THE TRANSITION FROM STRATEGIC TECHNOLOGY ALLIANCES TO Mergers AND ACQUISITIONS: AN EXPLORATORY STUDY*

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ABSTRACT

This paper studies a number of research topics derived from the basic question: do interfirm alliances change into mergers and acquisitions as companies that were previously co-operating become integrated? The analysis is limited to the group of strategic technology alliances, i.e., those interfirm agreements for which joint technology development or technology sharing is part of the agreement.

The paper first explores the literature that refers to the possible transition from strategic technology alliances to mergers and acquisitions. Based on this we formulate a number of hypotheses regarding the change in modes of governance and several dimensions of this process related to the international distribution of transformed alliances, their industry specificity, the size of firms, and the distribution of contractual and equity agreements. The major finding of our research is that the transformation from strategic technology alliance to merger and acquisition hardly ever takes place. This suggests that alliances and mergers and acquisitions are not part of a rather smooth continuum but they are first of all different modes of governance where one mode certainly does not lead to the other.

INTRODUCTION

This paper studies the transformation of strategic technology alliances into mergers and acquisitions (M&As) in the context of the well-known continuum that reaches from market transactions via the 'swollen middle' of hybrid modes of governance to integrated hierarchical structures (Hennart, 1993; Williamson, 1991). Most of the research on these alternative modes of organization has concentrated on economic or strategic implications for firms regarding each of the segments of the continuum or the trade-off in the choice between these alternatives. So far little empirical research has been performed that concerns the possible transition of different modes of company organization, e.g., the possible dynamic relationship between intermediary modes and hierarchies.

A number of contributions, in particular in the strategic management literature, links up to the intuitive understanding of such a relationship stressing an 'encroachment' strategy followed by some companies. For instance, Doz et al.
(1986), Haspeslagh and Jemison (1991) and Reich and Mankin (1984) analyse such strategies in the context of firms that use their alliances as a vehicle to get greater control over their partners, whereby these partners are running the risk of becoming integrated after a period of 'courtship'. However, if we study the vast body of literature on strategic alliances, co-operative agreements and joint ventures that has emerged parallel to the rapid increase of these interfirm agreements, we find only a limited number of examples where the encroachment thesis is tested empirically.

In the following we pay attention to a set of research questions related to the basic question: do interfirm alliances with different intermediary modes of organization, such as contractual agreements and equity sharing agreements, change over time as companies that were previously co-operating become integrated? This question addresses the rather 'strong' variant in the transformation process where companies are merged or taken over; as such it abstracts from another aspect of such a transformation concerning an equity agreement in which one of the partners increases its share in the equity distribution of an alliance. Although equity sharing agreements are still an important vehicle for interfirm partnering, it has to be stressed that the majority of alliances made in recent years have been of a contractual nature. It is estimated that in the late 1980s and early 1990s about 75 per cent of the strategic alliances are of a contractual nature without equity-sharing (Hagedoorn, 1996). Given this growing importance of contractual agreements it appears more interesting to study the possible transformation of alliances through an encroachment of partners than to concentrate on the 'weaker' variant, i.e. the increase of an equity-share within a joint venture. This dominance of contractual alliances over equity based alliances allows us to also abstract from a possible transformation of a contractual alliance into an equity based alliance, which is then later transformed into an M&A.\footnote{\textsuperscript{[1]}}

Following the above-mentioned continuum our paper concentrates on the cooperation integration related aspects of interfirm relationships. More specifically we distinguish three different modes – two forms of alliances and one that can be characterized as a hierarchy or an integrated mode:

- **contractual alliances**, in particular joint R&D pacts and joint development agreements through which companies undertake innovative projects with shared resources.

- **joint ventures** are combinations of the economic interests of at least two different companies in a 'distinct' firm which also performs R&D or undertakes innovative projects.

- **M&As** refer to cases where two separate companies are combined into one company, either by means of a combination of the economic interest of equals, or through an acquisition where one company obtains majority ownership over another company.

The above already indicates that we limit the group of strategic alliances to technology-related partnerships, i.e. those interfirm agreements for which joint technology development or technology sharing are part of the agreement. Although this has some obvious limitations, previous research, for instance Kogut (1991), mentions the particular role that technology related alliances can play in
possible takeover activities. In that context a strategic alliance is applied by at least one of the partners to assess the strategic importance of the technology involved. After the decision to invest in a particular technology is delayed for some time or only partially made in order to assess the importance of that technology, the company decides whether it intends to increase its activities through an acquisition of the alliance or its partner. Furthermore, the particular strategic importance of technology for the future competitive strength of companies is a major reason why technology related alliances are an interesting subset of a wider range of cooperative agreements (Mowery, 1988; Mytelka, 1991).

In the following sections we will first explore the scattered pieces of literature that refer to the possible transition from strategic technology alliances to M&As. Based on our understanding of the most relevant factors in this process of transformation we will formulate a number of hypotheses regarding the change from alliances into M&As in the light of several dimensions such as the international distribution, the industry specificity, the size of firms, and the distribution of equity versus contractual modes. Before we test these hypotheses with a so-called negative binomial Poisson regression model we will pay attention to the data sets that are analysed, the procedures used to link different data banks, and the description of the measures as applied in this study. Finally, our conclusions set our contribution against the current understanding of different modes of governance and the particular place taken by strategic technology alliances. We will briefly discuss our main findings in terms of possible consequences for a theoretical understanding of strategic technology alliances as a distinct mode of organization.

EXPLORING THE CONTINUUM: PREVIOUS RESEARCH AND HYPOTHESES

Strategic Alliances Leading to M&As

The current literature on strategic alliances discusses a wide range of motives for the formation of these partnerships. See Eisenhardt and Schoonhoven (1996), Hagedoorn (1993), and Mowery (1988) for a more detailed review of the motives mentioned below. Largely borrowing from these contributions we can reconstruct an overview of major motives for strategic technology alliances that covers both market and technology-related motives.

Market-entry and market-structure related incentives for alliances refer to the effort to create new markets, to provide international market entry and to search for international expansion of the product range of partnering companies. Apart from these concrete market entry-related motives, strategic alliances can also be used as a scanning device to monitor the environment in which companies operate and to search for possible new opportunities. In combination with new product development, alliances allow companies to monitor new product markets without fully entering into these new markets initially and to first rely on a quasi or partial diversification of their product portfolio. If these new opportunities materialize further, companies can still decide whether they will pursue these new opportunities through their alliance, on their own, or through M&As.

Another group of motives refer to technology-related incentives that are particularly relevant for understanding strategic technology alliances. Here the further advancement of research and the diffusion of some applied scientific or technolo-
gical knowledge among participating companies is crucial to the agreement. Motives also worth mentioning in that context are the need to reduce and share the uncertainty which is inherent to performing R&D as well as sharing the costs of R&D. With increasing competition, companies are also forging alliances for concrete innovative projects to reduce the total period of the product life-cycle of products and to jointly introduce new products and services. Other relevant pressures that play a role in the formation of strategic technology alliances are the increased complexity and inter-sectoral nature of new technologies and the cross-fertilization of scientific disciplines and fields of technology. Also here the role of alliances as a scanning device is important as it enables companies to monitor the evolution of technologies in order to assess potential technological synergies and relevant complementarities of technologies.

It is against this general background of motives for strategic technology alliances that we have to understand the encroachment strategy in which one partner decides to take over the other because the alliance has generated the opportunity for an acquisition after it demonstrated the importance of the innovative capabilities of the partner (Doz et al., 1986; Reich and Mankin, 1984). Several recent contributions pay specific attention to alliances as important instruments to assess the value of both partner companies and the opportunities generated through these partnerships. Kogut (1991) analyses joint ventures, which we understand as a particular group of strategic alliances, as an option for firms that can bridge two basic alternatives, i.e. to wait before one commits resources and to demonstrate strong commitment through investment. Joint ventures are then used to assess the value of a new technology, a new product, or the capabilities of a partner. After the chances of future success have become more clear the option to acquire is likely to be exercised. Bowman and Hurry (1993) apply the idea of the 'option lens' to discuss the sequential choice in incremental options that allow companies to make a small investment, e.g. in a joint venture, and then to postpone for some time a more definite decision that would imply the striking of an option, e.g. through an acquisition. In a somewhat similar line of thought Haspeslagh and Jemison (1991) point at the possibilities offered by alliances to investigate takeover opportunities and to first encroach a partner before it is acquired. These authors conclude that 'in many cases collaboration is the first productive step ... before complete acquisition, or to overcome a firm's reticence and open the way for a potential merger' (Haspeslagh and Jemison, 1991, p. 246).

Also Hurry (1993) and Lynch (1989) point at the general advantages of incremental strategies through which, over time, co-operation leads to the acquisition of partners. Firms that are active in forming alliances are expected to create these to learn about new opportunities or to use alliances as vehicles for acquisitions. Following this line of inquiry, which points at the relevance of an encroachment strategy whereby one of the partners in an alliance is acquired, we introduce the following hypothesis:

**Hypothesis 1:** Strategic technology alliances lead to the formation of M&As, whereby participating companies are taken over or merged and the strategic technology alliance is transformed from shared to single ownership.

Our reading of the literature suggests that very little is known about the actual
time-lag between establishing a strategic alliance or a joint venture and its possible acquisition. Kogut's (1989) study of nearly 150 joint ventures involving US firms shows that very few of them were acquired during the first year, during the following years about 25 per cent of the joint ventures were acquired. Given this degree of ignorance in the literature regarding possible time-lags, we will not formulate a hypothesis on this topic but keep it as a question as to what time-lag can be reconstructed for strategic technology alliances that lead to M&As.

**General Conditions Affecting the Process of Transformation**

Our contribution is probably the first attempt to systematically explore the empirical relevance of the encroachment strategy with a large data set. As there is no well-developed theory regarding this process of transformation, of which we still have to assess the relevance, we follow a more frequently used procedure in exploratory research where a relatively unknown or a new phenomenon is studied in the context of a number of structural conditions that, in this case, shape the outcome of alliance strategies. A useful approach is to analyse such a phenomenon in the context of both general environmental conditions as well as company- or organization-specific conditions. Such an approach comes close to the traditional industrial organization inspired analyses in the strategic management literature where both structure and conduct variables are included to understand the behaviour of companies. Following Ring and van de Ven's (1992) understanding of major aspects of interfirm co-operation we can analyse the process of transformation from strategic technology alliances into M&As taking into account different dimensions such as domestic and international aspects, the industry specific context, market power and size differentials, and relational characteristics such as the mode of co-operation. In the following we will discuss several hypotheses that deal with the possible transition of strategic technology alliances in the context of each of these dimensions of alliance strategies.

**Domestic Versus International Alliances**

A number of recent contributions suggest that the domestic or international character of an alliance influences the particular organizational mode being chosen. Research by Gulati (1995) and Hagedoorn and Narula (1996) indicates that international alliances are more equity-oriented, whereas a disproportionate share of domestic alliances are of a contractual nature. From both a transaction cost economics perspective and a strategic management perspective this preference can be explained in terms of the cost of monitoring and keeping control over a long distance agreement. As domestic alliances are formed in a familiar environment, equity control is probably less prevalent in order to monitor the agreement than in the case of international alliances, where the familiarity with the behaviour of partners is expected to be smaller. Enforcing a contract in an unfamiliar environment is rather difficult compared to enforcing partial control through an alliance in which equity-sharing gives a firm at least some degree of ownership advantages (Dunning, 1993).

An interesting question in that context is then whether the disproportionate equity orientation of international strategic technology alliances also implies that firms demonstrate a certain preference for increasing their control over their international partnerships through integration. For domestic alliances, this would
suppose that the familiarity with the environment implies that companies would find means of control other than formal and majority equity control both available and effective. Then, a transformation to M&As is not as opportune as in an international context. Earlier research by Blodgett (1991) does indeed appear to suggest that international strategic technology alliances have a bigger chance of being discontinued through the acquisition of one of the partners in the alliance than domestic alliances. Hence:

Hypothesis 2: If the transformation from strategic technology alliances to M&As occurs, the share of these M&As will be disproportionately higher for international strategic technology alliances than for domestic strategic technology alliances.

Industry Context
Existing or potential conflict of interests, in terms of overlapping industrial activities, can be expected to influence the development of the actual alliances between companies. For instance, contributions by Harrigan and Newman (1990) and Balakrishnan and Koza (1993) suggest that joint ventures between companies from similar businesses have a higher probability of being dissolved than those made between companies from dissimilar industries. Harrigan (1985), Mowery (1988) and Ohmae (1985) stress that complementarity of partners with little conflict of interests regarding overlapping businesses is an essential characteristic for successfully maintaining a strategic alliance. This suggests that complementarity of partners, that are operating in dissimilar product-markets with probably little conflict of interests, increases the viability of the combined effort. However, cooperation between companies with similar product-market combinations implies a higher probability of a conflict of interests. One way of solving this conflict of interest between two partners is found in one company taking command of this joint effort through an acquisition of the other company. Therefore:

Hypothesis 3: If the transformation from strategic technology alliances to M&As occurs, a disproportionate share of strategic technology alliances between companies from the same industry will lead to an M&A transformation, whereas a disproportionate share of strategic technology alliances between companies from different sectors will not be transformed into M&As.

Industrial context is also relevant in terms of the technological change that affects the behaviour of companies. A number of studies reveals that the level of technological sophistication of sectors of industry affects the distribution of equity or non-equity modes of strategic technology partnering. According to Harrigan (1985, 1988) rapid technological change in sectors of industry induces the formation of somewhat informal forms of co-operation such as non-equity agreements. These studies also demonstrate that in industries where technological change is less pervasive, more formal modes of co-operations such as joint ventures have become the preferred form of collaboration. Osborn and Baughn (1990) suggest that technological instability of industrial sectors is a crucial factor in explaining different patterns for equity and non-equity partnerships. R&D intensive sectors with short product life-cycles and an innovative industrial climate
are expected to demand more organizational flexibility leading to a general preference for contractual agreements. In sectors with low degrees of R&D intensity and little innovative turbulence where organizational flexibility is also less crucial, technology partnering agreements is expected to be dominated by joint ventures. Yu and Tang’s (1992) findings can be interpreted along similar lines: stable sectoral environments favour joint venture formation, uncertain environments will lead to a larger number of non-equity agreements. Hagedoorn and Narula (1996) also found that technology-intensive sectors are characterized by a vast majority of contractual agreements, whereas the formation of joint ventures accounts for a disproportionate share of technology partnering in medium and low-tech industries.

Although these studies all differ with respect to the indicators used to measure the level of technological change or technological sophistication, the general picture that emerges is one in which contractual alliances are particularly preferred in so-called high-tech sectors, whereas in other sectors joint ventures are preferred disproportionately. This preference for contractual agreements in technologically advanced sectors and equity oriented co-operation in other sectors suggests that the transformation of strategic technology alliances into M&As could also be unevenly distributed. High-tech sectors would demand in particular short-term contractual agreements with little need for integration of these partners; in other sectors where equity agreements are already more visible the step from an equity agreement to an M&A would be more likely. This line of reasoning follows Oster (1992), who suggests that new high-tech industries, characterized by risk and flexibility, favour strategic alliances to M&As, whereas M&As are expected to be more popular in other more mature sectors.

In the present contribution, we analyse this relationship between mode of cooperation, transformation to M&As and the degree of technological change in sectors with particular reference to new core technologies (biotechnology, new materials and information technologies), that we understand as so-called high-tech sectors, comparing these to other more mature sectors of industry. In our understanding of new core technologies as new high-tech industries we follow van Tulder and Junne (1988) and Hagedoorn and Schakenraad (1990) in their analyses of these core technologies as a turbulent high-tech environment. Hence;

**Hypothesis 4:** If the transformation from strategic technology alliances to M&As occurs, the share of these transformed strategic technology alliances in new core technologies is disproportionately smaller than the share of the transformed strategic technology alliances in other sectors.

**Market Power and Size of Firms**
The analysis of the role that companies of different size classes might play in the transition of strategic technology alliances fits quite well within the more or less standard industrial organization inspired tradition within strategic management where the different roles of companies from different size categories is frequently explored further. In that context Hurry (1993) places part of his analysis of strategic partnering strategies in the context of the relationship between financially stronger and weaker firms. He expects stronger firms to take control over
their alliances or acquire their weaker partners. Research by Berg et al. (1982), Hagedoorn and Schakenraad (1994) and Duysters and Hagedoorn (1995) suggests that larger firms are more active in partnering than their smaller competitors. Berg et al.'s contribution also hints at the possibility that in case of an unequal size distribution in a partnership, this alliance will probably be dissolved through a takeover. Taken together with the encroachment thesis, we can interpret the relationship between size of companies and the transformation of strategic technology alliances in terms of a relationship between unequals, suggesting that:

*Hypothesis 5a:* If the transformation from strategic technology alliances to M&As occurs, a disproportionate share of these cases of transformation is between companies of different size classes.

*Hypothesis 5b:* After a period of courtship through strategic technology alliances, large firms acquire their smaller partners.

**Differences between Equity and Non-equity-based Alliances**

The literature on strategic alliances and interfirm co-operation suggests that different modes of co-operation, such as equity-sharing alliances (joint ventures) and contractual modes have a different impact on performance, organization, and management of partnering firms (Hagedoorn, 1993; Harrigan, 1985; Osborn and Baughn, 1990). Hagedoorn (1993) found joint ventures aimed at shared innovative efforts to be rather complex, firm-like, organizations with a multitude of company objectives, whereas contractual strategic technology alliances are more one-dimensionally oriented. The complexity of joint ventures seems to make these organizations vulnerable and prone to failure (Berg et al., 1982). Contractual technology alliances, on the contrary, are more limited in scope, aimed at short-term technological achievement and fairly simple in terms of their organizational nature.

Although there is, to the best of our knowledge, no literature analysing the different options to acquire partners through contracts or joint ventures, we expect the likelihood of the creation of M&As through joint ventures to be higher than through contractual agreements. We already mentioned that research by Kogut (1991), Berg et al. (1982) and Blodgett (1991) indicates that joint ventures can be part of a takeover process. The multidimensional nature of joint ventures, reflected in their firm-like characteristics, provides partners with a better understanding of the technological and commercial impact of the venture. Compared to joint ventures, contractual agreements are more limited in scope and are aimed at single projects that seem of much less relevance to a future takeover or merger activity which concerns a wider range of company activities. Therefore, we expect that joint ventures have a higher probability of leading to M&As than contractual alliances. Hence:

*Hypothesis 6:* If the transformation from strategic technology alliances to M&As occurs, a disproportionate share of strategic technology alliances that are of an equity nature (joint ventures) will lead to an M&A transformation, whereas a disproportionate share of strategic technology alliances of a contractual nature will not be dissolved in M&As.
DATA AND METHODOLOGY

Data and Data Sources
In order to find out to what extent strategic technology alliances lead to M&As we combined data from two sources, the MERIT-CATI data bank on strategic technology alliances and the Securities Data data set on M&As. The MERIT-CATI data bank contains data on nearly 13,000 co-operative technology agreements involving about 5000 parent companies. The information is stored in the form of a relational database whereby its separate data files can be linked to each other in order to provide data in a (dis)aggregate and combined form. Since 1987 data on interfirm alliances has been systematically collected, including a retrospective search, and the database currently covers the period between 1970 and 1993. The most important data sources are a large number of international and specialized trade and technology journals for each sector of industry and many fields of technology. These journals cover particular companies from North America, Europe and Asia. Companies’ annual reports, the Financial Times’ Industrial Companies Yearbooks and Dun and Bradstreet’s Who Owns Whom provided information about dissolved equity ventures and investments, as well as ventures that we did not register when surveying alliances.

The database contains information on each co-operative agreement and some information on companies participating in these agreements. Co-operative agreements are defined as the establishment of common interests between independent (industrial) partners which are not connected through (majority) ownership. The transfer of technology or the undertaking of joint research is considered as crucial to these arrangements. Examples in this respect are joint research pacts and joint development agreements. In addition data are collected on joint ventures with technology sharing or which have a joint R&D programme. Mere production or marketing joint ventures are excluded. R&D oriented joint ventures and jointly owned research corporations are seen as joint ventures; joint development agreements, joint research pacts and research contracts are taken together as contractual agreements.

For the purpose of the present analysis information is used regarding the international or domestic character of the alliance, the sectors and fields of technology, the size of firms involved, the form of co-operation and the year of establishment of the strategic technology alliance. The distribution of firm size is according to employment in five categories (fewer than 500; 500 to 5000; 5000 to 50,000; 50,000 to 150,000, and more than 150,000 employees). Within the CATI database there are 65 (sub-)classifications with respect to sectors and fields of technology. A major distinction is made between new core technologies (information technologies, biotechnology, new materials) and other industrial sectors. Additional information on this data bank can be found in Hagedoorn (1993) and Hagedoorn and Schakenraad (1994), or obtained from the authors.

The second data bank provides information on M&As. This data bank is property of the firm Securities Data and can be used via on-line access. Currently it contains information on about 125,000 worldwide M&As for the period 1980–94. This information is arranged in several data files. For a limited period of time this database has been accessed and a specific data sample has been extracted. The relational form of the database facilitates the linking of these data files to each
other and also to files in other data banks. Within the M&As database there is information on the year the M&A was established. In addition, it contains company information on the acquirer, the target, the parent acquirer and the parent target firm. The industry information is provided in SIC codes of the acquiree and acquirer. Unfortunately, the distinction between a merger or an acquisition and a takeover as made by Securities Data does not always correspond to the real background of the M&A. This is partly due to the character of information on M&As in the trade literature. For example, a number of cases have been classified as mergers despite the obvious mismatches in firm-size indicating an acquisition. Acquisitions are frequently presented as mergers because of the negative publicity that acquisitions receive in particular if a foreign partner is involved. Also, the official classification, legal description and definition of both modes differs from country to country, which makes the actual difference between a merger and an acquisition in an international context quite debatable (Milgrom and Roberts, 1992). As M&As both lead to integration they are taken together and considered as one single category.

Procedures to Connect Information on Alliances to M&As

For the search procedure that would allow us to find any transition from strategic technology alliances to M&As we have taken the following steps:

First, a search procedure was developed that would guarantee that all firms involved in strategic technology alliances and M&As in both data banks could be identified. The actual search procedure applied examined the parent companies involved in strategic technology alliances and M&As. This procedure ensures the highest level of corporate control for the analysis with all subsidiaries that are part of a strategic technology alliance or an M&A being included. This procedure provided us with a population of strategic technology alliances and M&As made by a large group of companies using both modes. In other words, if the transition would take place, it has to show up in this population with firms that are active in both strategic technology alliances and M&As.

Second, a correspondence in the data fields concerning industry information in both data banks had to be made at the industry level. The technology classification in the CATI database was adjusted to the SIC code system in the M&As database using a correspondence table. As a result, the data on co-operative technology alliances within the CATI data bank relevant to the analysis amounted to 6425 strategic technology partnerships. The extracted amount of data from the database on M&As corresponding to the CATI data bank amounted to approximately 16,400 cases. In total about 3000 companies were involved in strategic technology alliances and M&As during the period 1970–94, i.e. 1970–93 for strategic technology alliances and 1980–94 for M&As.

Throughout this paper we will discuss alliances, although technically speaking we are analysing dyads or points of contacts between companies through alliances. In other words, an alliance with more than two partners has several dyads. Also, the first alliance (dyad) between companies as found in our data bank is taken as a point of reference; other alliances between the same partners before an M&A is created (chronologically multiple contacts) are neglected. As such we only analyse whether companies have been acquainted with each other through an initial alliance and then established an M&A.
Finally, to examine the probability of a transition from strategic technology alliances to M&As, the subset of data extracted from the CATI database is used as the starting point for the analysis. M&As preceding strategic technology alliances between the same partners are neglected as being illogical. In case of an identical announcement year for an alliance and an M&A, we also ignored these because of the high-risk of a misinterpretation of the announcement.

Sample
As discussed above, the population of strategic technology alliances under transition was examined with respect to different determinants that could affect this transition. The results of the examination of these different determinants for strategic technology alliances that were actually transformed into M&As were set against the population of non-transformed strategic technology alliances, to compare for different patterns. These non-transformed alliances are the total number of alliances that could have been transformed minus those that actually were minus the chronologically, multiple contacts between the same partners. In total our analysis refers to 6425 strategic technology alliances in which 2848 companies are involved.

Variable and Measures

International and domestic alliances (INT). The international or domestic character of strategic technology alliances indicates whether alliances were made between companies with headquarters in different countries or between companies with headquarters in the same country.

Identical and different sectors (SECT). This indicator measures whether companies that are engaged in an alliance are found in the same or in different sectors of industry. In the MERIT-CATI database each company is assigned to a sector of industry, largely following the Business Week and Fortune breakdown of sectors. Companies operate in identical sectors if their main business is in one of the following main categories: biotechnology and pharmaceuticals; information technology; new materials and chemicals; aerospace and defense; automotive; consumer electronics; engineering contracting, exploration, drilling, mining; food and beverages; heavy electrical equipment; instrumentation and medical technology.

Core technologies and other sectors (CORE). Strategic technology alliances in biotechnology, information technology and new materials are taken as alliances in core technologies, the others are assigned to other sectors.

Joint ventures and contractual alliances (EQUI). This measures whether a strategic technology alliance is of a shared equity nature (joint ventures) or a contractual agreement (joint R&D pacts and joint development agreements).

Size of companies (SIZE). This variable indicates whether companies that share an alliance are found in the same or in different size-categories according to their number of employees. There are five categories: fewer than 500 employees; between 500 and 5000 employees; between 5000 and 50,000 employees; between 50,000 and 150,000; and larger than 150,000 employees.
Combinations of large firms with smaller partners (hypotheses 5b) are measured as combinations of firms with more than 150,000 employees with all companies with fewer than 50,000 employees and combinations of companies with between 50,000 and 150,000 employees with all companies with fewer than 5000 employees.

Methods
The descriptive statistics and simple chi-square tests for differences in the distributions for both populations already provide some insight and allow us to test hypotheses 1 and 5b in a bivariate setting.

Given the binary dependent variable – i.e. the occurrence or absence of a transformation of a strategic technology alliance – and the dichotomous nature of the independent variables – i.e. the dimensions of a possible transformation process as discussed above – a Poisson regression model is applied to test the hypotheses in a multivariate setting. Poisson regression is used to analyse events that occur both randomly and independently in time (Ross, 1993). In particular we applied a so-called negative binomial model which allows for overdispersion in the data. Further details on some methodological aspects of the Poisson model are found in the appendix.

The dependent variable TRANS indicates whether strategic technology alliances are transformed into M&As, or not introduced (TRANS, transformed alliances = 1, non-transformed alliances = 0). The different characteristics of strategic technology alliances, or independent variables in the model are SIZE, INT, SECT, CORE and EQUI. The categorical variable SIZE indicates size differences of firms involved in a strategic technology alliance (SIZE, unequal size = 1, equal size = 0). The variable INT describes the (inter)national patterns of these alliances (INT, international = 1, national = 0). Sectoral and organizational patterns of these alliances are characterized with the categorical variables SECT, CORE and EQUI respectively (CORE, new core technology = 1, non-core technology = 0; SECT, same sector = 1, other sectors = 0; EQUI, equity-based = 1, non-equity based = 0).

EMPIRICAL FINDINGS

Our first finding, and we think also the most remarkable outcome of this research, is that only 2.6 per cent of the total number of strategic technology alliances that we studied could be linked to M&As. From the total of 6425 strategic technology alliances only 168 cases were linked to M&As of the same partners (see table I). If this transition from strategic technology partnership to an M&A took place, this happened within an average period of 6.1 years (with a standard deviation of 4.8).

Table I also presents some size-related characteristics of firms involved with strategic technology alliances that have led to M&As of partners. About 38 per cent of the firms involved in this transformation process employ between 5000 and 50,000 people. The group of large firms with over 50,000 employees has a share of 33.5 per cent of this particular group of alliances. Compared to the distribution of the non-transformed alliances that we searched in this study the distribution for
### Table I. Company size related characteristics of strategic technology alliances transformed into mergers and acquisitions, 1970–1993

<table>
<thead>
<tr>
<th>Size Distribution</th>
<th>Companies in transformed alliances ($n_1 = 189$)*</th>
<th>Companies in all other alliances ($n_2 = 2848$)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500 employees</td>
<td>15.0%</td>
<td>42.5%</td>
</tr>
<tr>
<td>500–5000</td>
<td>13.3%</td>
<td>27.1%</td>
</tr>
<tr>
<td>5000–30,000</td>
<td>38.2%</td>
<td>24.4%</td>
</tr>
<tr>
<td>30,000–150,000</td>
<td>23.7%</td>
<td>4.1%</td>
</tr>
<tr>
<td>&gt;150,000</td>
<td>9.8%</td>
<td>1.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Alliances with companies of:

- **Transformed alliances** ($n_1 = 168$)*
  - similar size 34.6% 23.1%
  - dissimilar size 65.4% 76.9%
  - of which dominated by large firms** 17.0% 33.4%

$X^2 = 11.4899; p < 0.0007$ for distributions of (dissimilar size

**Notes:**

*For 173 of the companies with transformed alliances the size could be traced; for all other companies, the size of 1375 companies could be traced; for transformed alliances the size of partners could be traced for 153 alliances; for all other alliances the size of partners could be identified for 4101 cases.

**Large firm dominance: combinations of firms > 150,000 employees with all companies <50,000 employees; companies with 30,000–150,000 employees with all companies <5,000 employees.

*Source:* MERIT-CATI and Securities Data – M&A

Alliances in transition is more skewed as firms with more than 5000 employees have a share of 71.5 per cent against about 30 per cent for all alliances. If we consider the distribution of partners from similar or dissimilar size-categories also involved in an M&A succeeding a strategic technology alliance, we see that two-thirds of these alliances are made between dissimilar companies. For the non-transformed strategic technology alliances the share of companies from different size-classes is significantly higher as about 77 per cent of the partnerships are made between dissimilar firms. Seventeen per cent of the total number of alliances leading to M&As refer to cases where a large or very large company acquires its smaller partner, which is nearly half of the share for non-transformed alliances.

Data regarding the (inter)national, sectoral and organizational patterns of the groups of strategic technology alliances leading to M&As and the non-transformed strategic technology alliances is presented in table II. The data and the simple chi-squared tests reveal that there are no significant differences between both distributions for domestic and international alliances and for joint ventures and contractual agreements. There are, however, differences between transformed and non-transformed alliances when it comes to alliances between companies from the same or different sectors and alliances made in new core technologies are in other sectors.

For the Poisson regression analysis the population consists of 6425 observations, with missing data on 2171 cases where the size of partners or the sector could not
Table II. International and sectoral patterns in strategic technology alliances transformed into mergers and acquisitions, 1970–1993

<table>
<thead>
<tr>
<th></th>
<th>Transformed alliances</th>
<th>All other alliances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n₁ = 168)</td>
<td>(n₂ = 6257)</td>
</tr>
<tr>
<td>Domestic alliances</td>
<td>45.8%</td>
<td>40.5%</td>
</tr>
<tr>
<td>International alliances</td>
<td>54.2%</td>
<td>59.5%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Identical sectors</td>
<td>72.7%</td>
<td>50.8%</td>
</tr>
<tr>
<td>Different sectors</td>
<td>27.3%</td>
<td>49.2%</td>
</tr>
<tr>
<td>Total*</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Core technologies</td>
<td>59.5%</td>
<td>67.1%</td>
</tr>
<tr>
<td>Other sectors</td>
<td>40.5%</td>
<td>32.9%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Joint ventures</td>
<td>41.7%</td>
<td>36.4%</td>
</tr>
<tr>
<td>Contractual alliances</td>
<td>58.3%</td>
<td>63.6%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*The actual numbers for the sectoral distribution of alliances are 154 and 4385
(International distribution, \( \chi^2 = 1.9478; p < 0.1628 \)
Identical sectors distribution, \( \chi^2 = 29.3995; p < 0.0000 \)
Core technologies distribution, \( \chi^2 = 4.3785; p < 0.0364 \)
Joint venture distribution, \( \chi^2 = 2.0072; p < 0.1366 \)

Source: MERIT-CATI and Securities Data - M&A

be identified, see also tables I and II. In the remaining sample 153 strategic technology alliances were classified as leading to an M&A, 4101 of them did not. The estimates of the negative binomial Poisson model are specified in table III. We arrived at this model using the following steps. First, we examined the independence assumption of the general Poisson model. In our application, we used an overdispersion test involving simple least squares regressions. The test proposed by Cameron and Trivedi (1986) revealed that t-ratios in the regressions are larger than 1.0. This suggests that the variance in the dependent variable is larger than the mean, implying 'overdispersion' in the data. Therefore the restriction of independence had to be relaxed. The negative binomial Poisson model allows for overdispersion. Second, in our application the negative binomial model performed better with respect to the goodness-of-fit statistics. Convergence to the global maximum in the general Poisson as well as in the negative binomial regression model was always rapid. With respect to the iterations, the negative binomial regression model performed better than the general Poisson model. In addition, the likelihood ratios were slightly higher for the negative binomial model suggesting a better fit of this model. Finally, the measure for overdispersion \( \alpha \) in the model is positive indicating that the data are consistent with the model.

According to the procedure followed, it can reasonably be assumed that the distribution of the data follows the distribution characteristics for negative binomial models. The model as a whole, however, is non-significant, indicating

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Table III. Results of the Poisson regression analysis (negative binomial model) for the relationship between characteristics of strategic technology alliances and the probability of transformation into M&As

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQUI</td>
<td>0.2470</td>
<td>0.1852</td>
</tr>
<tr>
<td>INT</td>
<td>-0.0887</td>
<td>0.1879</td>
</tr>
<tr>
<td>SECT</td>
<td>-0.9772***</td>
<td>0.1972</td>
</tr>
<tr>
<td>SIZE</td>
<td>-0.4398**</td>
<td>0.1945</td>
</tr>
<tr>
<td>CORE</td>
<td>-0.5290***</td>
<td>0.1940</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.3450***</td>
<td>0.2517</td>
</tr>
<tr>
<td>Variance parameter $\alpha$</td>
<td>0.0008</td>
<td>0.2914</td>
</tr>
<tr>
<td>$-2 \log$ likelihood</td>
<td>644.9844</td>
<td></td>
</tr>
<tr>
<td>Iter; Time</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

*** $p < 0.05$ (two-tailed test of coefficients, one-tailed test of likelihood ratio)

*** $p < 0.01$ (two-tailed test of coefficients, one-tailed test of likelihood ratio)

that variables other than the ones under observation are important for a transformation from strategic technology alliances to M&As.

DISCUSSION

Our main finding reveals that strategic technology partnering plays hardly any direct role when companies form M&As (hypothesis 1). Only in about 2.6 per cent of the relevant strategic technology alliances have these alliances led to an M&A between the same partners. This result is particularly strong as we used two large data sets combining information on over 6000 strategic technology alliances with information on 16,000 M&As of the same group of nearly 3000 firms.

This strong result seriously questions the relevance of the encroachment thesis as strategic technology alliances play only a limited role if companies form M&As. Also, many of the questions related to the process of transformation now have to be seen against the background of the limited relevance that this process apparently has.

Concerning the dissimilarity of size-classes of companies that use strategic technology alliances to acquire their partners or merge with them, we found little support for an encroachment thesis with large firms using their strategic technology alliances to take over their small partners (hypothesis 5b). The role of large firms in taking over their smaller partners is rather limited as this happened in 17 per cent of the cases where strategic technology alliances were transformed into integrated common ownership.

In the few cases where strategic technology partnering is part of a movement towards M&As, it seems this pattern defies the logic that one could deduct from scattered pieces of literature on joint ventures and strategic partnering that point at the relevance of an encroachment strategy. The negative binomial Poisson model demonstrates that only for the variable that distinguishes between strategic technology alliances from new core technologies and other sectors one finds a...
significant effect on the occurrence of such a transformation (hypothesis 4). This indicates that the share of these transformed strategic technology alliances in new core technologies is disproportionately smaller than the share of the transformed strategic technology alliances in other sectors. In line with what the literature suggests, this shows that in new high-tech sectors, such as biotechnology, new materials and information technology, there is even less attention for taking over another company after an initial strategic technology alliance than in other sectors.

All the other hypotheses with regard to the different dimensions of the transformation from strategic technology alliances into M&As (except the already discussed hypotheses 1 and 5b) could not be verified, either because we found no significant effect or the effect was contrary to what we expected. In other words, a different set of relationships and variables seems necessary to explain the behaviour of companies in the context of both strategic technology alliances and M&As, as, with few exceptions, the transition from one form of organization to the other does not seem to take place.

CONCLUSIONS

Before we formulate our conclusions in terms of an alternative understanding of the relationship between strategic technology alliances and M&As, it is important to stress a possible limitation of this paper. It should be noted that our research pertains to only one specific group of alliances, i.e. those for which the sharing or joint development of new technologies and joint undertaking of R&D is part of the alliance. Therefore, our results could probably have fewer implications for those strategic alliances that are aimed at joint marketing or the sharing of manufacturing or services. However, in recent years a growing number of contributions (Hagedoorn and Schakenraad, 1994; Osborn and Baughn, 1990; Mowery, 1988; Mytelka, 1991) stress the importance that strategic alliances with a large technology content play, in particular in turbulent high-tech industries that will shape much of the present and near-future competitive environment.

As suggested by our empirical results, strategic technology alliances seem to play such a small role in the encroachment of partners, that their relevance for company strategies will have to be found somewhere else. Understanding strategic technology alliances as part of a learning process of companies, in which they discover new innovative opportunities in a flexible setting of a multitude of partnerships (Ciborra, 1991; Hagedoorn, 1995), could provide an interesting perspective. Such a learning process in the context of co-operative technological development is of a complicated nature that resembles high-tech learning (Lyles, 1994), exploratory learning (Dodgson, 1993; March, 1991) or double-loop learning (Argyris and Schon, 1978) as it covers a change of routines, unlearning and the discovery of new issues in a joint effort. To some extent the complexity of this learning is due to partner differences (Parkhe, 1991). However, this complexity is at least as much influenced by the exploratory nature of learning in technological development itself, in particular in those industries where technological change is still of a turbulent nature.

Once this learning process of companies changes towards more standard information processing, and learning and flexibility become less important for large
groups of companies as industries gradually mature, integration through M&As will probably become a more viable option (CIBORRÁ, 1991). As long as sectors of industry or fields of technology can be characterized as turbulent environments with high technological risk (RING AND VAN DE VEN, 1992) combinations of internal learning and the timely absorption of new technologies through alliances can be more effective than takeovers or mergers of (parts of) companies. In other words, for technological renewal under dynamic-competitive circumstances (GURUD, 1994) where knowledge expires quickly, flexible partnering with capable partners might be more adequate than an encroachment strategy leading to formal integration.[3]

A major conclusion from this study appears to be that strategic technology partnering is a category on its own. In evaluating the impact of strategic decisions in the context of integration versus contracting strategies aimed at improving the innovative capabilities of firms (TEECE, 1987) there appears to be little room for transitional strategies as such. Separate modes of partnering, be it of a contractual or an equity nature, have different organizational and strategic properties (HAGEDOORN, 1993) but they share their distinctive character that sets them apart from common governance through integration. Companies utilize these different categories of strategic technology alliances for a variety of reasons, ranging from scanning market-entry opportunities to monitoring new technological developments and jointly developing new products and processes. In all of this, learning seems crucial but apparently companies are able to employ alliances as separate modes of organization which permit them to learn about the opportunities mentioned above without the need to enter into formal integration through M&As. In that sense, there exists, as far as strategic technology partnering is concerned, and with very few exceptions, no real continuum which suggests that strategic technology partnering is a ‘front porch’ for corporate growth through integration, by means of M&As.

APPENDIX

Note on the Poisson Regression Model
In our analysis, the substantive problem we encountered was to analyse the transformation of strategic technology alliances into M&As. Our dependent variable \( Y_t \) was the total number of strategic technology alliances transformed into M&As by partnering firms in a given year. The counting process referred to the total number of strategic technology alliances \( N(t) \) that are at or prior to time \( t \) transformed into M&As \( N(t), t \geq 0 \). Because of the skewed distribution of the data, we could experiment with but not use other more standard statistical models such as logit regression (see note 2) because they did not fit the data (MADDALA, 1983; ROSS, 1993).

The basic formulation for this kind of problem is the Poisson regression model. In its general form, it contains a discrete random variable, \( Y_n \), which denotes the number of occurrences, for the \( i \)th of \( N \) individuals, of an event of interest in a given time interval, \( Y_i = 0, 1, 2, \ldots \). The number of events in an interval of a given length can be described as Poisson distributed with the probability density

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\[ \text{prob}\{Y = y_i\} = e^{x_i \beta / y_i^\lambda}, \quad y_i = 0, 1, \ldots, \quad i = 1, 2, \ldots, N \]  

(1)

where \( y_i \) is the realized value of the random variable. In order to incorporate exogenous variables, the parameter \( \lambda \) is specified to be

\[ \ln \lambda_i = \beta' X_i \]  

(2)

In its general form the Poisson regression model assumes that \( \lambda_i \) is both the mean and variance of \( y_i \) (Kingman, 1993). In order to fit a Poisson model to the data we first had to examine this strong assumption and, if falsified, use a different model that could take into account for overdispersion, i.e. if the variance exceeds the mean. In our application, we used an overdispersion test as proposed by Cameron and Trivedi (1986) to examine the over- and under-dispersion in the actual Poisson regression model.

In case of over- or under-dispersion, the negative binomial regression model as an extension of the Poisson regression model could fit the data because it allows the variance to differ from the mean. In our application, this would mean that the total number of strategic technology alliances transformed into M&As is random, rather than fixed. We also applied this model to our data. As a modification of the general form of the Poisson regression model the negative binomial regression model requires that \( \lambda_i \) has to be respecified in the following way

\[ \ln \lambda_i = \beta' X_i + \epsilon \]  

(3)

where \( \epsilon \) has a gamma distribution with mean 1.0 and variance \( \alpha \) (Cameron and Trivedi, 1986). The modification leads to a different probability function

\[ \text{prob}\{Y = y_i\} = e^{x_i \beta / y_i^\lambda} \cdot \exp(\epsilon) \cdot y_i^\lambda / y_i^\lambda, \quad y_i = 0, 1, \ldots \]  

(4)

According to Greene (1995) the unconditional distribution of \( y_i \) is achieved by integrating \( \epsilon \) out. This generates the following distribution that was used for optimization

\[ \text{prob}\{Y = y_i\} = \Gamma(\theta + y_i) / [\Gamma(\theta) y_i!] \cdot u_i^{\theta} \cdot (1 - u_i)^{y_i} \]  

(5)

where \( u_i = \theta / (\theta + \lambda_i) \)

and \( \theta = 1 / \alpha \)

The additional parameter \( \alpha \) in this model takes the overdispersion into account. Therefore the over-dispersion rate is written according to Greene (1995) as:

\[ \text{Var}\{y_i\} / E\{y_i\} = 1 + \alpha \cdot E\{y_i\} \]  

(6)

Based on this probability distribution the log-likelihood and its derivatives of the model were computed. Goodness-of-fit statistics were used for testing in the same way as in other discrete regression models. The goodness-of-fit statistics also allows comparing the extent to which the different Poisson models fit the data (Agresti, 1996; Hausman et al., 1984; Maddala, 1983).
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[1] During our research we did not investigate whether this indirect transformation effect might have taken place, as we found little or no evidence of an initial transformation from contractual to equity-based alliances, in fact it turned out that only 2.4 per cent of all contractual alliances were transformed into joint ventures.

[2] Apart from a Poisson regression model we used different forms of logit analysis — such as a standard logit model, a loglinear version and a logit analysis with an artificially redistributed population — during our research. Given the low frequency with which the transformation of strategic technology alliances takes place, all logit analyses encountered similar methodological problems, such as a very low level of significance of the model and low correct classification scores.

[3] In negative binomial models, convergence problems in the estimation can occur, particularly when the data are censored or truncated. In order to test for these potential problems, additional specifications were imposed in earlier models. However, these specifications did not change the outcome significantly. The results and the predictions of the negative binomial model without additional specifications showed that this final model fitted the data better than its predecessors.

[4] Unfortunately, our data does not allow us to investigate other aspects of the evolution of strategic technology alliances such as their termination or their continuation in an altered or unaltered form. Also, the success of a strategic technology alliance in the sense of the significance of the innovative results might impact the probability of an M&A, albeit within the overall limitations of the probability of this transformation process as suggested by our current research.

[5] As suggested by one of the reviewers, the capabilities of partnering companies is influenced by the skills of key individuals, see Narin and Breitzman (1995).

REFERENCES


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