

**Internationalization of corporate technology:
an empirical investigation**

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Abstract

This paper explores some of the trends in the internationalization of corporate R&D efforts and innovation output through patents. Inter-firm strategic technology partnering through which companies share their innovation efforts are also included in the analysis to widen the scope of the study. The main conclusion of this contribution is that, despite all the attention given to the subject, internationalization of innovation, although by no means insignificant, appears still less important than expected.

Internationalization of corporate technology: an empirical investigation

Introduction

The basic understanding of the internationalization of corporate activities can, albeit with the useful lack of subtlety, be reduced to a simple dichotomy in which some authors refer to the process of internationalization as corporate globalization in which firms become 'footloose', whereas others still understand the process of internationalization in terms of national companies that only partially increase their international activities without losing their national identity. A clear example of the first line of thought is found in Reich (1991) who portrays a situation of continuous globalization of corporate activities in which "... national champions everywhere are becoming global webs with no particular connection to any single nation (p.131)." Quite the opposite point of view is taken by Hu (1992) who argues that even though companies might have spread their operations over a number of countries most international companies still depend on their home-nation as a home market and a 'centre of gravity' for their activities. Amongst other things this author points at the share of turnover or production realized by international companies in each individual host country being much smaller than that of the country of origin.

Without entering into the debate at this stage, we would like to point at the necessity to understand the issue of internationalization not so much as a present state of affairs but much more from the dynamic perspective of industrial change. The main question does not seem to be whether companies are already operating at a truly international level but whether they are gradually becoming more international with respect to their foreign direct investment in both tangible and intangible assets, their internal and external trade, the internal and external technology flows, the internationalization of their financial organization, and their strategic linkages to other companies. If firms would gradually develop global strategies regarding for instance international manufacturing, intra-firm trade and many other aspects of corporate activity (see Dunning, 1988, Kobrin, 1991) their corporate innovative activities can be expected to follow this pattern at some distance. Such inter-temporal differences in the internationalization of various corporate activities are also mentioned in Cantwell (1991), Mitsui (1990) and Pearce (1989) where it is argued that R&D tends to follow behind the establishment of manufacturing abroad with a certain time-lag.

In the literature the general advantage of an international R&D potential for companies is, as for instance mentioned by Pearce (1989), found in the ability "... to acquire a coordinated access to a wide range of innovative stimuli and sources of

scientific creativity. To leading companies the assimilation of dispersed heterogeneous inputs into coherent creative programmes may be a major facet of a competitive global strategy" (Pearce, 1989, p. 5). Despite such potential benefits many companies still understand the issue in terms of a dilemma as argued in Casson (1991). On the one hand firms are drawn towards major international centres of innovation in countries with relevant revealed technological advantages and on the other hand firms could have a preference to keep R&D as close as possible to their central office. In a similar vein de Meyer and Mizushima (1989) report some important changes in the internationalization of R&D by major firms, but these authors also stress that in many companies internationalization of R&D is only accepted with resignation.

Such arguments pro or contra the internationalization of corporate R&D can be linked to a discussion of the benefits of spatially concentrating R&D within the firm, see also Millar (1992) and Pearce and Singh (1992). Strictly taken concentration or dispersion of R&D is not identical to internationalization of R&D, but in particular for large, internationally operating companies one can expect a linkage.

Factors in favour of the dispersion of corporate R&D activities are:

- the transfer of knowledge to manufacturing facilities to increase local high-tech capabilities of subsidiaries
- the interaction with high quality suppliers in innovative regions to benefit from particular technological advantages, which together with the previous factor can be summarized as the advantage of regionally concentrated technological competences, the so called agglomeration effect
- the call for customization, responsiveness and adaptation to local market needs
- host government pressures and incentives to conduct research locally or to maintain existing facilities
- reduction in the minimum economic size and divisibility of R&D facilities due to improved communication that allows for a more decentralized research capacity.

Factors in favour of concentration are:

- economies of scope and scale in R&D that still exist within large facilities
- the unstructured and intangible nature of R&D information demanding personal interactions
- the need to protect and control product development as a major issue of corporate strategy close to the decision-making centre of the company, in short to have strategic control over technological development

- the potentiality to capitalize on the accumulated experience in the home market and the technology networks with main suppliers.

These factors suggest that, if corporate innovation is being internationalized at all, it will probably take place within a balanced and gradual development as pro's and con's are weighted in long term investment programmes. These different sets of factors also suggest that the issue is to a large aspect an empirical question as there is no a priori balance of the positive and negative effects of these factors. Therefore, in the following sections we will present some general indicators of the internationalization of corporate technology and assess the outcome of a number of empirical studies on the internationalization technological activity. The obvious research question we pose is to what extent companies have internationalised their innovation activities during the past decade.

In order to study this issue more in detail and to complement our general findings we have chosen the international information technology industry with sub-fields such as dataprocessing, telecommunications and microelectronics. Not only is this sector well established and characterized by a wealth of statistical data it also has a relatively long tradition of international competition that can substantiate our findings.

In the next section we will first summarize some empirical evidence on the internationalization of corporate innovation for which we will follow the classical distinction between innovation input, i.e. companies' R&D efforts, and their innovation output, i.e. the patenting activities of companies. In addition to this we analyze recent data of European patents that enable us not only to complement some of the previous findings with data on the second half of the eighties and the early years of the nineties, but these data also generate some supplementary insight in foreign subsidiary patenting.

International trends in strategic technology partnering are analyzed at some length in the following section. The subject of inter-firm strategic partnering receives a growing attention in the academic as well as in the more popular press. Both strategic technology partnering and international coalitions are important new phenomena of which the understanding can add to our further appreciation of global corporate innovation efforts.

Our exploration ends with a brief exposé highlighting the major conclusions that can be drawn at this stage.

Internationalization trends in corporate technology

If we consider the internationalization of corporate innovation input, i.e. the R&D efforts by companies, the most well-known set of statistics by the NSF (1992) show that foreign R&D by US-owned companies first decreased from about 11% in 1977 to about 6% in 1985 after which it increased again to about 11% in 1988. Figures for the EC indicate that foreign R&D in the EC slightly increased from a narrow 5% in 1981 to slightly more than 7% in 1989. For Japan estimates suggest an average of about 1% of foreign R&D during the eighties (MERIT, 1993)

A number of recent studies on specific industries or samples of companies suggest that many multinational companies have gradually increased their foreign R&D activities. Lee and Reid (1991) report that leading American companies in computers, telecommunications, microelectronics, pharmaceuticals and the automotive industry have increased their international R&D efforts to between about one-quarter and a third of their R&D activities. Warrant (1991) mentions an expansion of R&D by US companies in Japan, albeit from a very low level. Reich (1991) recounts an increase of 33% of overseas R&D of US companies between 1986 and 1987, compared with a 6% increase within the USA. Peters (1992) mentions the growth of the number of firms setting up new laboratories abroad. As far as leading US firms are concerned she estimates that about 20% of their R&D is located outside the USA. She also found that European companies spend a larger share of their R&D abroad than either the US or Japanese companies. Miller (1992) and Graves (1991) suggest that 25% of the research, development and engineering, i.e. a broader category than R&D, in the automobile industry is carried out abroad, which might be equivalent to about 15% of total R&D. Finally, in a recent study by Pearce and Singh (1992) on a large sample of 560 major internationally operating companies the growing role of internationalized R&D is stressed although it is also mentioned that global R&D is not yet a widely pervasive practice. The picture which emerges is that leading multinational companies have indeed increased their foreign R&D to a level of about 10 to 20% of their total R&D, although probably considerably less in the case of Japanese companies.

For the evidence on innovation output in terms of patenting we can refer to a few studies. Patel and Pavitt (1991) have made an extensive analysis of the patenting activities of multinational companies. They distinguish patents taken out in the USA by 'national' companies in each country from those taken out by foreign subsidiaries of those national companies. Only in the case of Dutch and Swiss companies does the number of patents

from subsidiaries rise to a very high proportion. This is mainly due to the existence of a few very large Dutch and Swiss companies that have strong manufacturing and R&D assets outside their small domestic base. Otherwise, the patent data confirm that although foreign subsidiaries of multinational companies do indeed contribute significantly to world inventive activities, this contribution was less than 10% of world patenting during the first half of the eighties.

In a somewhat similar line of research Cantwell and Hodson (1991) found higher shares of international patenting. They estimate the share of US patents attributable to research in foreign locations for the world's largest firms during the first half of the eighties at about 10%. These differences are partly due to the fact that whereas Patel and Pavitt include small and medium companies, universities and government laboratories Cantwell and Hodson include only the largest companies. However, also their research only indicates "... that the world's largest firms witnessed a mild trend towards the internationalization of technological activity over the 1969-1986 period ..." (Cantwell and Hodson, 1991, p. 137). They certainly do not suggest of a sudden explosion of globalization of innovation during the seventies and the first half of the eighties.

To a certain extent following Patel and Pavitt (1991) and Cantwell and Hodson (1991) we performed a somewhat similar analysis to detect a possible continuation of trends in the internationalization of innovative output, measured by patents, comparing patenting activity in two periods, i.e. 1980 - 1985 and 1986 - 1991. Instead of using data from the US Patent Office, as done in the previously mentioned studies, we compiled our data from the European Patent Office (EPO). As these data allow us to differentiate between the applicant and the inventor, we are able to discriminate between the total number of patents that were filed by institutions from a specific region and the percentage of those patents based on inventions from outside this specific region. We calculated those percentages for the whole population irrespective of size and institutional form. In our opinion this is a more precise representation of the overall importance of internationalization of technological activities at large than restricting our analysis to large firms only. Moreover, problems of consolidating data on a firm level are non-existent in such analysis. In our analysis we compare internationalization patterns for three major regions: Europe, Japan and the USA.

Because our analysis includes the whole population of patenting organizations we expect the overall degree of internationalization of technological activity to be below the findings of Patel and Pavitt (1991) and Cantwell and Hodson (1991). This expectation is

confirmed by our findings on the internationalization of technological activity, see Table 1. Overall only 6.6% of patents filed with the EPO by US institutions were invented outside the US. For Europe and Japan the figures were even lower, only 2.9% of European patents were invented outside Europe, whereas Japan lags behind the internationalization process with a modest 0.7%. The major differences between our findings and those of the other contributors can be attributed to the fact that we aggregated our data at an European level. This implies that the internationalization patterns for European firms found by Patel and Pavitt and Cantwell and Hodson probably largely refers to intra-European internationalization. It seems that extra-European internationalization of technological activity of European firms is found only in a relatively small number of cases.

Table 1 Foreign subsidiary patenting as a % of total EPO patents, 1980 - 1985 and 1986 - 1991

	Total 80-85	86-91	IT total 80-85	86-91	Computers 80-85	86-91	Micro 80-85	86-91	Telecom 80-85	86-91
Europe	2.6%	3.0%	2.0%	2.0%	3.2%	2.3%	1.3%	1.6%	1.5%	2.0%
US	6.8%	6.4%	8.0%	6.0%	7.2%	6.4%	6.4%	5.1%	11.7%	6.1%
Japan	0.7%	0.8%	0.4%	1.4%	1.0%	2.1%	0.1%	1.3%	0.5%	0.8%

Source: European Patent Office

A comparison of the periods 1980 - 1985 and 1986 - 1991 shows that only slight differences are found. Europe and Japan demonstrate a small increase in internationalization. Europe's number of patents invented outside Europe increased from 2.6% to 3.0% in the period 1986 - 1991. Japan experienced a modest increase from 0.7% in the first period to 0.8% in the latter period. The US on the other hand experienced a slight decrease in international patenting. The percentage of patents invented outside the US decreased from 6.8% in the first period to 6.4% in the second period.

For the information technology industry we found a slightly different picture. The US leads the internationalization process in all segments but suffered a severe drop from

8.0% in the first period to 6.0% in the second period. Although for the US the percentage of international patents fell in all information technology segments, this decrease can be primarily attributed to a decrease of 5.6% in the telecommunications industry¹. International technological activity of European institutions outside Europe remains at 2.0% of total patents. Europe's percentage seems to rise in telecommunications and microelectronics but decreases in dataprocessing. Japan on the other hand shows an increase in all three segments.

Apparently an industry that is often referred to as 'globalized' is found to be not very internationalized in terms of its technological activities. All this suggests that the moderate trend towards internationalization of technology found by Cantwell and Hodson (1991) has not continued during the second half of the 1980s and early 1990s.

Trends in the internationalization of strategic technology partnering

Given the modest degree of internationalization of firms' innovative activities, an interesting question would be to find out whether corporate strategic technology partnering demonstrates similar or dissimilar international patterns. In previous work it was already established that during the 1980s strategic technology partnering increasingly became more important to the innovation strategies of a large number of companies (Hagedoorn and Schakenraad, 1992 and 1993). Such strategic technology partnerships are to be understood as inter-firm agreements for which joint R&D and/or other innovative activities are a major objective and that can reasonably be assumed to affect the long-term product market positioning of at least one partner. Joint ventures with shared R&D resources, R&D corporations, joint R&D pacts, cross-licensing agreements, research contracts and second-sourcing agreements are clear examples of this category of inter-firm cooperation.

In the literature, see for instance Ohmae (1990) and de Woot (1990), it is sometimes suggested that strategic alliances are essential to international corporate strategies. Although we refer only to strategic technology alliances we think that in general internationalization is not the sole objective of strategic alliances. For many technology partnerships improving the innovative capability of at least one of the partners will be a major objective. This objective will frequently coincide with an

¹ This drop could well be the result of the divestiture of large parts of ITT's European telecom subsidiary to Alcatel in 1986.

internationalization or globalization strategy of the company but it could fit equally well within a domestic or more regionally concentrated strategy. Most of the arguments pro or contra the internationalization of corporate R&D also bear relevance on the international partial externalization of innovative activities through inter-firm partnerships. The bottom line of the argument would be that there is a clear tension between international partnering benefitting from 'foreign' capabilities and a larger degree of control through alliances that are closer to the 'domestic' span of control. We assume that joint R&D is closer to the corporate core of most companies than the sharing of certain production facilities or the joint entry of uncontrolled foreign markets. Therefore we can expect that the internationalization of R&D through international strategic technology alliances will still be at a moderate level compared to partnerships which are more directly related to market entry arrangements and joint production.

Based on such notions of corporate internationalization we can formulate two topics for further research:

- first, if strategic technology partnering has increased in recent years the question emerges whether this increase has been of a primarily international character or whether companies are predominately searching for partnerships with companies from the same economic region,
- second, we expect strongly international oriented inter-firm alliances to be more concentrated on commercial and production activities whereas R&D focused alliances are probably of a less international character.

Before we enter into the subject of particular patterns of the internationalization of strategic technology partnering we will first briefly sketch the broader picture of overall trends as found in the MERIT-CATI databank, see Appendix. In Figure 1 we present the flow pattern of newly established partnerships during the 1980's. This figure clearly shows that the growth pattern is quite different if one compares the overall trend with information technology and the three sub-fields that we analyze in this paper. The overall growth pattern demonstrates a strong increase of newly made alliances during the mid-eighties, after which the increase of new alliances is still strong but somewhat less prominent during the later years of the decade. The trend for the total of information technology alliances, that account for about 40% of the entire population, appears to be somewhat different. Here we notice a strong increase during the first half of the eighties, after which the growth pattern is first stabilized until it increases again in 1988 and 1989. For computers, the smallest sub-field of information technology in terms of strategic

technology partnering, we see a somewhat fluctuating pattern with a rise of new alliances at the end of the first half and at the end of the second half of the 1980s. In the other two sub-fields of information technology we see a larger number of strategic technology alliances than for computers. In microelectronics the first half of the decade appears to be a real growth period with a peak in 1984, after which the increase of newly made alliances is fluctuating at a lower level. For alliances in telecommunications we see a gradual growth pattern, albeit with some oscillations, from a very few alliances made during the first couple of years to an average of over fifty alliances made during the final years of the 1980s.

The next step in our analysis is to find an answer to the research questions introduced above and to see whether inter-firm strategic technology partnering is characterized by a truly international pattern. In Table 2 we find the distribution of the alliances for each field comparing the first half of the eighties with the second half. In order to get some preliminary understanding of patterns of internationalization we made a distinction in so-called intra-regional alliances made between companies within Europe (EC and EFTA), the USA and Japan and international alliances for which we took alliances made between companies from these different economic regions or blocks. Other combinations play hardly any role and will be neglected in this analysis where we concentrate on the Triad: Europe, USA, Japan.

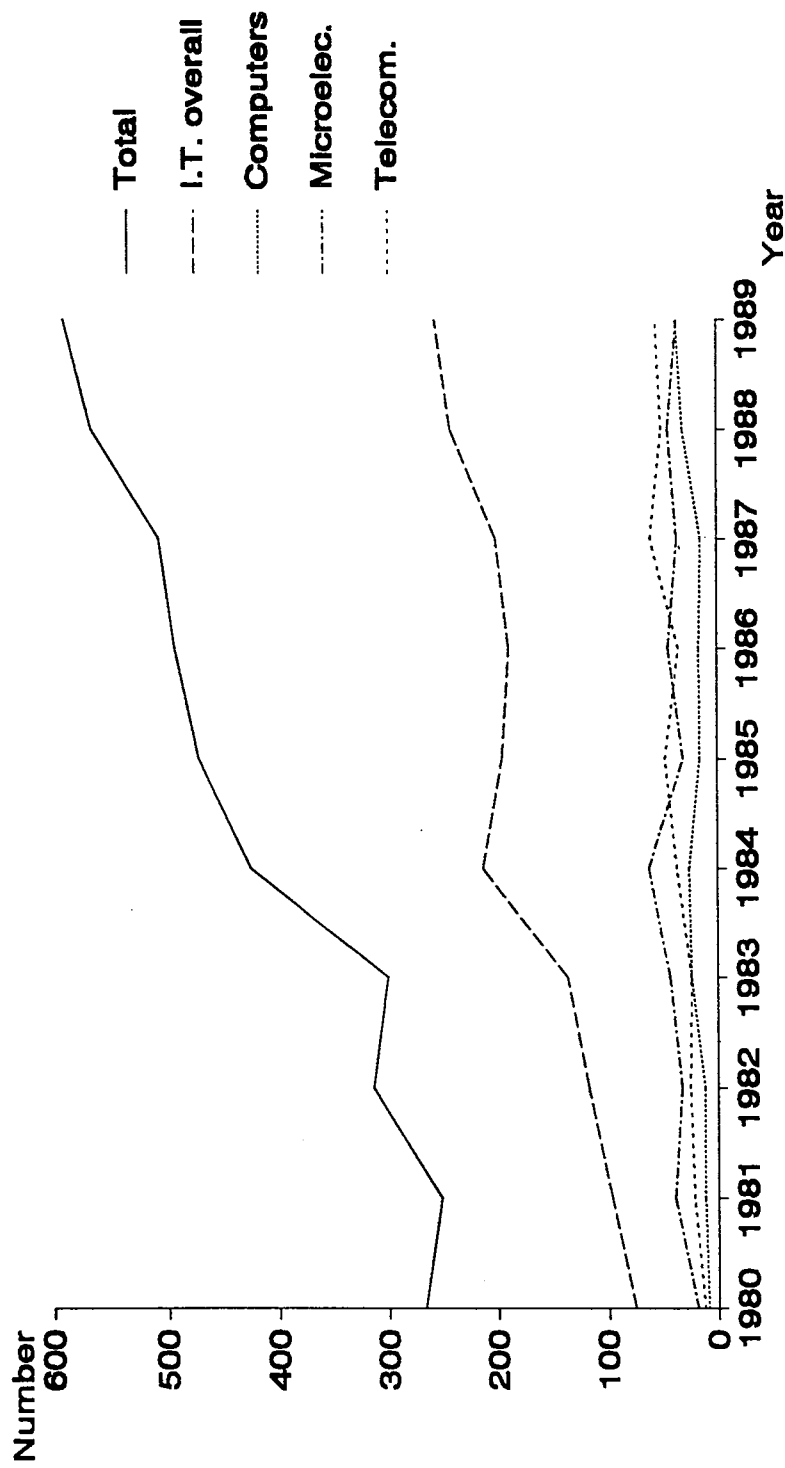


Figure 1 Growth of newly established strategic technology alliances in all fields, total information technology, and computers, microelectronics, telecommunications, 1980-1989

In Table 2 the row percentages for two periods in the eighties conform the growth pattern discussed above with an average of about 60% of all alliances made during the second half of the eighties. The only major difference is found for microelectronics where the total number of alliances made during the 1980s is almost equally divided between the first and the second half of the period. Looking at the more des-aggregated level of international versus intra-regional alliances the column percentages indicate that within this overall increase of strategic technology alliances the intra-regional alliances have increased disproportionately. Adding up the percentages of intra-European, intra-US and intra-Japanese technology partnerships shows that the total population of alliances with intra-regional partnering has increased from less than 45% during the first half to nearly 52% during the second half of the eighties. For overall information technology intra-regional collaboration increased from 40% to nearly 53%, for computers we find a growth from 38.5% to nearly 47% and for microelectronics from only 31% to 48%. Only in telecommunications did the share of intra-regional partnering remain at the level of about 47%. As the share of other combinations remained quite small the percentage of international or inter-block strategic partnering has dropped substantially, again with the exception of telecommunications where international partnering remained at about 43%.

Based on figures from Table 2 another indication of the possible internationalization or regionalisation of strategic technology partnering is found in a relative internationalization index which we calculated by setting the ratio of intra-regional partnering versus inter-regional partnering for each sector against the overall intra-regional/inter-regional ratio in Table 3.² This index indicates that in general strategic technology partnering in the information technology sector and its three sub-fields we analyse is more internationally oriented than strategic technology partnering at large. Exceptions are the information technology sector at large during the years 1985-1989 and telecommunications during the first half of the eighties with relative internationalization indexes larger or equal to unity. In addition to this, such figures also confirm that with the exception of telecommunications strategic technology partnering in information technologies is becoming more intra-regional.

² This relative internationalisation index is calculated as:

$$\frac{\% \text{ intra-regional alliances per sector}}{\% \text{ inter-regional alliances per sector}} : \frac{\% \text{ total intra-regional alliances}}{\% \text{ total inter-regional alliances}}$$

Table 3 Relative internationalization index of strategic technology partnering in overall information technology, computers, microelectronics and telecommunications, 1980-1984 and 1985-1989

	1980-1984	1985-1989
Total IT	0.76	1.0
Computers	0.67	0.76
Microelectr.	0.51	0.8
Telecomm.	1.13	0.86

Returning to Table 2 and considering the des-aggregated distribution for each economic block or the inter-block linkages during the eighties we see the following patterns:

- both within Europe and the USA strategic alliances have particularly grown in general information technology
- in the USA partnering in computers and microelectronics grew disproportionately, in Europe the same holds for microelectronics and telecommunications
- intra-Japanese partnering seems to stagnate in all information technology fields
- European-US and US-Japanese alliances are in particular lagging in microelectronics, European-Japanese partnering stagnates in computers whereas these particular inter-block alliances have grown in telecommunications.

In other words, the overall pattern suggests that, despite some sector specific and/or international irregularities, strategic technology partnering has become relatively more concentrated within major regions of the Triad instead of becoming overwhelmingly international.

Fortunately, our data also enable us to differentiate strategic technology partnerships into alliances that are primarily related to R&D and strategic alliances for which market access, despite their technology content, is still more important. This enables us to find out whether strategic R&D alliances are more intra-regional focused and market oriented partnerships are more of an international character. The relevant distributions for these relationships are given in Table 4. From this table we learn that for the overall figures on strategic technology partnering intra-block partnering is characterized by a strong

emphasis on R&D. About 70 to 80% of the overall intra-block partnerships made during the first half of the eighties are R&D oriented. During the second half of the period these percentages do increase slightly or stabilize. Although inter-block partnering, i.e. the more international technology sharing, also has a large share of R&D oriented alliances it is clear that in these international partnerships market oriented partnerships play a more dominant role. Or to phrase it somewhat differently: over 50 to 60% of the strongly R&D focused alliances concern less international intra-block partnering and, despite some decrease during the second half of the eighties, still over 50% of the market oriented technology alliances are subject to international inter-block partnering.

For information technology at large the distribution is somewhat different but not a radical change from the overall pattern. Regional intra-block partnering is for 60 to 80% R&D oriented. For inter-block technology alliances we see a more balanced distribution. If we look only at the R&D partnerships and compare the first half of the eighties with the second half the share of intra-block partnering has risen from nearly 50% to over 60%. For more market oriented technology cooperation the share of international partnering has dropped but it is still well above 50%.

Also for the three separate sub-fields of information technology we by and large find the same pattern. Leaving aside some particular intra-regional or inter-regional disturbances, the main deviations are the 'unexpected' large share of inter-block R&D concentrated partnering for computers during the whole decade and for microelectronics during the first half of the eighties. However, in general Table 4 demonstrates that most of the R&D directed alliances are found within economic regions while the majority of the market oriented technology alliances are international inter-economic block partnerships.

Table 4 International distribution of R&D or market and production oriented strategic technology alliances, overall figures, total information technologies, computers, microelectronics, telecommunications, %, 1980-1984 and 1985-1989

		Total				IT Total			
		R & D		Market		R & D		Market	
		80-84	85-89	80-84	85-89	80-84	85-89	80-84	85-89
Intra	Europe	18.0%	18.2%	12.3%	13.1%	13.9%	19.7%	11.1%	13.9%
	US	26.8%	31.8%	11.2%	14.5%	27.8%	38.1%	13.2%	20.3%
	Japan	5.5%	7.5%	1.5%	3.8%	6.5%	2.8%	1.8%	3.1%
Inter	Europe-US	22.2%	23.5%	23.6%	24.1%	21.3%	22.3%	26.8%	26.5%
	Europe-Japan	5.5%	4.4%	10.8%	9.6%	9.0%	4.1%	11.1%	8.7%
	US-Japan	16.4%	9.8%	27.9%	19.5%	19.1%	11.4%	27.5%	18.3%
Other		5.5%	4.7%	12.7%	15.4%	2.5%	1.6%	8.6%	9.3%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		Computers				Micro			
		R & D		Market		R & D		Market	
		80-84	85-89	80-84	85-89	80-84	85-89	80-84	85-89
Intra	Europe	10.0%	3.8%	5.0%	4.8%	11.5%	18.9%	4.1%	7.3%
	US	27.5%	51.9%	22.5%	32.3%	31.0%	32.8%	13.9%	23.2%
	Japan	5.0%	0.0%	0.0%	0.0%	5.7%	2.5%	0.8%	3.7%
Inter	Europe-US	30.0%	15.4%	25.0%	33.9%	23.0%	13.1%	27.0%	14.6%
	Europe-Japan	0.0%	0.0%	20.0%	3.2%	3.4%	4.1%	4.9%	12.2%
	US-Japan	27.5%	23.1%	22.5%	19.4%	25.3%	23.0%	41.0%	32.9%
Other		0.0%	5.8%	5.0%	6.5%	0.0%	5.7%	8.2%	6.1%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		Telecom							
		R & D		Market		R & D		Market	
		80-84	85-89	80-84	85-89	80-84	85-89	80-84	85-89
Intra	Europe	10.2%	24.0%	22.7%	22.3%	10.2%	24.0%	22.7%	22.3%
	US	30.5%	20.0%	6.8%	7.7%	30.5%	20.0%	6.8%	7.7%
	Japan	6.8%	4.8%	6.8%	6.2%	6.8%	4.8%	6.8%	6.2%
Inter	Europe-US	28.8%	27.2%	30.7%	31.5%	28.8%	27.2%	30.7%	31.5%
	Europe-Japan	0.0%	4.8%	6.8%	4.6%	0.0%	4.8%	6.8%	4.6%
	US-Japan	15.3%	9.6%	13.6%	15.4%	15.3%	9.6%	13.6%	15.4%
Other		8.5%	9.6%	12.5%	12.3%	8.5%	9.6%	12.5%	12.3%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Conclusions

In this paper we explored some recent trends in the internationalization of corporate technological activities. This issue is typically caught within the dichotomy of benefits that accrue from the international externalization as well as the internal dispersion of innovation processes. On the one hand firms are drawn towards major international centres of innovation in countries with relevant revealed technological advantages and on the other hand firms have a preference to keep R&D as close as possible to their headquarters. We suggest that companies are likely to perform a critical evaluation of the advantages and disadvantages of a further internationalization of their technological activities. However, as there seems to be no a priori balance in these (dis)advantages the issue is at least to some extent of an empirical nature.

The results of our analysis imply that companies are yet far from global in terms of the internationalization of their technological activities. Also a probable 'footloose' character of multinational firms with a global research base is not supported by the present investigation. On the contrary, for the by far larger part, companies appear to rely extensively on home country or nearby research facilities. In general, corporate innovative activities are still primarily of a local or regional character. As far as the importance of strategic technology partnering of companies is concerned our main findings suggest that, despite an overall increase in strategic technology alliances, this phenomenon has become relatively more concentrated within major economic regions instead of becoming overwhelmingly global. A comparison of R&D and market-oriented partnerships revealed that most of the R&D directed alliances are found within economic regions while the majority of the market oriented alliances are of a more international character.

In this paper we stress that internationalization should not be seen as a static phenomenon but much more viewed from a dynamic perspective. Therefore, the main question is not whether companies are already innovating globally at a large scale but whether they are gradually becoming more internationalized in their innovative activities and capabilities. The answer to this question appears to be that both the internal aspects of corporate innovation processes as well as the joint research activities of firms suggest only a very mild increase in the internationalization of corporate technological activities and certainly not a sudden explosion of globalization during the past decade.

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APPENDIX 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. So far information on nearly 10,000 cooperative agreements involving some 3500 different parent companies has been collected. Systematic collection of inter-firm alliances started in 1987. Many sources from earlier years were consulted enabling a retrospective view. In order to collect interfirm alliances various sources were consulted, of which the most important are newspaper and journal articles, books dealing with the subject, and in particular specialized journals which report on business events. Company annual reports, the Financial Times Industrial Companies Yearbooks and Dun & Bradstreet's 'Who Owns Whom' provide information about dissolved equity ventures and investments, as well as ventures that were not registered when surveying alliances.

This method of information gathering which one can refer to as 'literature-based alliance counting' has its drawbacks and limitations due to the lack of publicity for certain arrangements, low profile of certain groups of companies and fields of technology. Despite these shortcomings, which are largely unsolvable even in a situation of extensive and large-scale data-collection, we have been able to produce a clear picture of the joint efforts of many companies. This enables us to perform empirical research which goes beyond case studies or general statements. Some of the weaknesses of the database can easily be evaded by focusing on the more reliable parts, such as strategic alliances.

The data bank contains information on each agreement and some information on companies participating in these agreements. The first entity is the inter-firm cooperative agreement. We define cooperative agreements as common interests between independent (industrial) partners which are not connected through (majority) ownership. In the CATI database only those inter-firm 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 program. 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.