Trends and Patterns in Strategic Technology Partnering Since the early Seventies

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Abstract. This paper analyses some basic trends and patterns in inter-firm strategic technology partnering during the past two and a half decades. The description of growth patterns in strategic technology partnering reveals that this phenomenon has become increasingly popular during the eighties and the early nineties. Joint ventures, once the most prominent form of inter-firm partnering, have, to a very large degree, been replaced by a wide variety of contractual agreements. International patterns of partnering are discussed for the Triad (USA, Europe, Japan) in terms of changes in the distribution of domestic and cross-border alliances.

Key words: alliances, joint ventures, contracts, technology, international.

I. Introduction

This paper analyses some basic trends and patterns in inter-firm strategic technology partnering during the past two and a half decades. The paper concentrates on 'technology' cooperation as we discuss only those modes of cooperation and agreements for which a combined innovative activity or an interchange of technology is at least part of the agreement, although the agreement itself will very often pertain to many other subjects of corporate behaviour. The 'strategic' character of this group of alliances is given by looking only at those inter-firm agreements which are aimed at improving the long term prospects for the product market combinations of at least one of the companies involved. These strategic technology partnerships differ from other partnerships such as cost-economizing agreements which we think are more associated with the control of either standard transaction costs or operating costs of companies. Partnerships based on the standard transaction cost argument are largely related to economizing on the costs of information transfer from separate market partners through a lasting partnership which enables both partners to communicate more intensely, for instance in co-makership relations. When the control of operating costs is central to an agreement, firms outsource part of their production, for instance to economize on the costs of underutilization and below minimum scale efficiency of capital goods. These latter modes of cooperation are excluded from the present analysis.

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In the following we will compare trends and patterns of strategic technology partnering in so-called new core technologies, such as information technology, biotechnology and new materials, with strategic technology partnering in other sectors and fields of technology. The first section describes growth patterns in strategic technology partnering since 1970. This is followed by a discussion of the major factors that could explain this intriguing aspect of firm behaviour. Basic motives mentioned in that context are related to both technological and market opportunities. The next section is devoted to a brief discussion of the different organizational and contractual properties of basic categories of modes of cooperation. In that section we will also pay some attention to the analysis of changes in the historical distribution of different categories of partnerships. Finally, international patterns of partnering are discussed in terms of changes in the distribution of domestic and cross-border alliances, with special reference to the Triad: USA, Europe, and Japan.

In general this contribution is of an empirical nature. The empirical material provided in this paper is generated through the MERIT-CATI data bank, see the Appendix. Some concrete examples of inter-firm partnering will complement the more aggregate data.

II. Growth Patterns in Strategic Technology Partnerships

Figure 1 shows the growth pattern of newly established strategic technology alliances for the period 1970–1993. We see a strong growth pattern in the number of partnerships formed annually during the past two and a half decades, although most of this growth took place during the eighties and early nineties. During the first half of the seventies strategic alliances were almost nonexistent, in core technologies, such as information technologies, biotechnology and new materials, as well as in other sectors.

In particular for new core technologies we see a strong growth pattern since the late seventies. From 1970 to 1980 the number of newly made partnerships in core technologies rose from just over ten alliances made in 1970 to over 140 new alliances created in 1980. In 1985 this number had already risen to about 370. Strategic technology partnering in core technologies reached its peak with nearly 400 strategic technology partnerships created in 1988. Since then the number of newly made alliances dropped to below 300. However, during the most recent years we see an increase of alliances again, from a record low of nearly 280 in 1991 to over 430 partnerships created in 1993.

For the non-core sectors the increase of strategic technology partnering demonstrates a somewhat more gradual pattern of growth. Up to 1979 the number of annually made alliances in these fields was larger than the number established in new core technologies. Since then the number of strategic technology alliances in none-core technologies has remained substantially smaller. Since the early eighties
there is an annual increase between 70 and 150 alliances, with a peak in 1989 when about 220 new strategic technology partnerships were formed.

All in all, strategic technology partnering, in both new core technologies and other fields, demonstrates, despite some irregularities, an overall growth pattern in the number of newly made alliances. Since the early eighties strategic technology partnering is dominated by cooperation in new core technologies: information technologies, biotechnology and new materials. The second half of the eighties marked a period of some stagnation but in recent years we have again witnessed a growth in the number of newly made partnerships.

III. Some General Factors Explaining Strategic Technology Partnering

Although, due to a lack of sufficiently long time-series, it is impossible to explain the inter-temporal changes in strategic technology partnering during the past decades, it is possible to provide tentative explanations for the overall pattern of growth. Table I provides a categorization of factors frequently mentioned in the literature to explain inter-firm strategic technology partnering. These factors range from the complexity of scientific development, going beyond the capabilities of even the largest firms, to the scanning of international markets for new products in the
Table I. Factors explaining strategic technology partnering

- Basic and applied R&D and other innovative activities:
  - Increased complexity and inter-sectoral nature of new technologies and scientific disciplines, monitoring the evolution of scientific knowledge and complementary technology.
  - Sharing of uncertainty and costs in R&D.
  - Competitive pressures to shorten product life cycles and reduce the period between invention and market introduction.
- Market access and search for opportunities:
  - Monitoring of markets and other environmental changes and opportunities.
  - Internationalization, globalization and entry into foreign markets.
  - Search for new products and expansion of product range.

context of jointly followed preempting strategies.¹ In other words, they encompass all the stages of the innovation process from shared basic research to joint market entry with new products.

The first group of factors are those related to the joint undertaking of and further advancement of research and the diffusion of some basic scientific or technological knowledge amongst participating companies. Some of this is clearly related to concrete research activities, be it basic or applied research, other factors are associated with some general endeavour at the technological or scientific frontier of particular fields of technology, i.e. sharing the state-of-the-art. Other relevant factors are the increased complexity and inter-sectoral nature of new technologies and the cross-fertilization of scientific disciplines and fields of technology. Here it is the growing interrelationship between, for instance, sub-fields of chemistry, physics, and electronics; computer science and process technologies; materials science, electronics, and chemistry that build the necessity for close collaboration between companies. As even many very large and diversified firms still lack some competence in a number of scientific and technological fields, cooperation creates the necessary complementary technology and scientific inputs enabling these companies to capitalize on economies of scope through joint efforts. In the same domain we find the necessity for companies to monitor the evolution of technologies in order to assess potential technological synergies and relevant complementarities of technologies. Here also, the central explanation is that no company will have an all-embracing competence in every field of technology and therefore a concrete evaluation of possible synergies might at some stage of a particular technological trajectory warrant a joint undertaking with another company. A number of more specific factors are related to the need to reduce and share the uncertainty which

¹ The literature focusing on the rationale for the growth of this partnering behaviour is more extensively discussed in Contractor and Lorange (1988), Mowery (1988), Mytelka (1991) and Hagedoorn (1993)
is inherent to performing R&D as well as sharing of costs of R&D. Other factors are more closely related to concrete innovative projects in a joint activity of two or more companies in order to reduce the total period of the product-life-cycle and the contraction of the period between invention and market introduction.

Another set of factors explaining why firms cooperate through strategic technology partnering deals with opportunities for market entry through a joint monitoring of changes in the business environment in combination with developing new products or processes. At an international level combining some activities of two (geographically) separated firms for particular markets facilitates the internationalization and globalization of companies that lack the economic control, competence or experience to make such a strategic move independently. Finally, inter-firm agreements are mentioned in the literature for their ability to create new markets and products, to provide market entry and to expand the product range of both partners.

In Hagedorn and Schakenraad (1990) and Hagedoorn (1993) it is reported that two groups of factors appear to explain a substantial part of the growth of the number of strategic technology alliances. Technological complementarity and reduction of the innovation period are of particular importance in new core technologies. Market entry and production-related factors appear to be disproportionately more relevant in technologically less advanced or more mature sectors.

It is worth mentioning that although the lack of financial resources and the high costs of R&D projects are frequently mentioned to explain the possible growth of strategic technology alliances, the overall relevance of these factors appears rather small. Actually only in biotechnology and telecommunications are these factors found to have played a significant role in creating strategic technology partnering behaviour. In biotechnology the lack of financial resources plays a role as the research of many small firms has gradually entered the phase of developing new products. The necessary capital is frequently obtained through alliances with larger companies. For telecommunications the development costs of new digital switching systems and other equipment frequently exceeds the sum of US$1bln. That level of investment forces even the largest companies to think seriously about alliances and to enter into partnerships.

IV. Modes of Strategic Technology Partnering

So far we have discussed strategic technology alliances in general terms. However, it has to be stressed that strategic partnering takes place in a wide variety of organizational modes. In order to categorize these different forms of inter-firm cooperation a number of taxonomies have been introduced. Auster (1987) has differentiated ‘international corporate linkages’ into technology transfers and exchanges, R&D arrangements and joint ventures. Chesnais (1988) presented a taxonomy of types of inter-company agreements which are, amongst other things, set against government involvement, technological characteristics, capital require-
ments and industry structures. Somewhat different categorizations are found in Harrigan (1985), Casson (1987), Contractor and Lorange (1988) and Hagedoorn (1990). In the following we distinguish between a group of equity arrangements, such as joint ventures and research corporations, and a group of so-called contractual arrangements, such as joint development agreements, R&D pacts and R&D contracts. In several contributions (Auster, 1987; Buckley and Casson, 1985; Contractor and Lorange, 1988; Hagedoorn, 1990; Hagedoorn and Nurula, 1996; Harrigan, 1985; Osborn and Baughn, 1990; Root, 1988) it is argued that these different modes of cooperation have a distinctive impact on the character of technology sharing, the organizational context and the possible economic consequences for participating companies.

Joint ventures are probably the oldest and most well-known mode of inter-firm partnering. Joint ventures, in particular those with an impact on joint R&D, have, according to many observers, e.g. Berg and Friedman (1978), Hladik (1985) and OECD (1986), become more popular in the past decades. We refer to joint ventures as the combinations of the economic interests of at least two separate companies in a 'distinct' firm: profits and losses are usually shared according to equity investment. In the context of strategic technology partnering we consider as joint ventures those 'firms' that have shared R&D as a specific company objective as well as production, marketing, sales, etc. Examples of these innovation-oriented joint ventures are found in cases such as Optical Storage International, a firm formed by the electronics company Philips of the Netherlands and the US firm CDC in 1984 to develop memory systems and tape drives. Another joint venture involving Philips, now with Motorola of the USA, was established in 1992 to develop chips for CD-I and DCC. A good example of a joint venture between two companies with separate technological competences is VM Technology Corp. In 1987 the Japanese company Mitsui and Microsoft of the USA formed this joint venture to develop new microprocessors. In the chemical industry the German firm Hoechst and the South Korean conglomerate Lucky-Goldstar established a joint venture in 1992 that develops and produces HDP Plastics. Another international joint venture in that sector is found in the 1993 agreement between the US company Alcoa and the Dutch chemical company AKZO to jointly develop and manufacture fibre-metal laminates. A clear example of a joint venture between two companies with separated markets is found in the case of Nutrasweet, jointly owned by the US company Monsanto and the Japanese company Ajinomoto. This joint venture, established in 1991, develops and produces sweeteners for the food and beverages industry.

Research corporations are a subcategory of joint ventures with distinctive research programmes of which the main purpose is to supply R&D to the parent companies. Examples of international research corporations are the European Computer Research Centre owned by Fujitsu (Japan) and two European companies Bull of France and Siemens of Germany, set up in 1983, and the advanced ceramics research corporation Keramont established in 1986 by the Italian company Ferruzzi
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and the US firm Materials and Electrochemical Research Corporation (MERC). A well-known example of an R&D corporation in the USA is the Semiconductor Research Corporation, established in 1986 by AMD, AT&T, CDC, DEC, Nat. Sem., Motorola, General Electric, General Instruments, Harris Semiconductors, H-P, Honeywell, IBM, Texas Instruments and Intel.

From the brief description of joint ventures and research corporations it is obvious that the creation of a new firm with usually two parents creates a relatively high degree of organizational interdependence. In terms of Williamson's (1975 and 1985) 'markets and hierarchies' this comes close to hierarchical structures with parent companies sharing control over their joint venture. Different company strategies such as entry into new markets, repositioning and expansion in existing markets and exit strategies in declining markets are reflected in these joint ventures (Berg and Hoekman, 1988 and Harrigan, 1988).

Despite the 'popularity' of R&D-related joint ventures the economic and organizational stability of the joint venture mode as such appears questionable. Some experts estimate that about half of all joint ventures fall short of expectations or are discontinued within a couple of years. Major reasons for these failures are found in different views of participating companies on strategy and the lack of agreement in advance on how to run the joint venture. Kogut's (1988) research shows that over 45% of a sample of about 150 joint ventures were terminated within 5 years, with instability rates for international joint ventures peaking after 5 and 6 years. Berg et al. (1982) found that about 40% of 50 joint ventures in the U.S. chemicals industry in the period 1924–1969 was terminated within 5 years. Porter (1987) discusses a small sample of acquisitions, joint ventures in new fields and start-ups indicating that about 50% of the joint ventures are divested by one of the partners within a few years. However, others doubt whether there is hard evidence that the failure rate of international joint ventures exceeds the normal corporate failure rate for single-company ventures. See for example Contractor and Lorange (1988).

Problems in maintaining joint ventures are generally thought to derive from the risks of sharing proprietary know-how, the desire for control by individual partners, coordination of different time-horizons, disagreement on design specifications, government policies and the effects of minimum efficient scale in R&D which can make decentralisation of R&D both costly and difficult to control by partners. See for instance Harrigan (1985), Hladik (1988), Obleros and Macdonald (1988) and OECD (1986). Potential disadvantages mentioned from a more general welfare economics point of view are reduction of actual and/or potential competition, and the possibility of foreclosure of particular markets (OECD, 1986).

During the past decades a number of non-equity or contractual forms of strategic technology cooperation, in particular joint R&D agreements, have become an alternative to joint ventures. We understand these contractual arrangements to cover technology and R&D sharing by two or more companies through undertakings which establish research projects or joint development agreements with shared resources. Hence, these agreements suggest a relatively strong commitment of
companies and solid inter-organizational interdependence during the joint project, although the interdependence is smaller than in the case with joint ventures. This category of cooperation covers a wide variety of legal and organizational arrangements. In particular large companies seem to apply many of these agreements to explore possible benefits of new technologies (Hagedoorn and Schakenraad, 1994). Examples of these R&D pacts are found in international collaborative agreements made between companies such as the Japanese firm Sumitomo and the US telecom and information technology firm AT&T that decided to jointly develop ASIC technology starting in 1990. In 1992 Sumitomo and the French computer company Bull joined forces in a joint development agreement for mainframe computers. A similar agreement was made in 1993 by DKB (Fujitsu) and Siemens. Other recent examples are the joint development agreement between Sony and Apple to develop Apple's new powerbook, the R&D pact of Sharp and Intel on 'flash memories', and the agreement between Motorola and the South Korean company Samsung to develop a 'palm top' pc. In sectors other than those related to information technology examples are the 1980 research pact of BP (UK) and the Italian holding company ENI through which groups of researchers were matched to investigate the technological possibilities of single cell protein production and the Hoffman-LaRoche (Germany) and Genetics Institute (US) joint research on therapeutic agents against AIDS, that started in 1980. In 1993 the Japanese company Mitsui and the US firm Du Pont formed an alliance in the form of a joint development agreement which has as its major objective to jointly perform R&D on new materials replacing existing metals.

Research contracts are examples of non-equity alliances that regulate R&D cooperation in which one partner, usually a large company, contracts another company, frequently a small one, to perform particular research projects. During the eighties we find many of these research contracts in the biotechnology sector being made between large companies and small US biotech firms. In the early days of the modern biotech industry, in 1978, Eli Lilly granted Genentech an R&D contract to develop human insulin, when the latter company was still a small firm. Other examples of these contracts granted by large companies to small biotech firms are: the 1982 agreement between Boehringer-Ingelheim and Molecular Genetics, the 1984 contract between Schering and Genex, and the agreement between Monsanto and Biogen made in that same year.

For the contract initiating party advantages can be found in the possibility to focus on particular areas of research with substantial cost-saving compared to full fledged in-house research facilities. Disadvantages for those companies are related to the lack of in-house expertise to assess the value of contract research and the dissociation of development expertise from manufacturing expertise (Opleros and Macdonald, 1988, and Teece, 1987). For the other contractor benefits are found in terms of substantial R&D funding and cooperation with experienced partners. There are also considerable disadvantages such as low profit margins from licensing
technology and the transitory nature of these contractual relationships and their revenues.

An interesting question in this context is whether sectors differ with respect to the distribution of equity versus contractual arrangements. According to Harrigan (1985) rapidly changing technological development in sectors of industry induces the formation of somewhat informal forms of cooperation such as non-equity agreements. With growing maturity of industries joint ventures, as more formal modes of cooperation, become the more appropriate form of collaboration. In a similar vein Harrigan (1988) states that non-equity agreements are more suited for industrial sectors characterized by an uncertain environment, whereas joint ventures offer better opportunities for partnering companies in stable sectoral environments. Osborn and Baughn’s (1990) survey of the literature suggests that technological stability of industrial sectors is a crucial factor explaining different patterns for equity and non-equity partnerships. In sectors with low degrees of R&D intensity one will witness a certain dominance of joint ventures, while R&D intensive sectors will demand more organizational flexibility leading to a general preference for contractual agreements. Yu and Tang (1992) demonstrate that stable sectoral environments with oligopolistic structures seem to favour joint venture formation, while uncertain environments, with large number of companies, high risks and high investment intensity, will lead to a larger number of non-equity agreements. Recent research by Hagedoorn and Narula (1996) also suggests that the level of technological sophistication of sectors of industry affects the distribution of equity and contractual modes of strategic technology partnering. These findings demonstrate that high-tech sectors will be characterized by a disproportionate share of contractual agreements, whereas in medium and low-tech industries one finds a relatively large number of joint ventures.

Figure 2 shows the gradual decrease in the relative importance of equity-sharing alliances compared to contractual arrangements. During the 1970s, when there were only a small number of alliances, approximately 75% of the newly made alliances were of the joint venture type. Since the 1980s the share of contractual arrangements has increased from about 40% during most of the eighties to approximately 70% in the early nineties. In other words, with the growth of the number of strategic technology alliances over the past decades their organizational characteristics in terms of administrative control, ownership, and contractual relationship have changed substantially.

As the new core technologies are by far the largest contributors to the number of alliances since the early eighties, it is no surprise that the ratio of equity to contractual agreements is quite similar to the overall trend. As mentioned above, previous research indicates that contractual agreements tend to be favoured as a mode of cooperation in so-called high-tech sectors, whereas equity agreements are more popular in the less advanced sectors. This explains why during the eighties the share of equity alliances remained relatively high and above average in non-core technologies. In general it can be stated that the overall growth of strategic
technology alliances since the late seventies has in particular taken place through a wide variety of contractual agreements. In absolute numbers joint ventures are still important but in the early nineties close to about three-quarters of the newly made alliances are of a non-equity nature.

V. International Patterns in Strategic Technology Alliances

Contributions from both industrial and international economics (Cantwell, 1989; Chesnais, 1988; Contractor and Lorange, 1988; Dunning, 1988 a, b and Mytelka, 1991) and the management literature (Ohmae, 1985 and 1990 and de Woot, 1990) stress the role that strategic technology partnering plays in the internationalization strategies of companies. If one accepts that the economy at large is becoming more internationalized one could expect a growth in international strategic technology alliances as well. In this section we will see to what extent strategic technology partnerships have become more internationalized. We will pay special attention to alliances made between companies from the Triad. Ohmae (1985 and 1990) emphasizes the dominant role that companies from the USA, Japan, and Europe play in these international strategic technology partnerships. This is confirmed in findings by Freeman and Hagedoorn (1994) who report that over 90% of the strategic alliances made during the eighties were made between companies from within the Triad.
In the following, alliances between companies from the USA, Japan and Europe are accepted as international alliances, i.e. inter-Triad partnerships. Intra-European alliances (between companies from the EU and EFTA) are seen as regional alliances, as are alliances made within either the USA or Japan. All other combinations outside the Triad are treated as a miscellaneous category. Figure 3 demonstrates that a large share of the population of strategic technology partnerships is still of an intra-regional or domestic nature. Although this share has declined over the past decades, from an average of about 50% for most of the eighties to somewhat higher than 40% during the early nineties, it is still the single largest group of alliances. Only during a few years has the share of international, inter-Triad, alliances been higher than the domestic and regional alliances. Also, during the most recent years we see a growth of the share of other combinations. This growth is to a large extent caused by the growth of alliances with companies from the Newly Industrialized Countries, in particular South-East Asian countries such as S. Korea, Taiwan, Singapore and Hong Kong.

Despite some differences found in comparing core technologies with other fields, the same basic pattern is also found at this more disaggregated level. For instance, for strategic partnering in core technologies, as shown in Figure 4, we see that, although international partnering is substantial, it is stagnating at a level of about 37% of all partnerships during the second half of the eighties and the first period of the nineties. Probably the most striking feature of this cooperation in
new core technologies is the leading position taken by US companies, not only in international alliances but in particular with regard to their domestic alliances, as the largest single group of alliances concerns intra-US partnerships. Contrary to this the role of companies from European countries has diminished as for instance the share of intra-European partnerships has decreased from about 25% during the seventies to nearly 9% in the early nineties. These changes indicate that US companies have become increasingly important as the major source of strategic technology partnering in new core technologies.

For the non-core fields (Figure 5) we see somewhat similar trends with a decline of international partnering from over 40% in the early eighties to about 30% in the early nineties. The role of the US is less dominant. As could be expected the role of other combinations is more important, as their share increases from about 15% during the seventies and first half of the eighties to over 30% during the early nineties. Further analysis of this data demonstrates the increasing importance of Newly Industrialized Countries in strategic technology partnering, which is clearly more important in more traditional sectors than in the new core technologies. See also Freeman and Hagedoorn (1994).
VI. Conclusions

The speed of scientific and technological development, the effective complementarity of once separated fields of science and technology, the need for companies to increase learning economies, and the required shortening of the period between invention and market introduction describe much of the technological dimension of strategic partnering. Market-related aspects of partnering behaviour can be found in cooperation for new product markets, joint entry in geographically 'new' markets or attempts to subdue the forces of increased competition. As all these phenomena have become critical in the current process of inter-firm competition, it is no surprise that the past decades demonstrate a growth in the number of strategic technology alliances.

Parallel to this growth we also see an increase in the actual variety in different modes of partnering ranging from quasi-hierarchical forms such as joint ventures to a multiplicity of contractual arrangements, each with its own strategic, organizational and control-related implications. To these strategic and organizational aspects of partnering we have to add the aspect of internationalization, in the case of international alliances with partners from different countries or different continents, introducing additional elements of complexity such as increased distance of control and linguistic and cultural variation.
Changes in the distribution of forms of partnering are most apparent in the role taken by joint ventures, once the most prominent mode of inter-firm partnering, that has, to a very large degree, been replaced by a wide variety of contractual agreements. In particular in high-tech sectors inter-firm partnering is dominated by somewhat more informal modes of partnering. This development suggests that partnering in so-called high-tech sectors demands organizational flexibility with the actual mode fitted to the organizational needs of the project in which the partners are involved.

Organizational complexity returns if one considers international strategic technology alliances. As demonstrated in the above the increase of alliances has also led to a larger number of international partnerships. However, in relative terms these international partnerships have not been able to keep pace with the increase of domestic alliances or alliances in the same economic region. An explanation for this somewhat stagnant pattern can be found in the additional level of complexity that companies face in international alliances. Given all the different dimensions of complexity that companies already face with domestic technology partnerships, an international alliance creates additional problems in terms of organization and control. Therefore, international, more specifically intercontinental or global, alliances are not necessarily the first option for companies, in particular if cooperation involves strategic control over technology.

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 both disaggregated and combined information from several files. So far information on about 7,000 strategic technology alliances has been collected for the period 1970–1993. Systematic collection of inter-firm alliances started in 1987. Many sources from earlier years are consulted to establish a retrospective view. In order to collect interfirm alliances various sources are consulted: 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.
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 and second-sourcing 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, i.e. those agreements for which a combined innovative activity or an exchange of technology is at least part of the agreement.

References


