Comments Welcome

WHAT MIGHT MOTIVATE APPLIED R&D COOPERATION?

ANSWER VIA TWO CASE STUDIES

This is MERIT Research Memorandum 94-030. MERIT Research Memoranda can be obtained from the MERIT secretariat, or by anonymous ftp at meritbbs.rulimburg.nl (WWW: http://meritbbs.rulimburg.nl)

Pauline RUTSAERT[*]

first version: February 1994
this version: August 1994

[*] MERIT, Rijksuniverstiteit Limburg, Maastricht.

This paper is based on the empirical part of the dissertation I submitted to Cornell University. I wish to thank S. Goyal, B. Jullien, P. Legros, P.Rey, H. Wan, and especially R. Masson, my committee chairman, for their support and helpful comments. I also wish to express my gratitude to the business managers who made the case study feasible by sharing their time and experience. This research greatly benefited from a prolonged research stay at the Laboratoire d'Economie Industrielle (CREST-ENSAE) in Paris. Financial Support from the Jadot Fellowship, Cornell University, and from CREST-ENSAE is gratefully acknowledged. All remaining errors are my own responsibility.

ABSTRACT

A review of the existing literature concerning cooperation in research and development (R&D) seems to suggest that there are fewer motivations to cooperate in applied R&D than in fundamental R&D. Indeed, at the applied R&D stage, spillovers are lower, technological uncertainty is reduced, and the likely marketability of the outcome of applied R&D makes member firms fear fierce inter-member competition at the market stage.

The study of two cooperative agreements in applied R&D, one in a sector of the European food industry and one in the pharmaceutical industry, reveals that market factors provide in some situations stronger motivations to engage in applied R&D cooperation than technological elements do. In the two cases under examination, an innovative firm identifies the joint venture (JV) as the most profitable growth strategy to market its innovation, given the constraints on capital control and the necessity to have access to complementary assets. The cooperation in applied R&D is then agreed by the members to consist of an initial unilateral transfer of know-how and the joint development of new applications. It is viewed to act as the cement of a broader JV primarily aimed at joint production and joint marketing.

The motivation analysis of these specific agreements also highlights the possibility of an upstream causality link between R&D and market stages, i.e., production and sales collaboration inducing R&D cooperation. In addition, these case studies exemplify the theoretical result of Rutsaert (1994) that the incentive to cooperate in R&D when market competition is fierce after the cooperation can be restored by allowing the member firms to collaborate for sales after R&D cooperation. These two facts and the features characterizing applied research seem to suggest that authorities in charge of determining the legality of an applied R&D cooperation might reasonably suspect the existence of a broader agreement including the joint exploitation of the cooperative R&D outcome. Moreover, they lead to recommendations for R&D cooperation policy-makers. Programs promoting R&D cooperation need, in order to be efficient, to provide different incentives depending on whether applied or fundamental R&D is at stake. Similarly, a different internal organization might be required.

Address for Correspondence: Pauline RUTSAERT
MERIT
Rijksuniversiteit Limburg
P.O. Box 616
6200 MD Maastricht
The Netherlands

1. INTRODUCTION

The literature concerned with R&D cooperation examines arguments for and against R&D cooperation,[1] and identifies conditions under which such a cooperative agreement is likely to be socially desirable and conditions under which it might lead to a welfare loss.[2] The common wisdom is that R&D cooperation is socially desirable as long as it is not used (or likely to be used) as a means to reduce competition at the R&D and/or market stages. This position is reflected in most Western antitrust laws where R&D cooperation is judged according to a rule of reason and where R&D cooperation at a stage close to the market stage is suspected to be more conducive to anti-competitive outcomes than R&D cooperation at a stage far away from the market stage.[3]

The investigation of the private consequences of R&D cooperation also leads to distinguish various reasons for which firms decide to engage in, or refuse, R&D cooperation. As regards incentives for R&D cooperation, the existence of large spillovers especially, but also the presence of high risk, the need to access complementary assets, and the desire to monitor R&D investment of rivals are examples of motivations that may lead firms to R&D cooperation.[4] Indeed, R&D cooperation allows to internalize the inter-member spillovers, to spread risks among members, to realize the synergy of assets previously owned by individual members, and to control to some extent the members' R&D strategy. On the other hand, low levels of spillovers and/or risks, and the existence of harsh market competition combined with the interdiction to collaborate at the sales stage after cooperating in R&D are illustrative of what may discourage firms to cooperate in R&D.[5] Indeed, in any of these situations, the increase in gains caused by the members sharing R&D costs and risks is more than compensated by the decrease in gains induced by the members owning a similar innovation and competing for sales.

---

[1] See, for example, Jacquemin (1988) and Geroski (1993) for two interesting discussion of this issue.

[2] See, for example, Katz (1986) for a multi-stage game model leading to interesting policy-making suggestions.

[3] See Jacquemin (1988) and Jordan and Teece (1989) for a description of, respectively, the EU and the American antitrust treatments of R&D cooperation.

[4] The role of spillovers is shown in various contributions using multi-stage game models; see, for example, Katz (1986) and d'Aspremont and Jacquemin (1988). The influence of risk on the incentive to engage in R&D cooperation is illustrated by a two-stage game model in Marjit (1991).

[5] See, for example, Katz (1986) and Rutsaert (1994).

Although the existence of various stages of research in the innovative process is generally acknowledged, rarely more than two stages -namely, fundamental research and applied research- are effectively considered in contributions dealing with R&D cooperation.[6] Differences between fundamental research and applied research have been explored; three of them are frequently mentioned: the spillover intensity, the levels of intrinsic uncertainty and financial risks, and the closeness to the market stage. Economic and econometric studies show that compared to applied research, fundamental research features high spillovers, high intrinsic uncertainty, low financial risks and is more distant from the market stage.[7]

However, these differences have not all been systematically examined so as to determine how they may influence the emergence and the impacts of cooperative agreements that can rise at these two stages. In fact, until now, most efforts have focused on the difference in spillover intensity because "[w]hat really drives the case for cooperative R&D ventures is the existence of technological spillovers" (Geroski, 1993, p. 10 and 18). Several contributions show, in models incorporating a spillover rate parameter, that cooperative R&D leads to higher R&D investments than individual R&D do when spillovers are large.[8] This fact combined with the econometric finding about the relationship between spillover intensity and research stages suggests that firms have an incentive to invest larger amounts in R&D when they cooperate in fundamental research than when they cooperate in applied research.

Questions arise then: Is the lower spillover level characterizing applied research a sufficient reason for firms to be unwilling to cooperate in applied research? When and why do firms cooperate at the applied research stage? And the answers to these questions lead to further inquiries: Can the motivations to engage in applied research cooperation affect the competitiveness evaluation of such type of cooperative agreements? How can policy-makers integrate in their R&D cooperation policies what they learn about the logic of applied

---

[6] In fact, these two stages are often distinguished in economic and law discussion (see, for example, *Journal of Economic Perspective*, Summer 1991), but R&D activities are frequently dealt with as a bloc in theoretical work. Models of R&D cooperation where fundamental and applied research stages are made distinct are found in Vonortas (1991), and in Bhattacharya et al. (1990) and (1991).

[7] See, for example, Dosi (1988) and Watkins (1991) for a general approach. See Geroski (1993) for a discussion of empirical works on measures and estimates of spillovers.

[8] See, for example, Katz (1986), d'Aspremont and Jacquemin (1988), and Suzumura (1992).

research cooperation?

The object of this paper is to provide elements of answers to these questions. Two approaches are followed: first, the existing literature is reviewed, and second, two specific inter-firm agreements of applied R&D cooperation -one in the European food industry, and one in the Western pharmaceutical industry- are carefully investigated. In Section 2, a first attempt is thus made by exploiting existing models of R&D cooperation so as to suggest ideas of what factors motivate firms to cooperate in applied R&D. In Section 3, after a quick description of the methodology used to perform the case studies, the two cooperative agreements in applied research are presented. In Section 4, the motivations of both agreements are investigated and analyzed. In Section 5, conclusions are drawn from the motivation analysis of these two inter-firm agreements and suggestions are made to policy-makers about the implications this analysis might have for the successful organization of programs promoting inter-firm applied R&D cooperation.

2. TEACHING OF EXISTING MODELS ABOUT LIKELY MOTIVATIONS FOR APPLIED RESEARCH COOPERATION

In this section, models of R&D cooperation are reviewed with the objective of identifying reasons for which firms would agree, or refuse, to cooperate in applied research (henceforth, referred to as AR). These models are: that of Katz (1986), that of d'Aspremont and Jacquemin (1988), that of Marjit (1991), and that of Rutsaert (1994). They have been chosen because their dissimilarities should induce the incentive information gathered in one model to be likely to supplement (more than duplicate) that gathered in the other models. Although these models consider R&D as one stage they all include at least one parameter that can be related to a feature distinguishing AR from fundamental research (henceforth, referred to as FR). For each paper, a parameter is selected as representative of a characteristic distinguishing AR from FR, and then the effects of these parameters on the incentive to cooperate is studied, focusing on what happens when the parameters take the values characterizing AR.

First, the spillovers' influence on the incentives for AR cooperation is investigated. It is easily represented by a spillover parameter which specifies what percentage of the rivals' investments benefit each firm. Using d'Aspremont and Jacquemin (1988)'s model, it can be computed that the incentive to invest cooperatively in R&D increases as spillovers increase.[9]

Second, the impact of uncertainty on the willingness of firms to cooperate in AR is explored -technical and commercial uncertainties being distinguished. Technical uncertainty can be parameterized by means of a probability of discovery and commercial uncertainty can be represented via the (expected) market value of an innovation. The conclusions of Marjit (1991)'s model indicate that, even in absence of spillovers, duopolists may have an incentive to collaborate in R&D when the technical uncertainty is very high or very low.[10] That same model permits to investigate the impact of the innovation market value. It is easy to derive that the range of discovery probabilities for which firms agree to cooperate decreases as the innovation value for a monopolist innovator increases.

The third characteristic, namely the closeness with respect to the market stage, is difficult to symbolize by means of a direct parameter because R&D is treated as one bloc in all selected models.[11] Only indirect ways of representing this distance can be suggested. I choose the following one: the intensity of market competition, which refers to whether the R&D cooperative outcome is used by member firms to produce substitute, complementary, or independent goods. Firms cooperating in competitive research (i.e., at a stage close to the market) perceive the impact of market competition more precisely and often more strongly

---

[9] d'Aspremont and Jacquemin (1988)'s model is a two-stage game in which symmetric duopolists decide, first, how much to invest in R&D, and second how much to produce before competing for sales. The game is solved in three different contexts: i) when firms act independently at both the R&D and market stages; ii) when firms cooperate in R&D and sell individually; iii) when firms collaborate at both stages. In order to determine the influence of spillovers on the incentive to cooperate in R&D, the derivative with respect to the spillover parameter of the difference in profits between i) and ii) is computed and found to be negative.

[10] Marjit (1991)'s model is a game model in which symmetric duopolists decide whether to invest cooperatively or not. The pay-off of their decision is determined by the fact that there is no spillover, the amount to be invested is fixed, its outcome of the investment -success or failure to innovate- is uncertain, and the profits corresponding to each possible market structure is known.

[11] The few models of R&D cooperation in which the stages of FR and AR are distinguished consider cooperation only at the fundamental stage. Their set-up makes it difficult to investigate motivation differences between FR cooperation and AR cooperation.

than firms cooperating in FR.[12] In other words, they view each member's product resulting from cooperation as substitute to their own in case of AR cooperation much more than in case of FR cooperation. Indeed, in the latter situation, these firms still must develop and exploit independently the cooperative FR outcome in order to transform it into a marketable good, and this independent work would probably generate differences in final goods. Katz (1986)'s model gives an immediate answer in its conclusions.[13] When market competition is intense, firms have little or no incentive to conduct R&D under a cooperative agreement; they even have an incentive to use R&D cooperation to coordinate a reduction of R&D investment. By studying and comparing Bertrand and Cournot competition, Rutsaert (1994) confirms Katz's result and supplements it by taking into account a possibility of sales collaboration.[14] In presence of a harsh market competition, firms might still agree to cooperate in R&D if they can collaborate for sales.

All these results can be summarized and re-stated in terms of motivations for firms to engage in AR cooperation.[15] AR features relatively low spillovers; therefore an often mentioned reason to engage in research cooperation vanishes. AR is also characterized by a reduced technical uncertainty compared to FR.[16] Consequently, a further incentive to cooperate disappears. In addition, AR outcomes are usually marketable. The existence of tough market competition and of an interdiction to collaborate for sale are thus supplementary disincentives to start cooperation. Hence there seems to remain few of the above motivations

[12] Notice that in order to be pertinent and correct this competition intensity comparison is to be made within a same sector (i.e., between FR and AR of a same sector).

[13] Katz (1986)'s model is a four-stage game in which n firms decide, first, whether to cooperate in R&D, second, the organization rules of the cooperation, third, the amount of R&D they invest individually, and fourth their production levels before competing for production sales.

[14] Rutsaert (1993)'s model is a two-stage game based on that of d'Aspremont and Jacquemin (1988) and to which foreign competition is added.

[15] Other works dealing with R&D cooperation using a contract theory approach, such as Gandal and Scotchmer (1993), Picard and Rey (1990), do not contain parameters that can be easily interpreted as representative of either applied research or fundamental research. These works however are attentive to the issue of incentive to cooperate, since they determine the conditions under which a contract can implement R&D cooperation among firms.

[16] It is usually said that AR features lower uncertainty than FR, but higher financial risks than FR. The probability of success modelled in Marjit (1991) is said to represent uncertainty, and I will keep this interpretation for my conclusion. Whether financial risks could be modelled identically to uncertainty or would require a different parameter needs to be investigated.

to cooperate in AR.[17]

The low number of reasons to cooperate in AR coincide with the says of all the managers I interviewed: they always avoid engaging their firms in AR cooperation. They justify their position in terms of unwillingness to share the profits accruing to an innovator and the fear of leakages of core know-how (i.e., privately owned knowledge, skills and experience generating current profits) during the process of AR cooperation.

Despite these facts, agreements of cooperation in AR exist. In the next section, I describe two cases of inter-firm AR cooperation agreement: one existing in a sector of the European food industry and the other taking place in the Western pharmaceutical industry.

3. DESCRIPTION OF TWO SPECIFIC AGREEMENTS OF INTER-FIRM APPLIED RESEARCH COOPERATION

Before describing the agreement under examination and inquiring into its underlying motivations, a few words should be said about the methodology used to perform the case studies and about the consequences this method has on the significance of this empirical work.

3.1. Methodology remarks and caveats

The case studies are the result of an investigation run in several steps: the search of firms with an experience of AR cooperation, the elaboration of successive questionnaires, a sequence of interviews in the selected firms.[18] It is important to realize the sampling bias inherent in my case study investigation due to the fact that the members of the agreement had

[17] Remaining motivations to cooperate in R&D among those investigated above: either the probability of success is very high, or the market value of the innovation is low, or the cooperative innovation will not modify the competition structure existing among members. It is not straightforward to associate any of these features to one stage of R&D more than to another.

[18] A precise description of the chronology of the case study investigation is available in Rutsaert (1994) Chapter 8.

no obligation to respond to my request and to tell all the truth. Consequently, this case is particular in the sense that a firm is expected to be willing to discuss its joint venture (JV) experience only when it believes that its prosecution on the ground of existing antitrust legislation is unlikely. Although it is not representative of all cooperative agreements in AR, much less all agreements that would occur if there were no antitrust implications of JVs, it provides information about certain situations in which such agreements occur. This information is used to supplement existing views about the issues of R&D cooperation and to assess more carefully the competitive implications of research JVs.

In the next section, I recount in detail the facts of two AR cooperation agreement concerning their motivations. In order to preserve the anonymity of the firms, pseudonyms are used and some identifying details are suppressed. In particular, since the case involves mainly one product line, reference to that specific product line will not be mentioned explicitly, although the general industry characteristics will be mentioned. In the remainder of this paper, I denote as "host", the firm which initiated the JV, and as "guest", the firm which accepted taking part in the JV proposed by the host.

3.2. Applied Research Cooperation Agreement in the European Food Industry

The JV agreement in question takes place in the food industry between two European firms. The host firm and the guest firm are called Fari and Rofu, respectively. Their main industrial activity consists in the primary processing of an agricultural crop into a traditional, homogeneous, basic ingredient. This industry is heavily regulated by the common agricultural policy (hereafter, CAP) of the European Union (EU) by means of production quotas and a guaranteed price scheme for the products which is implemented through import tariffs and export subsidies. The consequence of this regulation is market segmentation along lines of the production quota allocations: firms face no suicidal competition at the sales stage because of the guaranteed price scheme and face almost no competition at the supply stage because farmers deliver their crops to the closest factory due to high raw product transportation costs. This situation provides rents to most industrial producers, especially to the largest producers in regions where the crop is abundant.

At the end of the 1970s, the Board of Directors of the medium-sized firm Fari decided that Fari's best survival strategy would be to develop new products and to improve its marketing management. New products and targeted marketing would move it away from its risky mono-specialization.[19] An R&D unit and a marketing unit were created as distinct entities. Also the Board agreed that Fari might resort to JVs or partnerships in order to supplement its own investments.[20]

In 1984, Fari started the industrial production of a new product derived from another crop; I call this new product Farilin. Farilin is not sold through retail stores to individuals, but is sold as an intermediate input to food manufacturers. From an industrial consumer point of view, Farilin is an imperfect substitute for the traditional product which is the main output of Fari. Fari's marketing strategy for Farilin relied on, first, emphasizing its specific properties which differentiate it from the traditional product and, second, developing a new clientele. The reason for this strategy was that Fari reckoned that it had no incentive to generate a substantial substitution effect between the two goods. Indeed, any drastic substitution effect would alter the pattern of the market transactions for the traditional product. This would upset important producers of the traditional good and probably trigger an aggressive counteraction from their part (such as lobbying of EU authorities to cover the new output by the CAP regulation or entry in the new product market).[21] Consequently, Fari's marketing subsidiary Faup Mktg carefully chose a price for Farilin such that only customers interested in its specific properties would agree to switch from the traditional

[19] Although a guaranteed price for the traditional product removes the risk of low sales revenues for a given production, the firm still faces other risks due to its mono-specialization. For example, a bad crop or a major technical problem in the processing of that crop could seriously affect the output, and thus the revenues of the firm based on that unique output.

[20] In 1980, as part of its efforts to strengthen its marketing strategy, Fari agreed with another small firm active in the traditional product industry and located in the same region as Fari, called Uplo, to create a joint subsidiary which would market the entire output of both firms. I refer to this joint marketing subsidiary as Faup Mktg.

[21] The threat of an extension of the regulation was credible because this had already occurred a decade ago for another imperfect substitute for that same traditional product. The possibility of entry existed because many large producers of the traditional product had already invested in R&D in the area in which Fari discovered Farilin. In addition, Fari's new product is not protected by a patent because of the time and costs needed to obtain one and because of the difficulty of enforcing a patent for a product like Farilin. Fari feared CAP regulation more than entry because CAP regulation often entails production quotas that the EU usually fixes on the basis of existing production capacities. This would restrain the development of the new good market, prevent Fari from exploiting all the potential uses of Farilin, and would limit Fari's return on its investment.

product to this new good.[22]

In 1988, Fari discovered another new product to be used as an intermediary input by food manufacturers and which is derived from the same crop as that from which Farilin is extracted. I will refer to this new product as Faribon. Faribon is neither a substitute nor a complement to Fari's main products, but is linked to Farilin by means of the production process.[23]

In Spring 1990, Fari signed a seven-year contract for supplying Farilin to a large European food processor manufacturer. The volume to be supplied from the third year onwards required Fari to rapidly expand its production capacity. In a provision of the contract, the buyer demanded that this expansion should be done via new plant construction. Three alternative growth strategies could be used to achieve this production capacity expansion: internal investment, takeover, or JV. And three alternative strategies could be used to meet the financial requirements for this expansion: to borrow the funds from banks, to augment the firm's equity capital, or to engage in a JV. Two sets of factors led Fari to choose the JV option. First, Fari was constrained in its choice of growth strategy. On the one hand, the option of taking over another producer was not available since there were not, as yet, any for this new product. On the other hand, it needed immediate access to skilled personnel for organizing and supervising the construction of the new factory and for running it, and Fari estimated that it would be very expensive and time-consuming to recruit new employees and train them. Second, the Board of Directors preferred the JV because it would maintain independence vis-a-vis the banks -which borrowing would not- and it would not lead to dilution of current shareholder equity control -which an increase in equity capital would. The reason behind this preference is that the Board of Directors wanted to keep control of Fari.[24] As a result, Fari evaluated the JV strategy as more satisfactory than internal

[22] This cautious pricing strategy turned out only to postpone entry and lobbying of the EU by competitors in the traditional product industry.

[23] The production of Faribon generates some quantities of Farilin as byproducts.

[24] Fari is a family business, and the family-related shareholders form a group which owns a substantial percentage of the shares that gives it control over Fari's management and long-run strategic planning.

investment because it offered a better trade-off between labor cost-minimization and control.[25,26]

Fari immediately started the search for a partner that would meet the following criteria: sufficient financial resources, strong technical abilities, a strategic location (i.e., located in an area where the crop could grow and which was distant from Fari), and an agronomic network (i.e., acquaintance with potential growers).[27] Fari looked for a partner among firms involved in the traditional product industry and located in neighboring countries.[28] Fari searched sequentially among the neighboring countries. After some time and efforts, Fari made its offer to Rofu, a large firm with which it had already had a small successful JV agreement. Rofu agreed to engage in a new JV with Fari because it fitted in its diversification strategy, because it offered a solution to a personnel placement problem created by the closing down of a small factory, and because it would give an opportunity to its R&D unit to work jointly with the dynamic R&D team of Fari.

The JV agreement between Fari and Rofu is a ten-year renewable contract involving the sharing of each firm's know-how that is relevant for the JV, the construction of a new factory, its joint operation, the joint marketing of its output and R&D cooperation. This contract creates a joint subsidiary owned equally by Fari and Rofu, which I will call Bortim Holding, the modification of the status of Faup Mktg so that it would be owned equally by Fari, Uplo and Bortim Holding, and the creation of two other subsidiaries, one owned by

---

[25] It turned out that the guest firm with which Fari entered into the JV agreed mainly because this JV offered a solution to a staff problem.

[26] There were at least two other potential advantages of the JV: access to the guest firm's other assets, such as R&D infrastructure and business contacts, and the strengthening of Fari's reputation and credibility vis-a-vis customers and financial institutions. As regards reputation and credibility, the Board of Directors hoped the formation of a JV with Fari would be interpreted by other economic agents as a signal of the soundness and profitability of Fari's business -especially if the guest firm were large and well-known.

[27] The last two requirements were motivated both by the need to rapidly start growing the crop used for the production of Farilin and by the wish to minimize the costs of the crop input. In particular, the distance condition was based on two considerations. First, Fari did not want its JV partner to be dependent upon the same agricultural cooperative as Fari for the supply of the crop because it wanted to avoid any possibility of tough bargaining between the JV and a cooperative dominating the available supplies in the area. Second, the transport costs of the input crop are much higher than those of the output.

[28] There were three reasons for focusing on these firms at first. First, there are similarities in the knowledge and expertise used in the production of the traditional and the new goods, and experience in the production of the traditional product could be usefully exploited in the running of the new factory. Third, the soil and climate conditions of the neighboring countries are good for growing the crop.

Bortim Holding, that I call here Bortim[29], and the other owned by Faup Mktg, that I call here Bortim Mktg[30]. Both Fari and Rofu have equal property and control rights as well as equal financial engagements in Bortim Holding. It is only via Bortim Holding that Fari and Rofu share the profits of their JV. The JV will be referred to as Bortim JV.

The individual contributions of Fari and Rofu to the various units of the JV are summarized in Table 1. After the table, the reasons for which R&D cooperation became part of the JV agreement are discussed.

[29] Bortim is the manufacturing subsidiary of the joint venture, the profits of which are shared between Fari and Rofu, indirectly via Bortim Holding. The creation of Bortim entailed the construction of the new factory which would supplement Fari's existing plant. At the beginning, the output of Bortim's factory would consist only of the new products discovered by Fari, namely Farilin and Faribon. Fari would keep running its own factory in which these same new products are manufactured out of the input crop supplied by the growers in Fari's region. The contract specifies a production ceiling below which the new product output belongs to Fari and above which that output belongs to Bortim. As regards the traditional product, Fari and Rofu remain independent: they keep their existing production and marketing structures, and run them separately. Finally, if other new products made of the same chemical content as Farilin and Faribon are discovered during further R&D efforts by Fari and/or Rofu, the joint venture agreement specifies that they would be manufactured by Bortim. Bortim would be supplied with input crop by the growers of this region which would have agreed to diversify in this new crop. In order to minimize the construction costs each firm contributed expertise in areas in which it excelled and that would complement its partner's contribution: Fari brought in its know-how about the new goods' production techniques, and Rofu, its construction skills and experience. All these contributions were billed to Bortim according to a remuneration scheme approved by both parties. In particular, it was accepted that Fari's know-how would be paid by Bortim by means of royalties as soon as Bortim would be profitable. These royalties would be based on Bortim's turnover at a predetermined licensing rate. For the training of future growers of the input crop and for running of the factory, Fari contributed its experience by temporarily lending its skilled staff to Bortim.

[30] Bortim Mktg is the marketing subsidiary of the joint venture and deals with the sales of the output of Bortim. Bortim Mktg is a subsidiary of Faup Mktg which is itself responsible for the sales of all the outputs of Fari and Uplo. All marketing decisions in Bortim Mktg must be approved by Faup Mktg, which is equally owned by Fari, Uplo, and Bortim Holding. The sharing of Faup Mktg profits follows a complex scheme which reflects the various output contributions and the property rights of the firms and their subsidiaries. In particular, Bortim Mktg profits belong to Bortim Holding, and are thus shared equally between Fari and Rofu.

Table 1. Bortim JV's Internal Organization and Individual Contributions

Bortim JV's Actions (Location)	Contributions by Fari	Contributions by Rofu
Factory Construction (Bortim)	Production Technique Know-How	Expertise in Construction
Factory Operation (Bortim)	Production Experience; Agronomic Expertise and Training	Skilled Staff; Agronomic Network
Sales and Promotion (Bortim Mktg)	Existing Clientele	Nothing
R&D (Parent Firms' R&D Unit)	New Products Know-How; R&D for New Use of New Products	R&D for New Use of New Products
General Management (Bortim Holding)	Management and Control	Management and Control

Rofu demanded that the R&D activities connected to the goods produced in Bortim be also the object of joint efforts. The principal motivation for Rofu's demand was to access Fari's knowledge about these new products.[31] Rofu perceived this access as a reward for its contributions, which it could keep in case of a breakdown of the agreement. Fari would have preferred not to share its knowledge and expertise because these intangible assets are the heart of its present market position and are a source for future market power. However, Fari accepted the demand mainly for two reasons. First, it would allow Fari to -indirectly- access Rofu's important R&D facilities and to benefit from Rofu's R&D expertise in tackling basic research problems. Second, the potentials for improving production techniques, for developing further applications for Farilin and Faribon, and for discovering new products made of the same chemical content as Farilin and Faribon, would be better exploited at the production and marketing stages if these new applications are the results of joint R&D efforts. Indeed, Fari anticipates many opportunities for process improvements and discoveries of new uses for the product because Farilin and Faribon are new and their markets are underdeveloped. In addition, Fari hopes to develop an alternative source of supply for the chemical substance used for Farilin and Faribon, which would extend the harvesting period, augment the volume of production, and improve the rate of utilization of the factory. By organizing cooperation in R&D for issues directly related to Bortim's activities, Fari hoped

[31] It is worth remembering that none of the new products to be produced by Bortim have been patented by Fari.

to reduce or avoid many tensions known to arise between partners when an innovation takes place, such as conflicts about the sharing of property rights, R&D costs and benefits, and disagreements about how to incorporate the innovation in the production process.

The cooperative research is organized as follows. The themes of research are selected by a committee composed of people from both parent firms; these themes are suggested by one of the parent firms' R&D units or marketing units. The same committee allocates each theme to the firm's R&D unit which is the most skilled to answer it; the R&D is performed in the R&D unit of the firm to which it is allocated (i.e., there is no joint R&D laboratory). The R&D expenditures resulting from these cooperative efforts are equally split among the two parent firms; the supervision of the R&D budget and strategy is the task of another committee. The outcomes of any cooperative R&D effort are the property of Bortim. Each parent firm is informed about them, and if it wants to use any of them for individual purposes it must purchase a license from Bortim which cannot refuse it. Each parent firm is allowed to pursue individual R&D efforts on themes connected to Bortim's business and productive activities which are not already selected for cooperation. The results coming out of these efforts belong to the inventing parent firm. Bortim and the other parent firm can ask to access any of the results which are relevant for Bortim's business or productive activity, and the parent firm owning the property rights must license it to them.

This completes the report on the JV agreement between Fari and Rofu. Next the second agreement of AR cooperation is described.

3.3. Applied Research Cooperation Agreement in the Western Pharmaceutical Industry

The JV agreement now described takes place in the prescription drug industry. It is an agreement between a European firm and a American firm, with the host member being a European firm, called Marp, and the guest member being a American firm, called Bial. Before starting describing this cooperative agreement, I review the features of the industry under consideration because they influence the strategic behaviors of firms in that industry.

The prescription and over-the-counter drug industry is regulated for reasons of

consumer safety and drug efficacy. Most industrialized countries have their own drug approval authorities which often demand that their own set of specific requirements be fulfilled before granting authorization for selling a drug. This as well as specific national regulations concerning drug pricing and medical insurance has led to a market segmented in zones often corresponding to national boundaries.[32] Another characteristic of the drug industry induced by the strict procedure to obtain approval is the length of the development stage.[33] The duration of this development phase is mainly caused by the stringency of the various tests required by the drug approval authorities, and by delays in the review procedure. This lengthy R&D process is very expensive, and the probability that a given patented active substance reaches the shelf of a pharmacist is very low.[34] The pharmaceutical industry also features a specific marketing structure: those who prescribe or recommend drugs are rarely those who consume them.[35] Therefore, drug companies usually market their products by means of a team of trained salesmen. To develop a dense network of contacts with doctors, pharmacists, etc., is an expensive, time-consuming investment. The costs of meeting the specific requirements of a country's drug approval authorities and those of developing a dense sales network in a country make it difficult for small and medium-sized drug companies to sell their drugs all over the world. Instead of selling on their own, or not selling at all, sometimes they license their drugs to companies located outside of the zone where they are located.[36,37]

---

[32] A 1985 OECD study about trade flows of finished and intermediary goods in the pharmaceutical industry highlighted this market segmentation. See OECD Publication (1985).

[33] See Appendix One for a summary of the development stage.

[34] For example, Grabowski and Vernon (1983) cite Hansen's estimates (capitalized at an 8% interest rate): the average expected costs of basic research and preclinical testing amount to US$ 30 million (1976 dollars), and those of clinical testing and approval amount to US$ 24 million (1976 dollars). Grabowski and Vernon also cite Wardell's estimated attrition rate for the New Chemical Entities (NCE): from about 10,000 NEC identified at the basic research stage, to about 1,000 NEC tested at the preclinical testing stage, to 10 NEC tested at the stage of clinical testing, to 1 NEC being approved (where the qualification "about" means a rough guess on the part of Wardell).

[35] See the OECD Publication (1985).

[36] In the OECD Publication (1985), it is stated that agreements concerning exchange of licenses had become common after the mid-1970s because the development costs of new drugs had increased so much that a pure sale of know-how was not viewed as profitable enough compared to an exchange. Marp's CEO confirmed this fact during the first interview.

[37] The therapeutic know-how and the hospital relationship network required to perform all the preclinical and clinical testings at a reasonable cost have led to a low industry-wide concentration in the global drug market, but a higher concentration index is observed within individual therapeutic markets (where a therapeutic market is defined from a product point of view as the drugs caring for diseases affecting a single functional system, such as the digestive system, the nervous system, etc.). For tables summarizing concentration in US pharmaceutical and therapeutic markets, see Duetsch (1991).

Marp, a large European pharmaceutical company, had traditionally specialized in relatively low R&D intensive drugs which could be profitably marketed through its sales network in Europe. However, the margins on these drugs would not justify the fixed costs of developing a sales network outside Europe. Toward the end of the 1980s, fewer small scale drug development projects were available.[38] Consequently, Marp had to engage in more expensive and time-consuming R&D in order to continue discovering and selling new drugs.[39] It began to realize that it had to increase its sales revenues in order to be able to cover the increasing costs of R&D activities directed toward discovering and developing new drugs. Marp decided to develop its sales network in North America and in Japan for two reasons. First, its sales network in Europe was already well-developed. Second, Marp believed that to sell its own drugs outside Europe on its own would be more profitable than to license them to non-European firms, after it developed a sales network in these countries, expecting to recover that fixed cost in the long-run by means of higher sales and returns on sales.[40,41]

Three alternative strategies were identified in order to create new sales networks outside Europe: direct investment abroad, acquisitions of well-established firms, or creation of JVs with firms established abroad. The last option was preferred by Marp's Board of Directors for three reasons. First, it allowed for the sharing of R&D costs and the risks. Second, the conditions that the Board thought necessary for a successful takeover, namely, reasonable price, product scope complementarity, and similarity of size and corporate organization, were difficult to fulfill simultaneously. Third, in keeping with the wish of

---

[38] This change in discovery opportunities (causing research to shift from cellular to atomic and molecular levels) has generated a concentration phase in the American and European drug industries. Small and medium-sized firms are closing down or being taken over because they are financially unable to continue to invest in an innovation-oriented strategy. See Tapon (1989), Duetsch (1993), and OECD Publication (1985).

[39] Because of imperfect capital markets, the principal shareholder in control of Marp might not have wanted to engage in more than the sum of the small projects back in the 1980s. However, it could afford to do it near the end of the 1980s without reducing its control.

[40] From Marp's annual report for 1991, only 15% of Marp's pharmaceutical (sales and license fees) revenues came from outside Europe. Marp's CEO said that most of their existing drugs are licensed to North American and Japanese drug companies which acquire, by the license agreement, exclusive sales rights in their respective countries.

[41] Until the end of the 1980s, the revenues from licensing agreements supplemented the revenues from selling drugs in Europe. Indeed, the sales margins on the low R&D intensive drugs in which Marp had specialized would not justify the fixed costs of establishing sales networks in Japan and North America, but they did justify licensing the drugs to foreign firms established in these regions.

Marp's principal shareholder, it permitted Marp to expand without increasing its equity capital. This shareholder had control over Marp's management and did not want to loose its control. It rejected any option involving an equity capital increase that would dilute the shareholdership and possibly reduce its control over Marp's management.

The Board of Directors decided that Marp would engage in a sequence of JV agreements until its sales network outside Europe is adequately large and profitable to allow Marp to proceed on its own at a reasonable cost.[42] Each JV would involve one foreign firm established either in North America or in Japan. The first phase of the JV would consist of the joint development of one of Marp's patented molecules for which pre-clinical tests had been successful. If the outcome of the joint development is approved by the drug approval authorities, the second phase would consist of the joint marketing of the drug. It is essential from Marp's viewpoint that R&D cooperation be combined with joint marketing since its ultimate objective is the development of a sales network outside Europe. Indeed, this combination would allow Marp to build a sales network while sharing the costs and the risks associated with this network creation. In addition, Marp thought that the spread of the cooperation over the R&D and the marketing stages would ease the reaching of a consensus about the various individual contributions. Marp would require that each JV agreement include four points. First, the remaining R&D tasks and their costs, namely, clinical trials on human beings and administrative approval, should be shared between the parent firms. Second, both parent firms should be allowed to sell, in the country in which the guest firm is located, the jointly developed drug as well as other drugs for which the parent firms would have obtained a sales and promotion contract.[43,44] Third, the profits derived from producing

---

[42] Marp's Board of Directors expected that the JV phase would last for about a decade.

[43] Marp's CEO said that the marketing section of their JV agreements could only be sketched because it was too costly to reach an agreement about the marketing strategy not knowing whether the joint development would be successful and approved. The marketing agreement would be discussed at a later stage if and when the commercialization becomes certain. However, the initial JV agreement would establish the main principles that would govern the later marketing agreement, if any.

[44] The marketing side of the JV should be understood in their context: Marp cannot sell its existing drugs outside Europe because either they are already the object of exclusive license agreements in both North America and Japan, or it would be necessary to engage in the various clinical trials demanded by these countries' drug approval authorities. Since Marp's ultimate goal is to develop a network in the country of the guest firm, the sale of the jointly developed drug in that country by both parent firms should, at least, be part of the agreement. In addition, according to the CEO of Marp, it is not profitable to hire salesmen to promote only one drug at a time. Therefore, the parent firms should agree in the JV contract that if sales of the jointly developed drug take place, salesmen could be hired to promote, in addition to the jointly developed drug, other drugs developed by third parties and for which the parent

and selling the jointly developed drug should be shared according to an agreed scheme which would depend on the joint marketing strategy adopted by the parent firms.[45] Fourth, the duration of the JV should be finite. Marp wanted to limit this duration because of the difference between expected total R&D and production expenditures and expected total sales revenues. According to Marp, the latter are higher than the former for a firm which already has an efficient sales network, but the difference is not high enough to cover the fixed costs necessary for the creation of a sales network.[46] Therefore, as long as the sales network had not reached a size sufficient for profitable independent operation, Marp would agree to share all costs and revenues.[47] However, once its new sales network could run autonomously, Marp would find more profitable to pay all the R&D and production costs and to earn all the sales revenues, i.e., to not share costs and revenues.

Marp looked for JVs simultaneously in North America and in Japan. Here I focus on the case of a JV between Marp and an American drug company.

First, Marp successfully finished animal testing of a new molecule identified to be active against a disease in a therapeutic field, which I refer to as area Z, in which Marp already had expertise. This new active substance, called Zuiz, involves a new mechanism that should make the new drug at least as good as drugs already existing for this disease.[48] Using the patent on the Zuiz molecule and the successful outcome of the pre-clinical results to attract potential partners, Marp searched for a North American partner interested in engaging in a JV for the remainder of the drug development and for its marketing in case of

---

firms have bought sales rights.

[45] Marp's CEO could not be more specific about the scheme of profit sharing because this scheme would vary from one JV agreement to the next according to the guest firm involved, and because no particular marketing agreement has been reached yet, as the commercialization of a drug developed in one such JV has not yet become certain.

[46] To create a sales network in a country is a once-for-all investment. Indeed, a firm uses the same sales network for marketing all its drugs.

[47] That is, Marp would prefer not to share its expertise and know-how concerning potential drugs having successfully reached the clinical testing stage because these intangible assets are likely to generate high future returns, higher than the costs of developing and exploiting them. However, Marp's view is that the difference between total R&D-cum-production costs and total sales revenues that the guest firm receives through profit sharing corresponds to the guest firm's compensation for its contribution to developing the Marp's sales network.

[48] Thus the targeted drug is not a mere copy of an existing drug (called a "me-too" drug). This means that Marp must go through the entire clinical testing procedure. (Procedures for me-too drugs are less involved.)

approval. Marp found two drug companies interested in becoming JV partners: an old, large firm and a new, small firm. Both firms had expertise in the Z area for which the new molecule is aimed at providing a remedy. However, Marp chose the small firm -that I call here Bial- for two reasons. First, Marp considered Bial easier to control during the cooperative efforts in development because the small size of Bial's research center permits observation and monitoring at reasonable costs and because the small budget of Bial's research unit does not allow Bial to parallel the project. Second, Bial is a new firm in the sense that until now it has only been involved in R&D and that it has not yet started to market drugs. In case of successful development and approval, Bial should start selling its first drugs before the JV would start selling its own. The newness of Bial's commercial network should make it easier to develop a joint marketing strategy with Bial than with the other large and established firm. Marp signed its first JV agreement with a North American drug company after 18 months of search and 2 months of formal negotiation.

The JV was organized in three parts: the R&D cooperation and the drug production were negotiated in detail, while the marketing collaboration was discussed and agreed upon in principle.[49] [50]

[49] It was agreed that the production of the active substance for the potential drug would remain the responsibility of Marp. There were two reasons for that decision. First, given the complexity of the production technique and its requirement for heavy and expensive equipment, the production is characterized by increasing returns to scale. The JV would benefit from these scale economies by restricting production to only one factory. Second, by keeping to itself the know-how needed to produce the active substance, Marp can protect itself against free-riding by Bial. Indeed, Bial could not afford to invest in a substantial factory given its small size and its budget constraint. In addition, Bial lacked the necessary production expertise.

[50] The joint marketing agreement will not be completely elaborated until the parent firms are certain that the drug will be approved by the drug approval authorities in the US. Indeed, firms were aware that negotiations about specific marketing issues were not worth engaging in so long as the jointly developed drug is not approved. However, the main principles of this joint commercialization were decided upon knowing that the targeted drug will only be sold by prescription under patent protection. The drug would be sold under a unique brand name in a unique package with both firms' names on it. According to Marp's CEO, this sort of unique brand name, unique packaging strategy already exists in the drug industry. The purpose of this strategy is to ease and to quicken the development of the sales network and to reduce confusion in buyers' minds. Regardless of the precise marketing plan, the sales profits would be equally shared. The risk that one firm would strategically report incorrect sales costs so as to get a larger share of the profits should be limited by the existence of the special committee in charge of supervising the progress of the joint efforts. This special committee will also be entitled to supervise each member's costs and sales reports and the potential for free-riding at the marketing stage. The duration of the agreement was decided to exceed the drug patent life so as to avoid any abrupt and unprofitable change in the two firms' relationship in anticipation of the patent expiration. Indeed, if the duration of the agreement is lower that of the patent, then the two firms would become fierce competitors when the agreement expires since they would be selling exactly the same drug. In addition, anticipating this severe competition, each firm would have an incentive to behave so as to maximize its own long-run profits (including the after-agreement period) instead of the JV medium-run profits. For example, if each parent firm is in charge of part of the sales forces, then, during the period of joint marketing, it might use the

R&D cooperation would be a mixture of purely individual contributions and sharing of tasks. Table 2 summarizes the internal organization of the JV and the individual contributions of the parent firms to the JV.

Table 2. Marp-Bial JV's Internal Organization and Individual Contributions

JV's Drug Development	Contributions by Marp	Contributions by Bial
Basic Research	R&D unit found molecule Zuiz	none
Preclinical Testing	R&D unit completed tests with success	none
Clinical Testing	R&D unit participates according to skills	R&D unit participates according to skills
Drug Approval	in charge of approval in Europe	in charge of approval in the US
Supervision	Management and Control	Management and Control
Production	Marp's factory in Europe produces Zuiz	none
Marketing	Marp sells in Europe and in the US	Bial sells in the US

Concerning the R&D cooperation in itself, Marp would first contribute its patented molecule and all the results of the pre-clinical tests. Then Marp and Bial would perform all the clinical tests needed to be granted approval in Europe and in the USA. They would share these tests between them according to their expertise and capability to satisfy the specific requirements demanded by each country's drug approval authorities.[51] These tests would have to be performed in the R&D units of each firm (i.e., no common laboratory is created) according to an agreed schedule. A special committee would be created to supervise the progress of the joint efforts, to solve any conflicts and to implement any revisions of the

salesmen it supervises to sell at a price lower than that which maximizes the JV profits in order to distinguish itself from its partner. It might do so to create a special relationship with its share of the clientele, hoping to keep it after the agreement's end. In order to reduce the incentive to free-ride during the joint marketing phase, both firms have agreed that their joint sales would last beyond the patent expiration date. The ending date of the JV agreement would be chosen so that enough time would have elapsed, after the patent expired, that producers of generic drugs would have started to aggressively compete against the JV. Then, the ending of the agreement would not lead to a substantial change in the competitive structure of the market for that drug.

[51] According to Marp's CEO, neither American nor European drug approval authorities require that the clinical tests be performed in a specific territory; only Japan requires that tests be performed in Japan. However, some requirements are so specific to a country that the equipment and expertise needed to satisfy these requirements are available at reasonable cost only in that country. According to that same person, the fact that some requirements are more demanding in the USA than in Europe would not be a source of tension in the JV with Bial. The sharing of the tasks would take this difference into account.

agreement. The results of these tests would be continuously exchanged between the two firms by means of frequent meetings and some temporary visits of R&D researchers to the partner's R&D unit. Then each firm would be responsible for registering the drug with its own country's drug approval agency.[52]

4. MOTIVATION ANALYSIS

In both the Fari-Rofu and Marp-Bial agreements, cooperation in AR takes place within a market relationship that was created at the same time as the research cooperative agreement. The parent firms are involved in AR cooperation knowing that the marketing of the outcome of the cooperative research is, or will be, the object of joint efforts. AR cooperation occurs as part of a broader growth strategy initiated by an innovative firm. The host firm, i.e., the firm which has the initiative of the JV, exchanges its innovative knowledge against the access to financial and other assets that it needs in order to grow successfully.

The cooperation in AR is not primarily caused by the impossibility for the host firm to complete its R&D project with profits. On the contrary, the host firm's expertise and know-how is used to attract potential partners to engage in an undertaking aimed at developing a new product and its market. Such expertise and know-how must thus be valuable. Both host firms said that it would have preferred not to share these valuable assets because they shape their firm's core, underlie their present market position, and are a potential source for future market power. Fari would have prefered not to share them especially since the returns on this technological information are appropriable by its owner.[53] Marp had a patent on the molecule that it contributed to the joint venture. Aware that their technological know-how was an attractive asset, both host firms agreed to share it in order to be able to

[52] The drug approval authority of the USA, the Federal Drug Administration (FDA), does not accept any other country's approval. Similarly, no drug approval authorities of the EU accept US approvals. Disparities among requirements exist among all countries. However, in the EU, a proposal for a unified procedure of approval for granting a European patent to firms of the EU member countries is under discussion. See, Rapport au Commissariat au Plan, Paris (1989).

[53] Fari's innovation had not yet been imitated, and Fari served alone the demand for its new product.

gain access to other assets needed to reach its own specific goals, namely growth. It should be noted that Fari and Marp are both closely held firms. One crucial part of the motives was to acquire assets without loosing control to banks or through equity dilution. This means that the host firms perceived the expected gains from growth through the JV to be large enough to overcome the expected losses from sharing their know-how as part of the JV.

Based on these two specific cases of AR cooperation agreements, an answer to the question "What did motivate cooperation in AR?" highlights three interesting facts. First, the above motivation analysis suggests the relevance of distinguishing the ability to innovate and the capacity to successfully exploit the innovation, i.e., to produce and sell with benefits. If a firm can do both, it is very likely that it will not cooperate in AR. If a firm can innovate but cannot valorize its innovation, it might consider getting access to the necessary assets or skills by means of a JV in which it exchanges its know-how against these assets.

Second, and more important, there exist agreements in which it is not the cooperation at the R&D stage that leads to joint production and marketing, rather it is the joint production and marketing which calls for applied R&D cooperation. The causal link usually mentioned in the competition policy debate is a downstream one: cooperation in R&D at a close-to-the-market stage may be abusively extended and lead to collusion at the market stage. My investigation shows that an upstream causality link may exist in some situations: cooperation in AR and development is included in the joint production and marketing agreements in order to cement the JV. In the Fari-Rofu agreement as well as in the Marp-Bial agreement, the initial sharing of know-how eased the search for a partner and the balancing of individual contributions. Then the cooperative continuation of AR related to the product which is the object of the JV has helped to stabilize the internal organization of the JV as well as make it durable.

Third, it is worth noticing, in relation to the previous point, that the combination of a cooperation agreement in AR with a sales collaborative agreement is to be paralleled to one result of Rutsaert (1994). This result shows that when price competition prevails firms selling an homogeneous good might agree to cooperate in R&D when they know that there will be collaboration for sales. By cooperating in AR until a marketable new product is deviced,

firms know that there will be fierce competitors on the market stage as they would sell the same new good. In other words, the cooperation at the applied R&D stage leaves little scope and time for firms to perform the research necessary to create sufficient differentiation among the products they will each sell. In the Fari-Rofu agreement, Fari would have never agreed to cooperate in AR with Rofu as it does now if there had been no sales agreement. Or, in other words, it is because of the joint sales agreement that Fari could dare to consider the possibility of cooperating in AR with Rofu. In the Marp-Bial agreement, the situation is slightly different. The new product cannot be the object of differentiation at reasonable costs because Marp owns a patent on Zuiz. Consequently, Bial cannot sell the final product that would emerge from development cooperation without infringing the patent. In addition, to achieve sufficient differentiation would require that Bial discover a new molecula all together. However, Bial agreed to cooperate in AR with Marp because of a clause in the cooperative agreement which garanteed Bial part of the sales revenues and the absence of fierce competition at the sales stage.

5. CONCLUSIONS

A review of the existing literature concerning cooperation in R&D suggested that there were fewer motivations to cooperate in applied R&D than to cooperate in fundamental R&D. Indeed, at the AR stage, spillovers are low, uncertainty is reduced, and the likely marketability of the outcome of applied R&D makes member firms fear fierce inter-member competition at the market stage.

The examination of the Fari-Rofu and Marp-Bial cooperative agreements supplements the debate on motivations for R&D cooperation by drawing attention to certain circumstances in which cooperation in AR takes place. The specificity of the cases forces me to consider the conclusions of the analysis as particular -clearly, much diversity exists among R&D cooperation agreements- but also as signals of possibilities that should not be overlooked.

It is observed that AR cooperation can be part of a broad JV agreement including a joint production and joint sales agreement and that the principal motivation behind the host

firm's proposal of a JV is growth without dilution of control. In the two cases that were examined, the host firms possess a (potentially) profitable technology on which to base its growth and its Board of Directors estimate that the preferred growth strategy would consist of proposing a JV where the costs, risks, and benefits from the development of the technology could be shared (i.e., where the existing know-how would be shared in exchange for the access to assets needed to pursue its growth). AR cooperation is included in the JV agreement so as to play the important role of consummating the entire JV agreement. It is not R&D cooperation that leads to collaboration at the market stage, but rather the goal of "Joint Production, Joint Sales" that induces AR cooperation in the JV.

This latter observation about the direction of causality, namely, from market collaboration to AR cooperation, stands in contrast with most of the traditional R&D cooperation literature which assigns causality from AR cooperation to market collaboration.[54] This upstream causality suggests that the causality issue deserves further examination. But also, it has an immediate consequence in terms of antitrust assessment: it is the entire JV agreement, and not only the AR cooperation agreement, which should be scrutinized.

Independently of upstream causality, the investigation into the motivations to cooperate in AR seems to generate the following antitrust recommendation: Authorities in charge of determining the legality of an AR cooperation agreement might reasonably inquire about the existence of a broader agreement and evaluate the entire agreement. Indeed facts suggest that AR cooperation would typically be only one part of an arrangement which also included joint production, joint sales, and profit sharing schemes. First, besides low spillovers, AR features low uncertainty, foreseeable returns, and high expenditures. As a result, firms take the market stage into consideration in their deciding whether or not to cooperate. Second, interviewed managers acknowledge that they avoid AR cooperation because the know-how and expertise corresponding to that stage is strategic for the firm's profitability and because it is feared that cooperation in AR would induce the sharing of this technological knowledge in a way that might harm the firm's future profits. Third, cooperation in AR was shown to be only a "cement", a part of a broader JV agreement the main purpose of which is growth by means

[54] See, for example, Jacquemin (1988).

of joint production and joint sales.

Because of the limited sample size and biases inherent in the sampling procedure, these case study observations are only suggestive of the diversity that policy-makers should take into account in designing R&D cooperation policy and that the antitrust authorities should allow for in formulating competition policy. On the one hand, the preceding discussion about motivations and R&D-market linkages support the position that AR cooperation agreements should neither be considered illegal per se, nor should they be granted safe harbor. On the other hand, the efficiency of R&D cooperation programs would be improved if they were designed with a clear understanding of which types of R&D cooperation firms are willing to engage in and under what conditions. This empirical study suggests that differences in motivation between cooperation in applied and basic research might justify differences in the internal organization of these cooperative agreements. It also stresses that firms' differences in know-how must be taken into account in the management of such agreements lest they impede cooperation -collaboration at the market stage might, for example, provide adequate channels for compensatory transfers.

BIBLIOGRAPHY

References

- d'ASPREMONT, C. and A. JACQUEMIN, "Cooperative and Noncooperative R&D in Duopoly with Spillovers", American Economic Review, Dec 1988, pp.1133-1137.
- d'ASPREMONT, C. and A. JACQUEMIN, "Cooperative and Noncooperative R&D in Duopoly with Spillovers: Erratum", American Economic Review, June 1990, pp.641.
- BHATTACHARYA, S., J.GLAZER, and D.SAPPINGTON, "Sharing Productive Knowledge in Internally Financed R&D Contests", The Journal of Industrial Economics, 1990, pp.188-208.
- BHATTACHARYA, S., J.GLAZER, and D.SAPPINGTON, "Licensing and the Sharing of Knowledge in Research Joint Venture", Center for Economic Research working paper, Tilburg, May 1991.

- DOSI, G., "Sources, Procedures, and Microeconomics Effects of Innovation", Journal of Economic Literature, Sept 1988, pp.1120-1171.
- GANDAL, N., and S. SCOTCHMER, "Coordinating Research through Research Joint Ventures", forthcoming in Journal of Public Economics, 1993.
- GEROSKI, P., "Anti-trust Policy Towards Cooperative R&D Ventures", 1993, forthcoming in Oxford Review of Economic Policy.
- JACQUEMIN, A., "Cooperative agreements in R&D and European Antitrust Policy", European Economic Review, 1988, 32, pp.551-560.
- JACQUEMIN, A., "Horizontal Concentration and European Merger Policy", European Economic Review, 1990, pp.539-550.
- JACQUEMIN, A., and M. SLADE, "Cartels, Collusion, and Horizontal Merger", in Handbook of Industrial Organization, R. Schmalensee and R. Willig (Eds), Volume 1, North-Holland, Elsevier Science Publishers, 1989.
- JORDE, T., and D.J.TEECE, "Innovation, Cooperation and Antitrust:
Balancing Competition and Cooperation", High Technology Law Journal, Spring 1989.
- KATZ, M., "An Analysis of Cooperative Research and Development", Rand Journal of Economics, 1986, pp.527-543.
- KATZ, M., and J. ORDOVER, "R&D Cooperation and Competition", Brookings Papers: Microecomomics, 1990, pp.137-201.
- MARJIT, S., "Incentives for cooperative and non-cooperative R&D in duopoly", Economics Letters, 1991, pp.187-191.
- PFEFFER, J., and P. NOWAK, "Patterns of Joint Venture Activity: Implications for Antitrust Policy", The Antitrust Bulletin, Summer 1976, pp.315-339.
- PICARD, P., and P. REY, "Incentives in Cooperative Research and Development", in Essays in Honor of Edmond Malinvaud, P. Champsaur et al. (eds), Volume 1, Cambridge, The MIT Press, 1990, pp.252-279.
- RIGGS, J., and A. GIUSTINI, "Joint Ventures Under EEC Competition Law", The Business Lawyer, May 1991, pp.849-908.
- RUTSAERT, P., "Research and Development Cooperation in an Open Economy", a dissertation submitted to Cornell University, January 1994.
- SATZKY, H., "The Merger Control Regulation of the European Economic Community", The Journal of Reprints for Antitrust Law and Economics, 1993, pp.251-276.

- SCHMIDT, I., "The New EEC Merger Control System", Review of Industrial Organization, 1991, pp.147-159.
- SUZUMURA, K., "Cooperative and Noncooperative R&D in Oligopoly with Spillovers", American Review of Economics, 1992, pp.1307-1320.
- VONORTAS, N., "Inter-firm Cooperation with Imperfectly Appropriable Research", 1991a, Discussion Paper D-9111, Departmemt of Economics, George Washington University.
- WATKINS, T., "A Technological Communication Costs Model of R&D Consortia as Public Policy", Research Policy, 1991, vol 20, pp.87-107.
- WILLIAMSON, O., "Economies as an Antitrust Defense: The Welfare Tradeoffs", American Economic Review, March 1968, pp.18-36.

Official Publications, Legal and Other Sources

- 1991 Annual Report of the Firm with Pseudonym "FARI".
- 1992 Marketing Brochure of the Firm with Pseudonym "FARI".
- 1991 Annual Report of the Firm with Pseudonym "ROFU".
- 1992 Professional Documentation of the Joint Subsidiary with Pseudonym "Bortim".

Appendix One

The various stages of the drug development and approval process, their objectives and their duration can conveniently be summarized as in Table A.[55]

Table A. Drug Development and Approval Process

R&D Stage	Objective	Testing Population	Duration
Basic Research	Screening and Chemical Analysis	Laboratory Manipulations	2 to 3 years
Preclinical Testing	Assess Safety and Biological Activity	Laboratory Manipulations and Animal Study	2 years
Clinical Testing I	Determine Safety and Dosage	20 to 80 Volunteers	1 year
Clinical Testing II	Evaluate Effectiveness and Look For Side Effects	100 to 300 Patient Volunteers	2 years
Clinical Testing III	Verify Effectiveness, Monitor Adverse Reactions	1,000 to 3,000 Patient Volunteers	3 years
Approval Procedure	Review by Drug Authorities		1 to 3 years
Marketing	Safety Monitoring		

Source: LANGLE, C., "Le coût d'un nouveau médicament", Courrier du Parlement, in Commissariat General du Plan, 1988.

[55] The schedule of R&D in the ethical drug industry described in that table was found to be almost identical to that found in the Journal Officiel de la République Française, January 28, 1986, in Grabowski and Vernon (1983) p.22, and to that mentioned by Professor Le Pecq in an interview (Paris, April 1, 1993).

.