THE POLITICAL ECONOMY OF STRATEGIC PARTNERING

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BY

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EXECUTIVE SUMMARY

This paper seeks to define strategic partnerships, map out the sectors and directions in which they concentrate, analyze the dynamics behind their formation, identify the factors that appear to contribute to their success or failure, and draw out some of the implications of the above for Canadian investment and technology policy.

A. Definitions

Strategic partnerships are defined as long-term agreements among firms designed to deal with the uncertainties of technological change. Strategic partnerships do not require either equity participation or remuneration for goods and services. By pooling resources, especially in technological expertise, they facilitate a reduction in the costs, risks, and uncertainties associated with research and development.

B. Characteristics of Strategic Partnerships

An examination of four published data bases yields several observations about the nature of strategic partnerships.

i. The number of agreements is increasing over time.

ii. Inter-firm agreements show a clear predominance of U.S. firms as the principal partners.

iii. Technology production and sharing have become important components of inter-firm cooperative agreements.

iv. Larger firms are more likely to enter into multiple agreements with a variety of partners to achieve their technological objectives.

v. Inter-industry and intra-industry agreements have both increased in importance.

C. The Dynamics Behind the Formation of Inter-Firm Cooperative Agreements

In the early twentieth century, companies began to require increasing knowledge to keep both their products and processes competitive. By the 1960s and 1970s, low productivity growth, high inflation and competition from low-wage countries accelerated the search for new technologies that might confer an advantage in the global marketplace. As a result, firms in dynamic, knowledge-oriented industries now formulate corporate strategy around technological capabilities as well as with a view to market characteristics. They realize that a strong foundation in several "generic" technologies can be applied to a wide variety of markets.

In order to develop such a base on a broad foundation, companies are increasingly entering into agreements with firms possessing complementary technological capabilities. This allows them to develop or access the necessary expertise without reducing flexibility by adding to the firm's inertia.

D. Factors Affecting the Success or Failure of Strategic Partnerships

In an ideal strategic partnership, each party should be able to contribute some part of the technology and each should be truly dependent on the other's contribution. Nonetheless, stable partnerships may be entered into which involve the provision of market access in return for a particular technology, or long-term customer-supplier relationships.

It is less likely that enduring partnerships can evolve between companies that are head-to-head competitors. Nor are they likely to arise if a large company supplies critical knowledge to a smaller firm as a way of locking it into an obsolescent technology. Such arrangements are inherently unstable and self-defeating, though smaller companies are especially vulnerable to them. For an inter-firm agreement to work it is necessary that both sides carefully define their needs and interests through close personal interaction and detailed negotiation.

E. Policy Implications

The increasing knowledge-intensity of products and processes has important implications for investment and technology policy. Companies not only need to engage in high level R&D, but they should seek partners with complementary technological capabilities. Since such partnerships are likely to be international in scope, the narrowly nationalistic and protectionist policies of the past demand revision.

In their place, new policies emphasizing R&D funding are being implemented in Europe, Japan and the United States.

The policies implemented must take into account the peculiar needs and characteristics of the country adopting them.

In the case of Canada, adoption of knowledge-intensive flexible production techniques holds out the promise of overcoming traditional Canadian disadvantages associated with a relatively small domestic market. Therefore Canadian investment policy must be geared to helping Canadian companies identify appropriate sectors, technologies, and partners that will assist them in adopting flexible production methods.

Additionally, investment policy should facilitate the shift toward more knowledge-intensive production by providing funding and assistance in order to:

- restructure activities within knowledge-intensive enterprises;
- negotiate strategic partnerships with foreign firms;
- stimulate R&D in frontier technology sectors in which Canadian firms can be internationally competitive.

Finally, investment policy should be augmented by a technology policy that supports basic research into generic technologies, complements initiatives in higher education, and encourages consortial R&D involving private firms, universities, and research institutions.

THE POLITICAL ECONOMY OF STRATEGIC PARTNERING

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November 1987

A. DEFINITIONS

There is, as yet, no single generally accepted definition of a strategic partnership, or, as it has also been called, a strategic alliance, or an inter-firm cooperative agreement. Nevertheless, it is possible to differentiate strategic alliances from both traditional joint ventures and from the broader set of industrial technical linkages into which firms have entered.

A joint venture is a form of direct investment. It may be defined as an agreement in which two independent legal partners establish a third independent legal firm. Consequently, an international joint venture can be viewed as a form of foreign direct investment.

Some, but not all, strategic partnerships are joint ventures. For example, some strategic partnerships do not involve an exchange of equity or indeed any direct investment at all.

"Strategic" partnerships, moreover, imply longer term considerations than those behind many joint ventures concerned with short-term profits. Joint ventures such as these are geared towards increasing sales or market shares through joint production or marketing activities. They can include either import substituting joint ventures that use the product and/or process technology of the foreign partner, or export-oriented extractive or manufacturing joint ventures in which the design, engineering or management technologies are supplied by the foreign partner.

Neither of these forms of direct investment or subcontracting is considered a strategic partnership. On the other hand, original Equipment Manufacturer (OEM) agreements are widely regarded as strategic partnerships. So, too, are the ATT-Philips agreement of August 1983 that created AT&T and Philips Telecommunications (APT), with headquarters in The Netherlands, and the ATT-Olivetti agreement of December 1983, under which ATT took a 25 percent interest in Olivetti. In these examples, the critical feature defining the strategic partnership is not the new legal entity created, but the purpose of the partnership.

Prior to World War II, international joint ventures resembled other forms of foreign direct investment in being concentrated in trading, mining or agricultural activities. By 1955, among the 180 U.S. multinationals covered by the Harvard Multinational Enterprise Survey, 58 percent of the joint ventures undertaken involved manufacturing. This figure rose to an average of 71 percent in the period 1956-65, falling slightly over the years 1966-75 to an average of 67.1 percent.

The absence of references to R&D activities in studies dealing with joint venture activity in this period would suggest that collaborative R&D remained uncommon in foreign joint venture subsidiaries until well into the 1970s. This is consonant with the need for easy access to the results of R&D and its strategic importance to the mode of international competition prevailing at that time. As competition changed, however, so too did the importance of collaborative R&D. The possiblity of such collaboration marks one of the important distinctions between the traditional joint venture and the joint venture that is also a strategic partnership.

Firms have developed a whole range of technical linkages in recent years. These may include R&D consortia with universities, research and development limited partnerships funded by banks or larger firms, and collective research performed by professional associations. Such activities are not in themselves strategic partnerships, though they may complement partnering activity. Some examples of such complementary efforts are the consortia established between European firms, research institutes, and university laboratories through the European Strategic Program for Research in Information Technologies (ESPRIT). In such examples, one vitally important function of strategic partnerships emerges: the production and sharing of knowledge.

Another significant feature of strategic partnerships is that they bring together firms that are actual or potential competitors. This feature, however, is not unique to strategic partnerships. Licensing and co-production by the licenser, also frequently brought together nominal competitors. This was true, for example, in the case of General Electric and Toshiba, or of Westinghouse and Mitsubishi during the 1970s.

In both the electrical industry during the first part of this century and the European petrochemical industry during the 1970s, cartels were formed among competitors to maintain profits by fixing price and output levels in given product markets. Strategic partnerships, however, trace their origins to a different dynamic and are designed to deal not with short-term profit considerations but with the longer term uncertainties of technological change.

In sum, like the joint venture, strategic partnerships are explicit, long-term agreements among firms. However, a post facto observation that a continuous but unformalized supplier-client relationship has come into existence does not qualify as a strategic partnership. Nor does a one-time purchase of goods or services.

Unlike the joint venture, however, strategic partnerships may or may not involve financial remuneration for goods and services, equity participation, or equity exchange. Mergers and takeovers, moreover, are considered distinct from strategic partnerships as are most joint ventures in production and marketing that have market penetration or cost reduction as their principal objective. Such ventures, together with traditional forms of licensing, are not strategic in nature.

Co-production, however, in which each of the partners contributes some element of the product design or manufacturing technology, would fall within the definition of a strategic partnership. So, too, would all inter-firm cooperative agreements that involve a knowledge production or knowledge sharing component. This may include joint ventures between firms in the advanced industrial and the less developed countries, as in some U.S.-Korean partnerships in the semiconductor industry. In the case of a strategic partnership, the decision to engage in an international collaborative agreement and the choice of partner are both functions of the strategic objective, and that objective, in an important and central way, involves knowledge production or knowledge sharing.

B. CHARACTERISTICS OF STRATEGIC PARTNERSHIPS

There are four data bases on inter-firm cooperative agreements that are extremely helpful in assessing the prevalence and direction of this new form of corporate activity.[1] The data bases have been prepared from published materials by the Center for Science and Technology Policy, Troy, N.Y.; Venture Economics, Wellesley, Massachusetts; Futuro Organizzazione Risorse (FOR), Rome; and the Centre d'Études et de Recherches sur les Entreprises Multinationales (CEREM) at the University of Paris. However, because their scope and contents differ, the data they contain cannot be aggregated and will be treated separately to illustrate the essential characteristics of this phenomenon.

These data bases contain enough information to draw a number of conclusions with respect to the principal characteristics of strategic partnering activity.

Venture Economics has similarly focussed on a specific set of firms and strategies: in this case, the alliance strategies of firms that have been the recipients of investments by venture capital firms. Their sample pool is thus largely restricted to agreements between a large firm and a smaller firm, and these agreements all involve an equity investment by the larger firm in the smaller firm with a view to providing the latter with capital for research and development activities.

In contrast to the above two data bases, in which the firm is the focus of attention, the data bases created by FOR and CEREM have been constructed around the agreements themselves, although the industrial sectors and dates for which data on agreements have been collected differ. In the case of FOR, data were collected for years 1982-85 and cover all agreements in the electronics, telecommunications, computer, aerospace, scientific instrumentation and pharmaceutical industries entered into by firms from the United States, Europe, Japan, the Asian NICs (newly-industrialized countries) and China. The data base presently contains 974 agreements.

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1. The Center for Science and Technology Policy has initiated studies on inter-firm cooperative agreements in three industrial sectors -- semiconductors, machine tools and biotechnology. In the semiconductor industry, the focus is upon a sample of 41 semiconductor firms and the 121 agreements they concluded over the period 1978-84. The machine-tool study covers the years 1980 through October 1985 and includes 162 firms involved in 132 agreements. The biotechnology study is now in progress.

The CEREM data base covers a similar range of sectors: aerospace; biotechnology; information technology, including computers, components, software and telecommunications; and the materials industries. Its time span, 1980-85, is somewhat longer than FOR's, but its coverage is restricted to agreements to which a firm from the European Community (EC) has been a party. The CEREM data base contains 481 agreements.

i) The number of agreements is increasing over time.

Each of the data bases for which it was possible to disaggregate the data by year shows an increase in the number of reported agreements over time. Table 1 presents the distribution of inter-firm agreements by function and by year from the CEREM data base. There it can be seen that the number of reported agreements rose from 15 in 1980 to 149 in 1985.

TABLE 1

DISTRIBUTION OF INTER-FIRM AGREEMENTS°
BY FUNCTION: 1980-85

Year	Knowledge	Production	Commercialization	Global*	Total
1980	11	12	6	2	15
1981	15	13	10	10	31
1982	17	16	15	24	58
1983	24	25	31	41	97
1984	36	37	36	57	131
1985	47	39	51	58	149
TOTAL	150	142	149	192	481
Percent	31.2	29.5	31.0	39.9	100

°Includes only agreements to which at least one European-based firm is a party.

*Agreements that involve two or more of the preceding functions.

Source: LAREA/CEREM, 1986b, 8.

Data from Venture Economics on the number of corporate strategic investments in venture-capital-backed companies (Figure 1) similarly shows a rising number of such strategic alliances. From 30 per year in the first three years of their survey, the total doubles in 1981 and doubles again two years later. In 1985, 245 corporate strategic investments were made.

Broken down by industrial sector, the data confirm the growing importance of strategic partnerships. In the semiconductor industry, for example, there has been a considerable rise in the number of agreements, from an average of two per year in the period 1978-80 to roughly 25 per year in the period 1982-84 (Figure 2).

In the machine tool industry, however, after a spectacular rise in the number of inter-firm agreements between 1982 and 1984, the figures through October 1985 show a possible small decline from 22 agreements in 1984 to 18 in the first three quarters of 1985 (Figure 3).

A number of factors suggest that such a decline, however, is not expected to continue over the medium term. First, the emergence of new intra-European, intra-Japanese and intra-American collaborative research programs provides a further stimulus to strategic partnering activities. Second, as an analysis of the European ESPRIT program illustrates, within the context of these collaborative research programs, large firms are not only developing their linkages with each other (Figure 4) but, as the case of CGE illustrates, they are networking more broadly with smaller firms (Figure 5). Were it not for the broader collaborative research program, many of these agreements would not have been reported in the professional and business press that is the principal sources for the data bases used in this analysis. Finally, inter-firm cooperative agreements among smaller firms comprise roughly a third of the projects undertaken within the context of the ESPRIT program. This also suggests that the phenomenon will continue to grow, at least in the short term.

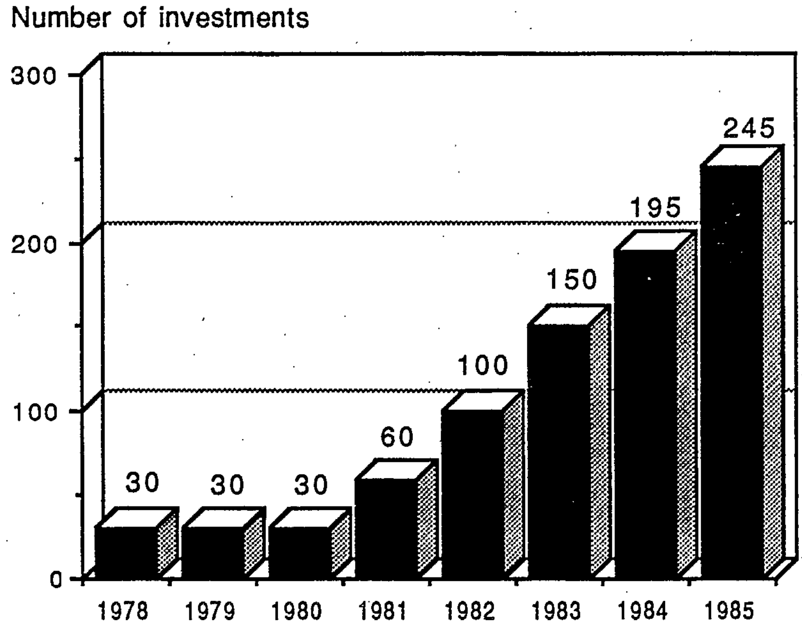

Figure 1. Corporate strategic investments in venture-capital-backed companies, 1978-1985.

Source: Venture Economics Inc., 1987a.

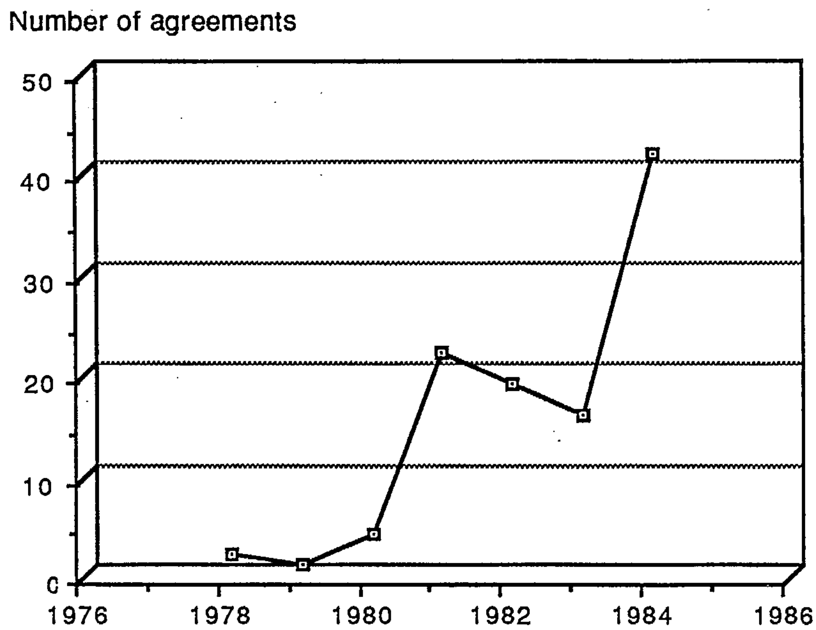

Figure 2. Interfirm cooperative agreements in the semiconductor industry, 1978-1984 (n = 106; 15 of the 121 agreements did not specify dates).

Source: Haklisch, 1986.

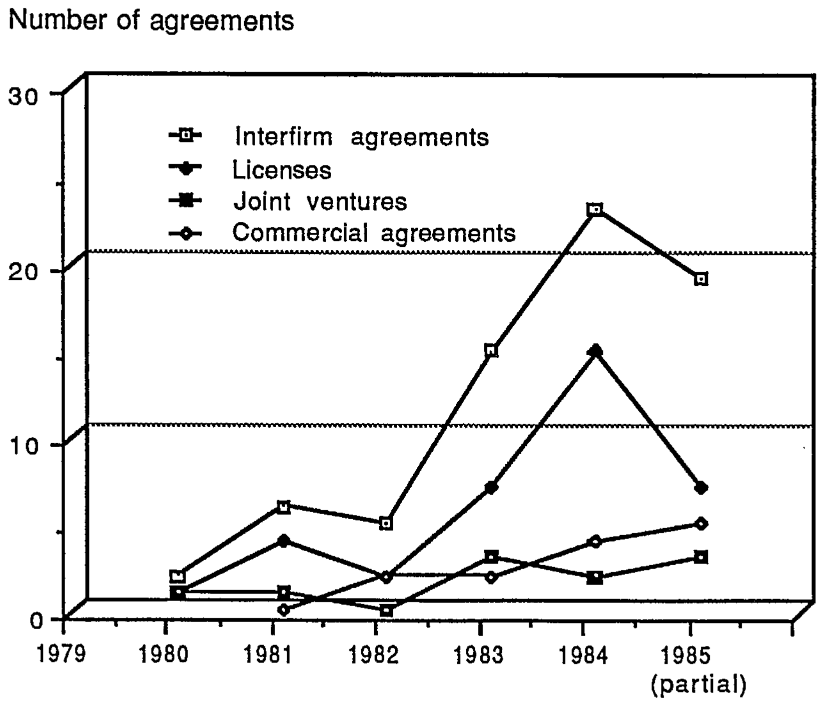

Figure 3. Interfirm cooperative agreements in the machine tool industry, 1980-1985 (data available only through October 1985).

Source: Haklisch and Vonortas, 1987.

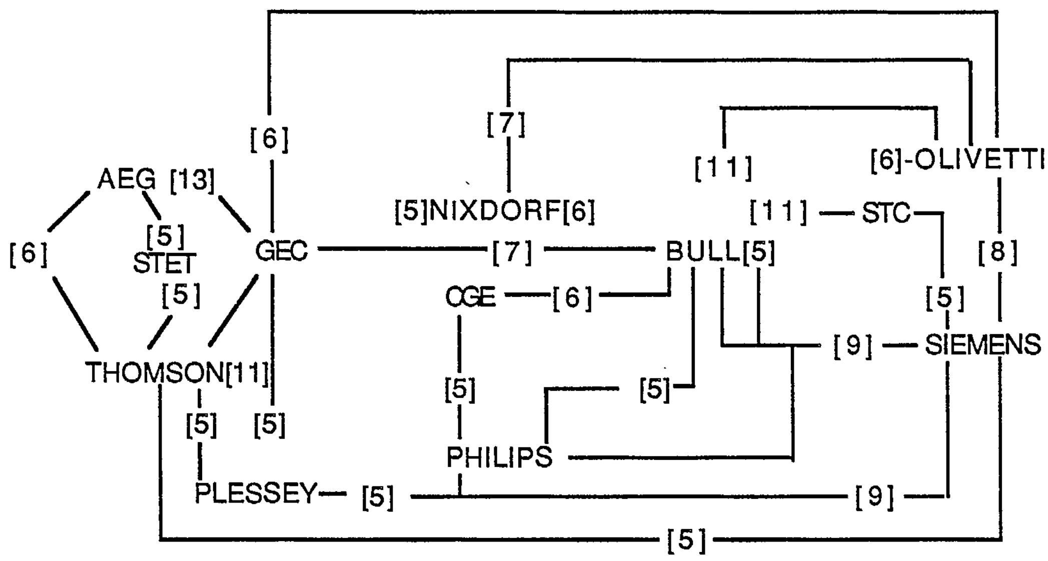

Figure 4. Linkages among Europe's major information technology firms through Esprit. (This diagram excludes pairs with less than five linkages.)

Source: Mytelka and Delapierre, forthcoming .

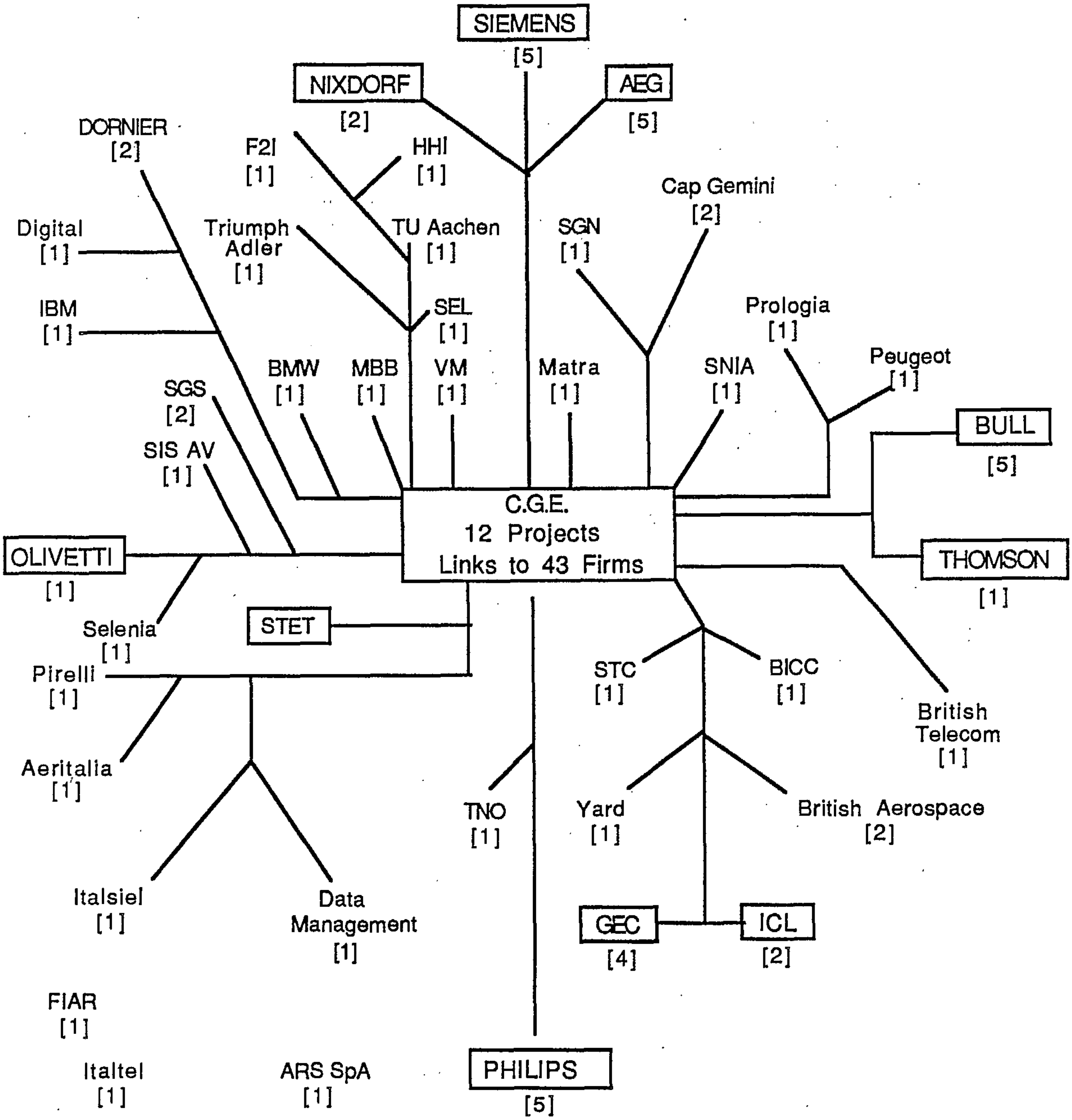

Figure 5. Compagnie Générale d'Electricité: inter-firm linkages through ESPRIT.

Notes: 1. Figures in parentheses indicate the number of agreements through which this firm is a partner with CGE.
2. Names enclosed in squares are members of the ESPRIT Management Committee.

Two other tendencies, however, are counterposed to these developments. A new wave of takeovers and mergers is accompanying this upsurge in collaborative R&D activity. As a result, the number of partners available for collaboration will decline. Participation in existing uncompleted projects, moreover, may slow down the rate at which new collaborative agreements between firms can be undertaken. There is some evidence for this in the lower participation rate of Italian firms in the second-year call for projects in the European ESPRIT program.

ii) Inter-firm agreements show a clear predominance for us firms as the principal partners.

Of the 974 agreements covered in the FOR data base, intra-U.S. agreements make up 24 percent, U.S.-EC agreements a further 26 percent and U.S.-Japan agreements 13 percent. Intra-EC agreements were only 14 percent of the total, EC-Japanese agreements were an even smaller 8 percent, and all other possible combinations came to only 15 percent. Thus the U.S. was a partner in 63 percent of the total agreements FOR surveyed.

Similarly, Table 2 shows that U.S. firms, with 100 agreements, were the most active in forging technical linkages. They were followed by Japanese with 64 and European with 53. American firms also sign a higher average number of agreements per firm (8.3) than Japanese (6.4) or European (3.5) firms.

TABLE 2

GEOGRAPHICAL DISTRIBUTION OF INTER-FIRM AGREEMENTS
SIGNED BY 41 SEMICONDUCTOR FIRMS

	U.S.	Japan	Europe	Korea	Total
U.S. firms	--	52	35	13	100
Japanese firms*	52	--	9	3	64
European firms*	35	9	4	3	53°
Korean firms	13	3	3	--	19

Notes: °U.S.-located firms fully owned by European companies (e.g., Signetics and Fairchild) are noted as European firms here.

*Includes two agreements with "others".

Source: Haklisch, 1986, 57.

Table 2 permits us to analyze the geographical preferences embedded in these partnerships. For American semiconductor companies, Japanese firms were the principal partners, accounting for 52 percent of all American agreements. Agreements with European firms, by contrast, accounted for only 35 percent of the U.S. total. Looked at in reverse, the importance of American alliances for Japanese semiconductor firms was even greater. Thus, agreements with U.S. firms constituted 81 percent of all reported intra-firm cooperative agreements concluded by Japanese semi-conductor firms in this period. Although the American connection was also important for European semi-conductor firms, linkages to U.S. firms accounted for only 66 percent of all such agreements, while agreements with Japanese firms accounted for 17 percent of the European total.

Looked at from the European perspective, of the 497 agreements surveyed by CEREM, on average only one fourth of the agreements involved an EC-based firm with another EC firm as partner. In well over 50 percent of the cases, the European firm's partner was an American company. There was, however, some variation by sector: for example, a smaller proportion of the EC's partners in the aerospace industry were non-EC. There was also variation by European country. French-based firms have a higher propensity to engage in a strategic alliance with American companies than do other EC firms. Thus, in 60 percent of the 163 agreements involving a French firm, the firm's partner was an American company. The comparable figures are 46 percent of the 57 agreements involving a UK firm, 42 percent of the 50 agreements involving a German firm, and 54 percent of the agreements involving an Italian firm.

iii) Technology production and sharing have become important components of inter-firm cooperative agreements.

Many inter-firm agreements are motivated by more than one concern. This gives rise to the possibility of double counting when preparing an analysis of these agreements. For example, one study by Mariti and Smiley reported that securing "economies of scale" was a factor in the case of every joint venture and bidding consortium considered. This motive is highly significant since joint ventures made up 55 percent of the agreements in the study, and bidding consortia another 29 percent.

On the other hand, it was also clear in the same study that the primary motivation of strategic partnerships was technology-related. Table 3 shows that in 41 percent of the cases studied the agreement was motivated by technological complementarity leading to a long-term transaction involving an exchange or sharing of technology.

Data from the CEREM survey of inter-firm cooperative agreements provides additional evidence of the growing importance of precisely this form of strategic partnering by European-based companies. Table 1 classifies these data by function. Agreements can involve knowledge production in a broad sense (choice of research priorities, joint pre-competitive research, joint engineering or development activities), goods production (including licensing, sub-contracting and joint ventures), and the commercialization of goods or services whether jointly produced or not. A fourth category covers global agreements involving at least two of these functions, as well as an exchange of equity.

Over the five-year period, the number of agreements involving a knowledge-production or knowledge-sharing component increased from 11 per year in 1980 to 47 per year in 1985, and the share of knowledge-production agreements in the total steadily increased from a low of 2.3 percent in 1980 to 9.8 percent in 1985.

It is difficult to correlate geographical preferences, the purpose of an inter-firm agreement, and industrial sectors. Only the CEREM data base permits a few tentative observations and these are, of course, limited to European-based firms. Looking first at the extent to which inter-firm cooperative agreements concentrate by sector, the data shows that of the 481 agreements surveyed, 244 are in the information technology sector, 104 in aerospace, 102 in materials, and only 51 in biotechnology. Over one-third of the agreements in aerospace and biotechnology involve a technology-production component. Although only 19 percent of the information-technology agreements are exclusively oriented towards technology production, a large number of the "global" agreements (31 percent of the total in this sector) also involve technology sharing. As for biotechnology, although fewer inter-firm cooperative agreements have been signed by firms in this sector, 34 percent of them are knowledge-production agreements. It would thus appear that the biotechnology industry is still "in an early and highly competitive stage, in which patentable processes and know-how are of great importance, and where even basic research can lead to commercial concepts that companies can quickly connect to practice" (Fusfeld and Haklisch, 1985, 9). Even here, however, firms are able to identify opportunities for cooperative activity. Work is also underway at CEREM on the automobile industry, but existing studies already indicate that a major effort in collaborative R&D has been undertaken by firms within this industry, and in partnership with electronics and robotics companies.

TABLE 3

MOTIVATIONS FOR INTER-FIRM COOPERATIVE AGREEMENTS CONTAINED IN THE FOR DATA BASE

Reported motivations for the agreement	% of total motivations
Technology transfer (a one way flow of information generally in the form of a licence)	29
Technological complementarity (long-term transactions involving an exchange or sharing of technology between the parties)	41
Marketing agreements (often between a producer and a distributor)	21
Economies of scale in production and/or distribution (including the rationalization of production through specialization in the production of components)	16
Risk-sharing (agreements that involve none of the above motivations but provide for the management of the operation by one partner while the other contributes capital and absorbs some of the risks of failure)	14

Source: Mariti and Smiley, 1983, 442.

The relationship between functionality and geographical preference is illustrated by the experience of the top 12 European information-technology firms. If inter-firm agreements within the context of the ESPRIT program are excluded, the remainder can be broken down by both partner and function to reveal a clear difference between intra-EC and EC-U.S. partnerships. Intra-EC agreements are oriented far more towards knowledge production than are agreements between EC and American firms. Thus, global agreements embodying a knowledge component account for 41 percent of total intra-EC agreements but only 20 percent of the EC-U.S. agreements. Knowledge- production agreements were 21 percent of intra-EC compared with 14 percent of the EC-U.S. agreements. While intra-EC agreements stressed knowledge production, EC-U.S. agreements related more to the need for greater market access. Thus, 37 percent of the EC-U.S. agreements involved the commercialization of products and a further 17 percent the production of goods. The comparable figures for intra-EC agreements were 27 percent and 9 percent respectively.

(iv) Larger firms are more likely to enter into multiple agreements with a variety of partners to achieve their technological objectives.

Because of their global scanning capabilities and the extensiveness of their international activities in trade and investment, larger firms frequently enter into multiple agreements with a variety of partners from different countries. The nature of the agreements they conclude tends to vary with respect to strategic importance and function. Any given firm may have adopted a number of alternative strategies as it pursues its broader strategic objectives. These may include participation in research consortia with universities, a research and development limited partnership, or inter-firm cooperative agreements each of which may involve a different form of technological cooperation and/or set of overall strategic objectives.

The example of the U.S. semiconductor firm, Motorola, illustrates this phenomenon. It has been pointed out that:

> Motorola is a member of Stanford University's center for Integrated Systems (CIS), the Semiconductor Research Corporation (SRC) and the Microelectronics and Computer Technology Corporation (MNCC). (It)...also has company-to-company technical agreements with National Semiconductor in the U.S. and with Thomson CSF and NV Philips abroad. It is also a major participant in 2 of the 3 teams established in Phase 2 of the U.S. Department of Defense Very High Speed Integrated Circuits (VHSIC) program.
>
> -- Haklisch, 1986, 2.

The phenomenon is not confined to the United States. Siemens, headquartered in the Federal Republic of Germany, for example, is involved in 24 inter-firm cooperative agreements, of which 13 are with other EC firms, seven with U.S. firms and four with Japanese firms. Among these strategic partnerships is the MEGA Project launched by Siemens with N.V. Philips to develop 1-megabit memories. A similar project using a different technology has been undertaken with the Japanese firm, Fujitsu. In another sphere of activity, Siemens has joined Bull of France and ICL of the UK to form the European Computer Research Center. It is linked through a 20 percent equity interest with AMD in the U.S. and has technical agreements with Intel and Zilog. In addition, it participates in 23 ESPRIT projects.

Through ESPRIT, Siemens is working with CGE of France, Philips of the Netherlands, Standard Telegraph and Cables of the U.K., CERCI of France, and Data Management of Italy to develop management support systems for software production and maintenance. It is cooperating with GEC and ICL of the U.K., Nixdorf of West Germany, Olivetti of Italy, and Bull of France to create a portable common tool environment that will be upwardly compatible with ATT's UNIX system. And it is collaborating with COMAU of Italy, Sincon SpA and Olivetti of Italy, and the Fraunhofer Gesellschaft of West Germany, to develop general purpose sensory-controlled systems for parts production.

(v) **Inter-industry and intra-industry agreements have both increased in importance.**

The growing number of agreements between firms in different industries is aptly reflected by the convergence of computing and telecommunications. Whereas the computer and the semiconductor industries have traditionally evolved in step, a link between information processing and transmission technology was only established in the 1970s. No company had a mastery over both computer and telecommunications technology while the rising costs of R&D had to be matched against the relatively short life cycles of these new products. Thus, even the largest firms were hard-pressed to create in-house R&D in both fields. Moreover, as product development costs soared and competition increased, small and medium-sized firms in the computer and telecommunications industries came under considerable financial pressure. At the national level these developments prompted a series of mergers, takeovers, and inter-firm cooperative agreements among computer and telecommunications companies.

Other industrial sectors followed a similar convergence. Numerical controls for machine tools as well as other machinery appeared in the 1970s, together with computer-assisted techniques for design manufacturing and management. As a result, just as in telecommunications and in the machine tool, aerospace, automobile, and eventually other machine-building industries, development came to rely heavily on research in the field of microelectronics and computers. For example, each development of new sewing techniques in Japan and Europe involved consortia of firms from the clothing, sewing machine manufacturing and robotics industries. In the automobile industry, strategic alliances brought together materials firms with electronics firms and automobile companies. For example, Hitachi is currently working with Nissan Diesel on the development of a ceramic diesel engine, Kyocera is collaborating with Honda Motors on ceramic engines, and Toshiba is cooperating with Toyota in the development of ceramic and gas turbines.

An analysis of the strategic partnerships concluded within the context of the European ESPRIT program reveals the importance of inter-industry agreements. Figure 5 illustrates some of these in the case of CGE, an electrical and electronics firms specializing in the telecommunications field. CGE is involved in joint research with firms from the computer industry (Nixdorf, Bull, ICL, IBM), the aerospace industry (British Aerospace, Aeritalia, SNIA, MBB), the automobile industry (BMW, Peugeot), as well as with tire manufacturers (Pirelli), consumer electronics firms (Philips), office machine manufacturers (Olivetti), many software companies, and other electronics and telecommunications firms.

Confirmation of the growing importance of both inter-industry and intra-industry linkages can also be found in the data collected by FOR on agreements involving technological complementarity. This data is presented in Table 4. Although the numbers are not large, certain industrial sectors clearly appear in a service relationship to other industries. This is the case, for example, in the electronics and data processing industry where both of the cooperative agreements involving technological complementarity were inter-industry. Three of the four agreements by mechanical engineering firms were also with firms from other industrial sectors. Curiously, the electrical/electronic appliances and telecommunications companies keep the majority of their inter-firm agreements within the same industry. This tendency, however, relates to the contemporary dynamics of competition in this industry. These include a rising number of mergers among telecommunications firms, a shakeout in consumer electronics, and a desire by larger firms to open a window on the future shape of the market through intra-industry cooperative agreements.

TABLE 4

AGREEMENTS CITING TECHNOLOGICAL COMPLEMENTARITY AS A MOTIVATION
IN THE FOR DATA BASE
BROKEN DOWN BY INDUSTRIAL SECTOR
AND BY INTER/INTRA-INDUSTRY DIRECTIONALITY
(number of agreements)

	Total	Number inter-industry	Number intra-industry
Electrical/electronic appliances/telecom (a)4 (b)5 (c)2 (d)1*	11	3	8
Electronics/data processing (a)2 (b)3 (c)1 (d)1	2	2	0
Chemicals (a)2 (b)1 (c)0 (d)0	5	3	2
Automobiles (a)3 (b)1 (c)6 (d)0	2	1	1
Other transport (a)0 (b)0 (c)3 (d)0	3	0	3
Mechanical engineering (a)1 (b)1 (c)0 (d)0	4	3	1
Oil refining (a)2 (b)0 (c)1 (d)6	2	2	0

*A number of agreements also gave (a) 'technology transfer' (b) marketing (c) economies of scale and (d) risk sharing as motivations.

Source: Mariti and Smiley, 1983, 443.

C. THE DYNAMICS BEHIND THE FORMATION OF INTER-FIRM COOPERATIVE AGREEMENTS

Two broad changes underlie the development of inter-firm cooperative agreements as a major corporate strategy in the 1980s. The first concerns the changing nature of production processes in the advanced industrial countries, and especially the evolving relationship of science and technology to production. The second arises from slow growth and high inflation rates during the global economic crisis, and the effect of these on both markets and on the strategy of firms. In both cases the result can be seen in inter-firm cooperative agreements that differ considerably from earlier forms of oligopolistic market behaviour.

(i) The salience of knowledge inputs in production.

In the 18th and 19th centuries, contact between scientists and industry was neither systematic nor institutionalized. This changed with the growth of the chemical and electrical engineering industries in the latter half of the nineteenth and early twentieth centuries. In these industrial sectors, and newer ones such as petrochemicals, electronics, and biotechnology, both product and process technologies were largely based on scientific discoveries and theories. The high cost of research and development in these industries made it increasingly difficult for the individual investigator to commercialize new products and processes without entering into collaborative arrangements with a manufacturing firm. Cost and complexity prompted researchers to seek access to the funding sources, laboratory facilities, and marketing networks of large industrial firms. At the same time, profitability considerations induced these companies to create in-house professional research and development (R&D) staffs. This was particularly true in the newer knowledge-based industries, where innovation lay at the heart of the firm's profitability. These sectors found it vital to control the direction of research, and to appropriate research results directly.

The multidivisional firms that began to emerge in the early part of this century also required increased knowledge-inputs -- this time in the form of centralized planning and administrative structures -- in order to integrate production. The head office became the locus of these functions, as well as the center of research and development activities. The growing importance of knowledge inputs in production is reflected in the large and growing number of scientists and engineers engaged in research and development activities (Table 5). It is also shown by the magnitude of expenditures on industrial research and development by firms in the advanced industrial capitalist countries (Table 6). For example, Japan and Germany -- two of the more technologically dynamic countries in the post-war period -- both displayed an increase in scientific and technical personnel, as well as a growth in R&D expenditures. This contrasts sharply with the steady decline in these indicators manifested by the United Kingdom over the same period.

TABLE 5

SCIENTISTS AND ENGINEERS ENGAGED IN R&D PER
10,000 LABOUR FORCE POPULATION
SELECTED OECD COUNTRIES AND THE USSR: 1965-80

Country	1965	1968	1972	1975	1978	1979	1980
Canada	n.a.	n.a.	n.a.	22.4	23.0	23.2	24.0
France	21.0	26.4	28.1	29.3	n.a.	n.a.	n.a.
Germany(FR)	22.7	26.2	36.0	41.0	n.a.	n.a.	n.a.
Japan	24.6	31.2	38.1	47.9	49.4	n.a.	n.a.
UK	19.6	20.8	30.4	31.3	n.a.	n.a.	n.a.
U.S.	64.1	66.9	58.2	56.4	58.3	59.2	60.4
USSR*	44.8	53.5	66.5	78.2	82.9	84.2	85.9

*lowest estimate

Sources: National Science Foundation, 1981, Appendix Table 1-1, 208; and Statistics Canada, 1977 and 1981.

This change in the relationship between knowledge and production had immediate consequences for competition among knowledge-intensive firms and for the internationalization of their production. In intermediate and capital goods industries where economies of scale were important, the wedding of science and technology to industrial production tended to stimulate high levels of concentration, as in the chemical and petrochemical industries, or in semiconductors. Alternatively, in a sector such as the electrical industry, it encouraged cartelization and patent-pooling.

TABLE 6

INDUSTRIAL R&D EXPENDITURES BY FIRMS IN SELECTED OECD COUNTRIES FOR SELECTED YEARS: 1967-77
(national currency in millions)

Country	Business enterprise R&D (BERD)a	BERD as a % of the domestic product
Canada		
1967	336	0.69
1971	468	0.70
1975	692	0.60
1977	841	0.60
France		
1967	6,292	1.42
1971	8,962	1.29
1975	15,617	1.37
1977	19,999	1.35
Germany (FR)		
1967	5,683	1.28
1971	10,521	1.54
1975	14,469	1.59
1977	15,717	1.64
Japan		
1967	378,969	0.84
1971	895,020	1.11
1975	1,684,846	1.19
1977	2,109,499	1.29
United Kingdom		
1967	605	2.00
1971	697	n.a.
1975	1,340	1.75
1977	n.a.	n.a.
United States		
1967	16,385	2.49
1971	18,314	2.12
1975	24,164	1.98
1977	29,907	1.91

Notes: 1. Includes R&D performed in firms and funded by government.
2. See also Table 3, U.S. industry's expenditures for R&D in universities and nonprofit institutions.

Sources: National Science Foundation, 1981, Appendix Table 1-9, 219; and Statistics Canada, 1977 and 1981.

By limiting competition, each of these strategies served to reduce the risks in a knowledge-intensive industry where research results were not spread evenly over time, where sunken costs were high, and where firms were thus induced to guarantee their markets.

In consumer-oriented knowledge-intensive industries, such as pharmaceuticals, risk reduction through concentration and cartelization were complemented by a systematic process of market segmentation. This was achieved by the establishment of brand name loyalty through high advertising expenditures. To a large extent, R&D expenditures in these industries were reoriented to reflect this emphasis on product differentiation. Du Pont, where R&D expenditures in 1967-77 averaged some $350 million annually, is a case in point. Its R&D expenditures were intended to:

> . . . generate product and process improvements and . . . (develop) new technology (but) new product introduction during the 1970s was double that of the 1960s . . . (and) during the first part of the 1970s some two-thirds of R&D outlays supported modifications in existing product lines and processes.
>
> -- Berhman and Fischer, 1980, 144.

Ultimately, high research, development, and advertising expenditures tended to create barriers to the entry of new firms into knowledge-intensive industries. Nevertheless, small firms still survived in some of the newer industrial fields or in specialized niches, and some medium-sized firms maintained themselves by relying on state support in the form of procurement policies, R&D funding, export subsidization, and even nationalization where other means proved inadequate. Even then, the evolution of the computer and telecommunications industries in the late 1970s and early 1980s suggests that concentration has continued in successive new knowledge-intensive industries as firms moved beyond their initial innovative entry and into second and third generation products.

The new relationship of knowledge to production also affected the foreign investment process. Traditionally, the search for new markets, market shares and secure sources of raw materials impelled large firms to invest abroad. Knowledge-intensive firms, however, were motivated to internationalize operations in order to fully utilize the market power which their monopoly of technological knowledge and organizational skills made possible. Through the <u>internationalization</u> of production, such firms could cover the high costs of innovation from as wide a range of sales as possible, while <u>internalization</u> of the market reduced the risks of price fluctuations and guaranteed final sales.

American firms were the technological leaders in the immediate postwar period. Operating within the context of a high-income home market, they were first to take advantage of knowledge as a unique asset in their growth and internationalization strategies. But firms in other advanced industrial capitalist countries soon followed their example. French multinational firms surveyed in 1971 reported that "exploitation of a technological advantage" was not among their principal reasons for investing abroad. By 1981, however, such an advantage was cited by 37 percent of French multinationals and ranked as the third most important reason for overseas investment.

During the postwar period, the process of capital accumulation within the large multinational firms came to be characterized by an interplay between strategies of profit maximization and those of labour specialization and risk minimization. The former focussed on product differentiation. The latter emphasized increased planning and control over knowledge, labour, and markets. Underlying these processes, however, was an accelerating rate of technological innovation and diffusion. Moreover, technological change was coupled to a strong emphasis on the mass production of standardized goods, which periodically threatened the system with a crisis of overproduction.

In the 1960s, new pressures for change in corporate structures emerged. Dynamic sectors spawned a host of new competitors, and where these did not spring up of their own accord, states intervened to support national champions in key high technology industries. At the same time, traditional industries faced a dramatic rise in competition from low wage countries. Augmenting these pressures were signs of impending economic crisis as the rate of productivity increase declined toward the end of the decade. It became more costly for governments to maintain high levels of mass consumption using Keynesian demand management techniques.

(ii) Technology bunching strategies and the formation of knowledge-based oligopolies.

The declining rate of productivity growth that began in the late sixties was followed by more than a decade of slow growth and high unemployment. The result was a competitive environment radically different from that which had characterized the first post-war decades. The slow pace of productivity growth resulted in a loss of competitiveness. Price-cutting strategies thus became more difficult to sustain and vanishing margins increasingly eroded both the capacity and opportunity for investment.

With slower growth in domestic purchasing power in the advanced industrial countries, and crisis conditions in much of the Third World, markets that depended on the sale of durable consumer goods became saturated. These changes undermined the strong linear relationship that had been established among a rapidly growing market defined in terms of a range of goods, a heavily equipped manufacturing base that permitted economies of scale, and a set of research and development activities primarily oriented toward product differentiation. This relationship had given rise in the 1950s to a pattern of competition characterized by setting a big firm on a big market and building an oligopolistic position within it. In this way, market shares were stabilized and oligopoly rents were secured. Within such a competitive framework, new technology was developed primarily to penetrate a previously identified market.

The crisis undermined this type of competitive behaviour. Reduced growth prospects exacerbated competition. New products, combining both new manufacturing processes and new goods, simultaneously stimulated the rise of new industries and brought new entrants into existing industries, thus shaking the position of established leaders. With markets under pressure, vertical integration linking the market to manufacturing and to R&D activities, once the formula for growth, now threatened to impair the ability of firms to adapt to change. Flexible response increasingly came to play a central role in the strategy of knowledge-intensive firms.

As technological change further accelerates in response to these pressures, the costs, risks, and uncertainties associated with knowledge-production have risen. This is especially pronounced in those knowledge-intensive industries undergoing rapid technological change. Earlier strategies had aimed at securing markets for products with high R&D costs, but these strategies are now less effective because the very definition of what might constitute the market for a new technology or product has become unclear. Under these conditions, the key to longevity has become an ability to control the transformation of the market, rather than merely to respond to changes in it. Firms in dynamic, knowledge-intensive industries are shifting away from the product-based oligopolies associated with a market-driven strategy. Instead, they are beginning to pursue new technology-based strategies in which the formation of knowledge-based oligopolies is coming to play an important role.

Emphasizing a logic that is the reverse of the linear relationship described above, these new technology-based strategies take as their point of departure the technological capabilities of the firm rather than the characteristics of the market. Their objective is to create a flexible technological base that can lead to the development of a wide variety of products destined for many different markets. The range of applications to which the knowledge base of the corporation can be put is thus no longer limited by the definition of a particular market.

The implementation of technology-based strategies begins with an assessment of the firm's technological capacities. These capacities are then structured through the addition of complementary elements taken from other areas of industrial specialization. A technological core is thus built through the bunching of various technologies around one or more generic technologies. To augment this base and increase its flexibility, firms pursuing a technology-based strategy may seek to acquire new skills and capacities. Nevertheless, in this period of uncertainty and change, there are advantages in doing so without adding to the inertia of the firm. Under contemporary competitive conditions, there is considerable strategic value to be derived from subcontracting, from establishing linkages among universities, research institutes, and companies, and from entering into inter-firm cooperative agreements in R&D, production, and marketing.

To sum up, then, strategic partnerships in R&D offer three principal advantages over the traditional joint ventures in production or marketing. In joint ventures, equity participation or exchange between the partners is common. Strategic partnerships, by contrast, do not require either financial remuneration for goods and services, or equity arrangements of any sort. By pooling resources, however, they facilitate a reduction in the costs, risks and uncertainties associated with knowledge production. They do so, moreover, without either circumscribing the flexibility or adding to the inertia of the firm. As the data in Section B illustrates, the most dynamic form of inter-firm cooperative agreement involves knowledge production or sharing.

D. FACTORS THAT AFFECT THE SUCCESS OR FAILURE OF STRATEGIC PARTNERSHIPS

Strategic alliances enable a firm to maintain its level of in-house R&D while shifting some research and development activities to the sphere of inter-firm cooperative agreements. This suggests that the most successful ventures will be those between two strong companies doing more, not less, by virtue of their partnership.

Herbert Fusfeld, Director of the Center for Science and Technology Policy in New York, has stressed precisely this point when he argues that, ideally, **each party should be able to contribute a part of the technology and each should be truly dependent upon the other's contribution**. This principle can be applied, for example, to the strategic partnership between Dow Chemicals and Corning Glass. In this instance, Dow develops a new technology but Corning performs the technical work necessary to apply it.

In the microelectronics industry, most successful ventures involve a blending of technological strengths. Complementarity drives a large number of U.S.-Japanese agreements. This is because U.S. firms have a dominant position in designing microprocessors and microcontrollers but the Japanese have mastered CMOS technology -- a wafer fabrication process with important advantages for semiconductors. Many U.S.-Japanese agreements in the semiconductor industry thus involve U.S. design and software capabilities and Japanese CMOS expertise. Such agreements have proved to be durable, leading in many cases to renewals. Intel, for example, signed an agreement with OKI to produce CMOS versions of Intel's microprocessors and microcontrollers in 1981 and the agreement was renewed in 1984. In 1981, Hitachi exchanged its high performance CMOS process for Motorola's 68000 mask sets. And, according to a 1984 agreement, Motorola will second source two of Hitachi's CMOS 8-bit single chip microcontrollers.

Other forms of complementarity are also possible. In the case of the ATT-Philips agreement, Philips provides market access in return for ATT's switching technology. APT, their joint venture, redesigns ATT's ESS5 system to meet European specifications. It is also expected that APT will expand into radio-telephones. By becoming a participant in four projects under the new "Research in Advanced Communications for Europe (RACE)" program of the European community, APT has already begun to expand the scope of its R&D activities.

Customer-supplier partnerships are also regarded as the kind of complementary relationships that tend to have a high survival rate. Fujitsu, for example, has a 10 year agreement to be the sole supplier of semiconductors for ICL's computers. Ultimately, this customer-supplier relationship has become a partnership:

> ICL is reported to have paid $25 million to Fujitsu to supply gate arrays as well as CMOS and ECL technologies for their product lines. Under this agreement, Fujitsu produces an 8,000 gate CMOS chip for ICL. Fujitsu's largest CMOS gate array prior to this was a 2,000 gate chip. ICL also utilized Fujitsu's basic logic chip to design its own microprocessor for the Estriel . . . . There are close contacts between technical personnel in the two companies, which are maintained through six-month visits, frequent meetings and high-speed facsimile between Tokyo and Manchester. This year, the agreement was extended to 1991 to cover collaboration on GaAs chips, fifth generation architectures and super computers.
>
> -- Haklisch, 1986, 42.

Intel and IBM have a similarly close relationship. In fact, IBM increased its equity involvement in Intel partially to provide the additional funding needed to develop a new generation of chips.

By contrast, alliances between firms that compete in the same product areas and markets are more likely to fail. Texas Instruments and Motorola, for example, are unlikely partners. Both are semiconductor manufacturers with second sourcing or other forms of technology-cooperation agreements with the same European companies, Philips in the Netherlands and Thomson in France. Motorola has followed Texas Instruments into the Japanese market by investing in wafer fabrication, though Motorola has chosen Hitachi and Texas Instrument has chosen to second source its principal products. Both have also established networks of strategic partnerships with other semiconductor firms and with user companies. Although they are head-to-head competitors, collaboration still remains possible through larger, more diffused ventures. Thus, both contribute funding to Cornell University's microwave compounds semiconductor research, Stanford University's Centre for Integrated Systems, and the University of Florida's electronic research program. They are also both members of the Semiconductor Research Corporation (SRC), an industry association whose purpose is to fund research in universities.

If the objective of the producer firms is predatory in nature, partnerships of the older sort involving joint ventures in production and using technology from only one of the partners may be inherently unstable.

> In a joint venture such as J2T (whose partners are JV, Thomson and Thorn-EMI, and whose purpose is to jointly manufacture VCRs in Europe), neither Thomson nor Thorn-EMI accept to be permanently relegated to a role of subcontractor and distributor for JVC's products in Europe. They may have ambitions to extract product engineering and manufacturing skills from JVC and, in a second stage, to regain their independence.
>
> -- Hamel, Doz and Prahalad, 1986, 5.

Success for these firms is not defined in terms of the reduced costs of knowledge acquisition or of production. On the contrary, the goal is rather to increase one's own competitiveness through a temporary reliance on a partner. Such alliances are thus likely to have short lives. Robert Reich and Eric Mankin have made a similar argument with respect to the predatory objectives pursued by Japanese firms in their alliances with U.S. companies. In fact, their argument illustrates the importance of firms being aware of and defending their own interests in negotiating a strategic alliance.

Problems have also been encountered in strategic partnerships built around one-way transfers of technology between a large and a small firm. This is particularly true when the relationship is asymmetric and the larger firm licenses its technology to the smaller. One study reached the following conclusion:

> Managers of small firms in the computer industry complain of a sort of predatory behaviour on the part of large computer firms. They stated that some time after they had signed long term licensing agreements, and ceased a portion of their own research and development activities as a result, the larger licensing firm (usually American) would bring out a superior product and refuse to license this product to the smaller firm. In some cases the smaller firm can be forced out of business as a result of being denied access to the improved technology while at the same time being limited to inferior technology by the long term co-operative agreement.
>
> -- Mariti and Smiley, 1983, 450.

The logic of inter-firm cooperative agreements suggests that the most successful alliances are those that have technology production and sharing as a goal. Predatory partnerships and many licensing agreements, as in the example above, imply not only a hidden agenda but an asymmetric power relationship that is unlikely to generate much loyalty to the partnership.

It should be remembered that partnerships can be little more than concealed divestment of productive activities, such as General Electric's transfer of all appliance manufacturing to Matsushita. They can also represent alternatives to the complete demise of the firm, such as British Leyland's partnership with Honda. However, such inter-firm agreements do not properly fit the definition of strategic partnership developed here. As a result, they are not an appropriate base against which to test newer forms of inter-firm cooperative agreements, especially those involving knowledge production.

Strategic partnerships designed to share or produce knowledge are multiplying. There is also a growing number of renewals or extensions of existing agreements as well as of second or third agreements between firms. Once sufficient time has elapsed, it may appear that the success rate of inter-firm cooperative agreements is little different from that of earlier joint ventures. This may be true either in terms of the accomplishment of their specific goals or in terms of the longevity of the partnership.

There are also many agreements between large and small firms in which major corporations invest in smaller innovative companies as a means to access new technology. In such cases, it is unlikely that the larger firm will block the smaller firm's capacity to innovate by withholding technological advances. Indeed, as Venture Economics has pointed out:

> The large company's strengths typically are in the areas of market access and credibility, an established technology base, capital availability (while) . . . the small company's strengths lie in its ability to identify opportunities in market niches, to lead innovative product development, to apply technologies to new areas and to adapt to changing market conditions -- a flexibility which relates to its size
> -- Venture Economics Inc., 1987a, 1-2.

Given the need for flexibility and the desire to avoid increasing the inertia of the firm, it is also unlikely that corporate partnering relationships built on a creative combination of these strengths will lead to unwanted takeovers.

One example of a successful technology production and sharing partnership between a large and small firm is the General Motors-Etak, Inc. agreement signed in May 1985. Etak is a company based in Sunnyvale, California, and founded in May 1983 to develop and manufacture computer-controlled automobile navigation systems. Under the terms of its agreement with GM, the latter became an OEM licenser of Etak's technology. In return, Etak receives "capital paid up front for technology; future royalties from the use of its technology; revenues generated from sale of the maps in the after market; credibility through its association with GM; and opportunities for further contracts with GM".

-- Venture Economics Inc., 1987a, 4.

Another example of how a smaller firm can protect its longer term interests is in the agreement between Du Pont and Synergen reported this year. Under its terms, Du Pont will provide $1.5 million in research support to Synergen, Inc. of Boulder, Colorado, to evaluate the therapeutic potential of a protein with potential uses in treating cardiovascular disorders and to develop a commercial process for its production. If successful, Du Pont will then provide some $17 million for development and clinical testing. The key to the protection of Synergen's longer term interests lies in the provision relating to production:

> Upon filing with the FDA, a commercial venture would be formed whereby Synergen would retain manufacturing rights and Du Pont would be responsible for marketing the protein. Profits and expenditures of the joint venture would be shared equally by the two companies. Synergen will retain all rights to topical application of the factor to promote wound healing.
> -- Venture Economics Inc., 1987b, 1.

Many strategic partnerships do not get past the negotiation stage. This occurs not because the agreement is strategically or fundamentally flawed in conception but rather because the partners have a poor understanding of each other's needs. This can be due to the inability of the firms to establish a hierarchy of their own objectives or to communicate these interests and needs effectively to their partners.

To some extent, this can be avoided by establishing close relationships between relatively powerful and well-placed persons in the prospective partner firms. Personal links between CEOs performed this function in the European Community's ESPRIT program. By bringing the CEOs together, the European Commission played a role akin to that of marriage broker. In Canada, a similar role could be envisaged for an agency such as Investment Canada.

Partnerships may also fail for other reasons. In some instances expected benefits outweigh costs. In other cases, the research in question does not bring benefits to each of the partners because they have not developed a definite and common set of objectives, or because they do not fundamentally understand each other's basic technology. Most of these problems can be overcome through a realistic assessment of the firm's needs and interests, careful negotiation, and close interaction between key technical and managerial staff prior to the conclusion of an agreement. As a result, the process of concluding such an agreement may be longer than initially foreseen. Nonetheless, it is an investment well worth the time, especially since it provides the kind of learning experiences that will facilitate cooperation during the lifetime of the agreement.

All too often, however, smaller firms seek to move rapidly into an inter-firm cooperative agreement as a means of overcoming a cash-flow problem. To speed up the process without sacrificing the time needed for careful negotiation, government could play a supportive role by aiding smaller firms in identifying appropriate partners and negotiating satisfactory agreements.

E. POLICY IMPLICATIONS

The growing knowledge-intensity of production in the current period of slow growth and accelerated technological change has consequences for the choice of technology partners and for traditional investment and technology policies. With regard to the former, these changes imply a need both to engage in high level research and development in order to become an attractive partner, and to seek partners with complementary technological capabilities.

With respect to the latter, the changes currently underway diminish the utility of narrowly nationalistic policies aimed at giving carefully selected domestic manufacturers a leading position on a well-defined and well-protected market segment. If such firms were efficient in a period of product-based oligopolistic competition, they prove extremely weak when flexibility, adaptability, and versatility are the dominant criteria for success. On the other hand, current conditions do not imply the exclusion of broader-gauged policies seeking to promote the development of specific technological bases. Indeed, much policy-making in the advanced industrial countries has taken this direction in the 1980s.

Over the past few years, new national policies that emphasize R&D funding have been developed or expanded in Europe and Japan. These include the European ESPRIT, BRITE, RACE and other programs, as well as Japanese projects in robotics, in the fifth generation computer, or in sewing technology. Policies with a similar thrust but administered by the Department of Defense are currently under discussion in the United States. The implementation of R&D policies by governments tends to enhance the strategic importance of technology to firms and thereby contributes both to the acceleration of technological change and to inter-firm cooperation to contain the uncertainties to which such change gives rise. Without similar policies, Canada will find the gap between its industrial capacity and those of its competitors widening still further inasmuch as it already lags behind other advanced industrial countries in R&D. Not all technology or investment policies, however, will be appropriate to Canada. Both the factors and the competitive environment within which they act must be taken into consideration in designing policies for this country's specific economic and technological conditions. A few examples will illustrate how different policies can be developed to match Canadian conditions.

While technology-sharing enables the production of both knowledge and goods at lower cost by reducing duplication in R&D expenditures, not all such agreements may have positive effects either for innovation in the industry as a whole or for the growth of participating firms. Under certain circumstances, inter-firm cooperative agreements for the exchange of information could reduce duplication in the approaches that firms take to a given research problem, but the result may be to restrict research to non-productive channels.

Others have suggested, however, that efforts to prevent collusion among firms in R&D on these grounds have not noticeably improved the rate of technological innovation. For example, a U.S. Department of Justice antitrust suit barred American automobile manufacturers from collaborating on emission control research on the grounds that such collusion might have slowed or halted implementation of U.S. emission control standards (e.g., by purporting to demonstrate that it would be impossible to meet such standards). However, the consent decree does not seem to have stimulated true technological innovation through competition. While each of the three major U.S. manufacturers pursued somewhat different emissions control strategies during the 1970s, none proved markedly superior based on criteria such as impacts on fuel economy, driveability, and manufacturing and maintenance costs. In the 1980s, emissions control technologies converged, with major companies in all parts of the world adopting quite similar approaches for meeting U.S. standards. But if technological competition as forced by the consent decree did not lead to innovation, this is not to say that cooperation among the automakers would have led to solutions that were any better in a technical sense or that would have held down purchase prices for new cars (Alic, 1986, 11).

A non-regulatory response to the same problem has been adopoted by the European Community. Through programs such as ESPRIT, RACE, and BRITE, the EC fosters the formation of research consortia and funds basic research on alternative approaches to the same research problem. The development of multiple approaches to common problems is thus directly stimulated.

Large multinational firms are able to pursue their varying objectives through different sets of strategic alliances with partners in other parts of the world. Consequently, both national and regional governments may become skeptical about the utility of funding R&D in local firms. The German government, for example, has begun to question Siemen's multi-approach strategy to the development of megachips. Siemens has a five-year R&D agreement with Philips aimed at propelling these two firms into the forefront of submicron CMOS technology through the development of 1-megabit (Philips) and 4-megabit (Siemens) memories. The joint venture with Philips is underwritten by the German and Dutch governments, who have contributed $900 million. Siemens is also involved in projects dealing with very large-scale integration through the European ESPRIT program to which the German government has also contributed. More recently, however, Siemens entered into an agreement with Toshiba to develop a megabit SRAM chip. From this, the German government appears to have concluded that Siemens is exploiting the government's good will to save its own funds for its joint venture with Toshiba, while using government funding to develop the very technology that will later be transferred to the Toshiba project. In today's highly transnationalized world, it is unlikely that this problem will be easily resolved.

There are a number of areas in which states in advanced industrial countries have begun to design new policies with a view to strengthening domestic technological and productive capabilities. These can be summarized under two headings: investment policy and technology policy. Both sets of policies, however, are intimately related.

Flexible manufacturing now permits efficient production with smaller production runs, so Canadian firms need not be disadvantaged because of the relatively small size of their domestic market. Moreover, products developed for the high-income Canadian market are likely to find acceptance in the markets of other advanced industrial countries. This applies equally to industries as diverse as textiles and clothing, auto parts, consumer electronics and custom semiconductors. Flexible production is a highly knowledge-intense form of production. To be successful, it requires a considerable increase in the R&D, design, engineering, management, and marketing capabilities of Canadian firms. To move towards this goal, investment policy must be geared to identifying:

° those sectors in which Canadian firms can acquire the technological capabilities needed for flexible production,

° the leading edge technologies that are currently lacking in these crucial productive sectors, and

° appropriate technological partners for Canadian firms willing to embark on the path toward flexible manufacturing.

In identifying partners, it must not be forgotten that inter-firm cooperative agreements are an ideal way of acquiring complementary technology and that identification of partners should not stop at the current frontiers of a given industrial sector. Inter-industry as well as intra-industry collaborative research and development ventures are both on the increase.

Another component of investment policy should be to facilitate the shift toward more knowledge-intensive production. This can be done in a number of ways:

° Funding must be found not only for research and development but also for restructuring activities within enterprises that reflect movement toward more knowledge-intensive production processes. Without such assistance, the risks of doing so are a serious disincentive, especially to smaller firms.

° Assistance should be provided in the negotiation of strategic partnerships with foreign firms so that smaller domestic firms are not disadvantaged by their choice of partners or by the terms of the agreement.

- Funding should also be provided for research and development activities in frontier technology sectors in which Canadian firms show signs of potential international competitiveness. Such sectors include the application of biotechnological advances to agriculture, forestry, fishery and mineral processing industries. As a result, Canadian firms will be able to build international competitiveness from a stronger domestic base.

To ensure that investment policies are successful in attracting desired foreign companies to form strategic partnerships with Canadian firms, complementary technology policies that strengthen the Canadian research and development base and its relationship to production are necessary. These should take at least two forms. First, there must be support for basic research into generic technologies whose commercial potential is as yet uncertain. Much of this research will undoubtedly be performed in universities and research institutes such as the NRC. Hence, technology policy must be coordinated with support for higher educational institutions. Secondly, R&D consortia that bring firms and universities together in the applied research stage and in some development activities are also needed. With such support, Canadian firms can emerge as attractive partners for dynamic, innovative, foreign companies.

BIBLIOGRAPHY

Alic, J., "Cooperation in R&D: When Does it Work?", prepared for the colloquium on International Marketing Cooperation Between Rival Trading Nations, San Miniato, Italy, May 29-31, 1986.

Behrman, J. and W. Fischer, Overseas R&D Activities of Transnational Companies (Cambridge, Mass.: 1980).

Fusfeld, H.I. and C. Haklisch, "Cooperative R&D for Competitors", Harvard Business Review (Nov.-Dec. 1985), pp. 60-7.

Haklisch, Carmela S., Technical Alliances in the Semiconductor Industry (New York: New York University, Center for Science and Technology Policy, 1986).

Haklisch, Carmela S. and Nicholas S. Vonortas, Export Controls and the International Technical System: The U.S. Machine Tool Industry (Rensselaer Polytechnic Institute, Center for Science and Technology Policy, July 1987).

Hamel, G., Y. Doz and C.K. Prahalad, "Strategic Partnerships: Success or Surrender?", paper prepared for the 1986 Conference on Cooperative Strategies in International Business, A Joint Research Colloquium between The Wharton School and Rutgers University, October, 1986.

LAREA/CEREM, Les strategies d'accord des groupes européens entre la cohésion et l'éclatement (Nanterre: Université de Paris-X, 1986b).

Mariti, P. and R.H. Smiley, "Co-operative Agreements and the Organization of Industry", The Journal of Industrial Economics (Vol. XXXI, No. 4, June, 1983), pp. 437-451.

Mytelka, L.K. and M. Delapierre, "The Alliance Strategies of European Firms in the Information Technology Industry and the Role of Esprit", Journal of Common Market Studies (1987 forthcoming).

National Science Foundation, Science Indicators -- 1980 (Washington: National Science Board, NSB-081-1, 1981).

Statistics Canada, Annual Review of Science Statistics (Ottawa: Minister of Supply and Services, Catalogue 88-201, 1977 and 1981).

Venture Economics Inc., Corporate Partnering in the 1980s (Wellesly, Mass.: Venture Economics, Inc., 1987a).

Venture Economics Inc., Corporate Venturing News, Premier issue (March 25, 1987b).