Pergamon

Technovation 19 (1999) 283–294

technovation

Innovating through strategic alliances: moving towards international partnerships and contractual agreements

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Received 22 August 1998; accepted 4 November 1998

Abstract

Strategic alliances are becoming ever more popular, particularly to undertake technological development activities. Their rapid growth since the 1980s is regarded as further evidence of globalization. In this paper we analyse the trends in strategic technology partnering (STP). In particular, the use of *international* STP has grown, although less so in US firms than European and Japanese ones. In addition, there has been a growing use of non-equity agreements, which seem to be a superior means to undertake technological development in high-technology and fast-evolving sectors. Among other things, our analysis suggests that as far as STP is concerned, firms appear to do whatever firms in the same industry do, regardless of nationality. © 1999 Elsevier Science Ltd. All rights reserved.

Keywords: Strategic alliances; R&D; Innovation; Internationalization; Organizational modes; Globalization; Multinational corporations

1. Introduction

Scarcely a day goes by without some press announcement of either a new strategic alliance or the dissolution of another. The growing popularity of this 'new' form of activity is taken as further proof of the unstoppable march of globalization, particularly as a large and growing number of these agreements involve firms of at least two nationalities.

It is essential, before proceeding further, to establish what we mean by globalization. Globalization as used here refers to the increasing similarity in consumption patterns and income levels across countries and the concurrent increase in cross-border activities of firms from these countries (Dunning and Narula, 1998). Two primary caveats should be noted of this phenomenon. First, globalization is fundamentally associated mainly with the industrialized countries of the Triad (Europe, North America and Japan). Second, its effects vary across industries, and is particularly acute in sectors which are capital and knowledge intensive, as well as those that depend on new and fast-evolving technologies. It is important to remember that our definition of globalization refers to countries becoming *similar*, but this does not mean that their economies are becoming identical (Archibugi and Pianta, 1992; Narula, 1996). This clarification is crucial, because these 'core' sectors are where firms have internationalized the fastest, not just because this allows them to compete in several markets simultaneously, but also because it allows them to exploit and utilize assets and technology that may be specific to particular locations. As Knickerbocker (1973) first demonstrated, firms sometimes simply establish themselves in some markets simply *because* their competitors have done so.

Take into account too that, in these sectors, both innovation and/or a quick response to the innovations of one's competitors are the key to survival in the market place, and the need to be omnipresent becomes obvious. Unfortunately, the high costs and risks of either of these options has made omnipresence an expensive option. Few firms can afford to duplicate their value chains in so many different locations, and as such they must consider collaborative activity.

The use of collaboration to undertake production relations with other firms is as old as time itself, but the

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PII: S0166-4972(98)00127-8

novelty comes at least four levels. First, collaboration are now often considered a first-best option, instead of a last resort (Dunning, 1995). Second, firms increasingly use such agreements to undertake R&D, an activity that traditionally has always been jealously guarded. Recent estimates place the number of R&D collaborations to be in the range from 10–15% of all agreements, and this number is believed to have tripled since the early 1980s.[1] Third, not only are firms doing more R&D through collaboration, they are doing so with overseas partners, and often, in foreign locations (Hagedoorn, 1996). The fourth novelty in terms of R&D alliances is the growing use of a several different non-traditional organizational modes, in particular the growing use of non-equity type agreements, which in some ways are a superior mechanism to undertake technology development in high-tech sectors (Hagedoorn and Narula, 1996).

Using MERIT-CATI, a unique database that contains information on over 10 000 instances of technology partnering (see Appendix A), we intend to examine the trends in strategic technology partnering (STP). In particular, we want to evaluate and explain why and how STP has been seen to grow over the last two decades, the gradual but dramatic shift towards contractual forms of agreements over time and the growth in the use of international technology partnering.

2. Understanding strategic alliances

Before we go further, it is useful to set up and explain some of the most important terms in use here. There is some confusion about the meanings of collaborative/cooperative agreements, networks and strategic alliances, with these terms often being used as synonyms. Cooperative agreements include all interfirm collaborative activity, while strategic alliances and networks represent two different (though related) subsets of interfirm cooperation.

More specifically, by strategic alliances we refer to interfirm cooperative agreements which are intended to affect the long-term product market positioning of at least one partner (Hagedoorn, 1993). In this paper we are specifically interested in alliances where innovative activity is at least part of the agreement, which we shall refer to as either strategic technology partnering or strategic technology alliances. What differentiates a strategic alliance from a customer–supplier network is the underlying motive of the cooperation (Fig. 1). We suggest that most cooperative agreements have two possible motivations.[2]

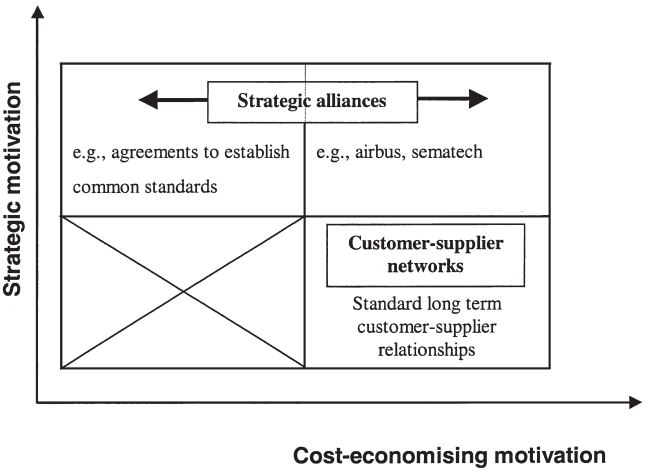

Fig. 1. Explaining the underlying differences between strategic alliances and customer–supplier networks.

First, there is a cost-economizing motivation, whereby at least one firm within the relationship has entered the relationship to minimize its net costs, or in other words, it is *cost-economizing*. Agreements which are mainly aimed at doing this are generally (but not always) customer–supplier agreements, or vertical relationships within a value-added chain and embody a shorter-term perspective.

Second, firms may have a strategic motivation. Such agreements are aimed at *long-term profit optimizing* objectives by attempting to enhance the value of the firm's assets. It important to understand the distinction being made here. While cost-economizing actions, such as acquiring a minority share in a supplier, may increase profits, it is often not the case that the value of the firm is enhanced beyond the short term (e.g. the hundreds of cost-cutting, outsourcing agreements that each major company has). When a firm engages in an agreement that, say, develops a common standard with a rival (e.g. Sony and Philips to establish DVD technology standards), it is often forgoing a much higher short-term profit (were it to go it alone) in the hope that the joint standard will enhance its long-term market position. Of course, firms would *like* to do both at the same time: increase short-term profits through cost-economizing as well as long-term profit maximize through value enhancement, but this is not always possible. It is important to emphasize that very few agreements are distinctly driven by one motivation or the other. What we are trying to establish here is that agreements that are established with primarily short-term cost efficiencies in

[1] These estimates are based on the results from two different surveys, Culpan and Kostelac (1993) and Gugler and Pasquier (1996).

[2] Considerable recent debate has centred around these seemingly alternate schools of thought. Recent work has attempted to show their complementarity. For a succinct overview, see Madhok (1997).

mind are generally customer–supplier networks, while agreements where a long-term value enhancement is the primary objective are strategic alliances. Fig. 1 illustrates our basic argument with a few examples.

3. Globalization and the growing use of R&D alliances

Although the relationship between globalization and strategic alliance activity has been thoroughly addressed elsewhere, we shall nonetheless run through the primary features of this relationship (Fig. 2). First, firms from the Triad (Europe, North America and Japan) are increasingly engaged in cross-border economic activity. Indeed, in order to survive, these companies have had to adopt policies that maximize their presence in not just those locations which are their primary markets, but also all those locations where their competitors are operating, in a variant of what is best described as a follow-my-leader strategy (Knickerbocker, 1973). This increasing network-like behaviour of MNE activity is prompted in part by the fact that there are still distinct differences in the resources available in different countries. That is, despite increasing similarities in consumption patterns and the *types* of technologies used in each country, there remains a clear specialization of locations and firms from those locations that has become more, rather than less, distinct (Cantwell, 1989; Archibugi and Pianta, 1992; Narula, 1996). This has been described as the factors that make up the national systems of innovation (see e.g. Lundvall, 1992) The effect of this has been that firms have an increasing interest in exploiting existing knowledge-based assets and developing new ones in several locations simultaneously to exploit the differing competitive advantages of each location. Second, there has been an increasing interdependence of technologies and industries, such that considerable cross-fertilization occurs between sectors. For instance, automobile production is no longer simply a matter of a mastery of mechanical technologies, but requires interdisciplinary expertise in, among other things, new materials technology, telecommunications technology, and semiconductor development. The growing costs of acquiring a competitiveness in these several areas simultaneously means that internalizing and integrating both horizontally and vertically is no longer possible. Even if a company focuses on only one sector, innovation has become steadily more expensive. For instance, a new car can cost several hundreds of millions of dollars to develop. Since most firms must now innovate in several diverse and different sectors simultaneously, it becomes clear that wholly owned subsidiaries and the internalization of all R&D activity is no longer a practical solution if a firm wishes to achieve the necessary economies of scale and scope. As if that were not enough, the fact of the matter is that in these new 'core' technologies, technological change is rapid, which implies that products are quickly obsolete, and firms need to recover their investment in a much shorter period than was previously the case. Indeed, some studies have shown that in certain industries, patenting is no longer a viable means of protecting an invention, since the product will be obsolete before a patent is granted. Thus, firms wishing to remain competitive in any given market must find ways and means to recover the costs of innovation, and this implies

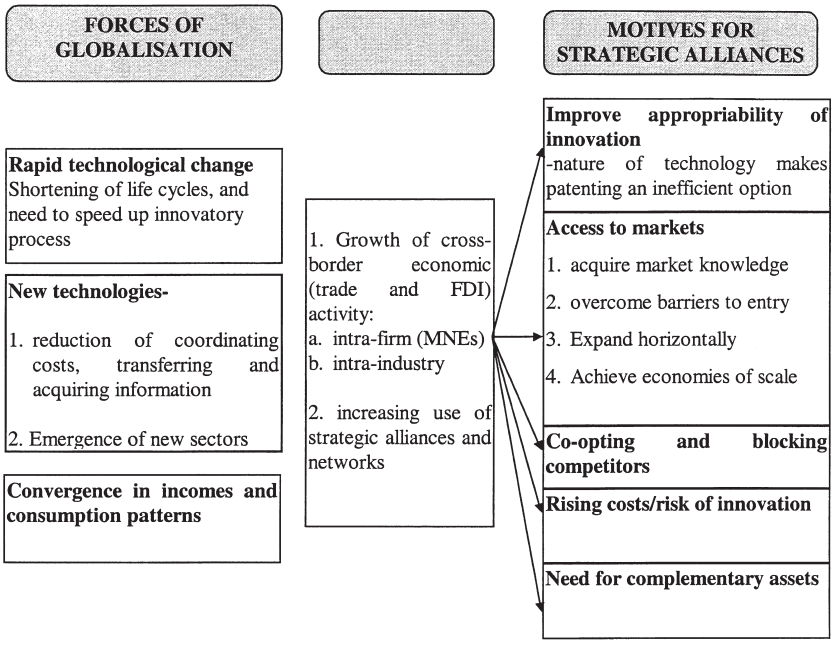

Fig. 2. Relating globalization to the motives for strategic alliances (Narula and Dunning, 1998).

increasing its market by expanding overseas. However, to do so ensues even higher costs and risks and thus firms must seek partners to share the costs and risks with, rather than simply through foreign direct investment (FDI). Despite the peculiar difficulties with partnering particularly those associated with their high failure rate (see e.g. Inkpen and Beamish, 1997) compounded by those peculiar to undertaking innovative activities (Narula and Dunning, 1998), there has been a growing number of alliances being undertaken with these intentions in mind, although sales and marketing activities dominate alliance activity, particularly in the international arena. However, it is worth noting that alliances involving marketing and sales are, more often than not, cost-economizing in nature, while R&D alliances are much more strategic in character. Nonetheless, two independent surveys of alliances (Culpan and Kostelac, 1993; Gugler and Pasquier, 1996) found that sales and marketing accounted for 41% and 38% of all alliances surveyed, while R&D alliances accounted for 10.8% and 13%, respectively. One of these studies notes that R&D alliances have tripled in relative importance since the 1980s.

Although the CATI database focuses exclusively on alliances that involve innovative activity and thus does not allow us to distinguish the relative significance of STP to other strategic alliance activity, it does confirm the rapid growth since the early 1980s (Hagedoorn, 1993, 1996). Fig. 3 charts the growth in the number of newly established alliances in any given year. Alliances grew at an annual average rate of 10.8% per year between 1980 and 1994, far higher than the growth of R&D expenditures, taken either on a country or a firm by firm basis. Over the period in question, Triad firms were involved in 94.6% of alliances established.

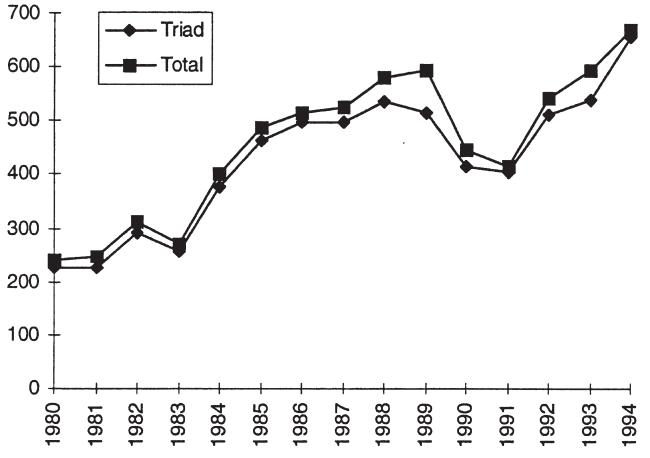

Fig. 3. Number of newly formed strategic technology alliances per year, 1980–1994.

3.1. Trends in partnering

What are the trends and what factors determine the propensity of firms, to undertake strategic technology partnering? Table 1 shows the total number of alliance undertaken by firms of some of the most important home countries and provides clear evidence that this propensity varies considerably by country. As one might expect, firms from the three largest industrial powers dominate STP, with the US, Japan and Germany engaged in 64.1%, 25.6% and 11.3% of all alliances included in the sample, respectively. Although on the surface the rankings of these countries in Table 1 might suggest that this propensity simply represents differences in economic size, this is not entirely true. For instance, companies from the Netherlands engage in more alliances, in both absolute and relative terms, than Italian companies, although Italy is four times larger than the Netherlands in terms of market size. We have included a few other variables that shed light on this, which suggest that two major factors determine the differences between countries.

First, the level of technological sophistication of the country plays a key factor in the propensity of its firms to undertake STP, both in terms of undertaking high levels of R&D activity, as well as being involved in high-tech (and therefore high R&D intensity) sectors. We include in Table 1 two proxies for this: the share of the OECD high-technology export markets of these countries and the level of business expenditure on R&D in these countries. Both are highly correlated to STP. The higher ranking of the Netherlands relative to Italy or Spain, both larger countries, is partly explained by this.

Second, the structure of the domestic sector plays an important role in determining the ability to undertake STP. On the one hand, countries such as Italy tend to be dominated by small and medium size enterprises, whereas countries such as the UK and US tend to have larger firms dominating the industrial landscape. On the other hand, Italy's landscape (and to a lesser extent, Germany) is populated by large numbers of small and medium size enterprises (SMEs). This is important, since large firms tend to undertake more R&D activity, and are thus more likely to undertake STP. We proxy this by the total number of firms from each of these countries that are included in the Fortune 500 list. These variables are also highly significantly related to the number of alliances by each of these countries.

Nonetheless, it is important to remember that strategic technology partnering is essentially a firm-level phenomenon. Although national factors do play an important role in determining issues such as the type of industries its firms operate in (because of its infrastructure and resource capabilities), the size of its firms (market structure and competition laws), the propensity of firms to do R&D is still very much a firm-level decision. As a

Table 1
Strategic technology partnering by major country and indicators of country-specific characteristics

Country	Number of alliances, 1980–1994			Percentage Int'l STP	Population ('0000)	Business exp. on RED (US$)	Share of OECD hi-tech exports (%)	Share of world outward FDI (%)	Number of Fortune 500 companies
	All	Equity STP	Int'l STP						
USA	4848	1615	2004	41.3	257 908	121 314	23.5	28.8	167
Japan	1931	961	1439	74.5	124 670	50 235	8.0	1.3	111
Germany	857	415	743	86.7	81 190	24 687	14.3	8.1	32
France	722	346	620	85.9	57 667	16 084	8.4	6.3	29
UK	927	397	790	85.2	57 830	13 445	8.9	15.9	44
Netherlands	703	315	561	79.8	15 300	2492	4.1	5.4	7
Switzerland	276	101	258	93.5	6940	2872	3.5	2.5	10
Sweden	231	110	199	86.1	8718	2830	1.9	0.9	15
Canada	163	82	149	91.4	28 753	4390	2.3	8.2	13
Italy	421	224	385	91.4	57 070	7783	4.1	4.2	7
Belgium	134	91	100	74.6	10 010	1900.1	1.9	2.7	3
Norway	46	30	42	91.3	4310	715	0.3	0.9	2
Denmark	42	13	41	97.6	5190	898	1.1	0.7	0
Spain	59	40	57	96.6	39 080	2330	1.4	4.8	5

Source: MERIT-CATI, OECD-STAN database, *Fortune*, UN (1996).

comparison of Tables 1 and 2 shows, there is a tendency to generalize a firm-specific activity, even though each firm is idiosyncratic and unique. This is particularly true when it comes to strategy as well as its technology management. Some firms may prefer to internalize, as much as possible, their innovative activity (such as Volkswagen), while others prefer to undertake joint research activities (such as Nissan). Indeed, when we try to examine the relationship between the propensity undertake STP and firm-level proxies for competitiveness (R&D expenditures, R&D intensity) and firm size (sales and employees) the results (using rank correlations) are much more ambiguous. Both R&D intensity and R&D expenditure are uncorrelated to STP. In other words, having a high (or low) R&D budget, either in relative or absolute terms does not imply that firms engage in more or fewer technology alliances; it is simply an issue of strategy. On the other hand, the size of the company (proxied by either total sales or total employees) is significantly correlated with the interest in doing STP: that is, large firms engage in more R&D alliances than do smaller firms. These results are somewhat influenced by the domination of large firms in Table 2, and although we do not control for sectoral differences, they suggest that size does play a role. Perhaps the explanation behind this goes back to two facts observed in much of the literature on strategic alliances. First, there is a high failure rate of strategic alliances in general: such interfirm agreements require much more involvement and resources, and there exist a certain threshold in terms of resources to be successful. Second, the data suggest that even though a large number of alliances involve SMEs, in general, at least one of the partners is large, and has the resources necessary to invest in the alliance. Clearly much more work needs to be done to clarify the dynamics behind these results, but it is also obvious that there is considerable variance on a firm level in R&D strategy, and eventually, the lack of interest of certain firms to undertake alliances may simply be force of habit. As we shall see in the next section, however, there is evidence to suggest some of these differences also represent industry-specific trends. That is, firms simply do whatever their competitors are up to, *regardless of differing nationalities*.

4. International R&D alliances

What of the international aspect of STP? About 65% of Triad alliances are international alliances (Table 1), although this also varies tremendously between countries. At the one extreme, at 41% of all their alliances, US firms have been the *least* internationally oriented. At the other extreme, 96% of alliances involving Spanish firms involved at least one non-Spanish firm. In general, it would seem that European firms tend to have a much higher share of international alliances than US or Japanese firms.

There are several underlying reasons for the different levels of international participation in alliances by country. First, there are country-size effects—firms from small countries tend to have a higher involvement in international investment and overseas production compared to firms from large countries. This is because local demand is often (as in the case of the US) sufficient to achieve economies of scale in large countries, while small country firms must seek overseas markets to achieve similar economies. In general, therefore, small country firms will show a greater propensity to engage in international strategic alliances. In addition, small coun-

Table 2
STP activity, R&D intensity and international production by world's largest MNEs

Firm	Total employment	Foreign employment	Share of foreign employment	All STP	% of int'l STP	% of equity STP	R & D expenditures (US$ millions)	Sales (US$ millions)	R & D intensity (%)
Ford	337 778	96 726	28.64	60	36.7	33.3	4332	100 132	4.3
GM	692 800	177 730	25.7	138	43.5	39.1	5917	136 590	4.5
IBM	219 839	115 555	52.6	254	35.0	24.8	5083	64 523	7.9
Volkswagen	242 318	96 545	39.8	18	44.4	27.8	1635	48 457	3.4
GE	216 000	36 169	16.7	131	58.0	40.5	1353	56 274	2.4
Daimler	330 551	79 297	24.0	121	20.7	38.0	6249	66 140	9.4
Mitsubishi	360 000	11 146	3.1	233	63.9	51.5	972	20 980	4.6
Nissan	143 310	34 464	24.0	53	52.8	60.4	1280	28 390	4.5
ABB	207 557	194 557	93.7	79	74.7	41.8	428	5286	8.1
Matsushita	265 397	112 314	42.3	71	70.4	25.4	3144	56 023	5.6
Sony	156 000	90 000	57.7	56	83.9	19.6	1809	29 444	6.1
Fiat	251 333	95 930	38.2	68	83.8	51.5	2025	45 755	4.4
Bayer	146 700	78 300	53.4	39	76.9	28.2	1699	25 837	6.6
Hitachi	331 852	80 000	24.1	112	58.9	28.6	3907	58 397	6.7
Unilever	307 000	276 000	89.9	17	76.5	47.1	816	43 668	1.9
Philips	253 000	210 660	83.0	207	89.9	32.4	2079	30 696	6.8
Siemens	376 000	158 000	42.0	200	88.0	25.0	5322	53 212	10.0
Dupont	107 000	35 000	32.7	90	43.3	34.4	1277	37 208	3.4
Hoescht	165 671	92 333	55.7	94	79.8	42.6	1865	30 136	6.2
Rhone polenc	81 582	46 430	56.9	80	75.0	53.8	1021	14 922	6.8
Ciba	83 980	63 095	75.1	68	94.1	32.4	1678	15 869	10.6
Volvo	75 549	30 664	40.6	39	74.4	56.4	1220	14 339	8.5
Toshiba	190 000	38 000	20.0	147	74.1	28.6	2392	35 512	6.7
Sandoz	60 304	51 258	85.0	31	93.5	29.0	930	9644	9.6
BASF	106 266	40 297	37.9	46	89.1	41.3	1315	29 566	4.4
Dow	53 700	24 165	45.0	64	37.5	51.6	1289	18 971	6.8
Toyota	172 675	27 567	16.0	45	51.1	62.2	3725	74 500	5.0

Source: UN (1996), MERIT-CATI, OECD-STAN, *Businessweek* (vd), *Fortune*.

tries tend to be specialized in fewer sectors and niches (Freeman and Lundvall, 1988; Hagedoorn and Narula, 1996), and if they need to access technologies outside these niche sectors, they are obliged to seek access to these comparative advantages in other locations. The reverse is true for the US, which, as a large country, possesses comparative advantages in several industries, and is home to clusters in most of these. This acts as a disincentive for US firms to venture overseas to engage in innovative activity, as it does toward overseas production. However, this is not the whole story: while Japanese and German firms also cater to a large home market, their participation in international STP is much higher than the US.

There are also certain broad differences in strategy between firms of different nationalities and regions. Veugelers (1996) observed that, among other things, EU firms have a higher propensity to engage in alliances in sectors in which they lack comparative advantages relative to US and Japanese firms, while Narula (1999) has demonstrated that EU firms have a higher propensity to engage in EU–US alliances.

Table 2 also provides details on a firm level regarding the propensity to undertake international strategic technology partnering. Using simple rank correlation tests, two distinct results emerge:

1. There is a strong positive relationship between the extent to which firms have overseas production (measured by the percentage of foreign employees in the total employees), and the percentage of international alliances. That is, alliances are not used as an alternative to wholly own subsidiaries, but are *complementary* to them. To some extent, this suggests that the more firms have overseas sales, the more likely they are to undertake overseas R&D, although once again, the firms in Table 2 are somewhat biased towards large, relatively internationalized firms. What is however not intuitive is that firms increasingly undertake this R&D through STP; and
2. In contrast to total alliances, there seems to be a negative and significant correlation between international alliances and size (measured by total sales and by total R&D expenditures), which might indicate that firms compensate for their small size (and limited resources) by engaging in international STP. That is,

firms that are large tend to already have considerable investment in wholly owned R&D activities, and are already have rationalized and globalized operations. As such, they are more easily able to absorb the high costs and risks of independent R&D projects, since they have already made considerable investment in wholly owned R&D laboratories, which are a sunk (and fixed costs). Furthermore, these large firms tend to be conglomerates, and are not as interested in seeking complementary assets or competences as smaller, more focused niche players.

Using some simple one-way ANOVA tests, the data reveal that these observations regarding the propensity to engage in technology alliances and international are not determined by differences in the country of origin after dividing the sample into European, Japanese and US firms. That is, nationality does not really play a role. However, when we classify the firms in Table 2 by broad industrial sectors (IT/electronics, automobiles and chemicals) we find that significant differences exist between the various industrial groupings. The electronics/IT sector demonstrates a much higher mean participation in STP and international STP than the other two sectors. In other words, firms behave similarly within the same industry, regardless of national origin.

5. Types of agreements

The discussion in the last section suggests there are myriad motives for firms to undertake strategic technology alliances, as summarized in Fig. 2. We do not intend to discuss the various motives in detail here (see Hagedoorn, 1990), but it is pertinent to point out that, just as no agreement can be purely strategic or cost-economizing, most agreements have several motives (Hagedoorn, 1993).

Fig. 4 describes the range of interfirm organizational modes generally utilized in collaborative agreement activity: there is a wide range of types of agreements, reflecting various degrees of interorganizational interdependency and levels of internalization (see Hagedoorn, 1990, for a discussion). These range from wholly owned subsidiaries, which represent completely interdependency between the firms and full internalization. At the other extreme lie spot-market transactions, wherein totally independent firms engage in arm's-length transactions in which either firm remains completely independent of the other. As Fig. 4 illustrates, we include within the rubric of collaborative agreements two broad groupings of agreements which can be regarded as representing different extents of internalization. Although it is difficult to be specific and concrete regarding the ordinal ranking, it is safe to say that equity-based agreements represent a higher level of internalization and inter-organizational interdependence than non-equity agreements.

There is clear evidence that over the past two decades there has been a growing use of non-equity agreements. This trend is particularly noticeable within strategic technology partnering—non-equity STP have increased from 53.1% of all agreements undertaken between 1980 and 1984, to about 73.3% of agreements between 1990 and 1994. In particular, joint R&D agreements account for the bulk of the non-equity STP in the most recent period, and account for much of the increase in non-equity STP (Table 3).

On the surface, this change in preference reflects some of the aspects of globalization. Equity agreements tend to be much more complex forms to administer and control, and take longer to establish and dissolve (Harrigan, 1988). In addition, globalization in certain fast-evolving sectors such as information technology has led to shorter product life cycles. Along with increasing competition in the race to innovate, this has tended to encourage firms to engage in contractual, non-equity STP which provide greater strategic flexibility, since firms need to have quick responses to changes in technological leadership (Osborn and Baughn, 1990). Globalization has also brought some level of harmonization in the legal and regulatory frameworks across countries. In some instances this has occurred on a regional basis, such as within the European Union, while in others it has occurred on a near-global basis through institutions such as the World Trade Organization (WTO) and the World Intellectual Property Organization (WIPO). As Tables 1 and 2 have shown, a large percentage of alliances tend to be international in scope. Innovative activity by its very definition involves considerable risk. As such there is a distinct possibility that one firm will learn more than the other within an agreement, with the firm that has learned the most terminating the agreement prematurely. Such situations result in the loss of proprietary and firm-specific technological assets to at least one partner. Particularly in the case of cross-country partnerships, it is much harder to seek legal recourse for such loss. Firms in international alliances have thus tended to prefer equity agreements, and have stayed in areas which have clear property rights. However, with the development of cross-national institutions and the gradual standardization of regulatory frameworks, firms are increasingly able to undertake non-equity agreements in R&D on an international basis, since contracts are more readily enforceable. Indeed, the development of supra-national institutions and frameworks such as WIP and WTO has made the enforcement of contracts more feasible across borders.

In addition to such exogenous changes, however, there is the organizational learning aspect. As firms acquire experience undertaking overseas activity, their perception of the inherent risk in undertaking overseas alliances

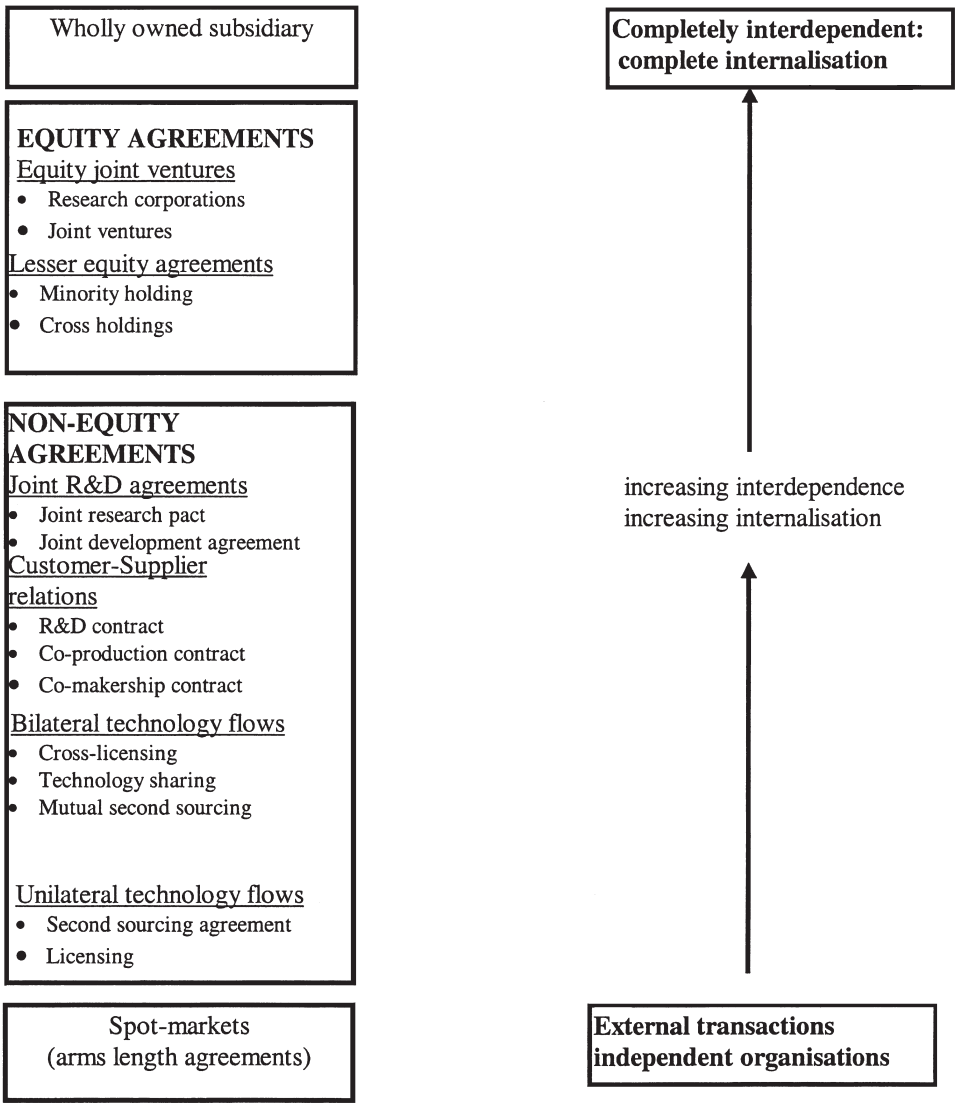

Fig. 4. Organizational modes of interfirm cooperation and extent of internalization and interdependence.

Table 3
Evolutionary changes in the organizational modes used in STP activity

	1980–1984	1985–1989	1990–1994
Equity STP	46.9	40.9	26.7
Joint ventures	21.9	23.7	19.7
Other equity SA	25.0	17.2	7.0
Non-equity STP	53.1	59.1	73.3
Joint R&D	38.0	47.5	70.4
Customer–supplier	10.1	8.2	2.7
Two-way technology	5.0	3.3	0.2
	100.0	100.0	100.0

Source: MERIT-CATI database.

falls. Furthermore, as firms become more familiar with a given partner, the risk that a specific partner will be dishonest declines with every subsequent agreement. Perhaps more important, though, is that the shift in preference for equity illustrates that the firms are increasingly motivated to undertake agreements with an explicitly strategic intent, rather than simply a cost-economizing one.

It is significant that while the move to non-equity agreements has occurred in general amongst firms of almost all nationalities,[3] there are clear differences between regions. Table 4 shows how the decline in the popularity of equity agreements has happened in all the different geographical regions of the Triad. Interestingly, although the percentage of non-equity STP by US firms was highest during the most recent period (77.8%) relative to European and Japanese firms, between 1980 and 1984, Japanese firms showed a much higher propensity for non-equity STP than did US firms. This is a particularly interesting observation, since Japanese firms have been noted to have a preference for wholly owned subsidiaries when undertaking overseas production. The dominance of non-equity agreements by US firms is not entirely unrelated to the fact that the US has the smallest percentage of international alliances.

In general, companies' ability to learn and transfer varies according to the organizational form of the alliance (Osborn and Baughn, 1990; Hagedoorn and Narula, 1996). As such, firms select a particular alliance form depending on the objective and industry of the alliances. For instance, non-equity forms of agreements are more efficient for undertaking more research intensive activity, since they promote more negotiation and intensive cooperation than equity forms. However, where firms seek to learn *and transfer* tacit knowledge back to the parent firm, such as market-specific knowledge when entering a new market, or are engaged in production as well as research, equity forms of agreement may be more appropriate (Osborn and Hagedoorn, 1997). In general, though, it would appear that the choice of a particular mode of cooperation varies with the technological characteristics of sectors of industry. Equity agreements are preferred in relatively mature sectors, while non-equity agreements are utilized in high-tech sectors. Some effort has been made to relate the choice of type of equity versus non-equity agreements from several aspects.

Although the data presented here are limited, when we examine the firm-level data in Table 2 and evaluate the propensity of firms to undertake equity, we find that significant differences exist between industrial groups of firms. This would suggest that, in fact, globalization has had some broad effects on the propensity of firms to undertake non-equity alliances, and has led to a homogenization of the propensity of firms to undertake alliances. Where differences do exist they represent differences between sectors. In general, it can probably be said that non-equity types of agreements may be a superior mechanism for the joint development of high-tech products and processes, whereas in lower-tech sectors equity agreements are preferred.

6. Conclusions

The use of strategic technology alliances is a phenomenon that has mushroomed over the past two decades, mainly in response to changes that are often described collectively as globalization. In particular, we have highlighted that strategic issues such as enhancing competitiveness and value of the firm in a more long-term horizon motivate this growth in alliances, rather than improving short-term cost efficiencies.

Globalization has affected the need of firms to collaborate, in that firms now *seek* opportunities to cooperate, rather than identify situations where they can achieve majority control. In addition, the increasing similarity of technologies across countries and cross-fertilization of technology between sectors, coupled with the increasing costs and risks associated with innovation, has led to firms utilizing STP as a *first-best* option.

STP, as with most forms of innovative activity, is primarily concentrated in the Triad countries. However, the propensity of firms of a given nationality to engage in STP varies according to the characteristics of the country. The propensity of a county's firms to engage in alliances is a function of its home country's character-

Table 4
Changes in organizational modes of STP by region

	1980–1984	1985–1989	1990–1994
US			
Equity STP	40.9	33.0	22.2
Non-equity STP	59.1	67.0	77.8
Europe			
Equity STP	44.1	43.3	3.1
Non-equity STP	55.9	56.7	66.9
Japan			
Equity STP	32.8	37.4	25.8
Non-equity STP	67.2	62.6	74.2

[3] Including developing countries, although once again, considerable differences exist between groups of countries (see Narula and Sadowski, 1999).

istics. For instance, small and technologically less advanced countries tend to be focused in fewer sectors than large countries. We also saw that strategic alliances are dominated by large firms, and there is indeed a positive relationship between firm size and STP levels by firm. On the other hand, the size and intensity of R&D activity (amongst the high-technology core sectors used in our study) do not seem to determine the propensity of firms to undertake STP. These seemingly contradictory results suggest that there is a threshold size due to the large commitment in resources required, given the high failure rate of alliances in these new and fast-evolving sectors.

We also observed a high percentage of STP utilized on a cross-border basis. US firms engage in the fewest international alliances, and European firms the most. In general, STP is seen to be complementary to overseas production—firms with large overseas production tend to partner more often with foreign firms. Large firms tend to have fewer international alliances, probably because these firms tend to be conglomerates, tend to be cost-efficient and have already made the necessary investment in fully owned overseas R&D laboratories. As such, since they may already have the necessary competences across several sectors, and have already made the sunk costs in overseas R&D, STP is less attractive. Most importantly, the data suggest that these trends are industry-specific; that is, firms simply do whatever firms in the same industry do, regardless of nationality. Furthermore, while some firms undertake STP as a means to complement their existing R&D activity, others seek to use STP as a substitute.

There is also a clear shift of alliance activity towards non-equity forms of agreements, and this has occurred more or less uniformly across countries. We attribute this change partly to the improved enforceability of contracts and intellectual property protection and partly to the increasing knowledge and familiarity firms now have in conducting international business activity. On a firm-level basis, the propensity to use equity agreements is associated with industry-specific differences, rather than country-specific differences. In general, it would seem that non-equity agreements are a more superior mechanism to equity alliances for the purposes of joint development in high-tech and fast-evolving products and processes.

US firms, in particular, seem to be something of the exception in much of our analysis. They undertake fewer international alliances relative to European and Japanese firms, and undertake more non-equity agreements. These two trends are not unrelated. While it is true that US firms engage in more alliances than those of any other nationality, it is, however, also true that relative to the sheer size of the US economy, this participation is muted. Although it has been suggested that non-US firms tend to engage in alliances because of government intervention and relaxed anti-trust regulations, this is not entirely true. The tendency to deal with overseas markets with some suspicion and a lot of caution was, until relatively recently, an often observed characteristics of US firms, along with a tendency to focus on short-term cost-efficiencies. However, growing international competition in what have traditionally been US-dominated sectors has forced US firms to forge alliances, and is increasingly seen as very much the way to conduct international business, particularly as a means to enter unfamiliar geographical and product markets. This is especially the case as the millennium draws to a close, now that international agreements have made contractual agreements more easily enforceable across borders.

Appendix A

The cooperative agreements and technology indicators (CATI) information system

The CATI data bank is a relational database which contains separate data files that can be linked to each other and provide (des)aggregate and combined information from several files. The CATI database contains three major entities. The first entity includes information on over 10 000 cooperative agreements involving some 4000 different parent companies. The data bank contains information on each agreement and some information on companies participating in these agreements. We define cooperative agreements as common interests between independent (industrial) partners which are not connected through (majority) ownership. In the CATI database only those interfirm agreements are being collected that contain some arrangements for transferring technology or joint research. Joint research pacts, second sourcing and licensing agreements are clear-cut examples. We also collect information on joint ventures in which new technology is received from at least one of the partners, or joint ventures having some R&D programme. Mere production or marketing joint ventures are excluded. In other words, our analysis is primarily related to technology cooperation. We are discussing those forms of cooperation and agreements for which a combined innovative activity or an exchange of technology is at least part of the agreement. Consequently, partnerships are omitted that regulate no more than the sharing of production facilities, the setting of standards, collusive behaviour in price-setting and raising entry barriers—although all of these may be side effects of interfirm cooperation as we define it.

We regard as a relevant input of information for each alliance: the number of companies involved; names of companies (or important subsidiaries); year of establishment, time horizon, duration and year of dissolution; capital investments and involvement of banks and

research institutes or universities; field(s) of technology[4]; modes of cooperation[5]; and some comment or available information about progress. Depending on the very form of cooperation we collect information on the operational context; the name of the agreement or project; equity sharing; the direction of capital or technology flows; the degree of participation in case of minority holdings; some information about motives underlying the alliance; and the character of cooperation, such as basic research, applied research, or product development possibly associated with production and/or marketing arrangements. In some cases we also indicate who has benefited most.

The second major entity is the individual subsidiary or parent company involved in one (registered) alliance at least. In the first place, we assess the company's cooperative strategy by adding its alliances and computing its network centrality. Second, we ascertain its nationality, and its possible (majority) owner in case this is an industrial firm. Changes in (majority) ownership in the 1980s were also registered. Next, we determine the main branch in which it is operating and classify its number of employees. In addition, for three separate subsets of firms time series for employment, turnover, net income, R&D expenditures and numbers of assigned US patents have been stored. The first subset is based on the *Business Week* R&D scoreboard, the second on *Fortune*'s International 500, and the third group was retrieved from the US Department of Commerce's patent tapes. From the *Business Week* R&D Scoreboard we took R&D expenditure, net income, sales and number of employees. In 1980 some 750 companies were filed; during the next years this number gradually increased up to 900 companies in 1988, which were spread among 40 industry groups. *Fortune*'s International 500 of the largest corporations outside the US provides amongst others information about sales (upon which the rankings are based), net income and number of employees.

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[4] The most important fields in terms of frequency are information technology (computers, industrial automation, telecommunications, software, microelectronics), biotechnology (with fields such as pharmaceuticals and agro-biotechnology), new materials technology, chemicals, automotive, defence, consumer electronics, heavy electrical equipment, food and beverages, etc. All fields have important subfields.

[5] As principal modes of cooperation we regard equity joint ventures, joint R&D projects, technology exchange agreements, minority and cross-holdings, particular customer–supplier relations, one-directional technology flows. Each mode of cooperation has a number of particular categories.

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