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The Role of Developing Countries and Emerging Economies in International Inter-Firm R&D Partnering

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Introduction

This chapter presents an analysis of major historical trends and sectoral patterns in international inter-firm R&D partnering from 1971 to 2000. The focus is on collaboration between independent companies through formal agreements, such as contractual agreements and joint ventures. We will mainly look at partnerships where R&D is at least part of the collaborative effort. It is well-established that the ongoing process of globalization has greatly influenced the growth of these international inter-firm R&D partnerships, and this is especially the case in technology-intensive industries that undergo a process of rapid technological development. Increased global competition together with enlarged complexity of technology and the associated risks and costs of innovative activities have stimulated many firms to enter into international R&D partnerships.

In the following we will pay specific attention to differences between the developed economies of the Organization for Economic Cooperation and Development (OECD), newly industrialized countries (NICs), less-developed countries (LDCs), and, in particular, the East European previously state-run economies and former communist countries (FCC). The opening of FCC markets resulted largely in the disappearance of regulations such as internal trade barriers and national protectionism, for instance the liberalization of foreign direct investment (FDI), discriminatory regional agreements, privatization and deregulation of industries (Van Den Bulcke, 1988; Kang and Johansson, 2000; Van Den Bulcke and Zhang, 1998; Zhang and Van Den Bulcke, 2000). Because of this, the pool of markets and potential partners for international partnerships has expanded to China, Eastern Europe and the former Soviet Union (Hagedoorn and Sedaitis, 1998).
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The MERIT-CATI database (see the Appendix) will be used to discover a number of general trends and patterns in international R&D partnering. This database is one of the few still existing databases that generate both cross-sectional and longitudinal insight. It allows us to study patterns in R&D partnerships in several industries, in different regions of the world over an extended period of several decades (Hagedoorn et al., 2000; Hagedoorn, 2002).

The chapter is organized as follows: first, we will explain the rationale behind inter-firm partnering and provide some definitions. Second, we will give a general overview of trends in international R&D partnerships since 1971, using the MERIT-CATI database. We will present growth data, as well as the distribution of major organizational features of R&D partnerships. Third, specific sectoral patterns of international R&D partnerships will be analysed because partnerships are known to be somewhat sector-specific as the propensity to enter into partnerships differs by industry. Fourth, we will present an in-depth discussion of the patterns in R&D partnerships of companies from different regions in general, and with companies from FCC countries in particular. Finally, we will discuss some of the main conclusions that can be drawn from this contribution.

R&D partnerships: definition, their rationale and organizational settings

Traditionally, firms have been understood to be independent and self-contained units. During the 1970s and early 1980s, however, a number of companies started to replace their traditional practices, such as mergers and foreign direct investment, with new forms of organization, such as joint ventures, joint development agreements and other types of partnerships (Duysters and Hagedoorn, 2000). This process was triggered by fundamental changes in the structure of the global economy and by the ongoing process of technological change (Haklish, 1989).

Strategic partnerships are often seen as an essential part of international corporate strategies (Ohmae, 1990; De Woot, 1990). It has been indicated in the literature that strategic partnerships can make up for the lack of economic power, competence or foreign experience of at least one of the partners. Furthermore, they are also increasingly used as scanning devices that allow firms to monitor new markets without the need to invest the full amount of resources (Duysters and Hagedoorn, 2000).

This chapter focuses on international R&D partnerships. We define R&D partnerships as the set of different modes of innovation-based inter-firm collaboration where two or more independent firms share part of their R&D activities (see for instance Hagedoorn, 2002; Hagedoorn et al., 2000). These partnerships are expected to have an impact on the long-term product-market combinations of the companies involved. R&D partnerships can be
divided into two categories: contractual partnerships such as joint R&D pacts and joint development agreements, and equity-based partnerships such as joint ventures. Joint ventures are organizational units created and controlled by two or more parent companies, thereby increasing the organizational interdependence of the parent companies. Joint ventures, including those with a specific R&D programme, are one of the older modes of inter-firm partnering and have become well-known during the past decades (Berg et al., 1982; Hagedoorn, 1996; Hladik, 1985). According to Hagedoorn (1996) and Narula and Hagedoorn (1999), joint ventures seem to have become gradually less popular if compared to other forms of partnering due to their organizational costs in combination with high failure rates (Kogut, 1988; Porter, 1987).

Contractual agreements cover technology and R&D sharing between two or more companies in combination with joint research or joint development projects. The costs are shared between the partners. Although these contractual R&D partnerships have a limited time-horizon, due to their project-based organization, each partnership appears to need a relatively strong commitment of companies and a solid interorganizational interdependence during the joint project. Compared to joint ventures, however, the organizational dependence between companies in a contractual R&D partnership is smaller and the time-horizon of the actual project-based partnership is almost by definition shorter (Hagedoorn, 1993). These contractual forms of R&D partnerships have become very important modes of inter-firm collaboration as their share has far exceeded that of joint ventures (Hagedoorn, 2002; Narula and Hagedoorn, 1999; Osborn and Baughn, 1990).

The literature mentions two important categories of motives for engaging in inter-firm partnerships: the cost-economizing motive, and the strategic motive (see for instance Narula, 1996). The cost-economizing motivation applies when at least one company enters the partnership mainly to lower the cost of some of its R&D activities by sharing the costs with one or more other companies. This cost-economizing rationale appears to particularly play a role in capital and R&D-intensive industries where the cost of single, large R&D projects are beyond the reach of many companies (Hagedoorn, 1993).

The strategic motive concerns organizational interdependence, such that there is a "strategic benefit" that accrues to either partner as the result of shared capital, technology or other resources. There must be some expected long-term positive effects of the agreement of the product-market positioning of at least one of the partners (Hagedoorn, 1993). Collaboration is seen as a means of shaping competition by improving a firm's comparative competitive position (Hagedoorn et al., 2000; Narula, 1996).

The strategic rationale becomes important if, for instance, companies decide to selectively enter into R&D partnerships that are not related to their core activities, while keeping their main R&D activities within their own
domain (Teece, 1986). The strategic intent of R&D partnerships is also apparent in those cases where companies jointly perform R&D in new, high-risk areas of R&D of which the future importance for their technological capabilities remains unclear for a considerable period of time. As mentioned before, the reduction and sharing of costs of R&D play an important role in the cost-economizing rationale. The strategic rationale, however, lies rather in the reduction, minimizing and sharing of uncertainty in R&D. Other strategic motives that can be seen as driving factors behind the choice for engaging in a R&D partnership are, among others, the increased complexity and intersectoral nature of new technologies, cross-fertilization of scientific disciplines and fields of technology, monitoring technological opportunities, monitoring of the evolution of technologies, technological synergies, and the access to scientific knowledge or to complementary technology (Hagedoorn, 1993). Other motives for participating in these research partnerships are found in gaining technical ability to diversify horizontally into new product lines, to vertically integrate production activities, and to leapfrog competition within their primary line of business (Hagedoorn et al., 2000).

For many R&D partnerships, however, cost-economizing and strategic motives are intertwined; that is, they are often both strategically motivated as well as cost-economizing, although some agreements are clearly biased towards one motivation (Das et al., 1998; Eisenhardt and Schoonhoven, 1996; Hagedoorn, 1993; Hagedoorn et al., 2000, Lorenzoni and Lipparini, 1999; Mowery et al., 1998; Narula, 1996). However, it is important to realize there is a dynamic aspect to all of this as the motives of a company can change over time due to both developments in the company itself, its environment and changes within the partnership (Harrigan, 1988).

**General patterns in international R&D partnerships**

Previous research (Chesnais, 1988; Hagedoorn, 2002; Hergert and Morris, 1988; Hladik, 1985; Mariti and Smiley, 1983; OECD, 1986, 1992) has established that there was a small growth of inter-firm partnerships during the 1960s and 1970s. During the 1980s there seems to have been a boom in the growth of inter-firm partnerships through all sorts of agreements, and this general pattern is also found for the particular group of partnerships studied in this chapter, that is international R&D partnerships (see Figure 7.1).

At the beginning of the 1970s the number of yearly established international R&D partnerships, found in the MERIT-CATI database, remained at a low level of around 15 made each year. Although these numbers are relatively small, they already attracted some attention in the literature, because this phenomenon puzzled academic observers (Hladik, 1985). Most of these partnerships were organized as joint ventures and the existing literature assumed
that companies would simply exclude R&D from joint ventures because of the risk involved in such sensitive activities. During the 1970s there was a gradual increase in newly made international R&D partnerships from around 15 per year in the early 1970s to nearly 20 by the middle of the decade. At the end of the 1970s there was a sudden increase to 80 new international R&D partnerships formed per year.

This phenomenon appears to have developed even further during the next decade, the 1980s, which marked a steep increase in new R&D partnerships from about 90 per year in the early 1980s to almost 300 made each year at the end of the 1980s and the turn of the decade. The movement to all kinds of partnerships since the 1970s and early 1980s was triggered by fundamental changes in the structure of the global economy and by the ongoing process of technological change. Some examples are homogenization of markets, fierce competition and ongoing globalization tendencies. Ever-increasing costs of R&D and the increasing complexity of products combined with a strong increase in the speed of technological developments are the main drivers from a technological perspective (Haklisch, 1989).

The early 1990s showed a decrease in the newly made international partnerships to about 170 per year. From then onwards there was an increase to another peak in 1995 with a record of nearly 315 new established international R&D partnerships. From 1995 to 1999, we can witness a decrease again to nearly 230 partnerships in 1999, still considerably higher than the figures found for most years since the early 1980s. In 2000, the number of
partnerships again increased to almost 260 newly established international R&D partnerships.

In other words, there is a clear pattern of growth in the newly made R&D partnerships if one looks at the historical data since 1971. In the early years there was a steady growth pattern with an acceleration since the 1980s. Explanations for this overall growth pattern of newly made international R&D partnerships are generally related to motives that lead to collaborations on R&D by companies. The main drivers for this growth are related to important industrial and technological changes in the 1980s and 1990s that have led to increased complexity of scientific and technological development, higher uncertainty surrounding R&D, increasing costs of R&D projects, and shortened innovation cycles that favour collaboration (see Contractor and Lorange, 1988; Dussauge and Garette, 1999; Hagedoorn, 1993, 1996; Mowery, 1988; Mytelka, 1991; Nooteboom, 1999; OECD, 1992).

In the above we indicated that previous contributions had already established that joint ventures seem to have become gradually less popular if compared to other forms of partnering. If we consider the specific trend for international R&D partnerships during the past three decades, we arrive at a similar conclusion. Looking at the overall trend in Figure 7.2, we notice a sharp decline in the share of joint ventures in international R&D partnering from on average an 85 per cent share in the early 1970s to 15 per cent in 2000. During the mid-1970s the share of R&D joint ventures was still at a level of about 70 per cent, whereas in the early 1980s this share reached around 55 per cent. In the late 1980s, the share of joint ventures increased to

![Graph showing the share (%) of joint ventures in all newly established international R&D partnerships, 1971-2000](image)

**Figure 7.2.** The share (%) of joint ventures in all newly established international R&D partnerships, 1971–2000

Source: MERIT-CATT database.
nearly 65 per cent, after which the downward trend reached a level of 20 per cent during the first half of the 1990s, until it arrived at a small share of 15 per cent at the end of the decade. These overall trends in newly established international R&D partnerships indicate two major developments. First, companies seem to increasingly prefer contractual partnerships to joint ventures. Second, the growth in partnerships since the early 1980s is largely caused by an overwhelming increase in the absolute numbers of contractual partnerships.

Sectoral patterns in international R&D partnerships

According to the literature, inter-firm partnerships are associated with so-called high-tech sectors and other sectors, where learning and flexibility are important features of the competitive landscape (Ciborra, 1991; Dussauge and Garett, 1999; Eisenhardt and Schoonhoven, 1996; Gomes-Casseres, 1996; Harrigan and Newman, 1990; Oster, 1992). The literature also reveals that many R&D partnerships are concentrated in a limited number of, mainly R&D intensive, industries (see for instance, Dussauge and Garett, 1999; Hagedoorn and Schakenraad, 1993; Link and Bauer, 1989; Mytelka, 1991). As this chapter concentrates on international R&D partnership, one can expect that, given the asymmetrical distribution of R&D efforts across industries, this particular group of partnerships will also be concentrated in R&D-intensive industries.

In order to discuss the importance of sectoral differences in R&D partnering, R&D intensity indicators will be used to differentiate between industries. High-tech sectors (with an R&D intensity ranging from 10 per cent to 15 per cent) include: pharmaceuticals including biotech, information technology, aerospace and defense, and heavy electrical equipment. Medium-tech sectors (with an average R&D intensity ranging from 3 per cent to 5 per cent): chemicals, automotive, consumer electronics, and instrumentation and medical technology. Finally, low-tech sectors (with an R&D intensity below 1 per cent) include: food and beverages, metals, and oil and gas (see OECD, 1997).

During the whole period, that is from 1971 to 2000, the share of high-tech sectors was 68 per cent. The share of medium-tech sectors accounted for 30 per cent. Finally, low-tech sectors had a share of 2 per cent during this period. From Figure 7.3 it can be seen that the above-mentioned expected dominance of R&D partnering by high-tech, that is R&D-intensive, industries has only gradually developed as it did not become apparent until the mid-1980s. During the 1970s, R&D partnerships in high-tech industries still counted for only between 20 per cent and 50 per cent. During that same period, medium-tech industries had a share of between at least 50 per cent and 80 per cent. Although the share of medium-tech sectors is high, we witness a decrease over time.

The 1980s and 1990s marked a period where the growth of R&D-intensive industries is reflected in the increasing importance of these high-tech industries.
in R&D partnering. From 1980 to 1997, the share of high-tech industries in newly established international R&D partnerships increased from about 50 per cent to over 80 per cent, after which there was some decline. During the same period, the share of medium-tech industries in these partnerships decreased sharply from about 50 per cent to less than 20 per cent from 1980 to 1997, after which we can witness an increase again. In 2000, the share of newly established international R&D partnerships in the medium-tech sector was nearly 30 per cent. The share in the high-tech sector was more than twice as much, that is nearly 70 per cent.

As high-tech industries have become so dominant in international R&D partnering, we also looked at the trends in the share of individual high-tech sectors (see Figure 7.4). The information technology sector (including computers and office equipment, telecom, semiconductors, industrial automation and software) has become important in terms of its total R&D effort, which is reflected in its share in international R&D partnering. With a few exceptional years during the 1970s and the mid-1990s, the information technology sector takes by far the largest share in the sectoral distribution of R&D partnerships. During the first half of the 1970s, it had an average share of about 6 per cent of all these partnerships, rising quickly to around 20 per cent at the end of the 1970s. The early 1980s mark a period in
which there was a very sharp increase in the share of the information technology sector from around 20 per cent in the early 1980s to on average 45 per cent during the rest of the decade. In the early 1990s there was again a decrease after which the average share of the information technology industry remains on average around 35 per cent.

Since the early 1970s there was a gradual increase in the share of pharmaceutical R&D partnerships, rising from about 10 per cent during most of the 1970s to 15 per cent during most of the 1980s. After a decline to about 10 per cent at the turn of the decade, the share of pharmaceutical R&D partnerships rose to nearly 40 per cent in 1996, after which we can again witness a decline. In 2000, the share of the pharmaceutical industry in international R&D partnerships was above 30 per cent, that is very close to the share of the information technology industry.

While the information technology sector and the pharmaceutical industry have become so dominant in international R&D partnering in high-tech industries, the share for the third and fourth high-tech industries, that is the aerospace and defense sector and the heavy electrical equipment sector, has remained relatively small. During the 1970s their shares were around 10 and 5 per cent, respectively. During most of the 1980s, the share of the aerospace and defense sector was around 5 per cent and peaked at 15 per cent in 1991, after which it decreased again. During the rest of the 1990s its share decreased to only 2 per cent in 2000. The share of the heavy electrical equipment sector was also around 5 per cent during the 1980s, while it decreased to 2 per cent during the 1990s.
With respect to the most important trends in medium-tech sectors, it can be said that the chemical sector dominates international R&D partnering in those industries. There is a decreasing trend in its share, starting at 50 per cent in 1971 to 10 per cent in 2000. The consumer electronics sector started quite dominant with about 30 per cent during the early 1970s, which decreased to 2 per cent at the end of the decade. During the 1980s and 1990s it remained at a level of around 2 per cent. The share of the automotive industry in medium-tech sectors remains around 5 per cent during the period from the 1970s to the early 1990s. Since 1995 there has been an increase, resulting in a share of 12 per cent in 2000. The share of the instrumentation and medical technology sector remained around 5 per cent from 1971 to 2000.

Finally, it will come as no surprise that low-tech industries (for instance food and beverages, metals, and oil and gas) do not seem to play an important role in all of this. The share of low-tech industries fluctuated around 6 per cent during the first half of the 1970s, after which their share remained at about 2 per cent.

Patterns in international R&D partnerships of companies from different economic regions

To take a closer look at international differences in R&D partnering, we now differentiate between partnerships and companies from different economic regions and trading blocks. The first group of countries that we distinguish consists of the OECD countries, that is the Triad (North America, Western Europe and Japan), and Australia, New Zealand, Turkey and South Korea. Partnerships and companies from the so-called newly industrialized countries (NIC) include Taiwan, Singapore, Malaysia, Hong Kong, some Latin American countries (Brazil, Argentina, and Mexico) and Israel. Partnerships and companies from the so-called less-developed countries (LDC) include Latin American countries (with the exception of those mentioned above), Asian countries (with the exception of those mentioned above) and Africa. Finally, partnerships and companies from East European previously state-run economies and former communist countries (FCC) refer to Bulgaria, Croatia, the Czech Republic (including former Czechoslovakia), Hungary, Kazakhstan, Poland, the People's Republic of China, the Russian Federation (including the former Soviet Union), Slovakia, Ukraine, Vietnam and (former) Yugoslavia.

When analysing trends and patterns in international R&D partnerships, we will use the following division: intra-OECD partnerships include all partnerships between companies from the OECD. Next, OECD-NIC partnerships, OECD-LDC partnerships, and OECD-FCC partnerships refer to partnerships in which at least one of the partners is from the OECD, whereas
also at least one of the other partners is from a NIC, LDC or FCC country respectively. Finally, non-OECD partnerships include all partnerships in which none of the partnering companies is from the OECD. Looking at the overall pattern in R&D partnering during the period under study, that is 1971–2000 (see Figure 7.5), it becomes clear that companies from the OECD have participated in over 99 per cent of these newly established international R&D partnerships. More than 90 per cent of the R&D partnerships are made between companies from the OECD. When taking a closer look at the distribution of these R&D partnerships for individual countries, it becomes clear that the USA plays a very dominant role. More than 70 per cent of all international R&D partnerships have at least one US company as a partner (see also Plasschaert and Van Den Bulcke, 1992). Japan comes second with almost 28 per cent of all international R&D partnerships having at least one Japanese company. The leading countries in Europe are the United Kingdom and Germany (both around 18 per cent), France (13 per cent) and the Netherlands (11 per cent).

Additional statistics, not presented in this chapter, reveal that the dominance of the USA has gradually increased from a share in international R&D partnerships of around 60 per cent in the 1970s to around 65 per cent and 75 per cent in the next two decades. Interestingly, the development in the share of Japanese companies has followed an opposite direction; it decreased from more than 40 per cent in the first decade of this study to respectively less than 35 per cent and around 20 per cent in the following two decades. Finally, Germany's share witnessed an increase from 13 per cent in the first decade to over 20 per cent in 1990–2000. Most other countries underwent relatively small changes.

![Figure 7.5 Distribution of newly established international R&D partnerships by economic region, 1971–2000](image)

*Source: MERIT-CATI database.*
Additional material also indicates that there has been a more or less gradual decline in the share of joint ventures in intra-OECD R&D partnerships, from 80 per cent in 1971 to nearly 15 per cent in 2000. The share of joint ventures in the total of OECD-NIC, OECD-LDC and OECD-FCC partnerships started at 100 per cent in the 1970s and this also decreased to nearly 15 per cent in 2000. The share of joint ventures in non-OECD R&D partnerships has remained rather high throughout the period 1971–2000. The share of joint ventures was around 65 per cent during the 1970s, while it decreased to around 50 per cent during the 1990s.

These findings are consistent with previous literature. Freeman and Hagedoorn (1994) analysed the extent to which diverging international patterns in the distribution of technological capabilities are also found in inter-firm technology cooperation. They reported that over 95 per cent of research relationships have been established within the Triad, suggesting a straightforward relationship between the degree of technological sophistication of an industry and the degree of participation of firms from less-developed countries. Not surprisingly, the higher the R&D intensity of the industry, the lower the participation of companies from developing and emerging economies, as such firms are seldom in possession of knowledge-intensive resources that would be attractive to a Triad partner.

Freeman and Hagedoorn (1994) also concluded that in high-tech industries the share of the intra-Triad research relationships established during the 1980s remained high, whereas the growth of inter-firm research partnerships with partners from outside the Triad was primarily found in partnerships with companies from Asian countries, such as South Korea, Taiwan, Singapore and Hong Kong. Furthermore, one of their major conclusions was that inter-firm partnering had not led to a catching up of the LDC countries and most of the NIC countries, as it is much more part of a process of concentration of technological competencies within the developed economies (Freeman and Hagedoorn, 1994; Hagedoorn, 1996).

Additionally, Duysters and Hagedoorn (2000) found that technological complementarity between partners turns out to be the major driving force behind the growth of international strategic technology partnerships. The most advanced NIC countries have increasingly become aware of the importance of building up technological competencies in knowledge-intensive sectors; technological know-how from companies in the developed economies is crucial to establishing a prominent (technological) position in high-tech markets. NIC companies were gradually becoming interesting partners for companies from the developed economies due to their technology-intensive assets, particularly in electronics and related industries.

Therefore it is not surprising that compared with other international partnerships, Triad-NIC partnerships are increasingly found in high-tech sectors. The use of contractual agreements, dominating intra-Triad alliance formation since the 1980s, has also become widespread practice for Triad-NIC
partnerships in the 1990s. This could indicate that these partnerships have reached a general level of sophistication that is coming close to that of many domestic and international R&D partnerships between major trading partners. If one considers these major changes, then it is clear that several NIC countries have developed from ‘junior’ partners in the early 1970s to important players in the 1990s (Duysters and Hagedoorn, 2000).

Patterns in international R&D partnerships of companies from FCC countries

As mentioned in the introduction, it is interesting to take a closer look at the FCC countries. According to Sadowski and Hagedoorn (1997), inter-firm partnering with firms from capitalist countries were the exception for companies from FCC countries prior to the opening of their economies to the West. According to our data, the number of R&D partnerships with FCC countries was very low during most of the 1970s and 1980s (see Figure 7.6). Their total number increased rapidly during the late 1980s and early 1990s, although it remained a ‘bumpy ride’. The establishment of R&D partnerships reached a peak in 1989, but the subsequent two years showed a sharp decrease. One year later, the establishment of inter-firm partnerships began to increase again, and in 1993 there was a second peak, albeit much lower than in 1989. From then onwards the amount of international R&D partnerships decreased again, with a third but relatively small peak in 1999.

Throughout this period, joint ventures played a dominant role in the formation of R&D partnerships with companies from FCC countries,

![Figure 7.6 Number of newly established international R&D partnerships with companies from FCC countries, 1971–2000](image_url)

Source: MERIT-CATI database.
although contractual partnerships gradually gained importance. From the 87 R&D partnerships formed between 1971 and 1990, 86.2 per cent were joint ventures. From the 82 partnerships that were established between 1991 and 2000, 53.7 per cent were joint ventures. Since the late 1980s, the importance of contractual R&D partnerships increased, and although the number is still very small, it is interesting to note that in the year 2000 all newly established R&D partnerships were contractual arrangements.

During the period 1971–2000 there was a strong dominance of high-tech sectors, taking 59.9 per cent of the international R&D partnerships with companies from FCC countries, followed by medium-tech sectors taking 38.4 per cent. Low-tech industries do not play a significant role. It is interesting to note that partnerships made in the information technology sector have dominated international R&D partnering with companies from FCC countries throughout this period. Sadowski and Hagedoorn (1997) indicated that most of these partnerships were state-regulated partnerships created to improve the telecommunications infrastructure in FCC countries. Other important sectors were chemicals, and aerospace and defence industries, followed by automotive, heavy electrical equipment and pharmaceuticals (see Figure 7.7).

Since the late 1980s, companies from Russia and China have played a dominant role in international R&D partnering with FCC countries (see Figure 7.8). More than 40 per cent of the R&D partnerships were established with companies from China and around 35 per cent with companies from the Russian Federation (including the former Soviet Union). These countries are followed by Hungary with almost 10 per cent, and Bulgaria, (former)

![Figure 7.7: Number of newly established international R&D partnerships with companies from FCC countries per sector, 1971–2000.](image)

Source: MERIT-CATI database.
Yugoslavia, and the Czech Republic (including former Czechoslovakia) with less than 5 per cent. The share of the other countries such as Poland, Croatia, Slovakia, Vietnam, Ukraine and Kazakhstan is very small.

Most of the R&D partnerships with Russian companies have been established in high-tech sectors, especially in information technology and chemicals. During the 1990s, the role of the high-tech sector in Russia became even stronger with the opening of the defense and aircraft sectors (Sadowski and Hagedoorn, 1997). Between 1992 and 1995, most of the R&D partnerships with Russian companies were formed in the aerospace and defense industries.

In terms of the form of R&D partnering with Russian companies, we notice a radical change. During the 1980s, 89 per cent of these international partnerships would be a joint venture, whilst during the 1990s more than 60 per cent of the newly established partnerships were of a contractual nature. Hagedoorn and Sedaitis (1998) indicated that partnerships with older Russian companies dating from the days of the centrally planned economy usually took the joint-venture form, whereas new firms were inclined to engage in contractual partnerships.

The creation of international R&D partnerships with Chinese companies has gained importance since the early 1980s (see also Zhang and Van Den Bulcke, 2000), and changes in Chinese regulations to encourage foreign investments (Van Den Bulcke and Zhang, 1998) probably played a role. During the 1980s, 86 per cent of all R&D partnerships in China were equity-based and most of them were established in the medium-tech sector. During the 1990s, around 67 per cent of the partnerships established with Chinese companies were still joint ventures. During this second wave of partnership formation, medium-tech and high-tech sectors gained importance. Chemicals
and information technology have become the most dominant sectors in R&D partnering with Chinese companies. These findings with respect to the dominance of joint ventures and particular industries are supported by previous literature on the internationalization of the Chinese economy (see for instance, Van Den Bulcke and Zhang, 1998).

Conclusions

Despite an overall increase in international R&D partnerships, their importance has become relatively more concentrated within major economic regions instead of becoming overwhelmingly global (see also Duysters and Hagedoorn, 1996). Such partnerships are dominated by companies from the world's most developed economies, and companies from OECD countries participate in nearly 99 per cent of all the international R&D partnerships and more than 90 per cent of these are within the OECD. US companies in particular play a dominant role in international R&D partnering. More than 70 per cent of all partnerships have been established with at least one US company, whereas more than 65 per cent of these partnerships are made between at least one US company and the OECD. This picture parallels the current worldwide distribution of R&D resources and capabilities (Freeman and Hagedoorn, 1994). The dominance of the USA also reflects its leading role in R&D and production in major high-tech industries such as the information technology industry and pharmaceutical biotechnology (OECD, 1992).

The overall growth in international R&D partnerships during the past decades is largely due to the growth in the number of contractual agreements. The dominant position of joint ventures in inter-firm R&D agreements is now almost completely taken over by contractual agreements as about 85 per cent of the recently established international partnerships are of a contractual nature. In general, the demand for flexibility has increased in many industries, where inter-firm competition is affected by increased technological development, innovation races and the constant need to generate new products. Contractual international R&D partnerships enable companies to increase their strategic flexibility through short-term joint R&D projects with a variety of partners.

The role of technological development is also apparent in the sectoral background of international R&D partnering. Over the last three decades, there has been a gradual increase in the share of high-tech industries in International R&D partnering. During the late 1990s, nearly 70 per cent of the newly established International R&D partnerships could be found in the information technology and pharmaceutical industries. There is an over-representation of contractual partnerships in these sectors, which again stresses the role of flexibility in inter-firm R&D partnering.

Two FCC countries, the Russian Federation and China, have witnessed a significant increase in newly established International R&D partnerships.
since the late 1980s. There is a strong dominance of R&D partnerships in high-tech industries, such as aerospace and defense, information technology, and in a large medium-tech industry, the chemicals sector. Although equity joint ventures are still important modes of partnering with companies from the Russian Federation and China, contractual modes of research partnerships have become very relevant in these industries.

As already mentioned, international R&D partnering appears to be heavily concentrated within the developed countries (OECD). Sadowski and Hagedoorn (1997) indicate that many companies from the developing countries and the FCC countries are locked-out from R&D partnerships concentrated in information technology and biotechnology. The maintenance of an advanced civilian technological infrastructure in order to approach worldwide technology standards is a prerequisite for FCC firms that wish to participate in international R&D partnering. We expect that structural changes in FCC countries, such as the opening of the defense and aircraft sectors and all kinds of deregulations to encourage foreign investments (Van Den Bulcke and Zhang, 1998), will foster the internationalization of the FCC economies and their further participation in international partnering.

Appendix: the MERIT-CATI database

The Cooperative Agreements and Technology Indicators (CATI) database 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 thousands of technology-related inter-firm partnerships has been collected for the period 1960–2000. Systematic collection of such information started in 1987, although many sources from earlier years are consulted to establish a retrospective view. 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 partnerships.

This method of information gathering, which one can refer to as ‘literature-based alliance counting’, has its drawbacks and limitations due to the lack of publicity for certain arrangements, and the low profile of certain groups of companies and fields of technology. Despite these shortcomings, which are largely unsolvable even in a situation of extensive and large-scale data collection, this database is able to produce a clear picture of the joint efforts of many companies and enables researchers to perform empirical research which goes beyond case studies.

The database contains information on each agreement and some information on companies participating in these agreements. The first entity is the inter-firm cooperative agreement. Cooperative agreements are defined as common interests between independent (industrial) partners which are not connected through (majority) ownership. In the CATI database only these inter-firm agreements are being collected that contain some arrangements for transferring technology or doing joint research. Joint research pacts and second-source data are clear-cut examples. Information is also collected on joint ventures in which new technology is received from at least one of the
partners, or joint ventures having some R&D programme. Mere production or marketing joint ventures are excluded. In other words, this material is primarily related to R&D collaboration and technology cooperation, that is those agreements for which a combined innovative activity or an exchange of technology is at least part of the agreement.

References


