



Internationalization of corporate technology through strategic partnering: an empirical investigation

Geert Duysters, John Hagedoorn *

MERIT, Faculty of Economics and Business Administration, University of Limburg, P.O. Box 616, Maastricht 6200 MD, The Netherlands

Final version received July 1994

Abstract

This paper explores some trends in the internationalization of corporate R&D efforts, innovation output and strategic technology partnering in the past decade. Inter-firm strategic technology partnering, through which companies share their innovation efforts, supplements the standard indicators of technological competence to broaden the scope from internal innovation processes to a wider range of innovative activities. The international information technology industry is singled out for empirical study. The main conclusion of this contribution is that, even in a 'global' industry such as information technology, internationalization of innovation, although by no means insignificant, appears less important than expected.

1. Introduction

The basic understanding of the internationalization of corporate activities can, albeit with the usual 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 to 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 out the necessity of under-

* Corresponding author. Tel. (31) 43-3883897 fax (31) 43-3216518.

standing 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 were to 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 would be expected to follow this pattern at some interval. Such inter-temporal differences in the internationalization of various corporate activities are also mentioned in Cantwell (1991) and Pearce (1989), where it is argued that R&D tends to follow 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 internation-

alization of corporate R&D can be associated with a discussion of the benefits of spatially concentrating R&D within the firm (see also Miller, 1994; 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 necessary speed of decision-making regarding innovative projects;
- shortened innovation cycles requiring shorter interface-distances;
- 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 innova-

tion is being internationalized at all, it will probably take place within a gradual development as pros and cons are weighted in long-term investment programmes. These different sets of factors also suggest that the issue is to some extent 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 of technological activity. The obvious research question we pose is: to what extent have companies internationalized their innovation activities during the past decade?

This topic has both an academic and a policy relevance. From an academic perspective it touches upon many issues that deal with our understanding of changing international market structures, national systems of innovation, the organization of international companies, the general internationalization strategies of firms, and eventually also the dynamics of economic and technological change. From a policy perspective it ties in with discussions about the relevance of national innovation policies in a period of gradual internationalization of the economy and the possibilities for supranational technology policies, for instance through the EC.

In order to study the research question introduced above 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 following 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. International trends in strategic technology partnering, as found in a relatively large dataset, are analyzed at some length in the following section.

The subject of inter-firm strategic partnering receives growing attention in the academic as well as in the more popular press. In that context joint technological development, supplementing intra-firm innovative activities, is mentioned as a major mechanism for improving the innovative capabilities and international competitive positioning of a growing number of companies (OECD, 1993). Increased world-wide competition, scarcity of innovative resources, the growing complexity of technological systems, global entry strategies, and world-wide simultaneous product introduction are mentioned as important motives behind these international partnering strategies. Given this growing importance of strategic technology partnering (Mytelka, 1991; Hagedoorn, 1993; Hagedoorn and Schakenraad, 1993), both strategic technology partnering and the international allocation of intra-firm research capabilities are important phenomena the understanding of which can enhance our appreciation of global corporate innovation efforts.

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

2. Internationalization trends in corporate technology

A number of studies on specific industries or samples of companies suggest that many multinational companies have gradually increased their foreign R&D activities. As both Granstrand et al. (1993) and Dunning (1994) recently presented overviews of the literature in this journal we will limit ourselves to a selection of contributions. 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 Peters 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 (1994) 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 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 the figure is 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 large 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. They report that only for countries such as the Netherlands, Switzerland, the UK and Belgium does the number of US patents from foreign subsidiaries rise to a high proportion. Otherwise, the patent data confirm that although foreign subsidiaries of large companies do indeed contribute significantly to world inventive activities, this contribution was less than 10% of world patenting during the first half of the 1980s. This leads Patel and Pavitt to conclude amongst other things that "... in spite of considerable variations among large firms based in different countries, their technological activities remained far from globalised" (Patel and Pavitt, 1991, p. 11).

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 1980s at about 10%. These differences are largely due to the fact that Patel and Pavitt include small and medium companies, universities and government laboratories in the denominator of the total of patents, whereas Cantwell and Hodson limit their total population to patents granted to the group of largest companies. However, Cantwell and Hodson's 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 a sudden explosion of globalization of innovation during the 1970s and the first half of the 1980s.

3. 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, 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, (e.g. de Woot, 1990; Ohmae, 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 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 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 with 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 predominantly 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 Fig. 1 we present the flow pattern of newly established partnerships during the 1980s. This figure clearly shows that the growth pattern is quite different if one compares the overall trend in

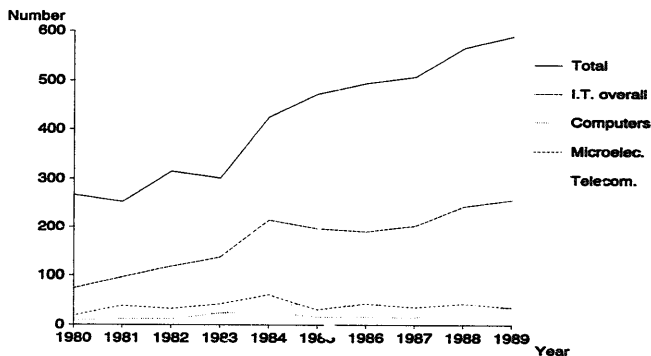


Fig. 1. Growth of newly established strategic technology alliances in all fields, total information technologies, computers, microelectronics, telecommunications, 1980–1989.

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-1980s, 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, which 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 1980s, after which the growth pattern is first stabilized, before increasing again in 1988 and 1989. For sub-fields of information technology we see a somewhat fluctuating pattern during 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 1 we find the distribution of the alliances for each field, comparing the first half of the 1980s with the second half. In order to get some preliminary understanding of patterns of internationalization we made a distinction between intra-regional alliances made between companies within Europe (EC and EFTA), the USA and Japan, and international alliances made between companies from these different economic regions or blocks. Other combinations play hardly any role and will be neglected in this analysis; here we concentrate on the triad: Europe, USA, Japan.

In Table 1 the row percentages for two periods in the 1980s conform with the growth pattern discussed above with an average of about 60% of all alliances made during the second half of the 1980s. 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 disaggregated 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 1980s. 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-bloc strategic partnering has dropped substantially, again with the exception of telecommunications where international partnering remained at about 43%.

Based on figures from Table 1 another indication of the possible internationalization or regionalization 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 2.¹ This index indicates that, in general, strategic technology partnering in the information technology sector and the 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 1980, 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.

Returning to Table 1 and considering the disaggregated distribution for each economic bloc or the inter-bloc linkages during the 1980s 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. For each alliance we identified one or more motives on a 'scale' from basic research to marketing. Agreements for which the majority of motives are related to R&D are qualified as R&D partnerships, market oriented alliances are those agreements for which market entry-related motives are dominant, (see Hagedoorn, 1993 for details). This procedure enables us to find out whether strategic R&D alliances are more intra-regional focused and market-oriented technology partnerships are more of an international character. The relevant distributions for these relationships are given in Table 3. From this table we learn that for the overall figures on strategic technology partnering intra-bloc partnering is characterized by a strong emphasis on R&D. About 70% to 80% of the overall intra-bloc partnerships made during the first half of the 1980s, are R&D oriented. During the second half of the period these percentages do increase slightly or stabilize. Although inter-bloc partnering, i.e. in-

Table 2

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	1.00
Computers	0.67	0.76
Microelectronics	0.51	0.80
Telecommunications	1.13	0.86

ter-continental technology cooperation, 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-bloc partnering and, despite some decrease during the second half of the 1980s, still over 50% of the market-oriented technology alliances are subject to international inter-bloc partnering.

For information technology at large the distribution is somewhat different but not a radical change from the overall pattern. Regional intra-bloc partnering is for 60% to 80% R&D oriented. For inter-bloc technology alliances we see a more balanced distribution. If we look only at the R&D partnerships and compare the first half of the 1980s with the second half the share of intra-bloc 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%.

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-bloc R&D concentrated partnering for computers during the whole decade and for microelectronics during the first half of the 1980s. 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-bloc partnerships.

² This relative internationalization index (RII) is calculated per sector as the relative distribution of the number of intra-regional alliances (RA_i) and inter-regional alliances (IA_i) set against the distribution of the total intra-regional alliances (TRA) and total inter-regional alliances (TIA):

$$RII_i = \frac{RA_i / IA_i}{TRA / TIA}$$

4. 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. Firm-specific innovative capabilities, sectoral specificities and country-specific technological advantages play a role in this process of internationalization.

Research so far implies that companies are as yet far from global in terms of the internationalization of their technological activities. A probable 'footloose' character of multinational firms with a global research base is not supported by clear empirical evidence. On the contrary, and for much the 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 technology 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 as dynamic. Therefore, the main question is not whether companies are already innovating globally on 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 a moderate increase in the internationalization of corporate technological activities and certainly not a sudden explosion of globalization during the past decade.

An explanation for 'regionalized' patterns of internationalization of both internal innovative efforts and joint R&D through strategic alliances can be found in the organizational complexities that surround these particular aspects of company organization and corporate strategies. The international coordination of production, servicing, sales and marketing already creates substantial organizational complexity for companies operating beyond their domestic markets. The internationalization of corporate R&D and other innovative activities, such as product development, with companies attempting to benefit from the internationally uneven distribution of technological capabilities through an innovative presence beyond their domestic markets, creates additional aspects of complexity in international strategies and company organization. This organizational complexity and the risk of organizational failure probably explains why international inter-firm R&D collaboration is still of a strong regional nature, i.e. to a large extent concentrated within each of the major trading blocs, and why the internationalization of corporate innovation is, although by no means insignificant, still quite moderate. It appears quite rational that many firms limit themselves to a more internationally regional strategy with only moderate extension beyond their region of origin. That particular option largely coincides with an international strategy that represents a compromise between a domestic and a global strategy with still sufficient scale effects and ample opportunities for capitalizing on regionally available technological competences.

Acknowledgments

Paper presented at the Academy of International Business Annual Meeting Hawaii, 21–24

October 1993. The authors would like to thank Duane Kujawa and Robert Hawkins, discussants at the AIB meeting, and two anonymous referees for their comments.

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 (dis)aggregate and combined information from several files. So far information on nearly 10000 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 inter-firm 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, and the 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.

References

- Cantwell, J., 1991, The international agglomeration of R&D, in: M. Casson (ed.), *Global Research Strategy and International Competitiveness*, (Blackwell, Oxford) pp. 104–132.
- Cantwell, J. and C. Hodson, 1991, Global R&D and UK competitiveness, in: M. Casson (ed.), *Global Research Strategy and International Competitiveness*, (Blackwell, Oxford) pp. 133–182.
- Casson, M., 1991 (ed.), *Global Research Strategy and International Competitiveness*, (Blackwell, Oxford).
- De Meyer, A. and A. Mizushima, 1989, *Global R&D management*, R&D Management, 19, 135–146.
- De Woot, P. (ed.), 1990 *High Technology Europe: Strategic Issues for Global Competitiveness* (Blackwell, Oxford).
- Dunning, J.H., 1988, *Multi-nationals, Technology and Competitiveness* (Unwin Hyman, London).
- Dunning, J.H., 1994, *Multinational enterprises and the globalization of innovative capacity*, *Research Policy* 23, 67–88.
- Grandstrand, O., L. Hakanson and S. Sjolander, 1993, *Internationalization of R&D – A survey of some recent research*, *Research Policy* 22, 413–430.
- Graves, A., 1991, *International Competitiveness and Technological Development in the World Automobile Industry* (D.Phil Thesis, University of Sussex).
- Hagedoorn, J., 1993, *Understanding the rationale of strategic technology partnering: Interorganizational modes of coop-*

- eration and sectoral differences, *Strategic Management Journal* 14, 371–385.
- Hagedoorn, J. and J. Schakenraad, 1992, Leading companies and networks of strategic alliances in information technologies, *Research Policy* 21, 163–190.
- Hagedoorn, J. and J. Schakenraad, 1993, Strategic technology partnering and international corporate strategies, in: K. Hughes (ed.), *European Competitiveness*, (CUP, Cambridge) pp. 60–86.
- Hu, Y.S., 1992, Global or transnational corporations and national firms with international operations, in: *California Management Review* 34, no. 2, 107–127.
- Kobrin, S., 1991, An empirical analysis of the determinants of global integration, *Strategic Management Journal* 12, 17–31.
- Lee, T. and P. Reid, 1991, *National Interests in an Age of Global Technology*, (NAP, Washington).
- Miller, R., 1994, Global R&D networks and large-scale innovations: The case of the automobile industry, *Research Policy* 23, 27–46.
- Mytelka, L.K., 1991, *Strategic Partnerships and the World Economy*, (Pinter, London).
- OECD, 1993, *The Measurement of Scientific and Technological Activities: Patent Manual* (OECD, Paris).
- Ohmae, K., 1990, *The Borderless World* (Harper, New York).
- Patel, P. and K. Pavitt, 1991, Large firms in the production of the world technology: An important case of non-globalization, *Journal of International Business Studies* 22, 1–21.
- Fearce, R., 1989, *The Internationalization of R and D by Multi-national Enterprises* (Macmillan, London).
- Pearce, R. and S. Singh, 1992, *Internationalization of R and D Among the World's Leading Enterprises* (Macmillan, London).
- Peters, L.S., 1992, *Technology Management and the R&D Activities of Multinational Enterprises*. Research paper, (CSTP-RPI, Troy, NY).
- Reich, R.B., 1991, *The Work of Nations* (Vintage Books, New York).
- Warrant, F., 1991, *Développement mondiale de la R&D industrielle*. Research paper (FAST, CEC, Brussels).