

Co-operation in R&D, efficiency and European policy

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In this paper, the role of co-operative agreements in R&D, as a strategic option for firms confronted with the globalization of markets and the multiplication of sources of new technology is examined within the European context. It is argued that a plausible case can be made for co-operative R&D ventures, especially where positive and large technological spillovers exist, when the fixed component of technology-development cost is high and the hedging of risk is an important incentive, and when participating firms produce complementary products. The empirical evidence of a significant multiplication of R&D partnerships in Europe illustrates, from this perspective, the strategic option that firms were confronted with as competition 'Europeanized' and 'globalized' and technology changed rapidly and unpredictably. Co-operative agreements in R&D also create problems. One such problem is that the agreements could be a vehicle for reducing competition in the downstream product market and for creating barriers to entry. From that point of view, existing EC regulations seems well adapted, but this leaves open the question of conflicts between differing competition policies at the world level. The growing web of international coalitions makes it increasingly difficult, if not impossible, to implement a European technology policy whose results are not accessible to companies and countries competing with Europe.

'Under what conditions will co-operation emerge in a world of egoists without central authority?' This was the first question raised by Robert Axelrod¹ in his seminal book on *The Evolution of Cooperation*. The basic problem occurs when the pursuit of self-interest by each could lead to a poor outcome for all.

There is a vast array of situations which have

this property, and one of them concerns the strategies of firms confronted today with the globalization of markets, the multiplication of sources of new technology and the costs of its transfer, the incremental and cumulative nature of innovations, and the growing need of interactive system of learning and information exchange.

Within this context, co-operation in R&D is becoming an important strategic option. This paper examines the roles of this class of co-operative agreements in the European context.

We shall first identify the main expected private

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and social advantages and disadvantages, and then follow with some results of empirical studies of the EC situation. Finally, the EC policies, with respect to such co-cooperations will be evaluated.

Benefits and costs of co-operative R&D

Three types of private potential benefits of co-operative R&D can be identified. First, co-operative agreements are an alternative to either pure market transactions or integration within the firm under a single administrative structure. Its choice could, therefore, indicate that it is perceived as a compromise between commitment and flexibility.

On one hand, in-house developments or mergers tend to create very rigid structures without an easy mechanism for switching research capability, strategy and partners over time. This can call into question a company's ability to innovate or respond to innovation, and impede access to know-how which it cannot develop internally or can acquire only with irreducible delays in developing and testing products in-house.

On the other hand, arms length transactions do not allow for long-term relationships, which are generally crucial in technology. Frequent switching is costly and inefficient because the process of R&D, as well as technology transfer, requires prolonged interaction and experience between partners to exploit or develop complementary components which affect the costs and benefits of innovations.

A second potential advantage of co-operative R&D is to accelerate the speed of innovation with less risk. What often matters is the speed at which firms can deploy the necessary resources and enter into new markets; this is, the first-mover advantage, which depends upon the ability to do this quicker than rivals. Joint actions also permit risk-spreading, i.e. sharing the benefits and costs of a project among a number of firms, and risk-pooling, i.e. pursuing more technological avenues and (relatively) independent projects.

Finally, the pooling of various complementary resources in R&D can provide financial capital at better conditions if capital markets are imperfect, can spread the high fixed costs of technology development, and produce synergistic effects by the combination of research information, teams of

scientists, technological and marketing know-how, and so on.

Despite the previous arguments, co-operative in R&D has a number of important handicaps. At the first stage, partner selection and the possibility of defining well-balanced contributions are important barriers. The fear is that one partner will be strengthened by the technological co-operation in such a way that the partner will become a dangerous competitor at the product market level. This situation is, of course, more probable in horizontal agreements than in vertical ones, which is why many corporations are reluctant to collaborate with direct competitors, and instead develop links with potential customers or suppliers to gain complementary expertise.

At a second stage, the management of existing co-operative agreements and the sharing of the benefits are also difficult. In the absence of an efficient system of management, the transaction costs of co-ordination and co-operation may outweigh the benefits, especially when a large number of actors is involved. Even with lengthy contracts containing explicit clauses concerning confidentiality, the transmission of information, patent licenses, trademark and copyright, there are fundamental limits on the ability to protect intellectual property, especially given that scientific knowledge has many aspects of public good, that its results are not easily incorporated and that the speed of incorporation will vary from one firm to another. In fact, there are often close connections between the effectiveness of basic research, conventional R&D resources and marketing and manufacturing resources. Successful achievement of first-mover advantages in research depends upon an ability to bring new products and techniques to the market quickly where the greatest potential strategic payoffs are encountered. Limiting co-operation to pure R&D or to the so-called 'precompetitive level' could then exercise a strong deterrent effect on the emergence of such co-operative arrangements.

The main arguments in favour of the socially beneficial effects of co-operative research is based on a problem of market failure, related to the appropriability of returns. The starting point is that the amount of research made by private firms and the diffusion of the knowledge generated by them may be socially inefficient. One situation is when there are substantial R&D externalities or

spillovers across firms, and over time, as innovative activities are often cumulative in nature. The benefits of each firm's R&D flow, without payment to other firms, lead to underinvestment in R&D relative to the social optimum. On the other hand, a high degree of private appropriability through localized learning, firm-specific forms of knowledge and various forms of protection could excessively impede the socially useful process of diffusion.

It can then be argued that co-operative R&D can alleviate the following trade-off: the incentives for a firm to perform R&D require a sufficient degree of appropriability of the benefits and, thus, a limited diffusion of knowledge; but on the other hand a near-perfect appropriability (whether created by circumstances or policy) impedes positive spillovers of the results of R&D to other firms.

Co-operative R&D can then be viewed as a means of simultaneously internalizing the externalities created by significant R&D spillovers—hence improving the incentive problem and limiting wasteful duplication—and providing a more efficient sharing of information among firms.

D'Aspremont and Jacquemin² have established the conditions under which a co-operative agreement could raise social welfare through its effects on the equilibrium level of R&D and on the cost of achieving a given R&D level.

Contrasting with these potential advantages of co-operative R&D, effects leading to a harmful reduction of competition must also be considered. One danger is that co-operative R&D could be a way for a dominant firm to avoid competition through innovation, by co-opting potentially very innovative rivals and by controlling and slowing down the innovation race. Co-ordinating the R&D process so as to avoid duplication can reduce initiative and lead to inflexibility and to waste in dead-end research, when multiple, not perfectly correlated research strategies could have been feasible. At the other extreme, firms with market power can, through concerted pre-emptive operations, highly accelerate their programmes of R&D and innovation in order to exercise a disincentive effect on potential entrants. There is also the danger of an extended collusion between partners, resulting from their action in R&D, so creating common policies at the product stage. As we shall see, this is an important issue for competition policy.

Empirical evidence

It is difficult to measure empirically the actual amount of R&D involved in co-operative R&D agreements, and formal statistical databases on R&D co-operative agreements are available in only publicly reported agreements. Traditional and inherent biases in 'bibliometric' databases, relying on the screening of newspapers and specialized journal reports are well known. Numerous studies (see the recent OECD overview³) suggest that the past two decades have been characterized by a burst in the growth of such co-operative agreements. Despite all the caveats, the empirical evidence collected independently by various authors in different countries lends support to the view that since the late 1970s and, in particular, since the mid 1980s, a rapid growth in co-operative R&D agreements has occurred within Europe, the US and Japan as well as between firms of each of those three regions.

Figure 1 presents the number of newly established 'strategic technology partnerships' over the 1980s for all technologies, and also for the total of so-called 'information technologies' further separated out into computers, microelectronics and telecommunications. The 'information technologies' account for more than 40% of all partnerships. (See Hagedoorn and Schakenraad's results⁴ on some 10 000 reported, so-called 'strategic technology partnering' involving some 3500 different parent companies over the 1980s.)

In Figure 2, the number of technology partnerships or alliances are grouped according to their intra-regional (EC, EFTA, US and Japan) or more truly international nature (i.e. primarily between the three regions considered above). According to the figures there has been an increase throughout the 1980s in the number of intra-regional alliances, particularly in the case of the European region.

Both Figures 1 and 2 raise the question as to the particular role of the EC and the specific European R&D collaborative support programmes in enhancing co-operation between European firms in R&D.

The role of the European Commission in technology policy has increased substantially since the early 1980s and was given legal support by Title VI of the 1987 Single European Act. After the

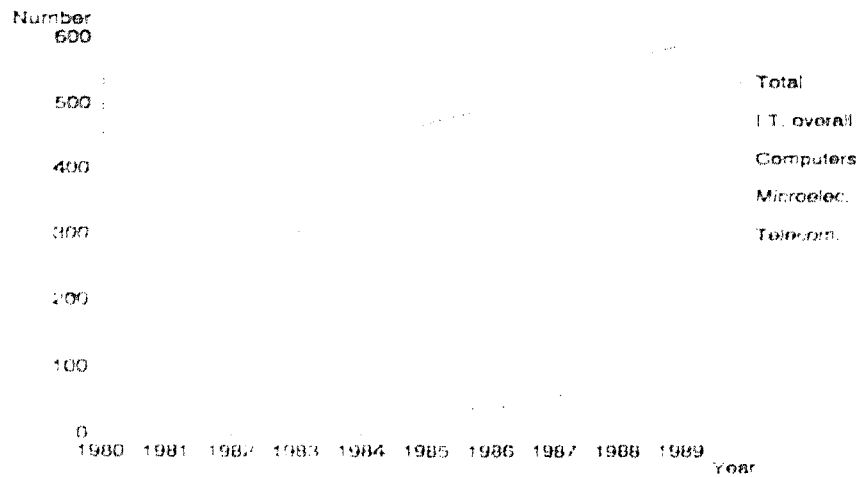


Figure 1. Newly established technology partnerships (Source: MERIT).

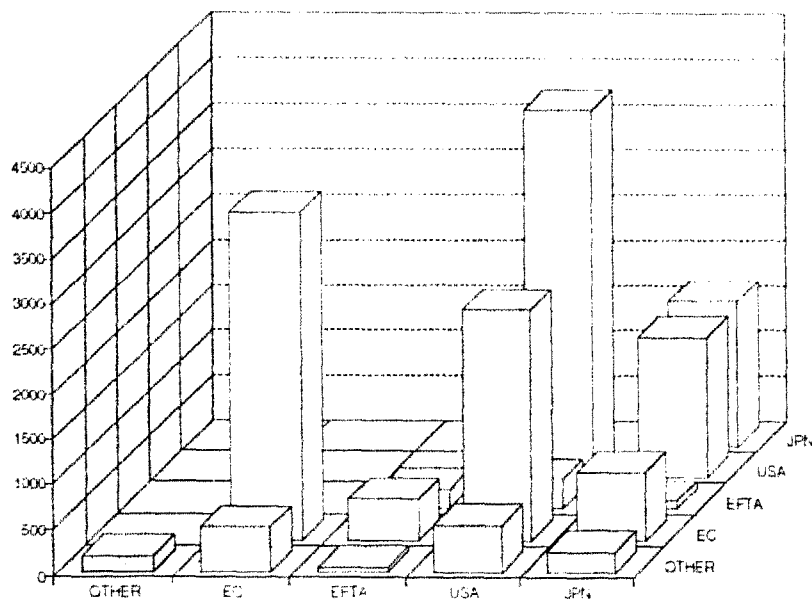


Figure 2. Technology-partnerships by region, numbers, 1970-1989 (Source: MERIT).

experience in some mature industries, such as steel, with 'structural adjustment' policies aimed at reducing overcapacity and improving efficiency, the policy shift initiated by the former commissioner Davignon towards more technology-oriented 'sun rise' sectors, found a 'natural' focus on R&D collaboration and information technology. The latter indeed appeared to encompass all the economic and strategic features justifying European government involvement.

Initiated in the late 1970s, ESPRIT provided, to some extent, the inspiration for the subsequent Framework Programme and is a good example of a technology support programme that includes both a diffusionist and an interventionist component, yet has at its core the aim of enhancing collaboration in R&D. While ESPRIT was instigated by the Commission, its final form was developed with the active participation and support of the 12 largest European information technology

firms. The requirement for collaborative research in order to receive EC research subsidies both reinforced existing collaboration and networks between the big 12 electronics firms and supported the development of new links between a wider network of electronics firms and between electronics and industrial firms, such as Aerospatiale, Peugeot, and ICI.^{5,6}

Turning now to the actual impact of such EC technology policy on the establishment of inter-firm links and collaboration in 'information technologies' in Europe, Figures 3 and 4 represent the intensity of international business collaborations for a selective subset of 35 firms in the IT sector.

In Figure 3 these linkages are represented for cost-sharing European programmes, while in Figure 4 for private co-operative R&D links. The method used in Figures 3 and 4 is based on a multi-dimensional scaling techniques, whereby the observed distances between companies is linked to the number of research partnerships. (For more detail see Hagedoorn and Schakenraad.⁴) As becomes obvious from comparing Figure 3 with

Figure 4, the EC sponsored alliances are an order of magnitude larger than the privately initiated co-operative alliances, and can be considered a success—at least from the immediate, most direct, EC policy aim, that is of enhancing over European borders R&D collaboration in IT.

European policy issues

Such EC technology policy raises a number of broad European policy issues, two of which appear of particular importance. First and foremost, to what extent have these initiatives not led to further cartelization, as described previously, with monopoly pricing being the main cost to the European consumer; and secondly, to what extent have such strategic support R&D programmes not been dispersed to other 'foreign' global firms, through 'strategic' alliances between European, US and Japanese firms.

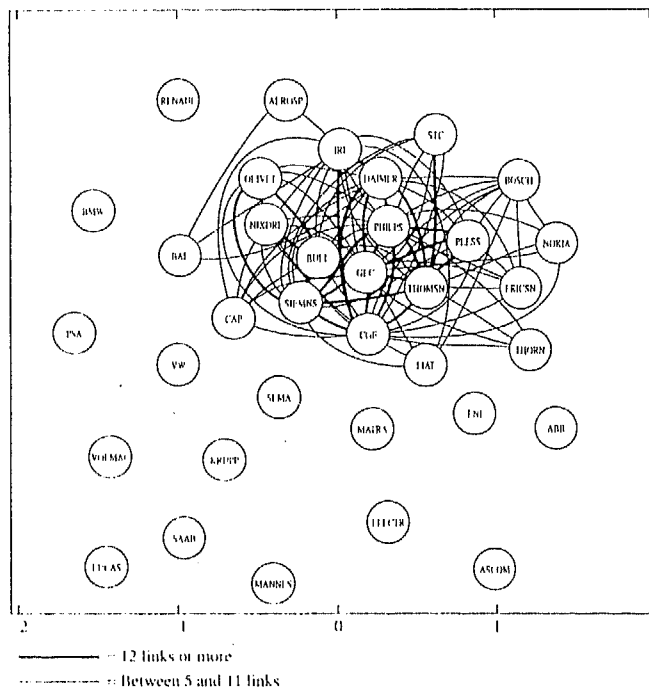


Figure 3. Inter-firm links among 35 firms in the IT sector within European cost-sharing programmes (1983-1989).

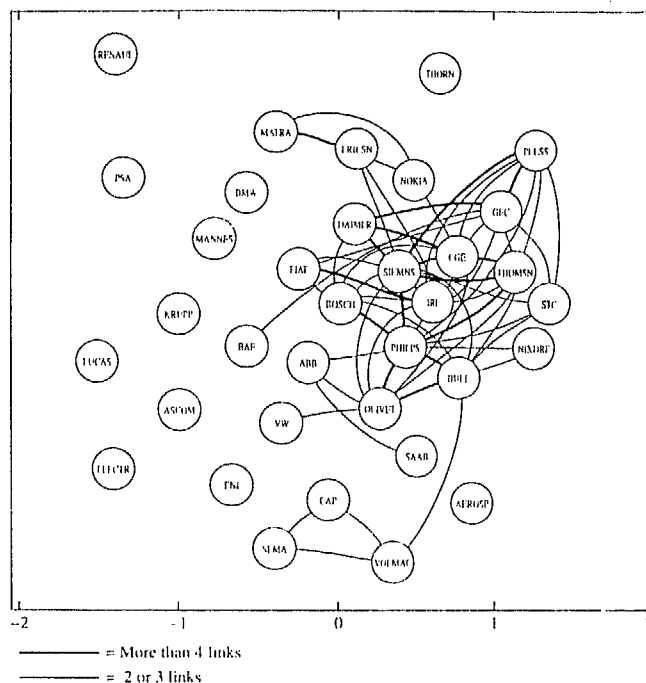


Figure 4. Inter-firm links among 35 firms in the IT sector: private co-operative R&D links 1980-1988.

European versus global competition policies

There is little doubt, as already emphasized, that a strong case could be made on the basis of both economic and technological arguments for an active, 'strategic' European technology policy aimed at reaping some of the potential benefits of co-operative R&D, including the advantages associated with a large single European market.

At a more global level, there is also little doubt that international competition becomes dramatically more intensive in 'high tech' industries over the 1980s, probably less because of trade liberalization as such, than due to the entry on to the world market of some major newcomers in the south-east Asia area. Thus, the number of competing firms in global markets and in European markets increased significantly. From this perspective the large, harmonized European market was better matched to the competitive advantage of the large US or Japanese firms, who were less capable, or interested, in competing on the small fragmented and (in terms of norms and standards) more

differentiated European markets of the 1960s. Not surprisingly, those firms invested heavily in the EC over the last five years, further challenging the competitive strengths of the domestic European firms in their enlarged 'home market'. Such an increase in international competition combined with a more rapid international diffusion of technology and the emergence of new entrants, led to a significant reduction in product life cycles and thus dramatically increased the risks of introducing new products. In order to recover such R&D costs, firms would have to spread them over larger global markets. While this drove firms to reduce the time needed to develop and market new innovations, it also led them to consider more positively international R&D collaboration and alliances. Furthermore, and quite independently from the tendency towards shortened product life cycles, there is again little doubt that the complexity of the research and production processes along with the broadening of the spectrum of relevant scientific disciplines have been major factors in increasing the costs and risks associated with R&D in areas such as electronics.

It is in this context of a more intense and global

competition that the dangers of actively encouraging R&D co-operation must be appreciated. The trend towards globalization and international networking, in so far as it involves a far greater share of world production, including component suppliers, cannot be viewed independently from the trend towards world oligopoly in many activities dominated by high technology. From this perspective the policy issue to be addressed here goes well beyond the borders of the EC and is ultimately related to the question of whether some global competition policy regulation might be needed, and if so, how it should be implemented. This is not the place to elaborate on this issue (for more specific policy proposals along this line see Ostry⁷ and Jacquemin⁸), but it will be clear that the existence of a supra-national form of international competition policy aimed at counteracting the emergence of world-wide cartels between global firms, will be difficult to achieve.

What should be noted though, is that contrary to US policy, EC competition policy has so far provided much more guidance on strategic R&D alliances in order to avoid restrictive practices. Thus, compared with the vagueness of the US 'National Cooperative Research Act' of 1984, which provides that joint research and development ventures must not be considered illegal *per se*, but that such ventures should be judged on the basis of their reasonableness, 'taking into account all relevant factors affecting competition', the EC regulation adopted in 1985 provides more guidance on applying the rule of reason and, under strict conditions, offers a safe harbour for firms that do not compete directly with each other. It also exempts the joint exploitation of the results of co-operative R&D, but under the constraint of a comprehensive list of prescribed practices.

Global R&D co-operation and EC policy

Within the EC there has been an obvious need to bring national domestic European firms, each with a limited primarily national technological capacity, together; particularly at the technological level and to develop a long-term strategic 'vision'. Today though, European technology policy, particularly in the R&D collaborative area, is at a critical crossroad and is in need of re-direction.⁹ Insisting

on intra-European research consortia was indeed justified in the 1980s to stimulate cross-border co-operation between industrialists, research centres and universities in preparation for the Single Market. This approach must be reviewed taking into account the realities of global competition in the 1990s where, by the large, technology co-operation appears to be a game of US, Japanese and European large global firms, responding to a strategy of long-term positioning in core technologies.

From this perspective, the attempt of global firms to become 'multi-domestic' and present themselves as 'good domestic citizens' in as many countries as possible, is also the result of the importance of national and EC strategic support schemes intended to provide major competitive advantages to 'their' corporations.¹⁰

These 'multi-national' firms question the relevance of national and EC policy making. The fact that these firms have their tentacles spread throughout the world does not mean that they are stateless and not dependent on their original nationality. In fact most multinationals do the bulk of their R&D in their home nations. But it suggests that it will be more and more difficult for national and EC authorities to identify the beneficiaries of their technology policy. The problem is especially complex for global co-operation in R&D. Attempts could be made to exclude such global companies from EC (or national) sponsored strategic policies. However, at the local site level, there will be increasing rivalry concerning the services offered to attract such firms, with little interest in their domestic or foreign origin. One implication of such a situation is that the Commission and member states will have to take a very pragmatic view about the 'domestic' or 'foreign' nature of a firm, which could become a member of a co-operative research programme, on the basis of its commitment to building up its research, technical expertise and production in the EC.

Conclusions

To conclude, a plausible case can be made for co-operative R&D ventures, especially where positive and large technological spillovers exist, when the fixed component of technology-

development cost is high and the hedging of risk is an important incentive, and when participating firms produce complementary products.

It is no accident that we have observed a multiplication of such coalitions in Europe. They represent an important strategic option as competition globalizes and technology is changing rapidly and unpredictably.

However, co-operative agreements on R&D also create problems. One such problem is that they could be a vehicle for reducing competition in the downstream product market and in creating barriers to entry. From that point of view, the EC regulation seems well adapted but leaves open the question of conflicts between differing competition policies at the world level.

Another issue is that the growing web of international coalitions makes it difficult, if not impossible, to implement a European technology policy whose results are not accessible to companies and countries competing with Europe. Given the multiplication of inter-firm links, it is less and less easy to determine 'who is Europe?'¹¹ From that point of view, a new approach to technology policy is required.

To the extent that the social rate of return of research activities to the world as a whole is higher than the individual country's social rate of return, a more internationally harmonized regulatory framework and collaboration are needed, whereby the results of research carried out in one country can be more easily exchanged and used in other countries.

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