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Strategic technology alliance termination: An empirical investigation

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ABSTRACT

There is growing consensus that overall alliance termination rates are high. However, despite this track record of termination and despite unsurpassed growth rates of strategic technology alliances, little is known about the reasons for their termination. Typically strategic alliances have been characterized as inherently instable, i.e. often involving unplanned and premature termination of the alliance by partnering firms indicating alliance failure. The literature on strategic *technology* alliances, however, proposes that alliance termination does not always indicate failure, but can be intended and can be a sign of strength. We examine these different perceptions by using a sample of 48 strategic technology alliances in different high-technology industries. The findings in the paper confirm that the rates of termination are rather high for strategic technology alliances. Overall, we found that in particular negative prospects about future cooperation, negative perceptions about joint benefits and the lack of a win-win situation had an impact on the decision to terminate a strategic technology alliance. Also, the fact that some companies opt only for short-term (not for long-term and renewed) cooperation seems to introduce a negative factor into the longevity of strategic technology alliances.

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1. Introduction

Since the 1980s, the strong growth of strategic technology alliances has dramatically changed the competitive landscape. Strategic technology alliances have become a key competitive weapon for

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companies contending in an increasingly hostile international environment. It allows companies to efficiently leverage their resources, to participate in emerging cutting-edge technologies and to strategically re-position themselves in different market segments. By allying with competent technology partners, firms are able to share risks and costs associated with technological development. At the same time, they are able to reduce time-to-market because of complementarities in skills and technologies among alliance partners (Tyler, 2001). It has often been argued that the flexibility and adaptability of these alliances makes them a perfect substitute to more conventional modes of organization such as mergers and acquisitions and internal development (Dyer, 2000; Duysters and de Man, 2005). In spite of these noted advantages, less is known in the literature about the reasons for termination of strategic *technology* alliances (for a notable exception see Bierly and Coombs, 2004a,b).

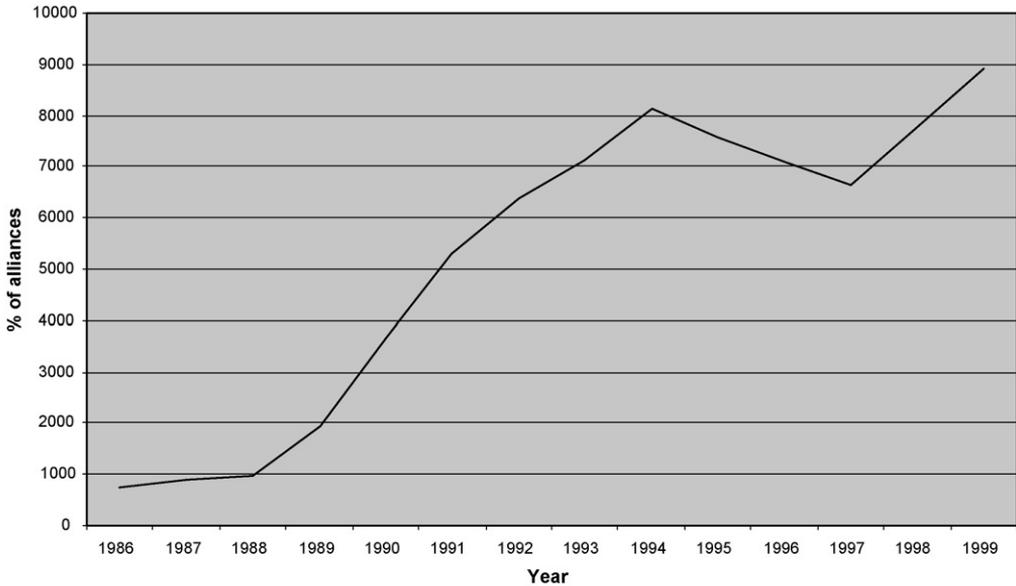
Within the long-standing debate in the marketing, strategic management, and technology management literature, the termination of strategic *technology* alliance has just recently been considered as a distinct outcome compared to termination of other forms of strategic (e.g. marketing) alliances. As the early literature contended that termination was due to insufficient value creation within the strategic alliance (Harrigan, 1986, 1988), more recently performance differentials between partnering firms have been considered as major reasons for (strategic) alliance termination (Madhok and Tallman, 1998; Spekman et al., 1998; Spekman and Isabella, 2000). For strategic technology alliances, research has characterized technological capabilities of partnering companies and their link with these alliances as crucial to determine the outcome of these alliances (Reuer and Zollo, 2005). This literature has not yet explored the termination of strategic technology alliances in high technology industries in which companies utilize these alliances to enhance (different forms of) their technological capabilities (Vanhaverbeke et al., forthcoming).

Given the growing number of strategic technology alliances and their strategic importance for companies, questions about reasons for alliance termination (and failure) have become more important than ever. With empirical studies suggesting a termination rate of strategic alliances somewhere between 40% and 70% (for an overview of the literature see Duysters et al., 1999), the termination rates for strategic technology alliances might be different (Duysters and de Man, 2003). This paper aims to shed more light on the specific causes of termination. In order to examine termination of strategic technology alliances, we assume that termination can either be (1) deliberately planned, pointing to a successful ending of an alliance, or (2) associated with an unintended termination, which is generally associated with failure. This dichotomy allows us to exclude alliance termination which has been intended and has been considered as desirable by the parties involved. In the paper, our focus is on strategic technology alliances, i.e. cooperative ventures in which the development of technology has been a strategic objective at least of one partner. This definition excludes short-term inter-firm agreements as well as more conventional (e.g. marketing) alliances. It allows us to focus on the importance of the technological component in the evolution of these ventures.

This paper is structured as follows. First, we characterize the discussion on alliance termination rates and their measurement in the light of current trends in strategic technology alliance activity. We then examine the theoretical discussion on alliance termination and develop a conceptual model that is related to partnering company's dissatisfaction due to insufficient managerial skills and competencies in coordinating and stabilizing existing alliances. This conceptual model is then used to examine a sample of 48 strategic technology alliances. This paper is concluded by summarizing our arguments and by drawing some conclusions with respect to preventing unintended termination of strategic technology alliances.

2. The termination of strategic technology alliances: paradoxes and mismatches

Quite paradoxically, we have been witnessing an enormous growth in terms of the number of strategic technology alliances since the 1970s despite of an ongoing discussion of high failure rates for strategic alliances in the theoretical and business literature. As the data show (see Fig. 1), there has been a vast increase in the number of strategic technology alliances since the late 1970s and, in particular, in the early 1980s. Despite some decline in the early 1990s, the growth of strategic technology alliances has been continuous and seems unaffected by fluctuations in the world economy.



Source: Thomson Financial, 2003.

Fig. 1. Number of newly established strategic alliances per year (1985–2000), 3-year moving averages.

It has been argued that these growth patterns will persist in the near future (Baum et al., 2000; Ernst et al., 2001; Duysters and de Man, 2005).

In spite of the potential advantages of strategic alliances, the empirical evidence on failure rates, however, has painted a rather dark picture.

'Let the potential alliance partner beware: all is not as it seems. It is true that one can leverage resources, jump-start technology and facilitate market development. It is also true that one can learn a great deal from one's partner in a shorter time than it would have taken to develop that particular skill set or tacit technology internally. The espoused gains are many and well documented. The data, however, paint a different and more somber picture' (quoted from Spekman et al., 1996).

In other words, the striking paradox is that companies continue to engage in strategic alliances despite rates of failure are quite high. This poses some awkward questions as to what kind of skills and competencies of managers involved in strategic technology alliances are necessary to prevent an unintended termination of the alliance. For example, are these managers aware of the current rates of unintended termination of strategic technology alliances? to what extent does organizational and technological fit between partnering firms matter for the longevity of a strategic technology alliance? or to what extent can mutual benefits provided to partnering firms prevent termination of a strategic technology alliance?

3. Termination of strategic technology alliances: failure rates

The literature on alliance termination has generated a mixed bag of findings. However, the general picture has been rather pessimistic. For example, Spekman et al. (1996) proposed that the failure rate of strategic alliances has been at around 60%. In the literature, this high failure rate has been used as a benchmark to characterize alliance termination (see Kok and Wildeman, 1997; Dacin et al., 1997). More optimistic studies have postulated that only half of all strategic alliances fail (Brouthers et al., 1997; Douma, 1994; Bleeke and Ernst, 1993). Or as Pekar and Allio (1994) have pointed out that this rate might even still be lower. In their study they concluded that only 40% of the firms surveyed judged

their strategic alliance experiences as a failure. Interestingly, distinctions between strategic technology alliances and other forms (e.g. marketing) of alliances have rarely been made in this literature.

In linking the experiences with strategic alliances to the literature on corporate growth, [Lorange and Roos \(1991\)](#) have argued that academic authors tend to overemphasize the problems of strategic alliances. They contend that there is no hard evidence that the failure rates of alliances exceed the normal level of corporate failure of comparative single-owner ventures. If consumers do not accept a new product or service in the market, the activity is seen as a failure no matter if it was introduced by single-owner venture or a strategic alliance. In general, it can safely be assumed that the percentage of strategic alliances that fail is about 50–60%. From the limited evidence available it seems that failure rates for strategic technology alliances are on the higher end of the scale. We conclude that the variation in failure rates cannot only be attributed to different performance measures used ([Park and Ungson, 2001](#)), but also to the different forms of alliances investigated in the studies.

3.1. The problem of achieving sufficient performance in strategic technology alliances

[Gulati \(1998\)](#) has argued that the performance of strategic alliances has received less attention compared to other areas in management theory because of some onerous research obstacles, which include measuring strategic alliance performance and the challenges of collecting data necessary to assess these issues in greater detail. It seems rather strange that not much attention has been devoted to strategic alliance performance, especially because of the startling observations on alliance failure.

[Park and Ungson \(2001\)](#) even concluded that there currently is no systematic and comprehensive framework of strategic alliance failure due different interpretations (measures) of alliance failure and the lack of cross-fertilization between different theoretical approaches in the area. In their survey of the literature on performance measures of strategic alliance termination, they found that empirical studies have focused at the alliance level on measures such as survival (or stability), duration, financial performance or different subjective or corporate indices. On the partner level, the focus has been on the achievement of individual goals and learning ([Park and Ungson, 2001](#)).

They conclude that there is an emerging preference of dissolution as the appropriate measure of alliance instability and that instability of a strategic alliance may be signaled by an unexpected termination ([Park and Ungson, 2001](#)). In our analysis we asked managers who have personally been involved in a strategic technology alliance to characterize if the alliance was terminated unexpectedly. They were asked to answer the question “Was the termination unintended because the goals were not achieved?”. Afterwards a number of questions were asked relating to reasons for termination with respect to the alliance itself and the partner level (see [Appendix A](#) for a copy of the questionnaire). In the following section, we discuss some of these reasons for alliance termination as reflected in the literature.

4. Relevant literature

4.1. Reasons for strategic alliance termination

Since the 1980s, a growing number of studies has dealt with the issue of termination of strategic alliances with only a few focusing on strategic technology alliances. In our theoretical discussion we therefore characterize the general and mostly empirical literature on strategic alliance failure which has developed over the past years and produced some interesting new insights.

First, in the literature a shift could be observed from more static approaches towards a more process-oriented perspective on alliance termination. Second, we witnessed an emerging interest in examining the technology component underlying termination. [Table 1](#) provides an overview of the literature on alliance failure by taking on a dyadic point of view on strategic alliances. Traditionally, the alliance performance literature has focused on partner fit. Partner fit is often operationalized in terms of strategic fit, operational fit, technological fit or cultural fit. In focusing on the strategic fit, [Niederkofler \(1991\)](#), for example, postulated that joint goals should be set by top management to create compatible interests and complementary resources which form the fundamental basis for

Table 1
Reasons for strategic alliance termination.

Authors	Alliance complexity		Inter-firm rivalry										
	Personnel	Complexity	Alliance evolution	Partner/ Partnership	Goals and strategy	Nationality	Commitment	Strong-weak/ weak weak partner	Geographical/ operational overlap	Asymmetric incentives	Uneven learning	Expectations	Trust
Beamish and Delios					⊗								
Lorange and Ross					⊗		⊗	⊗		⊗	⊗		
Brouthers et al.	⊗												
Schuler et al.	⊗			⊗			⊗						
Chevalier		⊗	⊗	⊗	⊗		⊗		⊗				⊗
Wildeman and Kok				⊗		⊗	⊗						⊗
Stafford					⊗	⊗		⊗				⊗	
Douma					⊗	⊗		⊗		⊗			
Maljers						⊗	⊗	⊗	⊗				⊗
Adarkar								⊗					
Bleeke and Ernst								⊗	⊗			⊗	
Niederkofler		⊗	⊗		⊗	⊗	⊗		⊗			⊗	
Khanna et al.			⊗							⊗			⊗
Medeof				⊗	⊗								⊗
Dacin and Hitt				⊗					⊗				⊗
Kanter				⊗									

Source: various articles are combined, see authors. Note: authors should have analyzed a reason for failure in order to be added to the table. Authors who only have mentioned some failure reasons are not taken into account in this comparison.

satisfactory performance of the alliance. By the selection of the (right) partner, firms should not rely on 'love at first sight'. Short-run alliance strategies and single partner alliances do not present a realistic starting point for the selection of suitable partners. Flexible and experienced management of a strategic alliance is, during the whole evolution of the alliance, essential for the partnership to be successful.

Most reasons for strategic alliance failure have their origin in a badly managed partnership in which no trust and goodwill is created between the partners involved. Different management styles can also be due to differences in corporate and national culture. Cultural differences should not be neglected as they can lead to unnecessary failure. An important factor that influences success and failure of strategic alliances is associated with control and ownership. The analysis in Table 1 shows the importance of 'partner and partnership', 'strong-weak and weak-weak partnerships', 'trust', and 'culture' as reasons for failure (Duysters et al., 1999). Recent studies on strategic technology alliances have emphasized the importance of firm-specific capabilities (for an overview, see Heimeriks and Duysters, 2005). Authors have pointed out to the importance of various micro-level mechanisms such as functions (e.g. alliance department), tools (e.g. alliance training), control and management processes (e.g. alliance metrics) and external parties (e.g. use of external consultants) that can play a significant role in alliance success (Dyer et al., 2001; Lambe et al., 2002).

4.2. Alliances and innovation

After discussing the more general literature on strategic alliance failure, we now concentrate on the termination of strategic *technology* alliances which has also been described from a number of theoretical perspectives (see Duysters and Kumar, 2005). From a learning perspective, termination of an alliance has been attributed to the problem that one or more of the alliance partners either lacked the motivation and/or the ability to learn (Hamel, 1991). As the existence of superior learning capability of one partner can lead to a better appropriation of results of an alliance, the company might be satisfied with the outcome of the alliance and terminate it prematurely (Inkpen and Beamish, 1997). There might also be an option in which the other partner in an alliance might be discarded after the relevant technology has been absorbed by the partner with superior learning capability (Hamel, 1991).

The issue of absorptive capacity has also achieved prominent attention in the literature (Cohen and Levinthal, 1990). Firms that do not have sufficient capabilities to absorb the knowledge of their partners will be likely to fail. Alliances are most effective when there is common basic knowledge (sufficient absorptive capacity) and differentiated specialized know-how. Moreover, companies can only successfully tap into other companies' technology base if they have sufficient absorptive capacity (Lane and Lubatkin, 1998). In its turn, absorptive capacity results from investments in internal technological know-how. Hence, internal technological knowledge and external technology acquisition via alliances are considered as complements.

From an alliance capability tradition, it has been proposed that alliance survival depends on the company capability to manage a strategic alliance (e.g. Draulans et al., 2003; Duysters and Heimeriks, 2002; Ireland et al., 2002). In this context, alliance capability has been defined as a set of organizational mechanisms that are used by partnering firms to develop a set of routines for managing alliances (Kale et al., 2002). The organizational mechanisms have been linked to the use of alliance training, the use of an alliance specialist and/or the use of an alliance evaluation mechanism (Draulans et al., 2003). Given that companies can utilize these alliance capabilities, the chances of success of a strategic alliance are higher. Conversely, once these alliance capabilities are less developed, the chances of termination increase. These alliance capabilities consist of different components such as control and management processes or the use of external parties that increase the chances of success of a strategic alliance. Increasingly these alliance capabilities have been linked to the innovation process within companies which is characterized by the exploitation and exploration of new knowledge.

The termination of strategic technology alliances is also affected by processes of exploitation and exploration of new knowledge within companies. In the process of exploitation, knowledge is added to existing knowledge bases and competence sets within firms without changing the nature of these activities (March, 1991). As companies are able to plan and control their exploitive activities, there is a

common understanding among partnering firms about the range of possible solutions and the relevant issues at hand. As a result, strategic goals for the strategic technology alliance can be set from the start.

If these goals are achieved, the alliance can successfully be terminated. If these goals are not achieved, termination points at a failure of the alliance, i.e. it is unintended. In the process of exploration, however, the development of knowledge bases and competence sets within a company is characterized by a break with an existing dominant design and a shift away from existing rules, norms, routines, etc. within a company. Explorative activities of companies are difficult to plan. Based on strategic technology alliances, firms can jointly search for new technologies and potential emerging business opportunities. These alliances are a convenient form for companies to explore options to gain access to novel knowledge and/or to screen and evaluate it. The outcome of such alliances is, however, difficult to predict from the start and termination can just indicate the end of an entrepreneurial search process (can therefore be intended) (Levinthal and March, 1993).

In a review of the more recent empirical literature on the effect of strategic technology alliances on innovative performance of companies Duysters and de Man (2005) found that 73% of the quantitative empirical studies on alliances found a positive relationship between the use of strategic alliances and innovative performance. Only 10% of the studies reported a negative significant effect. This provides a much more optimistic view of the performance results of alliances than the grim picture that is displayed in the alliance literature in general.

The use of success measures used in these studies varied from input measures (R&D expenditures), to output measures such as patents, patent citations and new product announcements. There seems to be however a very high correlation among these measures (Draulans et al., 2003; Hagedoorn and Cloot, 2003).

Two observations stand out from this review. First, alliance capabilities of companies enable them to significantly increase alliance success (Anand and Khanna, 2000; Gray et al., 2001; Powell et al., 1996; Takeishi, 2001). Second, firms that have sufficient absorptive capacity and overlapping knowledge bases outperform alliances in which shared knowledge bases are lacking (Chan et al., 1997; Koh and Venkatraman, 1991; Lane and Lubatkin, 1998; Mowery et al., 1996).

Another conclusion that can be drawn from the empirical literature is that more intensive cooperation modes have a more positive impact on innovation than looser forms of cooperation such as licensing agreements (Anand and Khanna, 2000; Hagedoorn and Schakenraad, 1994; Dyer, 1996, 2000). Furthermore, it has been found that the network level perspective is also an important determinant for alliance success. Some network positioning strategies prove to be more successful than others (Powell et al., 1996; Rowley et al., 2000).

There have been a number of attempts to consolidate the different theoretical traditions and provide a more coherent framework for analyzing termination of strategic alliances (Das and Teng, 2000; Park and Ungson, 2001; Yan, 1998; Yan and Zang, 1999). The different approaches have shared the assumption that strategic alliances are inherently unstable, i.e. they involve major structural changes and dissolutions that are unplanned and premature from one of the partner's perspectives (Inkpen and Beamish, 1997). Structural instability has been related to unexpected (external) contingencies of a strategic alliance (Yan, 1998), inter-firm rivalry and coordination of (increasing) complexity within an alliance (Park and Ungson, 2001). The structural instability perspective on strategic alliances has some intuitive appeal as it attempts to integrate different theoretical traditions while providing some common ground in the area of strategic alliance termination. However, as strategic *technology* alliances are a new and different organizational phenomenon in themselves, their sources of instability seem to differ from more traditional strategic alliances (Douma et al., 2001; Hagedoorn and Sadowski, 1999).

In our conceptual framework, we approached the termination of strategic technology alliances by utilizing these three levels of instability related to unexpected (external) contingencies, inter-firm rivalry and problems of coordination of (increasing) complexity within an alliance. We characterized unexpected external contingencies as the degree to which companies were able to alter the configuration of the alliance to fit to the changing environment. Problems of alignment to external conditions such as changes in the technological or commercial environment can cause termination of a strategic technology alliance as these changes might not be anticipated at the establishment of an alliance.

With respect to inter-firm rivalry (i.e. the dynamics within the strategies and priorities of partnering firms), we related the success (or failure) of a strategic alliance to the process of collective alignment, i.e. to the (in-) effective and (in-) efficient alignment (i.e. fit) between the partners involved. As partnering firms remain independent in strategic alliances (in contrast to merger and acquisitions), the balance of the interests and background of the partnering firms involved becomes central. Fit in strategic alliances is related to concepts such as complementary balance, mutual benefits, harmony and dependency (Douma et al., 2001).

In order to examine the extent to which dissatisfaction of partnering companies can lead to the termination of a strategic technology alliance, we utilize the distinction between organizational and technological fit. As organizational fit characterizes the extent to which a strategic alliance can rely on existing firm-specific capabilities and competencies (Douma et al., 2001), technological fit defines the level of compatibility between the knowledge bases of cooperating partners in a strategic alliance. Lack of organizational fit increases the chance that the alliance becomes terminated without providing alliance partners with the expected gains. The availability of alliance capabilities and competencies within the partnering firms such as management and communication skills can improve organizational fit. Similarly, a lack of technological fit can lead to unintended termination of the alliance. With divergent knowledge bases, the chance that both partners appropriate equal benefits from a strategic technology alliance diminishes, increasing the probability of alliance failure. However, it seems that too much technological convergence can also lead to the termination of a strategic technology alliance. Therefore, it can be assumed that there might be an optimum here.

In order to characterize the skills of managing the complexity of the alliance, we focused on the contributions of partnering firms to the strategic alliance. As firms involved in a strategic alliance differ with respect to market positioning, organizational structure or management style, a “balanced” and continuous contribution of alliance partners to the alliance is necessary. This contribution is rooted in the firm strategy and requires commitment, financial capabilities and trust. Unequal contributions increase the change of unintended termination of a strategic alliance. In our study we related success (or failure) of a strategic alliance to the degree to which the underlying objectives of the companies for the alliance were (not) achieved. If the objectives of the partnering firms were not achieved, the termination of the alliance was unintended, i.e. resulted in a failure.

5. Methodology

5.1. Data and descriptive statistics

We used as a primary source of information the MERIT-Cooperative Agreements and Technology Indicators (CATI) information system. This databank contained information on nearly 10,000 cooperative agreements in various sectors, ranging from high technology sectors such as IT and biotechnology to less technology intensive sectors, such as chemicals and heavy electrical equipment (Hagedoorn and Sadowski, 1999). As a first step, we identified strategic technology alliances of which information on termination was available. This was the case for approximately 1500 cooperative agreements. For these alliances, we tried, in a second step, to identify (a) a person within the partnering company who was involved in a strategic technology alliance and (b) could give us information for reasons for its termination. For most cooperative agreements, this information was difficult to obtain as people moved, for example, within the company or to other companies. With the managers identified, we organized face-to-face interviews and used trade fairs for the initial contacts. The data were collected based on a standardized questionnaire, which asked these managers apart from firm and industry-specific information, detailed questions on the specific alliance (see Appendix A).

As a result of this procedure, we obtained a dataset that contained 48 strategic technology alliances in the industries in which the development of new technologies has been important, e.g. information technology and software. Table 2 shows the distribution of strategic alliances according to the different industrial sectors.

The selected interviewees provided detailed information on 48 alliances. In the sample, 43 alliances (89.5%) were established in order to achieve technological goals. Three did not state these

Table 2
Distribution of strategic alliances according to industrial sectors.

NACE	Description	Terminated alliances	Total
17–19	Textiles	5	6
23, 24	Petrols and Chemicals	6	8
30–33	Electronics, e.g. Telecom	10	13
34, 35	Cars, e.g. automotive	2	3
72	Computer and related activities, e.g. software	10	12
92, 93	Information technology	5	6
Total		38	48

goals explicitly, and for two alliances we did not receive the appropriate information. The majority of these technology-oriented alliances also followed commercial goals (37 firms or 77%).

A typical strategic alliance in the sample would have the following characteristics: two international partnering firms would engage in a strategic alliance that had explicit technological and commercial goals where different reasons related to the structure and evolution of the alliance as well as to strategies of the partnering firms would lead to the termination of the alliance even if its goals were not achieved. In the automotive industry, for example, we found a case in which two companies engaged in a joint venture development with equal participation that had explicit technological objectives and lasted for 3 years. The joint venture was terminated because the cost of maintaining the venture became too high and there was a lack of financial capabilities to further sustain the venture. But more importantly the priorities of the firms engaged in the venture changed.

In our sample, the failure rate was rather high. For 38 alliances the termination was unintended because they did not achieve the intended goals (failure rate: 79%). Just eight alliances were terminated because the intended goals were achieved. For one alliance no information was provided. This is in line with research on strategic alliances and innovation which has demonstrated that failure rates for strategic technology alliances are slightly higher than for more traditional (strategic) alliances.

In general, we attained the following distribution of reasons for unintended termination in our sample (see Table 3).

5.2. The empirical model

The objective of the empirical analysis has been to determine whether (or not) a number of alliance as well as firm specific factors affect the propensity of terminating a strategic technology alliance. The dependent variable in the empirical model has been a measure of termination. It is a yes/no answer to the question: was the termination of the strategic technology alliance unintended because the goals were not achieved? As the dependent variable has a binary character, a probit model was formulated that relates the measure of termination, denoted for convenience as $Term_tech_i$, to a vector of regressors X_i . The underlying regression has been defined as

$$Term_tech_i = \beta_1 + \beta_2 Inter_i + \beta_3 Fit_i + \beta_4 Fut_coo p_i + \varepsilon_i \quad (1)$$

Table 3
Reasons for unintended termination.

Reasons for unintended termination of alliance	Was a reason	Was not a reason	No answer	Total
Difficulties to generate the expected technological results	13 (34.21%)	23 (60.52%)	2	38
Alliance did not generate the expected commercial results	25 (65.79%)	10 (26.31%)	3	38
Problems related to communication within the alliance	20 (52.63%)	14 (36.84%)	4	38
Management of the alliance became too complex	12 (31.58%)	22 (57.89%)	4	38
High costs of maintaining the alliance	13 (34.21%)	21 (55.26%)	4	38
Goals of the alliance remained unclear	15 (39.47%)	21 (55.26%)	2	38

where β are the estimated coefficients and ε_i is a normally distributed error term (Greene, 2003). We observe

$$Term_tech_i = \begin{cases} 1 & \text{if } Term_tech^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

where $Term_tech_i = 1$ represents the probability that a strategic technology alliance is terminated and $Term_tech_i = 0$ if it is not. In other words, there is a critical threshold of the index called $Term_tech^*$ in a way that if $Term_tech_i$ exceeds $Term_tech^*$ the strategic technology alliance will be terminated otherwise it will continue. The application of a probit model allows us to estimate the probability that a strategic technology alliance will be terminated conditional on a number of independent variables.

In order to correct for the sample selection problem, we followed the framework suggested by Heckman (1987). In this framework, we first estimate a probit for technology alliance termination from which a sample selectivity correction term, λ , is computed. Then we estimated a second model in which the selection correction term has been included in the list of regressors as an extra variable (Verbeek, 2004; Greene, 2003).

To account for the high failure rate of strategic technology alliances, a possible explanation found in the literature has linked termination to the presence of the nationality of partnering firms. As it has been proposed companies from different nationalities have a higher chance of terminating their strategic technology alliance compared to firms with the same nationality. Therefore we assumed that strategic technology alliances with international partners (denoted by *Int*) will have a higher probability of termination compared to such alliances with partners with the same national background.

Another important reason for termination of a strategic technology alliance prematurely as found in the literature has been related to the extent at which the alliance provided benefits to the partnering firms (denoted by *Joint_ben*). If the alliance did provide benefits to the partnering firms, the chance of continuation of the alliance would increase. For example, in the case of a research and development (R&D) agreement in our sample that was aimed at developing an interface for a payment system, the agreement was terminated after three years because – as indicated in the questionnaire – it was difficult to generate benefits for both firms involved in the R&D agreement. Alternatively, as the partnering firms would not receive benefits the change of alliance termination would increase.

We furthermore examined the extent of organizational and technological fit. As has been suggested in the literature, the most desirable alliance arrangement has been with partners that are approximately equivalent in terms of size, country of origin, industry, and costs structure. In order to analyze these factors, we focused on issues such as organizational and technological fit of the partnering firms. We assumed therefore that fit, as representing technological and organizational fit between partnering firms (*Fit*), would have a negative effect on the termination of a strategic technology alliance.

In order to test whether (or not) the perspective of a future cooperation would affect termination of a strategic technology alliance, we introduced the variable *Fut_coop*. In line with the literature on the termination of strategic technology alliances, we would expect that negative perceptions with respect to future cooperation would have effect the termination of the strategic technology alliance, albeit the purpose of the alliance could also be served in one agreement.

In order to control for the different industries, we introduced a number of dummy variables (*Telecom*, *Comput*, *Inform*, *Chemi* and *Autom*). We assumed that the reasons for the termination of the alliance from the company's perspective varied widely depending on the industrial sectors in which the strategic technology alliance was established. For example, in a joint venture between two telecommunication firms, aimed at introducing new switching equipment, the adaptation of the alliance to a changing market environment was considered as a main reason for the termination of the venture. In the textile industry, a joint venture aimed at producing high fashionable consumer goods was terminated due to problems in the adaptation of the venture to changing market conditions, but also to the lack of finance and the lack of communication within the alliance.

Before the analysis, the level of correlation between variables in the data was checked. It appeared that there have been no unexpected multi-collinearity problems in the data with respect to the use of a multivariate model. As can be seen in Table 4, the models 1–4 presented have a high explanatory

Table 4
Probit and Heckman estimates that a strategic technology alliance gets terminated.

Model Variables	1		2		3		4	
	Probit	Heckman	Probit	Heckman	Probit	Heckman	Probit	Heckman
Constant	0.923 (0.548)	0.920 (0.160)	1.417 (0.894)	0.916 (0.174)	0.383 (0.461)	0.718 (0.144)	0.724 (0.775)	0.757 (0.191)
INTER	−0.242 (0.521)	−0.161 (0.148)		−0.203 (0.138)	0.137 (0.481)	−0.025 (0.145)	0.124 (0.535)	−0.006 (0.143)
FIT	0.456 (0.431)	0.113 (0.116)	0.904 (0.561)	0.198 (0.119)	0.731* (0.437)	0.206 (0.116)	0.768 (0.516)	0.198 (0.131)
JOINT_BENE	−1.213** (0.492)	−0.468** (0.146)	−2.244** (0.863)	−0.622** (0.160)				
FUT_COOP					−1.458** (0.608)	−0.502** (0.171)	−1.394** (0.687)	−0.431** (0.181)
TELECOM			−0.285 (0.892)	0.002 (0.179)			−0.325 (0.875)	−0.035 (0.194)
COMPUT			−0.125 (0.710)	0.012 (0.133)			−0.094 (0.656)	0.011 (0.194)
INFORM			2.075 (1.344)	0.0543* (0.254)			0.484 (1.078)	0.134 (0.238)
CHEMI			−0.656 (0.717)	−0.656 (0.717)			−0.846 (0.679)	−0.204 (0.163)
AUTOM			−0.902 (0.997)	−0.902 (0.997)			−1.032 (0.953)	−0.339 (0.241)
Lambda		−1.212 (0.076)		−0.122 (0.068)		−0.084 (0.079)		−0.070 (0.077)
(Uncens.) Obs.	48	(48)	48	(48)	48	(48)	48	(48)
χ^2	8.47	13.08	17.87	29.99	8.31	11.29	12.86	18.36
<i>P</i>	0.037*	0.005**	0.022*	0.001***	0.040**	0.010**	0.011*	0.019*
−2LL	22.47	40.54	17.76	34.69	22.54	41.28	40.40	38.60
Pseudo- <i>R</i> ²	0.1586		0.3347		0.1557		0.2408	

Note: standard errors are in parentheses. The estimates are robust maximum-likelihood probit estimates.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

power of independent variables as indicated by the significance level and the χ^2 in the different regressions. Table 4 shows four regression models that show the effects of a number of independent variables on dependent variable *Term_tech*. Both the probit and selectivity corrected Heckman estimates are reported. In characterizing the probability that strategic technology alliances become terminated, the model takes strategic technology alliances that are reported as being not unsuccessfully terminated as a base category. Forty-eight observations were used in the models. For models 1 and 2 (as well as models 3 and 4) the overall fit of the model improved by moving from a restricted to the full model that included industry dummy variables. The Wald test showed that the variable for joint benefits (*Joint_bene*) and future cooperation (*Fut_coop*) belong to the subset of coefficients that contributed to the explanation of the different regression models. As the Heckman estimates show we did not find significant evidence of sample bias in our analysis.

By looking at the results of our model, we did not find that lack of technological and organizational fit (as indicated by *Fit*) has been a major reason for managers to terminate a strategic technology alliance. In all four models, these variables remained insignificant. Similarly, the variable for partnering firms from different nationalities (*Inter*) remained insignificant.

In general, we concluded that the negative perspectives on future cooperation as well as negative perceptions about the joint benefits have an impact on the termination of strategic technology alliances. However, our model has been limited that it did not allow us to characterize a wide variety of firm as well as alliance specific motivations that might influence the termination of strategic technology alliances. Furthermore, it might be that the causal effect is reverse and that firms that engaged in a prematurely terminated alliance for that reason did not seek further cooperation and do not see mutual benefits. It seems that there is a wide variety of reasons for the termination of strategic technology alliances that could not be examined in greater detail considering the nature of the data.

6. Summary and conclusions

The growth in strategic technology alliances since the 1970s has been accompanied by an intense discussion on failure rates without having led to a more coherent approach towards alliance termination. The different theoretical traditions in the alliance area are still very much dispersed ranging from learning based to transaction costs accounts, which evolved to include more process explanations and included more recently also alliance-capability explanations. The common denominator in this literature has been that strategic alliances are inherently unstable, i.e. that alliance termination is often unplanned and premature from the partner's perspective. However, this instability characteristic has critically been examined in the literature with respect to strategic technology alliances as these alliance forms seem to represent a more stable organizational form. With our conceptual framework, we accounted for different levels (external contingencies, inter-firm rivalry and managerial complexity) at which instability in strategic alliances could be originated. This provides us with a conceptual approach then included traditional fit-based explanations. Furthermore we are one of the first to empirically explore the termination of strategic technology alliances in high technology industries.

In our study we found a termination rate which has been considerably higher than the failure rates reported in the existing literature. We attributed this to the fact that the alliances under study were international by nature. However, the extent to which the (different) nationalities of partnering firms, for example in international joint ventures, increases the chances of alliance termination requires some further analysis as we could not find any statistical evidence on this issue. Furthermore, the strategic alliances examined had a technical component and have been in industries characterized by a faster rate of technological change than normally observed in slower moving industrial sectors. In these industries, the evolution and stability of strategic alliances is governed by other mechanisms compared to traditional sectors as knowledge generation and sharing is central to their establishment (Cummings and Bing-Sheng Teng, 2003). Other mechanisms leading to the establishment (and termination) of strategic technology alliances are becoming important such as exploring and exploiting new technologies.

Overall, we found that negative prospects about future cooperation and negative perceptions about joint benefits had an impact on the termination of strategic technology alliances. The often-quoted

win-win situation that should be created in a strategic alliance seems to be indeed a requirement for a successful strategic alliance. Firms might therefore have to engage in extensive pre-alliance discussions (so-called joint business planning sessions) in order to assess the viability and joint benefits about the future cooperation. Also the “repeated tie” effect seems to be relevant. Firms tend to be more loyal to partners once they expect future cooperation with the same partner to emerge. The probability that companies opt only for short-term (not for long term and renewed) cooperation seems to introduce a negative factor into the possible termination of technology alliances. Furthermore, the perspective that both partners would not benefit from the strategic technology alliance also contributes to its termination. Partnering firms dissatisfied by their ability to receive benefits from the alliance would be more willing to terminate it prematurely.

At first sight we were surprised that we did not find that lack of technological and organizational fit has been major reason for managers to terminate a strategic technology alliance. However, recent literature has shown that alliance success is less dependent on individual fit between companies but is largely dependent on the alliance capabilities that companies possess. Firms that have consciously build alliance capabilities over time by, for example hiring well trained alliance managers and alliance specialists, and by using a structured alliance formation process have shown to outperform other firms by very high numbers. Therefore, the more recent literature seems to go beyond the traditional fit literature of the 1980s and 1990s.

7. Implications and directions for future research

In spite of the interesting results, our model has some limitations: first, it did not allow us to characterize a wide variety of firm as well as alliance specific motivations that might influence the termination of strategic technology alliances. Second, it might be the case that the causal effect is reverse and that firms that engaged in a prematurely terminated alliance for that reason did not seek further cooperation and do not see mutual benefits. It seems that there is a wide variety of reasons for the termination of strategic technology alliances that could not be examined in greater detail considering the nature of the data.

We are also aware that due to the sample size and the variety of firms involved in the questionnaire, our results can only be considered as tentative and indicative. However, as our results support a number of intuitive conclusions from the literature, we consider them as a first and initial step towards further more in-depth analysis on alliance termination. Given the high failure rates of strategic technology alliances and the importance of understanding the reasons for alliance termination, more research is needed to uncover key success and failure factors for strategic technology alliances.

Appendix A. Questionnaire on termination of strategic technology alliances

General information on the firm:

- Name of partners.
- Address of firm.
- Form of co-operation.
- Field of technology/industry.
- Starting date of co-operation.
- For joint venture equity distribution in %.

General information on the alliance:

- Is the alliance still existing?
- When was the alliance terminated?
- Was the termination planned because goals were achieved?
- Was the termination unintended because goals were not achieved?

Planned termination of the alliance:

- Did both partners appropriate the results of co-operation?
- Did your company appropriate the results of co-operation?

- Did your partner(s) appropriate the results of co-operation?
- Do you expect future co-operation with the same partner?
- Reasons for unintended termination of alliance:
- Difficulties to adapt the alliance to technological conditions.
- Difficulties to generate the expected technological results.
- Difficulties to adapt alliance to commercial conditions.
- Alliance did not generate the expected commercial results.
- Organisational problems within the alliance.
- Problems related to communication within the alliance.
- Management of the alliance became too complex.
- High costs of maintaining the alliance.
- Goals of the alliance remained unclear.
- Your own company's perspective on the alliance failure:
- Lack of technological fit.
- Lack of organisational fit.
- Lack of financial capabilities.
- Lack of commitment.
- Change in your priorities and strategy.
- Lack of trust on your side.
- A threat to your core competences.
- Changes in broader environment:
- Did changes in the broader environment affect termination?
- Was termination caused by changes in technological environment?
- Was termination caused by changes in relevant markets?
- Did cultural backgrounds of partner companies affect termination?
- Would you consider cooperating with the same partner in the future?

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