Global strategies in innovation: networks in research and production

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Abstract: The main objective of this paper is to present some elements of an economic analysis of the observable changes in the organization of production and innovation, in particular among large manufacturing companies. Such changes have received some attention in the popular business press, and are gradually receiving more attention from academic economic analysts. The paper focuses on (1) changing company structures and the organisation of production, and (2) strategic partnerships and innovation strategies.

Keywords: company structure; global strategies; innovation; strategic alliances; strategic partnerships; cooperative agreements; multinational companies.

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Biographical notes: John Hagedoorn was born in 1950 in The Hague, The Netherlands. He studied Economic Sociology and Political Economy at Leiden University, The Netherlands. He joined the Centre for Technology and Policy Studies (STB) of the Dutch research organization TNO in 1978, where he became senior researcher in 1982. His research at STB focused in particular on innovation policy and the relationship between technology and sectoral growth and development. He was visiting research fellow at the Science Policy Research Unit, 1983–84. Since 1985 he has been involved in work on the diffusion of information technology, economic theory and, more recently, on inter-firm technology agreements. He is frequently engaged in consultancy for the EEC, the OECD and the Ministry of Economic Affairs in the Netherlands. His present position is Professioral Fellow of Maastricht Economic Research Institute for Innovation and Technology (MERIT), University of Limburg, and he is also a part-time Professor of Business Studies of the Open University of the Netherlands. Within MERIT he is in charge of the research program Technology, International Competitiveness and Company Behaviour.

1 Introduction

The main objective of this paper is to present some elements of an economic analysis of the changes one can observe in the organization of production and innovation, in particular among large manufacturing companies. Such changes have received some attention in the popular business press and they are gradually receiving more attention from academic economic analysis as well (see for instance, Contractor and Lorange [1]). I will refer in particular to such phenomena as changing customer–supplier relations and corporate strategies to engage in strategic alliances and cooperative research with other companies.
The first subject I will discuss concerns changes in the internal organization of production in larger companies. In economic analysis, vertical integration of suppliers is stressed as a major force for economic concentration and the expansion of economic control by leading companies. A possible change towards out-sourcing, in which particular phases of manufacturing are performed by supplying companies, is a reversal of a trend which has been dominant in industry for many decades. I will present some thoughts on such a development which is often referred to as 'co-makership' or even the emergence of the 'hollow corporation'. Current analyses of this phenomenon suggest that such changes in the organization of production will not necessarily lead to vertical disintegration. As far as I understand these developments, it would be more apt to see them as a reorganization of the network of different stages of production through which large companies control the overall production process. It is in particular the application of information technology which enables a central company to control the complete production processes of its own units and of its suppliers. If control in terms of information flows and dependency is favoured by the large user firm, vertical integration would be replaced by a new form of quasi-integration. Then, small and medium-sized supplying companies, although legally independent, would perform manufacturing or service tasks for a small number of customers who integrate and control these activities within their planning and production processes.

The second subject to be discussed is the growth of international strategic alliances involving many large companies. These alliances refer not so much to manufacturing activities, but in particular to the sharing of R&D with other companies. Such alliances are not necessarily stimulated by international initiatives, such as EUREKA and ESPRIT in Europe — many of these agreements have been established by companies without any direct or indirect support from other agents than the partners engaged. In the sections below, I will pay attention to what is known about the motives, trends and international patterns of such partnerships. Some of the results known from the literature will be introduced, but particular attention will be paid to some preliminary results from ongoing research.

2 Changing company structures and the organization of production

In modern capitalism one can observe a wide variety of companies of different sizes. Company size ranges from the extremely large, multinational and multidivisional companies to small firms with only a few employees. For economic analysis, the relation between this diversity and the growth of companies is of particular interest in understanding the dynamics of the capitalist organization of production. The growth of companies and also of plant size have been recognized as important features of capitalism ever since the days of the classical economists. Both these topics have also been the subject of a long-standing debate in economics on the relation between (in)efficiency and size. The debate goes back at least as far as Marshall’s theory of decreasing returns to scale. The main arguments in favour of this theory have been countered in later years by those who point to the role of improved information control and intra-firm cooperation within the so-called M-divisional structure of large companies. In that context, organizational changes within companies have been discussed as solutions to problems related to increasing inefficiency following company growth.

Such organizational changes are also relevant to our understanding of company strategies which are related to the innovation process, or to the reorganization of production
in large companies with a multidivisional structure. In seminal work by Chandler, Williamson and others, different company and management structures have been identified [2–6]. Chandler stresses, in particular, the obsolete character of the so-called unitary, departmentalized, U-form organization of a large company with respect to major issues in its strategic decision-making. The alternative is found in the so-called M-form, multidivisional organization, in which strategic and operational decision-making are separated at different levels. At the top level, the general office is involved in the coordination and evaluation of strategic decision-making. Operational decisions take place at lower levels of separate divisions. The classical U-form organization with vertically integrated divisions can still be dominant in medium-sized companies as this structure is most suitable for decision-making on familiar problems within a non-diversified company [7].

In the work of Hymer [5], close attention is paid to the role of multinational companies and their organizational changes. Aglietta [6] has been able to take the argument somewhat further in presenting an interesting concept of the company as a global system. Hymer presented a theory of the evolution of the corporation which developed from the workshop, the factory and the national corporation to the multinational corporation. Aglietta analyses changes in corporations from the centralized U-form company to the decentralized multidivisional company and on to the new stage of a centralized and global system. In this development there is an organizational transformation back to centralization, although under different conditions from the situation of the U-form company. The present transformation of the organizational structure is, according to Aglietta, a movement back to centralization, but based upon automated information processing and overall production control.

This new structure is pictured as a star-form, as compared to the divisional structure in the form of a pyramid. The central control unit is found in the centre of the star, coordinating and programming all company activities. Furthermore, all elements of the company are interacting with each other. This new system of organization enables the company to set up semi-autonomous groups in order to improve the external ‘sensitivity’ of companies. Within this system, the development of communication, automation of routine managerial tasks, improvement of planning and budgetary methods, and production control, are compulsory. Around these companies there is a ‘network of subcontracting’ with legally independent companies, which can be considered as a part of the production process of larger companies. As discussed below, such subcontracting companies can be seen as becoming quasi-integrated into their larger users.

2.1 Quasi-integration and the reorganization of production

Subcontracting and so-called out-sourcing by large companies has been discussed in some theorizing on vertical integration and quasi-integration. Alternative modes of company organization are mentioned in the context of vertical integration as alternatives to avoid opportunistic behaviour by contractors. Vertical integration can then be seen as a counter-strategy of companies to avoid the appropriation of so-called quasi-rents on specialized assets (e.g. technology) [8]. In cases of fixed supply characterized by specialized assets, one contracting party can be confronted with the appropriation of quasi-rents if the supplying company violates the contract. Vertical (backward) integration will occur in particular if one party depends to a large extent on the technology incorporated in the supply, which then becomes a critical asset in its (innovation) strategy. Klein et al. assume that in such
cases “... as assets become more specific and more appropriable, quasi-rents are created (and therefore the possible gains from opportunistic behaviour increases), the costs of contracting will generally increase more than the costs of vertical integration. Hence, ceteris paribus, we are more likely to observe vertical integration” [9]. In such reasoning, long-term contracts can offer an alternative, but there is a trade-off between the costs of contractual legal guarantee and the risk of opportunistic behaviour. In that sense, integration and cooperation are alternatives in situations with appropriable specialized quasi-rents. For these alternatives, it can be expected that contractual relationships or integration depend upon the degree of appropriability of specialized quasi-rents generated by the assets involved.

Monteverde and Teece [10] have elaborated upon this set of alternatives. They investigated whether ‘quasi-vertical integration’ can prohibit the acquisition of appropriable rents by opportunistic behaviour. This quasi-vertical integration is defined as the ownership of a supplying firm’s capital goods or essential resources by another, procuring, company. It is relevant to our understanding of some forms of customer-supplier partnerships, such as co-makingship and co-production contracts, if one company has control over the critical assets of its partner(s) in a joint activity. This control can be exercised either with respect to the ownership of capital goods, the restricted transfer of technology, or close collaboration on production and quality control according to standards set by the procuring company which takes a substantial part of its partner’s supply.

2.2 Changing customer-supplier relations

In recent years increasing attention has been paid to the changes in customer-supplier relations briefly noted above. In the popular business press, some observers have mentioned a tendency for larger companies to concentrate their production on a ‘core activity’. If large parts of the capacity of manufacturing companies were contracted to sub-contractors, we would face an interesting reversal of straightforward vertical integration. In cases where companies decide to subcontract parts of their production they seek an alternative between the market and integration within the firm. Such a trend towards focusing on core businesses, accompanied by subcontracting the supply of other components, could result in larger companies abandoning parts of manufacturing. In extreme cases, companies could pursue a strategy of out-sourcing almost their entire production. This would lead to a new kind of company in which manufacturing is reduced to a minimum; and consequently such a company would increasingly become service-oriented. It would perform a range of activities from R&D to distribution, but without substantial manufacturing. Such a company is already characterized, in a negative sense, as the ‘hollow corporation’ (see, for example, Jones [11]).

All this, however, is still far from present-day reality for the majority of manufacturing companies. Most manufacturing companies still have their own production base. But if this trend were to develop further, it could eventually lead to a breakdown of the manufacturer’s traditional vertical structure, in which they produce all critical parts, to be replaced by a network of suppliers. Such a change in the customer-supplier relation would also cover a change from ‘off-the-shelf’ supply to more custom-made supply. In the latter case products are made in close cooperation with the customer, while off-the-shelf supply is sold from stock.

In the literature on changing customer-supplier relations, four related trends can be identified [12]:

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Networks in research and production

1 There is a possible growth in out-sourcing of manufacturing. Motives for companies to out-source parts of their production include:
   (a) Out-sourcing reduces both invested capital and the fixed costs of a company. This increases flexibility, which is advantageous in the light of frequent changes in product mix and in diversity in demand, and of shorter product lifecycles.
   (b) Costs and risks are shifted towards suppliers, including a substantial share of costs related to temporary shortages as well as the cost of stocks and of quality control.
   (c) The buyer can also take advantage of the supplier’s special assets, including crucial technical skills and knowledge that are difficult or expensive to develop.

2 Quality demands have become more important and more specific. Some companies are transferring the responsibility for quality control to their suppliers completely, thus avoiding duplication of control costs. A related issue is Just-in-Time delivery, which has become an essential element of overall quality control.

3 The number of suppliers per procuring company is decreasing; in particular, the world’s leading companies are reducing their supplier bases. At first sight, this seems to contradict the already mentioned increase in out-sourcing of production. However, the value of out-sourcing for an individual company can increase whilst the number of its contractors decreases. Furthermore, many main suppliers extend their out-sourcing to other suppliers as well.

4 Many large companies are developing closer relationships with their suppliers. This phenomenon has been labelled ‘co-makership’. The creation of a more permanent relationship between users and suppliers is essential. Out-sourcing of complete sub-assemblies makes the procurer dependent upon his suppliers with respect to the quality as well as the regular supply of basic parts. This leads to a need for better control of the manufacturing processes of suppliers. Moreover, a closer contact is compulsory because the information to be transferred is usually too expensive and complex to be transferred by repeated market transactions. Feedback on product deficiencies and adaptations can be better organized if procurer and supplier are in close contact.

All this leads to the development of inter-firm production networks organized by large procuring companies with co-makers or main suppliers, special jobbers and material suppliers. Modern technology such as flexible manufacturing systems and on-line communication systems enable further integration of such networks: for example, through linking CAM systems of suppliers with CAD systems of procurers as well as on-line communication for Just-In-Time production and flexible supply. If suppliers become more closely related to the production process of a smaller number of procuring companies, and if their design, quality control, delivery planning, etc. are ‘integrated’ into the planning system of larger companies, one could define such a situation as a new form of quasi-integration.
3 Strategic partnering and innovation strategies

In recent years, a number of interesting contributions to the study of strategic, long-term partnerships of companies have been made. A popular account of such company strategies and technological development is that by Ohmae [13]. According to Ohmae, horizontal, and I assume also vertical, sharing of complementary technologies is one of a large company’s major options for improving its international position. As speed is a critical element in the world-wide strategies of leading companies, alliances are formed to facilitate simultaneous market penetration [13, 14]. Ohmae pays particular attention to the US-Japanese-European ‘triad’. Cooperation between at least two companies from any of these ‘zones’ is important, because there is a ‘global impasse’ in competition as world-leading companies have not been able to gain positions abroad that are equivalent to their position in their respective home-markets. Other reasons for cooperation mentioned by Ohmae are:

- the extremely high costs and risks of R&D in high-tech industries; and
- quick cooperative pre-emption strategies on a world-scale are preferable, despite the ‘loss’ of potential profit.

There is also a number of studies based upon more systematic research. Haklsch [15] found amongst other things that there has been a sharp rise in the number of technical alliances in the semiconductor industry since the early 1980s. Furthermore, she found that most agreements are between partners with comparable technological sophistication, and that cooperation in applied technology is stressed instead of pure research. Hladik [16] found several variables with a significant influence on the likelihood of joint R&D activities. Positive effects on the likelihood of joint R&D ventures are caused by:

- the size of the relevant international and domestic markets;
- the technical environment of the industry;
- partnerships with technically-skilled foreign partners;
- market access through foreign partner’s distribution networks;
- the general technical environment in the host country.

Negative effects on joint R&D ventures are found for:

- scale economies in R&D operations as found in the effect of minimum efficient scale, which can be interpreted as the well-known effect of the R&D threshold (see for example Freeman [17]).
- R&D intensity of the US company compared to low intensity of the foreign partner.

Both negative effects support the idea that comparable technological sophistication is compulsory and that companies are reluctant to share critical assets such as R&D without returns in terms of R&D inputs.

Maritit and Smiley [18] found that technology transfer and technology complementarity were mentioned as main motives for cooperation by about 70% of the companies in their database. Technology transfer, mentioned by about 30% of the companies as a main motive, is undertaken by the ‘purchasing company’ because purchasing information is cheaper and less risky than producing it. In a study by Mariotti and Ricotta [19], it was found
that technological motivation for cooperation has become more important than any other
motivation. Such motivations for cooperative arrangements mentioned in their study are:

- exploration of new products and market niches;
- reduction of the costs and risks of R&D;
- shortening of the period between discovery (invention) and market introduction
  (innovation);
- monitoring of the evolution of technologies and opportunities;
- increased complexity and inter-sectoral nature of new technologies.

An interesting issue, but one which is difficult to disentangle, is the question of
disproportionate benefits of cooperation for different partners. Some stress the benefits
of strategic partnerships for all partners (see for example Ohmae [13] or Walker [20]).
Others have cautioned against ‘hidden agendas’ which some partners might follow in their
cooperative agreements. In several publications, Hamel, Doz and Prahalad [21] have stated
the dangers that some partners might encounter in their cooperative agreements. The
emphasis in the debate is on the ‘hidden agenda’ that Japanese companies might follow.
My own research also suggests that other companies, if not following a secret strategy,
do at least view cooperation as a second-best strategy which is part of a wider strategy
to improve the company’s capabilities (see for example Hagedoorn and Schot [12] and
Hagedoorn and Schakenraad [22].

So far, research suggests that strategic partnering is a particular feature of (international)
competition. Most companies probably still prefer to follow a competitive strategy and
to strengthen their technological capabilities by either developing these internally or by
taking over appropriate companies. Cooperation is likely to be sought if this is found
necessary to overcome some shortcomings in the companies’ capabilities, only if the
technology involved is of secondary importance, or if the costs and uncertainty of particular
technological developments are too high.

3.1 The 1980s — a period of growth in cooperation

There is strong evidence to suggest that there has been an increase in cooperative
agreements. To the best of my knowledge, there is only one study in which such an increase
in coalition activity is not found; this study by Ghemawat et al. refers to data for the period
1970–82 [23]. On the other hand, studies by Hladik [16], Haklisch [15], Hergert and
Morris [24], and the OECD [14] all report a rise in the number of cooperative agreements
in the 1970s and particularly in the early 1980s. This trend is confirmed by some results
of my own research [22]. As shown in Table 1, the number of agreements in our database
has risen, particularly during the 1980s, although the numbers have stabilized during the
last couple of years.

The above allows me to conclude that there is strong evidence of growth in the number
and relative importance of technology-related agreements since the early 1980s.

3.2 International distribution of cooperation

I have already noted Ohmae’s emphasis on collaboration between companies in the triad
USA-Europe-Japan. In some studies one finds some empirical support for the idea of the
Table 1  Number of technological cooperation agreements in information and biotechnology

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</thead>
<tbody>
<tr>
<td>Biotechnology</td>
<td>3</td>
<td>5</td>
<td>63</td>
<td>48</td>
<td>55</td>
<td>68</td>
<td>43</td>
<td>55</td>
<td>123</td>
<td>124</td>
<td>108</td>
<td>695</td>
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<tr>
<td>Information</td>
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<tr>
<td>technology</td>
<td>12</td>
<td>34</td>
<td>122</td>
<td>68</td>
<td>110</td>
<td>128</td>
<td>161</td>
<td>206</td>
<td>242</td>
<td>252</td>
<td>249</td>
<td>1584</td>
</tr>
<tr>
<td>TOTALS</td>
<td>15</td>
<td>39</td>
<td>185</td>
<td>116</td>
<td>165</td>
<td>196</td>
<td>204</td>
<td>261</td>
<td>365</td>
<td>376</td>
<td>257</td>
<td>2279</td>
</tr>
</tbody>
</table>

Source: Hagedoorn and Schakenraad (1990)

importance of collaboration between companies from these ‘regions’. Hladik found that of all joint ventures in her sample for the period 1974–82 the majority were established in economically advanced countries. Her records show that about 55% of the US—foreign joint ventures are found in ‘high-income’ countries, 40% in ‘middle-income’ countries and but few in ‘low-income’ countries [16, p.40]. In the study on the semiconductor industry Haklish demonstrated that US companies are very active in establishing all sorts of technology agreements. US—Japanese agreements dominate, with about 50% of the total number of agreements, followed by 35% for US—European agreements [15, p.36]. From data provided by FOR (1985), Hergert and Morris [24] and INSEAD, one learns that, as far as these records are concerned, most agreements affect the three major economic regions.

Table 2 shows that in our data 32% of all agreements are intra-USA, about 21% are Western European—US agreements and 17% are US—Japanese agreements. Intra-European agreements amount up to about 15%, which leaves about 15% of all agreements to other combinations. (The number of Japanese agreements in our database can be expected to be biased due to a lack of information).

3.3 Networks of leading companies

For a further understanding of company behaviour with regard to strategic partnering, it is interesting to see whether certain patterns of partnerships are evolving. In order to find the degree of cooperation between companies, a non-metric multidimensional scaling (MDS) technique was applied to analyse our database on cooperative agreements in information technology and biotechnology. Multidimensional scaling is a data reduction procedure that can be compared with principal components analysis and other factor analytical methods, although there are a number of technical and methodological differences. The objective of the MDS technique is to provide coordinates for points (i.e. firms) in such a way that distances between pairs of points fit as closely as possible to the observed (dis)similarities. In order to facilitate interpretation, the solution is given in two dimensions, provided that the fit of the model is acceptable.

In the examples given, the number of cooperative agreements between two companies is seen as a measure of similarity between those two companies. A large similarity indicates intensive cooperation. Dimensional interpretation is the most common approach used in MDS as well as in other factor analytical methods. The first dimension is the most important as it accounts for the greatest part of the observed (dis)similarities. From Figure 1 it follows that many US and Japanese companies cooperate both within and between their regions
Table 2 Regional distribution of technological cooperation agreements, numbers and percentages

<table>
<thead>
<tr>
<th>Regions</th>
<th>Totals</th>
<th>Biotechnology</th>
<th>Information technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. Europe</td>
<td>352</td>
<td>82</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>15.4%</td>
<td>11.8%</td>
<td>17.0%</td>
</tr>
<tr>
<td>W. Europe-USA</td>
<td>481</td>
<td>117</td>
<td>364</td>
</tr>
<tr>
<td></td>
<td>21.1%</td>
<td>16.8%</td>
<td>23.0%</td>
</tr>
<tr>
<td>W. Europe-Japan</td>
<td>104</td>
<td>19</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>4.6%</td>
<td>2.7%</td>
<td>5.4%</td>
</tr>
<tr>
<td>USA</td>
<td>729</td>
<td>316</td>
<td>413</td>
</tr>
<tr>
<td></td>
<td>32.0%</td>
<td>45.5%</td>
<td>26.1%</td>
</tr>
<tr>
<td>USA-Japan</td>
<td>388</td>
<td>94</td>
<td>294</td>
</tr>
<tr>
<td></td>
<td>17.0%</td>
<td>13.5%</td>
<td>18.6%</td>
</tr>
<tr>
<td>Japan</td>
<td>95</td>
<td>41</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>4.2%</td>
<td>5.9%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Other combinations</td>
<td>130</td>
<td>26</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>5.7%</td>
<td>3.8%</td>
<td>6.5%</td>
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<tr>
<td>TOTALS</td>
<td>2279</td>
<td>695</td>
<td>1584</td>
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<td></td>
<td>100%</td>
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Source: Hagedoorn and Schakenraad (1990)

Because they are found at the right-hand side of Dimension 1. US companies more engaged in intra-US agreements are CDC, Honeywell, Wang, Xerox, National Semiconductor and Unisys. Other companies, such as Texas Instruments, Sun Microsystems, Microsoft, Intel, and IBM, are relatively heavily tied to Japanese companies, although it is clear that the latter three have many ties with European companies as well. Our database provides little information on intra-Japanese cooperation, which makes it difficult to make definite statements on their internal pattern of cooperation from Figure 1. On the left-hand side of Dimension 1, a concentration of intra-European cooperation can be observed, in particular ASEA-Brown Boveri, Telecomica, GEC, AEG, Fiat, Nixdorf, Plessey, CCE, STET and British Telecom. Companies in the centre of both Dimensions 1 and 2 are those that have the largest number of international cooperative agreements with other companies. Of particular interest are Philips, Siemens, Ericsson, Olivetti, AT&T, Fujitsu, Thomson, IBM, Mitsui, NEC.

Apart from dimensional interpretation, structure can be observed in Figure 1 by a neighbourhood interpretation (small distance in the configuration means large similarity) and the application of clustering techniques like drawing lines between companies. One can also draw lines between every pair of companies whose proximity exceeds some threshold value. Thick solid lines indicate very strong cooperation, thin solid lines reflect strong cooperation between two companies, while dashed lines represent moderate cooperation. The intensity of cooperation between companies that are not connected to
other companies by lines is by no means truly peripheral. Rather, their agreements are spread over a number of companies without having specifically strong ties with one in particular.

As it would take too long to list all the tie-ups which can be read from this figure, a few examples will suffice. Philips has many agreements with Bull of France, Siemens, Thompson, and also with Sony, Nixdorf, Olivetti, in addition to a number of agreements with STC, Ericsson, Matsushita, Hewlett Packard, ATT and DEC. Siemens has a number of agreements with Philips, Bull, Olivetti, Intel, Toshiba, Fujitsu, Thomson, IBM, Ericsson, Nixdorf, Plessey, CGE and STET. The general conclusion from Figure 1 is that nearly
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Figure 2 The network of cooperation in telecommunications

Legend: 
- = 5 or 6 cooperative agreements
- - = 4 agreements
- - - = 3 agreements
- - - - = 2 agreements

All large companies in information technology are participating in a network of cooperative agreements.

It is obvious that an analysis of particular technological sub-fields within information technology, such as (tele)communications might give a somewhat different picture of alliances. In Figure 2, the network in telecommunications as it emerges from an MDS technique is presented. Compared to the picture for information technology at large, one can observe that a number of companies play a dominant role in both networks. It also becomes clear that there is a strong Japanese link-up. Compared to Figure 1, one can observe that in the telecommunication industry nearly all firms have a number of agreements
with others. Particularly strong relations are found for Mitsubishi and Mitsui, Siemens and Philips, Siemens and Plessey, Siemens and STET and Northern Telecom and STC.

Finally, in Figure 3 the outcome for biotechnology is given. The dimensional interpretation of this figure is more difficult than in the previous figures. There is no clear pattern emerging, which indicates that the pattern of international partnering in biotechnology is not as well developed as it is in information technology. As in Figures 1 and 2, the ‘intensity’ of cooperation is given by different lines for numbers of agreements between companies. Apart from a number of US tie-ups, some international cases of more

Figure 3  The network of cooperation in biotechnology

Legend:  = 4 or more cooperative agreements  
= 3 agreements  
= 2 agreements
intensive cooperation are combinations of Merck and Ciba-Geigy, Boehringer and Genentech, Bayer and Genetics Systems, Gist-Brocades and Shell, and Shell and Cetus.

As with our data on information technology and telecommunications, it becomes clear that in biotechnology too, the larger and more advanced companies are engaged in networks of cooperation.

4 Concluding remarks

In the preceding sections, I have attempted to analyse some changes in company strategies, in particular those of the largest companies, which relate to cooperation between firms at both the operational and the strategic level.

At the operational level, a number of changes in company structures have been associated with out-sourcing and co-makership of non-critical parts of production with supplying companies. Through this out-sourcing, large companies have been able to create a network of suppliers which produce a substantial share of the leading companies' turnover. In the course of such a development, there tends to be a reduction in the number of suppliers while the value of supply is increased. This change from production to more integrated but external supply has a certain economic rationality, but it is largely made possible by the diffusion of information technology and related technologies. Important economic benefits are: the reduction of production overheads; saving of fixed and variable costs; shifting of risks; benefits from special capabilities of suppliers; and flexibility due to shortened lifecycles of products. The diffusion of information technology, in particular as embodied in computer-aided control of planning, production, shipping and supply, enables companies to organize their production processes into a complex network of in-house and outside production.

Out-sourcing and co-makership could lead towards disintegration if larger companies relinquished particular manufacturing or service units. However, it seems more appropriate to understand such a development as a new form of quasi-integration. This quasi-integration is not necessarily based upon ownership of, for example, capital goods in another company, but it is above all arranged through long-term contracts, inclusion of supplier’s production and quality control within an overarching control regime, technology transfer within the requirements of the larger user, and even the appropriation of some critical assets of the supplier.

Strategic partnerships have been analysed as partnerships which affect the long-term strategy of companies in respect to their innovative requirements and their research potentials. Although such partnerships have probably been established throughout capitalist economic history, there is evidence that this phenomenon has become relatively more important in recent years. Factors explaining this growth can be found in the expansion of relevant markets, the speed of major technological developments, the uncertainty and costs of advanced R&D, and the inter-relatedness of technological fields. Cooperation between companies in this context has to be interpreted as a pre-emptive strategy. In particular, leading multinationals create a network of cooperative agreements with a number of partners. Due to the global character of such a strategy, partnerships take the shape of different formal arrangements with inter-temporal changes. A preliminary analysis of some data on strategic partnerships shows that different patterns emerge for technologies at distinct stages of development. As demonstrated above, the pattern of cooperation in biotechnology is less apparent as yet than in information technology or telecommunications.
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References and Notes

8 In the case of fixed supply relations, quasi-rent can be interpreted as a return to a supplier over and above its opportunity costs.
14 OECD (1986) Technical Cooperation Agreements between Firms: Some Initial Data and Analysis, Paris, OECD.