Organizational Modes of Strategic Technology Partnering

Geert Duysters
Eindhoven University of Technology, Faculty of Technology Management,
P O Box 513, 5600 MB Eindhoven (Netherlands)
Ph: (31) 40-2473972
and
John Hagedoorn
Maastricht Economic Research Institute on Innovation and Technology (MERIT),
Faculty of Economics and Business Administration, University of Maastricht,
P O Box 616, 6200 MD Maastricht (Netherlands)
Ph: (31) 43-3883897

The paper addresses an issue that is often neglected in the literature on strategic technology alliances, i.e., the organizational modes of partnering as such. A classification of modes of technology cooperation in terms of inter-organizational dependence is used here to discuss major trends and characteristics of different forms of inter-firm partnering. The empirical material is taken from the MERIT-CATI database. We have demonstrated that other, more flexible, forms of cooperation than joint ventures, such as R&D pacts, technology exchange agreements and research contracts, have become so important that the preoccupation with joint ventures cannot be justified.

Introduction

Although relationships between companies have for a long time been largely neglected in the literature, a rapid increase in the number of alliances in the 1980s led to a growing body of literature on both the use and structure of inter-firm relationships. However, in many of these studies cooperation between companies is still discussed without differentiating between organizational and economic dissimilarities of different forms of cooperation. Based on data from an extensive database (the MERIT-CATI database, Appendix I) this paper shows that next to joint ventures other, more flexible, forms of cooperation such as R&D pacts, technology exchange agreements, research contracts, and other modes of cooperation have become so important that the preoccupation with joint ventures cannot be justified. It is argued that modes of cooperation differ significantly with respect to both organizational and economic characteristics. Modes of partnering in terms of their degree of organizational inter-dependence as well as in terms of their strategic content are discussed. As will become clear from the following, these partnerships can range from more hierarchical structures to forms of cooperation that come very close to standard market transactions. Discerning the strategic content of these different modes of alliances is important to assess the long-term impact of the alliance for the companies involved in the agreement. At a more disaggregated level, discuss the growth of strategic alliances at a sectoral level, is also discussed.

Although cooperative agreements can take numerous forms such as marketing, production and research agreements we limit our study to technology partnerships. Technology partnerships are defined as those forms of cooperation in which a combined innovative activity or an interchange of technology is at least part of the agreement. Before the mid-1970s these technology-related alliances were virtually unknown. During the 1980s and 1990s, however, several authors started to report a strong and steady increase in the number of technology alliances.
Table 1 — A classification of modes of cooperative agreements and their organizational interdependence

<table>
<thead>
<tr>
<th>Mode of cooperation</th>
<th>Organizational interdependence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint ventures and research corporations</td>
<td>Large</td>
</tr>
<tr>
<td>Joint R&amp;D, such as research pacts and joint dev. agreements</td>
<td>Medium</td>
</tr>
<tr>
<td>Minority investment, minority and cross-holding</td>
<td>Medium</td>
</tr>
<tr>
<td>Customer-supplier relations, R&amp;D contract, Co-production, Co-makership</td>
<td>Medium</td>
</tr>
<tr>
<td>Technology exchange agreements (mutual), Technology sharing, X-licensing, mutual second-sourcing</td>
<td>Large</td>
</tr>
<tr>
<td>One-directional technology flow, Second-sourcing, licensing</td>
<td>Small</td>
</tr>
</tbody>
</table>

Source: adapted from Hagedoorn

Modes of Inter-Firm Technology Cooperation

In the management and economic literature several taxonomies have been introduced for inter-firm cooperation. Auster's taxonomy differentiates agreements into technology transfers and exchanges, R&D arrangements and joint ventures. Chesnais presents types of inter-company agreements which are, among others, set against government involvement, technological characteristics, capital requirements and industry structures. For other taxonomies, one may consult works given in refs 12 to 14. In this paper the tentative classification of modes of technology cooperation is suggested in terms of the extent of inter-organizational dependence and is also presented in Table 1. Distinction is made between modes that are associated with relatively strong ties between companies such as joint ventures, research corporations and, on the other hand, contractual arrangements such as joint R&D agreements and technology exchange agreements that require less inter-organizational governance. Many studies suggest that these modes of cooperation have a different impact on the character of technology sharing, the organizational context and the possible economic consequences for participating companies.

With the creation of a new firm by, usually, two parent-companies, joint ventures have a relatively high degree of organizational interdependence, which comes close to hierarchical structures. One-directional technology flows, such as licensing and second-sourcing agreements, however, come very close to standard market transactions with one firm obtaining technological input in return for a fee or other forms of payment. Other modes of cooperation, such as joint R&D pacts, have intermediate degrees of organizational interdependence.

Technology alliances are understood to be strategic, if they aim at improving the long-term perspective of 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 transaction costs or operating costs of companies. Although there is no strict correlation between organizational modes of cooperation and their strategic or cost-economizing content, we think some modes of cooperation are more strategically motivated, whereas others tend to be more oriented towards cost-economizing (Table 2). Earlier research has shown that, e.g., R&D joint ventures and research corporations, joint R&D agreements and equity investments are for over 85 per cent strategically motivated. Other forms of agreements such as technology exchange agreements, one-directional technology flows, and customer-supplier relationships are expected to be less strategically motivated.
Table 2—The assumed relation between modes of technology cooperation and their strategic content

<table>
<thead>
<tr>
<th></th>
<th>Joint ventures, research corporations</th>
<th>Joint R&amp;D</th>
<th>Technology exchange</th>
<th>Minority investment</th>
<th>Customer supplier relationships</th>
<th>One-directional technology flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost economizing</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>-</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Mixed strategy</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Long-term positioning</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>+++</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Legend: Little or negligible relevance, + indication of growing relevance

Source: based on Hagedoorn

with the exception of research contracts, which we assume to be at least partly strategically motivated.

The character of different modes of technology cooperation and their strategic content can also be related to various motives for partnering. Hagedoorn has provided an evaluation of the motives for different modes of strategic technology partnering. His analysis suggests that equity sharing agreements such as joint ventures, are of a multidimensional nature that are used for both market and technology-related objectives, whereas contractual agreements are more limited in scope and primarily R&D-driven.

Some Further Explorations of Organizational Modes of Inter-Firm Cooperation

Joint ventures and research corporations are created by partners who agree to combine their skills and resources in a separate company characterized by joint ownership. Research corporations are particular types of R&D ventures that have distinctive research programmes. In general, joint ventures can be analyzed in the context of a number of transitional company strategies in different market situations. Berg and Hoekman and Harrigan have argued that market entry, repositioning and expansion in existing markets and exit strategies in declining markets are well known rationales for firms to enter into joint ventures. Potential advantages of joint ventures are associated with the spreading of risks, sharing of fixed costs, capturing of economies of scale, access to new markets, competitive repositioning, and sharing of research efforts. Sometimes, cost-economizing is introduced as the decisive factor in explaining joint venture behaviour.

In the context of our current contribution we consider as joint ventures only those partnerships in which joint R&D is at least part of the agreement besides possible joint production, marketing, sales, etc. Many observers have argued that joint ventures, in particular, those with an impact on joint R&D, became more popular during the 80s. Despite the still existing popularity of R&D-related joint ventures the economic and organizational stability of the joint venture mode as such appears questionable. Several studies estimate that about half of all joint ventures fall short of expectations or are disbanded. Major reasons for these failures are found in different views of participating companies on strategy and difficulties associated with the management of the venture. 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. 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.

We understand joint R&D pacts to cover those (non-equity) agreements in which firms pool resources in order to undertake joint development agreements or other joint research. Although such agreements are dependent on a strong commitment of the partners the interdependence is usually smaller than in (equity) joint ventures. If certain projects are not very successful, they can be terminated with only a relatively small loss. This category of cooperation covers a wide variety of legal and organizational arrangements such as joint development agreements and joint research pacts. In general the aim of this sort of inter-firm agreement is to organize joint R&D activities of two or more companies in order “... to reduce costs, minimize risk, and allow synergy among firms pursuing similar innovations”.

Minority investments made by one company in another company can be seen as a form of inter-firm cooperation which in the long run could affect the technological performance of at least one partner. In high technology industries, minority investments are often coupled with technology exchange agreements. In many turbulent industries, large companies are investing in small innovative companies in order to acquire access to promising new technologies. This allows firms to explore new fields of technology without the need to come up with the full investment that would be needed in the case of internal development. If the technology turns out to be extremely promising then a takeover can be considered. This practice has been extensively used in the biotechnology industry where until the mid-80s minority sharing was the most frequently used mode of inter-firm partnering.

In spite of the attention being paid to minority investment its achievements and present popularity could be relatively small. Earlier research has shown that minority investments peaked during the second-half of the 70s, in particular, because of the direct investments in biotechnology. Since then the number of annually made new agreements has been almost constant but due to the overall increase of strategic technology partnering its relative position has dropped far below its contribution in earlier periods.

The other modes of cooperation that we consider as (partly) strategic technology partnerships are cross-licensing agreements, second-sourcing agreements, customer - supplier relationships in combination with licensing agreements and R&D contracts. Cross-licensing and mutual second-sourcing can be considered as the bilateral form of the more general licensing and second sourcing agreement. Therefore, they share many of their characteristics. In licensing agreements, a company is granted the right to use a specific patented technology, in return, for a payment. Licensing is a relatively cheap and fast way to acquire a technology. According to Roman and Puett, licensing may be used when capital is scarce, when import restrictions forbid any other means of entry, when a country is sensitive to foreign ownership, or when it is necessary to protect patents and trademarks. Cross-licensing is often used if there are complementary patents involved which are more or less indispensable to each other.

In the case of mutual second sourcing, firms trade the rights to make an exact copy of the other firm’s product. Second sourcing is used by large customers to allow market growth by creating many suppliers in order to avoid opportunistic behaviour of a monopolist.

Customer-supplier relations refer to close contacts between customers and suppliers. They provide a means of combining knowledge and technology from customer and supplier in order to create a product that meets the standards of the customer. Research contracts regulate R&D cooperation in which one partner, usually a large company, contracts another company, frequently a small one, to...
to perform particular research projects. In the literature some (dis-)advantages of this mode of cooperation are discussed. 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 fully fledged in-house research facilities. Disadvantages for those companies can sometimes be found in the lack of in-house expertise to assess the value of contract research and the dissociation of development expertise from manufacturing expertise.\textsuperscript{25,27}

**Distribution of Different Modes of Strategic Technology Alliances**

In Figure 1, we present the distribution of the various modes of strategic technology partnering as found in the MERIT-CATI data bank during the period 1980-1996. It is evident that R&D partnerships (joint development agreements and research pacts) and research joint ventures (including research corporations) are the most important modes of technology cooperation; their combined share has risen from over 76 per cent during the first period to 85 per cent of all strategic technology alliances during the second period. As a result, the share of minority holdings and the combined group of some forms of customer-supplier relationships, R&D contracts, and technology exchange agreements has dropped from 33 per cent during the first half to a mere 15 per cent during the second period. In other words, the importance of the more strategically motivated and the organizationally strongly interdependent modes of inter-firm technology partnering has increased substantially during the 90s. In particular the share of joint R&D pacts has risen from 45 per cent in the first period to 67 per cent during the second period, the share of research oriented joint ventures has slightly decreased to 18 per cent of all technology alliances.

The individual growth pattern of each of the four basic modes of strategic technology partnering over time is shown in Figure 2. The number of Joint R&D Partnerships showed a remarkable upswing, with a particularly strong annual growth during the 90s. The relative decrease of the share of minority investments, joint ventures, and other modes of cooperation is the result of the more or less stable growth pattern of these modes of partnering during the past decades. In other words, the growth of new strategic technology alliances during the 80s and 90s is actually based on the steep rise of R&D partnerships during the mid-80s and 90s.

Given the differences in the growth patterns of strategic technology alliances, it is interesting to see to what extent different modes of partnerships also demonstrate divergent growth patterns at the sectoral level. Table 3 provides some growth indices using 1980-1988 as a base. As discussed earlier, the general increase in the number of strategic technology alliances is not reflected by a similar increase of different organizational modes. Joint R&D pacts show
Figure 2—Growth of different modes of strategic technology partnerships, annual increase of partnerships, 1980 - 1996, three year moving averages (Source: MERIT-CATI)

Table 3 — The growth of newly created strategic technology alliances and changes in different modes of cooperation, 1989-1996 (1980 - 1988 = 100)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Joint ventures</th>
<th>Joint R&amp;D</th>
<th>Minority investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology</td>
<td>181</td>
<td>212</td>
<td>54</td>
</tr>
<tr>
<td>New Materials</td>
<td>115</td>
<td>113</td>
<td>62</td>
</tr>
<tr>
<td>Computers</td>
<td>143</td>
<td>418</td>
<td>94</td>
</tr>
<tr>
<td>Industrial Automation</td>
<td>9</td>
<td>141</td>
<td>98</td>
</tr>
<tr>
<td>Microelectronics</td>
<td>123</td>
<td>267</td>
<td>97</td>
</tr>
<tr>
<td>Software</td>
<td>164</td>
<td>434</td>
<td>138</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>84</td>
<td>317</td>
<td>89</td>
</tr>
<tr>
<td>Other/Consumer Electronics</td>
<td>49</td>
<td>114</td>
<td>29</td>
</tr>
<tr>
<td>Automotive</td>
<td>111</td>
<td>176</td>
<td>35</td>
</tr>
<tr>
<td>Aviation/Defence</td>
<td>833</td>
<td>164</td>
<td>61</td>
</tr>
<tr>
<td>Chemicals</td>
<td>131</td>
<td>577</td>
<td>16</td>
</tr>
<tr>
<td>Food &amp; Beverages</td>
<td>152</td>
<td>1</td>
<td>61</td>
</tr>
<tr>
<td>Heavy Electrical Equipment</td>
<td>119</td>
<td>117</td>
<td>3</td>
</tr>
<tr>
<td>Instruments/Medical Technology</td>
<td>84</td>
<td>202</td>
<td>2</td>
</tr>
<tr>
<td>All Sectors</td>
<td>125</td>
<td>237</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: MERIT-CATI
the largest increase: the number of newly created joint R&D agreements in the second period is more than twice the number of the years 1980-1988, reflected by a growth index of 2.37. The number of joint ventures also increased with a factor of 1.25, but the number of minority investments decreased in the second period.

At the sectoral level we can find a number of specific developments. Information technology-related sub-fields show remarkable patterns of growth. In particular, in computers and software, most modes of partnering show a strong growth during the second period, with the numbers of joint R&D pacts growing at an unprecedented rate. In biotechnology the number of direct investments decreased, while the number of joint ventures and joint R&D arrangements has risen considerably. It was primarily earlier than 1985 that direct investment was the most prominent form of cooperation in biotechnology. It was also in those years that many small R&D intensive biotechnology firms were established in which many large companies took minority stakes. In recent years, however, this mode of cooperation has been outnumbered by other modes. The chemical sector stands out in terms of the growth in the number of joint R&D pacts. The more traditional sector food and beverages shows a rather different trend. In this sector, joint ventures still remain very important. However, aviation and defence is the sector with by far the largest growth in the number of joint ventures. This is probably due to the role of the government and the need for extensive regulations and strong contracts in military applications. For the other sectors, of which many appear to have only a limited number of strategic technology alliances, it seems that, with a few exceptions the growth pattern of different modes of cooperation is not too different from the overall pattern.

An interesting question is whether one can expect R&D-related joint ventures and R&D pacts to be concentrated in R&D-intensive industries\(^22\). Before the mid-1970s, there appeared to be an inverse relationship between R&D-intensity of industries and the number of cooperative alliances in sectors. In the 1980s, however, several studies showed that high technology sectors accounted for the majority of all newly established alliances\(^1,4,7,17\). The MERIT-CATI data bank also shows that most R&D joint ventures and R&D pacts are found in sectors where companies undertake substantial R&D activities. Additional material reveals that in sectors such as information technology, biotechnology and new materials which take more than 75 per cent of all R&D related joint ventures and R&D pacts in the MERIT-CATI data bank.

Conclusions

This paper addresses an issue that is often neglected in the literature on strategic technology alliances, i.e., the organizational modes of strategic technology alliances as such. We used a classification of modes of technology cooperation in terms of inter-organizational dependence to discuss major trends and characteristics of different modes of cooperation between companies. There are clear differences in the degree of organizational coherence depending on the form of cooperation. Modes of cooperation range from close cooperation in a joint venture to more market transaction-related agreements such as licensing and second sourcing agreements. R&D-related joint ventures, with research corporations as a particular form, are characterised by the highest degree of inter-firm interdependence. Despite this interdependence and its ‘popularity’, it appears a somewhat unstable form of organization, though probably more stable than some of the other modes of cooperation that we discussed. At a somewhat lower level of interdependence, we find joint R&D pacts. These (non-equity) alliances are reported to be much more flexible. As a result, R&D pacts are used extensively by organizations to increase their ability to switch from research in one technology to another. Withdrawal or transfer of know-how, personnel and assets, is often much easier to facilitate in those more flexible types of agreements than in agreements that involve substantial equity participation. Therefore, non-equity agreements are often preferred over joint ventures when demand is uncertain or business risk is high\(^22\).
As far as the distribution of strategic technology partnering is concerned we found significant differences among sectors. For information technology and the chemical sector, we found a strong increase in the number of joint research pacts. In biotechnology, minority investment was traditionally one of the preferred forms of cooperation. However, more recently the number of minority investments decreased significantly in favour of joint ventures and joint R&D pacts. The aviation and defence sector, as well as the more traditional food and beverages sector, show that joint ventures are still quite popular in some industry segments.

Joint ventures and joint R&D agreements together represent about 85 per cent of all strategic technology alliances during the most recent period. Whereas, most of the attention in the literature has been paid to joint ventures, it is particularly the group of joint R&D pacts that appears to have grown immensely. Joint R&D pacts stand out as the single most preferred form of cooperation. In the most recent years, joint R&D pacts have even outnumbered joint ventures by a factor of five. The unstable character of joint ventures the cost of setting up joint ventures and the increased need for flexibility, explain why joint R&D agreements have achieved a larger share of all agreements in recent years at the expense of the share of joint ventures. Such considerations made companies decide to experiment with joint R&D agreements which are both less expensive and less complex than joint ventures but more solid than some of the other modes of cooperation we discussed.

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About the authors

Geert Duysters is currently working as an associate professor at the faculty of Technology Management of the Eindhoven University of Technology. He studied business economics at the University of Maastricht and completed his PhD at the Maastricht Economic Research Institute on Innovation and Technology (MERIT). He joined the University of Maastricht as a staff member in January 1995, where he became an associate professor in International Business Strategy, in 1996. From 1998 until September 1999, he worked as a part-time consultant for KPMG Alliances in Amstelveen. He is a founding partner and President of the International Center of Alliances, Networks and Strategic Innovation (ICANS). He also acted as a consultant for the European Commission and the OECD. His main interests are in international business strategies, strategic alliances, mergers and acquisitions, and network analytic methods. Geert has published over 20 articles on alliances in international refereed journals and books.

John Hagedoorn received an MA in economic sociology and political economics from the University of Leiden, The Netherlands and a PhD in industrial organization from Maastricht University, The Netherlands. He is currently professor of Strategic Management and International Business at Maastricht University and professorial fellow with the Maastricht Economic Research Institute on Innovation and Technology (MERIT). He has held visiting scholar and visiting professor positions at the SPRU (University of Sussex), SIEPR (Stanford University), CISTP (The George Washington University), the Haas School of Business (University of California at Berkeley) and the University of Paris. He has published his research papers in the Academy of Management Journal, Industrial and Corporate Change, Journal of International Business Studies, Journal of Management Studies, Journal of Common Market Studies, Organization Studies, Research Policy, Review of Industrial Organization, Strategic Management Journal, Technovation, World Development, and other journals.
Appendix - 1

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. The CATI database contains information on over 13,000 cooperative agreements involving some 6000 different parent companies. The data bank contains information on each agreement and some information on companies participating in these agreements. We define cooperative agreements as common interests between independent (industrial) partners which are not connected through (majority) ownership. In the CATI database only those 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. Consequently, partnerships are omitted that regulate no more than the sharing of production facilities, the setting of standards, collusive behaviour in price-setting and raising entry barriers - although all of these may be side effects of inter-firm cooperation as we define it.

We regard as a relevant input of information for each alliance: the number of companies involved; names of companies (or important subsidiaries); year of establishment, time-horizon, duration and year of dissolution; capital investments and involvement of banks and research institutes or universities; field(s) of technology1; modes of cooperation2; and some comment or available information about progress. Depending on the very form of cooperation we collect information on the operational context; the name of the agreement or project; equity sharing; the direction of capital or technology flows; the degree of participation in case of minority holdings; some information about motives underlying the alliance; the character of cooperation, such as basic research, applied research, or product development possibly associated with production and/or marketing arrangements. In some cases we also indicate who has benefited most.

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

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