

INTER-FIRM TECHNOLOGY COOPERATION AND IMPLICATIONS FOR CAPABILITY BUILDING

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Summary

Since the 1980s, there has been a spurt in inter-firm technology cooperation agreements worldwide. These agreements differ from the earlier cooperation agreements in their motives, characteristic features and content. The present day technology cooperation involves each partner firm contributing its expertise or knowledge to the common objective. One of the important motives for inter-firm cooperation in recent years has been the need to spread the costs and risks of innovation. Another important motive has been the acquisition of new technical skills or technological capabilities from partner firms. In recent years, firms from developing countries have also emerged as viable partners in such cooperation. Inter-firm technology cooperation provides an opportunity to speed up the process of acquiring technology, co-developing technology, producing and tapping new markets. Reliance on arm's length technology acquisitions will only provide access to mature technologies for specific activities, with limited possibilities for learning. However, there is a danger that a few firms in an industrial sector may come to dominate the market through cooperation arrangements. This will have negative effect on *competition* in the market. An oligopolistic, if not a monopolistic, competition may emerge, creating barriers for new entrants or the smaller competitors may be forced out of the industry sector. In such a situation, even when a firm or group of firms may prosper, the growth of the specific industrial sector in a country will be stunted.

1. Introduction

In recent years, technology cooperation has been increasingly used as strategy by firms to reduce the pressures of global competition, and to enhance their technological

capability and innovativeness. Such cooperation takes place, mainly between firms in the industrialized world, but increasingly also between firms from the industrialized countries and developing countries, as well as between firms in the developing world. Such cooperation takes place between firms across national borders as well as within the same country. Such cooperation is also common between firms and academic establishments.

Historically, international inter-firm cooperation agreements have always existed in one form or another. Joint ventures between firms belonging to different countries have been in existence since the beginning of last century. Similarly, licensing of technologies between companies has been in vogue in industries, such as chemical and electrical equipment since the early decades of the last century.

Since the 1980s, however, there has been a spurt in inter-firm technology cooperation agreements worldwide. These agreements differ from the earlier cooperation agreements in the context in which they are entered into, as well as in their motives, characteristic features, content and magnitude. The new forms of cooperation, such as joint R&D, involve activities where a greater degree of technology transfer and exchange takes place among participating firms.

Growing global competition, high costs and risks associated with the development of new technologies, shortage of knowledge resources, complexity of technological systems and worldwide market entry strategies are some of the major reasons for spurts in inter-firm cooperation.

Inter-firm technology cooperation takes a variety of forms, ranging from simple one-way contracts, such as licensing (e.g., technology purchase), through more complex contractual arrangements, such as technology sharing and joint development, to 'equity-based' joint ventures, formed separately by the partner firms. The activities range from basic research cooperation to competitive R&D and technology cooperation and manufacturing and marketing.

The new forms of agreements have become popular among firms due to a set of factors that have characterized the world economy since the late 1970s. Firms encountered uncertainty and turbulence in the world economy. At the same time, the emergence of new techno-economic paradigm led to rapid and radical technological changes. In such a complex business environment, according to Chesnais, enterprises viewed the new forms of agreements as offering a high degree of flexibility that is critically needed in their operations. In a rapidly changing technological environment, the flexible, risk- and knowledge-sharing, and resource pooling features of inter-firm agreements opened up opportunities for acquiring key scientific and technical inputs from external sources. These opportunities may, under given circumstances, be even superior to the strategies of internationalization of activities through vertical or horizontal integration or foreign direct investment.

Another distinguishing feature of the new forms of the cooperation agreements has been the reciprocity, where knowledge and information are exchanged both-ways. This is in

contrast to the old forms in which the predominant form of cooperation was one-way flow of knowledge, e.g., licensor to licensee. Until recently, technology cooperation, especially that of research and innovation activities, was confined to the firms from industrialized countries. However, in recent years the firms from developing countries and economies in transition have also emerged as viable partners in such technology arrangements. Another important type of agreement has been the arrangement between foreign firms and research institutes/universities in developing countries and economies in transition.

In the light of the growing importance of international cooperation agreements to firms as well as policy makers, this paper examines the following main issues: a) to what extent the firms from developing countries and transition economies are involved in interfirm technology cooperation? b) what are the types and characteristic features of such arrangements? c) what are the implications for technological capability building at the firm and industry levels?

This paper is organized into six sections: Section 2 explains the concept of interfirm technology cooperation and the general context in which cooperation takes place. Section 3 presents some empirical analysis of technology cooperation agreements. Section 4 describes the different forms of technology cooperation that are particularly relevant to firms from developing countries and economies in transition. Section 5 analyzes the firm- and industry-level implications for technological capability building. Section 6 draws conclusions and some policy recommendations.

2. What is A Technology Cooperation Agreement?

There is no single definition of what constitutes a cooperation agreement. According to Dodgson, these agreements, also known as alliances, collaboration and networks, are formed by firms with other firms, such as suppliers, customers (vertical cooperation) and even competitors (horizontal cooperation), as well as with academic institutions. The cooperation takes place in a wide range of activities, including research, product development, manufacturing and marketing. Vertical cooperation takes place throughout the production chain for particular products, i.e., at all stages from the supply of raw materials, through manufacture and assembly of parts and systems, to distribution and servicing. Horizontal cooperation occurs between firms at the same level in the production process (e.g., competitors).

In the past, technology cooperation involved one-way transfer of technology from one partner to the other, usually from large to small firms. For instance, traditional joint ventures between firms, especially between developing country firms and industrialized country firms, involved the transfer of technology from the latter to the former, with the former paying royalties for the technology received. In contrast, the present day technology cooperation involves each partner firm contributing its expertise or specialized knowledge, and it may or may not be accompanied by equity contribution. As a result, in the present context, technology cooperation means two-way flow of technologies. As specialized knowledge is contributed to the common objective, such cooperation can take place on an equal footing between large and small firms. Thus,

technology cooperation agreements mainly focus on knowledge generation and sharing activities, aimed at the development of new products or processes or establishment of new routines within the firm or in the organization of inter-firm contractual relationships.

There are several motives for firms to enter into technology cooperation agreements. One of the most common motives for inter-firm cooperation in recent years has been the need to spread the costs and risks of innovation, due to the capital required for technology development in industries such as pharmaceuticals and electronics. Coupled with the higher development costs and risks, shortened product life-cycles in many technology-intensive industries necessitate rapid penetration of foreign markets in order to recoup the costs and this may be more easily accomplished through an alliance. According to Grindley, some technology cooperation agreements, especially those between users and suppliers of new products, are formed with objectives of coordinating and formulating technical standards and ‘dominant designs’.

Another important objective of technology cooperation has been the acquisition of new technical skills or technological capabilities from partner firms. According to Mowery, Oxley and Silverman, many firm-specific technological capabilities based on tacit knowledge and are difficult to transfer with complete certainty concerning their characteristics and performance. As a result, it is difficult to incorporate all the elements into simple contracts for the sale or licensing of such capabilities. On the other hand, by combining the market incentive structures with the managerial controls associated with hierarchy (internal organization), cooperation agreements can provide a better means to access technological and other capabilities.

Cooperation agreements may take several different forms and may be formed with very diverse objectives. However, according to Dodgson, the agreements are entered into with some general assumptions: 1). Cooperation is perceived as leading to “positive sum gains” in internal activities of the participants, i.e., the participants can together derive mutual benefits which otherwise could not be gained independently. 2). Cooperation is perceived as a strategic tool to deal with “environmental uncertainty”. The growing competition, demanding customers, globalized markets and rapidly changing technologies are increasing pressures on firms, which can be more easily dealt with through cooperation than independently. 3). Cooperation agreements are seen as offering greater “flexibility” in comparison to other strategies. For example, cooperation may be better alternative to foreign direct investment (FDI) or to mergers and acquisitions (M&As), which are difficult to amend once entered into. 4). Cooperation is perceived as facilitating more effective transfer of knowledge between organizations than purely market transactions.

2.1. The General Context

In general, transnational corporations (TNCs) tend to favor internalized hierarchies and therefore prefer establishing wholly owned subsidiaries to joint ventures. This is mainly because TNCs perceive internalized hierarchies as permitting reduction in transaction costs and also leading to more effective appropriation of rents from tangible or

intangible assets. However, in a situation where wholly owned subsidiaries are not feasible for various reasons, such as higher risk and financial costs or the restrictions of national policies, TNCs tend to establish joint ventures.

Chesnais analyzed the main factors that are responsible for the rise of inter-firm cooperative agreements as a major corporate strategy in the 1980s: the first set of factors relates to the global competition. In all technology-intensive industries, competition now takes place between a relatively small number of large firms (e.g., oligopolistic), in a geographical area, that includes both industrialized and developing country markets. The second set of factors relate to the on-going developments in science and technology (S&T). The general trend has been that basic scientific knowledge is playing a crucial role in major technological advance and many recent major innovations have occurred through cross-fertilization of different scientific disciplines. These ongoing paradigmatic changes in S&T are increasing the pressure on firms by increasing the number of technical fields relevant to corporate growth, and placing totally new requirements for significant technical advances. These pressures can be met partly by increasing in-house R&D or by the establishment of technology cooperation with other firms or universities.

Due to the rapidly changing technologies since the 1980s, the product life cycles in most industries shortened. The short product life cycles also compelled firms to increase their R&D investments to keep up with the technological change in their industry. In order to amortize the rising costs of R&D, firms are compelled to geographically widen their markets. According to Hagedoorn and Schakenraad, technology cooperation is seen as a flexible way of dealing with some of these problems that include: the extremely high costs and risks of R&D in high-tech industries; quick pre-emption strategies on a world scale, even at the cost of loss of potential monopoly profits; technology transfer and complementarity; exploration of new markets and market niches; reducing the time lag between discovery and market introduction; monitoring the evolution of technologies and opportunities.

3. Inter-firm Technology Cooperation Agreements – Some Empirical Analysis

Among all types of cooperation agreements, the inter-firm technological alliances became more common in the 1980s. MERIT/UNCTAD database, as cited in UNCTAD's World Investment Report 1998, shows that during the period 1980-96, a total of 8254 inter-firm technology cooperation agreements were registered. The number of these agreements sharply rose from an annual average of less than 300 in the early 1980s to over 600 in the mid-1990s. In 1996 alone, 650 agreements were registered. The bulk of technology cooperation agreements were registered in the industries dealing with the new science-based technologies such as biotechnology, information technology and new materials.

The database also revealed the differences in the propensity to use technology cooperation as a strategic tool among various industries. The knowledge-intensive industrial sectors have entered in to the largest number of inter-firm cooperation agreements. During the period 1980-96, the information technology (IT) industry

dominated the technology agreements formed, accounting for 37 percent of all agreements. Their number rose sharply from an annual average of 74 during the 1980-83 to 248 during 1992-95. 1996 registered 254 technology agreements in IT industry. Similarly, pharmaceuticals, especially bio-pharmaceuticals, registered a rising trend, with their share in total agreements doubling from 14 percent during 1980-83 to 28 percent in 1996.

In the international technology cooperation agreements, the participation of firms from developing countries has so far been modest, numbering only 455 agreements in the MERIT/UNCTAD database. However, over time, their number has been rising. In the early 1980s, developing country firms accounted for an annual average of 10 agreements, but by the mid-1990s, the figure has risen to nearly 40 per year. In terms of proportions, the share of developing country firms has increased from 4.9 percent of the 4270 agreements registered in the 1980s to 6.2 percent of the 3984 agreements registered in the 1990s.

An interesting phenomenon has been the growing trend of technology cooperation agreements among the developing country firms themselves. They accounted for nearly 7 percent of the 455 technology agreements involving a developing country firm. About a half of the 31 such agreements were registered during the period 1992-96. Following the global trend, even in the case of developing country firms, information technology predominates, accounting for 27 percent of the agreements involving at least one firm from a developing country. The number of agreements in the IT went up from an average of four per year during the 1980s to 13 in the 1990s. In the case of developing country firms, the chemical and automotive industries have been the second and third most important for cooperation, accounting for 19 percent and 9 percent of the total respectively. The share of pharmaceutical industry is less than 6 percent of the agreements with participation by a developing country firm. The capability of developing country firms as viable partners in technology cooperation is reflected in the growing importance of two-way agreements, which is most visible in the knowledge-intensive industries, such as information technology. In the 1980s, one-way agreements accounted for 78 percent of the agreements in IT with participation from a developing country firm. But, by the 1990s, the share of two-way agreements significantly increased to 55 percent. Many of these agreements initially began as one-way arrangements, but over time have been upgraded into two-way agreements.

The firms from developing countries, especially those dealing with information technologies, are increasingly using international technology cooperation agreements to enhance their technological capability and global competitiveness.

The information Technology Strategic Alliances (ITSA) database registers publicly announced inter-firm alliances in information technologies (IT) worldwide. As analyzed by Vonortas and Safioleas, the release of 95.0 of ITSA registered 27 280 agreements (23 802 complete records) announced during 1984-94. These included 2683 alliances (2,361 complete records) with at least one partner from a developing country or economies in transition. According to this data, the alliances involving firms from developing countries and economies in transition not only kept pace with the rapid rates

of growth in the total alliances worldwide but also gained considerable ground. Alliances involving at least one firm from these countries increased from 6 percent in 1988 to 12.8 percent of total alliance records in 1994.

The majority of alliances by developing country firms involved either the creation or exchange of technological knowledge. Contractual agreements and joint ventures have been the dominant mode of alliances involving firms from developing countries. Equity investments, agreements for cooperative R&D, and licensing followed the order respectively. Mergers and acquisitions occupied the last place. The agreements involving R&D cooperation doubled during 1989-90 and doubled again during 1993-94 indicating an increasing number of developing country firms that are capable of not only adapting imported technologies but which are also capable of participating in the creation of new technologies. The rapid growth of alliances with developing country firm participation is largely due to growing cooperation agreements with explicit technological content. During 1984-94, a larger proportion of cooperation agreements with developing country firm participation had explicit technological content (75%) than the overall sample of reported alliances in the information technology (IT) industry (worldwide) in the database (69%).

A database, cited in Reddy, on global corporate R&D activities outside the industrialized world contains information on strategic R&D activities of TNCs being carried out in developing countries and transition economies. At the end of March 1999, a total of 286 strategic R&D activities are registered in developing Asia. 59.0 percent of the total R&D activities in developing Asia have been in the form of own R&D affiliates, followed by joint venture R&D (18.2%), technology alliances (10.5%), university collaboration (7.0%) and subcontract R&D (5.2%). In other words, 41 percent of such R&D is carried out through various types of inter-firm technology cooperation. All forms of R&D are represented only in case of one host country, India. Technology alliances have been prominent in case of South Korea and Taiwan. This is largely because firms from South Korea and Taiwan have already gained international reputation for their technological capabilities, and therefore, TNCs do not hesitate to establish technology alliances with these companies. Such alliances are also growing in India, particularly in software field, where Indian companies earned international reputation. In case of India, what is interesting is the collaboration between the Indian academic establishments and the TNCs, where significant generic type of research is being carried out.

Selected Company Illustration

The scientific and technological capabilities and the low cost of Russia's R&D sector have attracted a number of transnational corporations (TNCs) seeking alliances with Russian partners to access quality skills and technological knowledge at competitive prices. As reported by Hagedoorn and Sedati, in the early 1990s, the US company Rockwell entered into a number of joint research and development agreements with several Russian companies through contractual forms of cooperation. In 1992, Rockwell entered into a contractual agreement for joint development of aerospace products with both RSC-Energia and NPO-Energia. In 1993, Rockwell established alliances with spin-

off companies from the Vavilov Institute, called Magtec and Criomag, to perform joint research on magnetometry.

4. Forms of Inter-firm Technology Cooperation

There are several different types of international technology cooperation agreements. However, it is important to note that the distinction between different forms is only relative and the borders between them are blurred. For example, subcontracting may contain several elements of joint R&D. The types of cooperation discussed here are particularly relevant for firms from developing countries and economies in transition.

Based on the objective for which technology cooperation has been formed by developing country firms, UNCTAD (1996) makes a distinction of two kinds: 1. Those related to the objectives of *cost reduction*, in this respect, it may be advantageous for a firm from a developed country to find a partner in a developing country when the product cycle is already at a well developed stage. Such an alliance may take the form of a linkage with the components' suppliers, which may be more or less stable and of a long-term nature. Subcontracting, original equipment manufacturing (OEM) and second-sourcing agreements with a variety of input suppliers are possible examples; 2. Those related to *product development for 'niche' markets*. According to Mody, a product development cooperation, directed towards the creation of a *niche* market, may represent a mutually interesting strategy. New product development adds branches to the underlying cycle of a product class, and increases overall industry profits. An additional advantage is the fact that exploiting *niches* in the domestic market may provide a possibility of learning with regard to the development of new products that become internationally competitive in due course.

Based on the form in which cooperation takes place, international technology cooperation agreements can be categorized as: joint ventures, joint R&D or co-development, subcontracting, parts and component supplier networks, OEM and consortia.

i) Joint Venture

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