of alliances upon firms' technological capabilities provide mixed evidence (see for instance Nakamura *et al.* 1996, Mowery *et al.* 1996 and 1998). Lastly, if the choice of an equity form would result in an increase of the degree of similarity between partners' technological specialization due to more profitable interaction as is suggested by the aforementioned literature, my results would be reinforced.

[17] See Colombo (1995) for a more detailed description of such variables and their alleged effects upon the likelihood of establishing an alliance.

variables capturing the complexity of alliances exhibit larger values in the EJOV category than in the remaining ones, with the exception of SPECTASK. On the contrary, there seems to be no support for the argument that firms prevalently resort to equity forms to govern technological collaborations; while only 53% of the equity joint ventures in our sample have a R&D and/or design and/or engineering component, such figure is as high as 85% for non equity bilateral agreements, with non equity quasi-market arrangements being in an intermediate position. Even more interestingly, the mean value of CTS in the EJOV category is negative (-0.064), while it is positive in the NEJC category (0.039). In accordance with the hypothesis inspired by the capability approach, equity joint ventures seem to be more often used by firms characterized by divergent patterns of technological specialization. Lastly, no substantial differences emerge as to the remaining explanatory variables.

5. The empirical findings

The results of the econometric estimates are illustrated in Table 4. The first two columns refer to the unrestricted model which includes all explanatory variables described in the previous section. The third and fourth columns report the findings relating to a model which was obtained through subsequent nested restrictions; at each stage the null hypothesis that the coefficients of the dropped variables are not statistically different from 0 was checked through a χ^2 LR test. The Table shows the estimated values of the coefficients of the explanatory variables, their standard errors and significance levels, and the results of a series of χ^2 LR tests of hypothesis.

Generally speaking, the econometric results are quite robust. As is illustrated in Table 5, the unrestricted and restricted models correctly predict the governance mode of 80.1% and 76.7% of the sample collaborations, respectively. I have also carried out a simulation study based on the estimates of the restricted model. This is an especially useful exercise with multinomial logit models, as marginal effects need not have the same sign as the estimated coefficients. More precisely, I have firstly defined two «benchmark» alliances in the following way. All dummy variables but TECH in the «benchmark 2» alliance have been set to 0, all discrete variables have been evaluated at their median value and all remaining variables (*i.e.* continuous variables) have been evaluated at their mean value. In particular, benchmark alliances span over two functional contents and are established by two partners that belong to different geographical areas. The «benchmark 1» collaboration focuses on production and/or marketing, as TECH equals 0, while the «benchmark 2» includes a technological component. Then I have calculated the values of the probability that each of the three organizational forms under consideration be chosen when a) each of the binary and discrete explanatory variables is assigned specific values, with all

remaining variables being equal to the «benchmarking» value and b) each of the continuous variables takes «low» and «high» values, with all remaining variables at the «benchmarking» value. As to the former group of variables, the following values have been considered: NFCONTENT=1 and NFCONTENT=3, with this latter value being inadmissible when TECH equals 0; NPARTNERS=3; NGEOAREAS=1. The «high» value of the continuous variables is defined as the value associated with the 27^{th} alliance in descending order, that is the lowest value in the first decile; the «low» value is the highest value in the last decile. The results of the simulations are displayed in Table 6.

In accordance with the evidence provided by previous studies inspired by TCE, the empirical findings show that firms tend to resort to equity collaborations for complex relations. NPARTNERS and NFCONTENTS have positive and statistically significant (at 99%) coefficients in the EJOV estimates. The coefficient of NGEOAREAS also is positive though only marginally significant (at 90%). Only SPECTASK takes the wrong sign, but is not significant; the reason may be that recourse to a standardized classification for the definition of the sectoral scope of a transaction does not allow to reveal its underlying complexity. Note also that the estimated magnitude of the likelihood of choosing a joint venture turns out to be very sensitive to an increase of both the number of partners involved in a collaboration and the variety of functional contents. As is apparent from Table 6, with all other variables being set to their benchmarking values, the probability that an alliance in production and/or marketing be governed through an equity form rises from 22.8% if only two firms are involved up to 54.9% if NPARTNERS equal 3. Furthermore, an alliance between two partners which focuses either on production or on marketing (*i.e.* NFCONTENT=1) is very unlikely to be a joint venture: the probability that such form be chosen is lower than 3%. Note that the probability of such alliance being a non equity quasi-market arrangement is as high as 91%. A similar pattern applies to collaborations which also have a technological component. In particular, in spite of the fact that alliances confined to R&D, design and/or engineering are unlikely to be governed through equity forms, with the estimated probability being lower than 1%, such probability exceeds 40% for complex alliances spanning over technological, production and marketing activities.

As to GEOAREAS, it is also interesting to note that in the NEQMA estimates such variable exhibits a positive, highly significant coefficient. This result is in line with the popularity of licenses as a mechanism to enter into foreign markets.

On the contrary, neither the arguments proposed by studies informed by game-theoretic and sociological approaches nor those of mainstream industrial organization studies, are

supported by our empirical findings. On the one hand, PREALL and EXPALL have a positive coefficient in the EJOV estimates, significant at conventional levels in the restricted model. The greater the number of previous alliances established by the firms involved in a collaboration, both between each other and with other firms, the higher the likelihood that they will resort to an equity organizational form. In particular, when PREALL takes a «high» value, indicating that a cooperative venture occurs between partners linked to each other by numerous previous alliances, the probability that such venture be an equity joint venture is more than three times as large as the benchmarking value. Following the reasoning outlined in section 2.2, this result may be explained by failure to take into due account modifications in the underlying characteristics of newly established collaborations engendered by prior alliances. In this regard, information on the amount of resources committed by the parties to a collaboration (e.g. value of tangible assets, number and professional characteristics of employees) would be very helpful to shed new light into this issue. Unfortunately, such information is usually not available in this kind of studies. On the other hand, there is no evidence that firms which are in the same sector of activity are more inclined towards equity collaborations. MAINSECT has a positive, though not significant coefficient in the EJOV estimates; the coefficient of COMMONSECT is negative and not significant.

As was mentioned earlier, firms included in our sample quite unfrequently turn to an equity arrangement for collaborations in the technological sphere. The same holds true for non equity quasi-market arrangements. Namely, the estimated coefficient of TECH takes a negative, statistically significant at 99% sign in both the EJOV and NEQMA estimates. Simulations reported in Table 6 show that when TECH equals 1 indicating that an alliance has a technological component, the estimated likelihood of non equity bilateral forms is 61.4%, with all remaining variables being evaluated at their benchmarking value. The corresponding value when an alliance is confined to production and/or marketing is lower than 5%. Differences between my findings and those of some previous studies mentioned in section 2 may be explained by the finer classification of the forms of cooperative agreements adopted in this paper, which distinguishes bilateral from unilateral non equity arrangements. Actually, agreements of this latter category quite rarely extend to R&D, even though they may involve technology transfer activities; thus placing them in the contractual agreement category along with bilateral joint collaborations may have biased previous results.[18] Of course, such differences might also

[18] My findings are in line with those of Garcia Canal (1996) which makes a similar distinction between unilateral and bilateral non equity collaborations. Oxley (1997) considers as well three categories (*i.e.* joint ventures, bilateral and unilateral contractual arrangements), but she eliminates R&D collaborations from the sample. In addition, use in such

partially be explained by industry biases. The characteristics of technology do differ across industries as to aspects such as the degree of tacitness and appropriability hazards (see for instance Levin *et al.* 1987), which may influence the relative appeal of different governance modes. Unfortunately, my data are limited to IT industries. Additional evidence relating to other industries would be very useful to get further insights into the impact of technological factors on the organizational form of alliances.

One of the main concerns of this study was with the role played by firms' distinctive capabilities. The findings of the regressions clearly support the argument inspired by the capability perspective that the likelihood of choosing an equity mode for a technological agreement increases with the diversity of the collection of technological competencies developed by partners. When TECH equals 1, CTS which reflects similarity of the patterns of technological specialization between the firms engaged in a cooperative relation, has a negative coefficient in the EJOV estimates of both the restricted and unrestricted models. The null hypothesis that such variable has no significant effect can be rejected, as is apparent from the χ^2 LR tests reported at the bottom of Table 4. The χ^2 statistics equal 10.40 (with two degrees of freedom) and 8.46 (with one degree of freedom) in the unrestricted and restricted models, respectively; both values are significant at 99%. In addition, the simulations highlight the large magnitude of the impact of such variable. When the partners engaged in a technological collaboration have a largely overlapping knowledge base so that CTS takes a «high» value, a joint venture has a probability lower than 1%. Instead, when the patterns of technological specialization of such firms diverge quite substantially, a situation which is denoted by a «low» (and negative) value of CTS, such probability exceeds 23%.

When we turn attention to non equity unilateral agreements as opposed to bilateral ones, CTS looses its explanatory power. It has a positive coefficient when an alliance focuses on production and/or marketing and a negative one for technological collaborations. However, the χ^2 LR tests show that such effects are not statistically robust.

Lastly, let us consider control variables. Their overall explanatory power is rather modest, especially as regards the NEQMA estimates. As to this latter category of agreements, none of the control variables is statistically significant at conventional levels, with the exception of DIVEDIFF, which captures diversity in the degree of diversification between the partners of an alliance. As regards equity forms, they seem to be more likely if firms have low innovative

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study of an ordered probit model, which conforms to the TCE assumption of a linear continuum of institutional forms, may partly be misleading, in so far as it does not allow to highlight differences between unilateral and bilateral

intensity and a focused sectoral scope within IT, are of similar size but have different propensities towards international activities.

6. Concluding remarks

In this paper, I have analyzed the choice by firms of the organizational form of strategic alliances. I have contrasted approaches variously inspired by contractual theories of the firm, which rely on static efficiency considerations and transaction cost minimization, with arguments suggested by the capability perspective, which instead emphasizes the role of alliances as interactive learning devices oriented towards innovation and the development of new capabilities.

I have considered a sample composed of 271 alliances which were concluded by 67 out of the world's largest enterprises in IT industries between each other over the period 1983-'86. A multinomial logit model has been estimated, providing new insights into the use of equity joint ventures and non equity unilateral agreements as opposed to non equity bilateral ones.

The findings of the empirical analysis confirm the evidence provided by previous studies inspired by TCE that equity modes are more frequently used to govern complex transactions. The likelihood that such organizational form be chosen clearly increases with the functional span of an alliance, the number of partners and to a lesser extent the number of regional areas from which they originate. However, my findings do not support the view suggested by TCE that such forms are suitable to relations concerning R&D and other technology-related activities; the overwhelming majority of alliances that include a technological component turns out to be governed through non equity bilateral arrangements. Nor are the empirical results consistent with the proposition set forth by game-theoretic managerial contributions and sociological approaches that due to the «shadow of the past», firms that are involved in a network of prior alliances are more likely to resort to non equity arrangements, as the threat of opportunism is less severe. On the contrary, evidence is provided that the probability of a collaboration being an equity joint venture increases with the number of prior alliances established by partner firms, both between each other and with other firms. This may indicate an omitted variable problem which is common in this kind of studies, due to failure to properly control for modifications over time in the underlying content of newly established alliances. I also did not find any support for the view proposed in the industrial organization literature that the sector of activity of the partners of an alliance exerts an influence on their decisions as to the organizational form.

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contractual collaborations which are independent of transaction costs.

Even more interestingly, the empirical analysis shows that in accordance with competence-based theories of the firm, the characteristics of the collection of technological capabilities possessed by firms have a considerable impact on the form of their alliances. More precisely, if we confine attention to technological alliances, firms with overlapping patterns of technological specialization much more frequently resort to non equity bilateral forms than firms characterized by divergent technological capabilities. For these latter firms, the need to set up a more intense relation and to create an environment more conducive to interactive learning plays a key role in orienting their choice towards equity forms.

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