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Collusive Behaviour, R & D,
and European Policy

by Alexis Jacquemin *

Internal paper

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ABSTRACT

The European Commission White Paper (1985) on "Completing the Internal Market" underlines the role played by cooperation among firms, which is viewed as an important means of improving European competitiveness, especially in high technology. In the first part of our paper, section 1 looks at the main factors that facilitate or hinder cooperation in general, and that constitute the basic ingredients of a private firm's cost-benefit analysis. It is suggested that on the whole, the probability of collusion, tacit or explicit, is greater than what is suggested by conventional wisdom. Section 2 discusses the public view of cooperation in light of the goals and tools of European conpetition policy, and stresses the pragmatic application of Article 85 of the Treaty of Rome. The second part of the paper illustrates how these issues are involved in cooperative agreements in R & D. Our analysis first shows that from a private point of view benefits from such a cooperation, although real, are more difficult to identify and to capture. The following section explores the arguments in favour of socially beneficial effects of cooperative research and shows that cooperation can improve the incentive problem as well as provide a more efficient sharing of information than non cooperative behaviour. This gives some support to the permissive European regulation allowing cooperative research whereby member firms share the costs and the results of a research project. A general conclusion is that too much collusion is expected to occur in domains where non-cooperative, non-collusive behaviour would be more efficient; and too little collusion can occur in activities where socially desirable outcomes might arise from cooperation, R & D being a case in point.

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INTRODUCTION

Over the past few years, the traditional view that market structure largely determines the conduct (or behaviour) of firms in a market, and industry structure determines industry performance, has lost ground. The "New Industrial Organization" literature insists on the central role of market conduct, the necessity of detailed analysis of business behaviour and the usefulness of well-defined microeconomic models to understand the complex relationships characterizing the structure-conduct-performance paradigm[1]). Given the dynamic nature of strategic competition, each firm knows that over time its behaviour can have an effect upon the other firms and that its best plan of action depends upon the plans chosen by its rivals. Firms must then be conceived as actors able to modify to some extent their environment instead of being subject to it. In this perspective the configuration of industrial structures and organizational forms is as much the outcome of deliberate strategies as of initial conditions and predetermined rules of the game[2]).

One crucial strategic choice for a firm is between collusive and non-collusive behaviour. While collusion is generally expected to raise a firm's profits, it is also in the interest of each firm to let its competitors pay the cost of cooperation and to gain a "free-ride" by acting as an independent outsider. From the point of view of public interest, the question is also complex, and there have been many changes in academic

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1) An overview of this literature is given in J. Stiglitz and F. Matthewson (ed.) 1986

2) For an extensive analysis, see A. Jacquemin (1987).

thinking and antitrust policy. At times it has been fashionable to emphasize the negative effects of collusion, such as deviations from marginal-cost pricing, which reduce welfare. At other times, emphasis has been put on the dynamic effects such as the provision of new technologies and new products which could be fostered by cooperative behaviour. For example, Article 85 of the Treaty of Rome condemns agreements between firms and concerted practices which may affect trade between Member States. On the other hand, the White Paper on Completing the Internal Market (1985, p. 34) states that: "The removal of internal boundaries and the establishment of free movement of goods and capital and the freedom to provide services are clearly fundamental to the creation of the internal market. Nevertheless, Community action must go further and create an environment or conditions likely to favour the development of cooperation between undertakings. Such cooperation will strengthen the industrial and commercial fabric of the internal market.....The Commission will seek to ensure that Commuity budgetary and financial facilities make their full contribution to the development of greater cooperation between firms in different Member States".

The purpose of this policy paper is to suggest that too much collusion, tacit and explicit, can be expected in many domains where non-cooperative, non-collusive behaviour would be socially more efficient, and that too little collusion can occur in activities where socially desirable outcomes might arise from cooperation, R & D being a case in point. In the first part, we deal with the general problem of collusion. We first identify, on the basis of recent models, various situations facilitating the adoption and stabilization of collusive behaviour (sectio 1). We then discuss the public view of collusion in light of European competition policy which, contrary to the US approach, provides an "efficiency defence" for some collusive actions (section 2). In the second part of the paper, we consider cooperative agreements in R & D. A discussion of the private costs and benefits of joint R & D (section 1) leads to the conclusion that specific characteristics of R & D, mainly the difficulty of appropriating the results of the joint efforts, tend to impede and destabilize many agreements in this domain. A brief public cost

benefit analysis (section 2) suggests in other respects that cooperative R & D can sometimes improve efficiency. This provides support for the 1985 permissive European regulation allowing cooperative research whereby members firms agree to share the costs and the fruits of a research project.

PART I: COLLUSIVE BEHAVIOUR AND EUROPEAN ANTITRUST POLICY

The conventional wisdom underlines various intrinsic difficulties at each state of the collusive process: reaching an agreement, detecting cheating, punishing credibly the defector. This could lead to the view that the probability of collusion tacit or explicit is very small. But in fact collusive arrangements are common practice and every year a great number of cases are brought to the European Commission and the European Court of Justice (see the Annual Reports on Competition Policy published by the European Communities). Recent models have suggested some explanations of this paradox.

Section 1: Factors that facilitate collusion

Various factors tend to make collusion successful. Let us consider infinitely repeated oligopoly games and suppose that each player chooses its quantity of production[3]) in order to maximize its discounted stream of profits. Then

$$S_i = \sum_{t=0}^{\infty} w^t \pi_{it}$$

where π_{it} is the ith firm's profit in period t and w = 1/ (1+r) is the discount factor (r being the discount rate). Denoting by π_i^* the firm's profit under a tacitly collusive equilibrium, firm i earns $\pi_i^*/ (1-w)$ by cooperating permanently.

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3) For a discussion of price-setting supergames (repeated Bertrand games), see Brock and Scheinkman (1985).

Let us assume that that on the contrary if one of the players defects, it will induce non-cooperative behaviour in all the subsequent periods. Calling π_i^d the defector's profit during the one period in which is deviates from the collusive scheme and π_i^c the non-cooperative profits following its deviation, the defector's overall payoff in the game is given by $\pi_{id} + w/(1-w)\pi_i^c$. Tacit collusion will be the outcome so long as the profit obtained by colluding is no less than the profit obtained by defecting. The corresponding well-kown condition is:

$$w \geq \frac{\pi_i^d - \pi_i^*}{\pi_i^d - \pi_i^c} \qquad i = 1 \ldots n.$$

This equation allows us to identify several conditions for tacit collusion:

(i) If w is close enough to unity, i.e. if firms give enough weight to the future, non-cooperative collusion can be sustained. As a high w means that successive periods payoffs are highly valued, this condition also implies that the scope for tacit collusion is great when detection lags are short. This suggests that "policies designed to make secret price cuts possible are valuable in undermining tacit collusion or conscious parallelism. And industry practices that inhibit secret price setting should be subject to close antitrust scrutiny (Shapiro, 1986).

(ii) Profits from defection must be bound ($\pi_i^d < \infty$ for all i) and the smaller these profits, the higher the supportable level of collusive profit π_i^* .

(iii) Only mild punishments ($\pi_i^c < \pi i^*$) are needed. And moreover the more severe the punishment is (the lower π_i^c is), the higher the level of π_i^* that can be supported as an equilibrium[4]).

Note that there are various ways to sustain the collusive outcome non-cooperatively. In the previous model, firm j cooperates with i unless

[4]) Shapiro (1986) remarks that this leads to the following paradox: any underlying market condition that makes very competitive behaviour possible and credible can, by lowering π_i^c, actually promote collusion!

and until i defects, in which case j is triggered into perpetual non-cooperation. An alternative and less severe strategy is "tit-for-tat" (Axelrod, 1984), according to which each firm starts by playing friendly and then chooses in the current period what the other player chose in the previous period[5]). More generally, Abreu (1984) has been able to characterize what he calls "optimal penal codes", i.e. the most effective credible strategies for punishing deviations from collusive behaviour. Within the class of symmetric punishments (punishments which assume that all firms act identically), he shows that the optimal punishment has a two-phase structure: if a firm deviates from collusive behaviour, there would immediately be one period of punishment, followed by a return to the most sustainable collusive configuration.

Collusion might also occur non-cooperatively in the finitely repeated game, once we relax the artificial assumption of complete information and suppose instead that a firm has a small degree of doubt about the motivation of one of its rivals. Then "reputation" can operate to maintain effective collusion. Similarly, if there is uncertainty about the end of the game, the factor w may be interpreted as the probability that the game will continue into the next period. When this probability is sufficiently high, any individually rational outcome can be sustained as a credible Nash collusive equilibrium of the repeated game[6]).

The rapidly growing literature suggests that the number of possible tacitly collusive strategies and outcomes is indeed very large and that it is not very easy to make the solution determinate. If the equilibrium is not unique, then "at least verbal assent will be required on which equilibrium among those possible will be chosen. Such discussion might be considered tantamount to collusion even if no explicit coordination is needed after that preliminary decision" (Waterson, 1984, p. 46).

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5) Aumann and Sorin (1986) have recently provided a theoretical basis for the situation in which players start by playing friendly and continue with tit for tat thereafter. Their model shows that utility-maximizing behaviour on the part of each separate individual necessarily leads to cooperation.

6) An individual rational outcome is what a firm can obtain by minimizing over the strategies of its opponents the maximum payoff it can achieve against them, i.e. its minmax value.

This leads us to the case of explicit collusion or cooperative behaviour. Again many difficulties have been mentioned in the literature about cartels (Osborn, 1976, Jacquemin and Slade, 1986): locating the contract surface, i.e. the points or set of points providing maximum profits to the cartel, sharing activities and results between members; maintaining members in the cartel and controlling non-members (either firms already in the industry or entrants attracted by the high profits); and detecting breaches of the agreement and deterring effective breaches through various types of penalties.

Various answers can be given to these problems[7]). We should like to focus on one important aspect.

Once the explicit formation of a cartel has been decided, stability of this cartel does not necessarily require coercitive mechanism or side payments. Thus d'Aspremont, Jacquemin, Gabszewicz and Weymark (1983) have shown that there is always stability for a cartel establishing the leading price if the set of firms is finite. To illustrate the argument, let there be a set of n identical firms, k of which form a cartel that fixed the price in such a way that profits are maximized for each firm in the cartel, given that production of competitive firms is determined by the equality between the fixed price and their marginal cost. Because all firms sell at the same price and because the firms in the fringe choose without any constraints the output that maximizes their profit at this price, we have

$$\pi^f(n,k) \geq \pi^l(n,k)$$

where $\pi^f(k)$ and $\pi^l(k)$ denote the profits of firms in the fringe and the cartel respectively.

Two types of stability are then defined. A cartel made up of k members has internal stability if $k \geq 1$ and if $\pi^f(n,k-1) \leq \pi^l(n,k)$; it has external stability if $k \leq n-1$ and if $\pi^l(n,k+1) \leq \pi^f(n,k)$. The cartel is called stable

7) For example MacLeod, Norman and Thisse (1986), using a solution concept based on models of spatial competition, have shown, in a two stage game, that once market areas have been determined by the Bertrand-Nash competitive process, collusion in price becomes feasible and profitable even given free entry. Indeed a switch to the appropriate Bertrand-Nash pricing is a credible threat.

if there is internal and external stability at the same time d'Aspremont et al. then wrote a simple algorithm showing that there is always a stable cartel. Having established that the profits of each firm in the cartel increase with the size of the cartel, they assumed that the cartel with k=1 has internal stability. If the case k=1 also has external stability, then a stable cartel has been found. Otherwise, the case k=2 is considered: this has internal stability, or else the process would have stopped at k=1. If k=2 has external stability, the search for a stable cartel has ended. According to the algorithm, either a stable cartel is found with k n, or the algorithm reaches k=n. In this case, k=n has internal stability, and because all the firms are included, the monopoly cartel is stable. Building on DJGW, Donsimoni (1985) examines the impact of variations in cost and demand conditions on the structure of the stable cartel. In her model, demand and cost functions are linear and costs vary across firms. As before, with a finite number of firms there always exists a stable cartel. In addition, the members of the stable cartel are the efficient firms (those with low costs). Finally the size of the cartel is a decreasing function of the industry elasticity of demand[8]).

From this section, it appears that a private firm's cost benefit analysis of collusive behaviour is a complex matter. But several factors can in general promote cooperation: making the future more important than the present, making the interactions between firms more durable and more frequent, improving the firm's ability to recognize defection when it occurs, changing the payoff structure so that the punishment for defection is greater and the gains from mutual cooperation higher and more easily appropriable, recognizing the effects of its own action on the structure of the market.

At the light of the European Competition Policy, we shall see in the next section if the existence of the often observed collusive behaviour has positive or negative connotations from the point of view of social welfare.

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8) For further results, see Rothschild (1984), Donsimoni et alii (1986).

Section 2: Collusion and European Competition Policy

Article 85 of the Treaty of Rome contains a broad prohibition of explicit and tacit collusion where it is likely to affect trade between Member States and has as its purpose or result the prevention, restriction, or distortion of competition within the Common Market. Such collusive agreements are void unless EC Commission is notified of them and grants an exemption.

A priori, such a broad prohibition could be based on one or several goals which are traditionally at the core of competition policy. One eventual goal is the diffusion of private economic power, the protection of individual freedom and individual rights. The use of cartels can then be seen as a radical departure from such an individualism[9]). This aspect, which was originally basic to antitrust legislation, still occupies an important place, although perhaps more at the level of public opinion than at policy level.

A second eventual goal of competition policy may be to protect the economic freedom of market competitors. Here the protection of competitors takes precedence over the defence of the competitive process as such.

9) It is in the light of these "non-economic values" that Mestmacker (1980) has characterized the attitude adopted by German authorities with respect to cartels before World War II. "The Nazis", he wrote, "had shown how to transform highly concentrated and cartelized economy into a central planning system...Boycotts and collective discriminations were applied against outsiders in order to discipline them in the public interest. If the more traditional measures of economic coercion proved insufficient for the purpose, even the formal transformation of private cartels into compulsory cartels was provided for after 1933" (p. 388). Mestmacker adds that acceptance of cartels was not limited to conservatives who cherished them as safeguards against the anarchy of free competition. Marxists also looked upon cartels (and concentration) as forerunners of rational socialist planning. He quotes Hilferding, who interpreted this development as tending towards "a universal cartel, that is a rationally regulated society"! According to Fox (1986), the U.S. Clayton act's sponsors were motivated by "a belief that Hitler had attained power through the support of the German cartels. They feared that high industrial concentration would tip the country either into socialism or communism, on the one hand, or fascism on the other" (p. 565, note 60).

Attention will be directed towards abusive practices such as coercion, discrimination, refusal to sell, boycotts, and cartels through which powerful firms might endanger the existence of weaker competitors. This type of approach is particularly in evidence in European countries in the national laws of "unfair competition"[10].

A distinction is then usually made between competition policy concerning efficiency and market injury, and competition law concerning unfair conduct and private injury to one or a few firms. In most instances, like the law on boycott, fairness and efficiency require the same outcome, but there are situations where a conflict could arise. An especially important one in the domain of cartels concerns exclusive dealing agreements. The basic principle expressed in the Beguelin/G.L. Import Export case (Judgment of the Court, 25/II/71, in the Court of Justice of the European Communities, Reports of Cases Before the Court, 1971, Part II, pp. 949-972) is that an exclusive dealing agreement is liable to affect trade between Member States, and may have the effect of impeding competition if, owing to the combined effects of the agreement and of the national legislation on unfair competition, the dealer is able to prevent parallel imports from other Member States from entering the territory covered by the agreement. On this occasion the Court of Justice clearly confirmed that the European rules of competition were not formulated to give protection to individual competitors on the basis of fair practices.

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10) According to the Paris Convention of 1883, unfair competition is "any act of competition contrary to honest practices in industrial or commercial matters". The corresponding laws are intended to ensure that the competitors fight in a fair way, and carry out their social functions according to an ethical code of conduct. The standard of business ethics plays an important role in developing such a code of honest trade practices, but it is ultimately ascertained through the common sense of the courts.

If there is a conflict between a national law on unfair competition and the European competition rules, the latter predominates[11]).

The third type of goal of competition policy is dear to the hearts of economists. Competition policy is one of the main instruments to assure consumer welfare through both allocative and productive efficiency. The neatest affirmation of a purely efficiency-directed competition policy has been made by Bork (1967). According to his view, antitrust law must challenge inefficient conducts. A necessary (but not sufficient) attribute of inefficiency is a restriction of output beyond levels which would prevail under competitive conditions. Conduct not so identified must be presumed to enhance efficiency, and should not be the subject of legal sanction[12]). On the contrary price-quantity cartels create inefficiency which can be measured by the well-known formula for deadweight loss D

$$D = 1/2 \sum_{i} \varepsilon^{i} \Delta q^{i} \Delta p^{i}$$

where p^i, q^i and ε^i are price, quantities and the price elasticity of demand in the ith sector, the symbol Δ representing a change due to monopoly pricing[13]).

However, in recent years new research in industrial organization has shown that simple formulas for efficiency appear to be deceptive and misleading.

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11) According to the Advocate-General, "the rule of national law on the subject of unfair competition should not be ... used for purposes which conflict with the general objectives of the common market, and this places a corresponding limit or restriction on the exercise of the rights to which in this field, national rules give rise" (op.cit. p.970). The distinction between antitrust law and laws governing unfair competition has been strongly attacked, especially in the Federal Republic of Germany. There is an increasing tendency today to consider that the "unfairness" of the individual competitor in his struggle with the other competitor('s) is mainly determined by his impact on the functioning of the market. Such a view has been defended in Germany by various members of the Max Planck Institute. For a recent analysis, see Kaufman (1986).

12) This has been the typical position of the so-called "Chicago School"

13) For a general criticism of this measure, see Jacquemin and Slade (1986)

An important example in the domain of collusive behaviour is the sharing of information by oligopolists. It has been shown that the incentives for information-sharing and its welfare consequences depend crucially on the type of competition, the nature of the goods, and the degree of product differenciation. Clarke (1983) demonstrates that with Cournot competition and homogeneous products, there is never a mutual incentives for firms in the industry to share information unless they plan to collude. But Vives (1984) finds that in Bertrand competition or if the goods are not close substitutes the results are reversed[14]). More generally, "free competition" can lead to too much or to too little information, product variety, R & D, entry, etc.[15]), according to the characteristics of the game.

The main implication is that once the neoclassical paradigm is abandoned, there is no longer the kind of general theorem about the Pareto optimality of the methods of strategic competition that we have for perfect competition. The results are at best ambiguous. Furthermore, with the various types of non-price competition, consumer welfare becomes more multi-dimensional and includes aspects such as the quality of the product, the speed and security of the supply and so on. Most of these aspects are

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14) A relatively general result in oligopoly models is that opposite results are obtained as firms achieve equilibrium in output (Cournot) or in price (Bertrand) levels. The basic explanation is that a firm faces a very different firm-specific demand in the two cases: when the price of the rival is taken as given, the firm's perceived elasticity of demand is larger than when the quantity of the rival is taken as given. Thus in Bertrand equilibrium, firms quote lower prices than in Cournot equilibrium. The case of information pooling is an application of this general idea. When the goods are substitutes, in Cournot competition, pooling of information has two effects. First, it reduces the variance of the errors about the random intercept of the (linear) demand function and increases expected profits. Second, it correlates the strategies that the firms choose. This decreases the firm's expected profits, given that in the case of substitutable goods the optimal choice to do for one firm is to produce a high output when the other firm is expected to produce a low one. The second effect dominates. On the contrary, in Bertrand competition with substitutes, correlation of strategies increases expected profits.

15) See for example, Von Weizsäcker (1980), Dasgupta and Stiglitz (1980), Perry (1984).

not measurable. Value judgements are necessary to determine, for example, whether allocating a greater amount of resources to activities which result in technological change or product variation than would be allocated under a more "classical" form of competition contributes enough to consumer welfare to outweigh the possible losses resulting from static inefficiencies. On the whole, a precise definition of the "efficiency" criterion is more apparent than real and most of the time requires a delicate appreciation of complex trade-offs.

In contrast to the U.S. tradition[16]), such trade-offs are explicitly accepted by the Treaty of Rome in Article 85 para. 3, according to which some collusive behaviour restricting competition in a non minor way may be exempted because of sufficient beneficial effects. Four conditions are required:

(i) the agreement must contribute to the improvement of the production or distribution of goods or promote technical or economic progress;

(ii) it must allow ultimate buyers a fair share of the resulting benefits;

(iii) the restriction must be necessary for the attainment of the objective;

(iv) the firms concerned must be unable to eliminate competition in respect to a substantial part of the product in question.

What Williamson (1968) calls a "naive trade-off model" for mergers is a good way of illustrating these conditions. This model tells that in order

16) According to the Report of the Attorney General's National Committee to Study the Antitrust Law (1955), the standard adopted in the Standard Oil of New Jersey case (1911) "makes obsolete once prevalent arguments, such as, whether monopoly arrangements would be socially preferable to competition in a particular industry, because for example of high fixed costs, or the risk of cutthroat competition or other similar unusual conditions". See also Procter & Gamble (1967). In the 1984 revisions of its merger guidelines however, the Justice Department chose to enact as administrative policy what the US Congress has refused to enact as law: mergers that are illegal under section 7 of the Clayton Act would be found legal if they bring about a sufficient increase in efficiency.

to appreciate whether the cartel can benefit from the "efficiency defence", it is sufficient to compare the surface corresponding to the "deadweight loss", i.e. the loss of consumer welfare which is not otherwise compensated, and the surface corresponding to the savings in resources which become available for alternative use.

This "naive" static partial equilibrium model, with its cost-benefit analysis limited to two-dimensional terms requires a number of qualifications which strongly reduce its operationality. These qualifications include matters of timing, non-price competition, X-inefficiency, income distribution effects, second-best considerations, as well as the inference and enforcement expenses needed to prove the existence of economies[17]). What is in fact suggested by such a model is the difficulty of identifying precisely the efficiency consequences of a business conduct and of advocating fine-tuned optimal antitrust rules. The conditions of Article 85 para. 3 cannot rely on a strict welfare analysis and will often require political compromises between conflicting and incommensurable values.

These dangers can be reduced in two ways. The first one would be to rely more on the use of a reasonable test in applying Article 85 para.1[18]). On the basis of the general presumption that an antitrust policy augmenting competitive forces is needed to enhance efficiency, a pragmatic interpretation of Article 85 para. 1 could broaden the number of cases where economic behaviour can be said to comply with Article 85 without having to resort to the criteria and procedures of paragraph 3. For example this interpretation might allow some type of vertical agreements which could appear to represent a restriction of competition, but which actually do not impose an unreasonable restraint on competition or even increase it in the relevant dynamic and uncertain framework. Given the previously

17) Williamson (1977) provides himself a stimulating discussion of several qualifications of his model.

18) This was already proposed in the 1970's (Jacquemin, 1970). Recently, Forrester and Norall (1984) have defended the same position arguing that in determining whether there was a restriction of competition within the meaning of Article 85 para. 1, the economic nature and consequences of the conduct involved have to be examined.

mentioned theoretical works of the "new industrial organization", it is evident that this approach will not eliminate the ambiguities nor offer strong legal security to businessmen. Nevertheless, this interpretation is less demanding than the trade-off system of Article 85 para. 3, which requires notifying and disclosing all doubtful matters to the Commission in order to obtain an exemption[19]). A pragmatic application of Article 85 para. 1 could reduce information and transaction costs[20]) and allow the Commission to use its limited resources to formulate general policies and prosecute important cases.

The second way which has effectively been used to reduce the burden of the trade-off is to implement Article 85 para. 3, not so much on a case by case basis, but by granting group (or block) exemptions dealing with important types of agreements for which there exists a presumption that a situation of market failure can occur. This system of exempting certain classes of agreements from the notification requirement avoids the necessity of a detailed analysis of each conduct. It creates codes of conduct that can increase the credibility of the policy and limit the discretionary power involved in the Article. At the same time, it preserves the Article's valuable message that antitrust policy must be sensitive to economies and that in some circumstances cooperative behaviour can restrict competition in a non-negligible way and still produce socially desirable results[21]).

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19) There is no duty to notify, but the possibility of exemption can be one important incentive; freedom from fines is another. There are certain agreements listed in Article 4 of Regulation 17 that are exempted from notification. Furthermore, notifications are not required where there is no appreciable effect on trade between Member States. However, this "de minimis" concept is not very reliable.

20) As noticed by Forrester and Norall (1984), businessmen "wish to discern the path to sanctity or absolution without passing through the burdensome process of confession" (p. 308, note 2).

21) Recently the European Commission elaborated a general project proposing a definition and a typology of joint ventures setting out a framework of competition policy within which "constructive joint ventures can flourish". The Commission intends to provide general practical guidance for enterprises in the form of a **Notice** , ultimately to be published in the Official Journal. This kind of "policy announcement" could reduce the difficulty of unpredictable enforcement of the competition rules in everyday business life.

A clear illustration is the block exemption Regulation of R & D agreements, which came into force in March 1985. This new regulation leaves intact the 1968 Notice on cooperation between enterprises, which states that cooperation agreements relating only to R & D normally do not fall under Article 85 para. 1. But it extends this favourable treatment to R & D agreements which also provide for joint exploitation of the results. To appreciate its content, it is necessary to examine in some depth the role of cooperative R & D.

PART II : COOPERATIVE AGREEMENTS IN R & D

In this second part, we shall first identify the main private advantages and disadvantages of R & D cooperation, then their main public costs and benefits. The paradox that will emerge is that there are more obstacles to cooperative R & D than to collusion in other areas, in spite of the positive social welfare effect often associated with such cooperation. The Policy option taken by the European Commission in its Regulation 418/85 will then be discussed.

Section 1 : Private cost-benefit analysis of cooperative R & D [22)]

Three types of private potential benefits of cooperative R & D can be identified. First, cooperative 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 the one hand, in-house developments or mergers tend to create very rigid structures without 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 irreductible delays in developing and testing products in-house.

22) The following arguments are partly based on empirical studies and interviews. For the U.S. see e.g. Berg, Duncan & Friedman (1982), and for the EEC, Jacquemin, Lammerant and Spinoit (1985).

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, require prolonged interaction and experience between partners to exploit or develop complementaries which affect the costs and benefits of innovations. Furthermore, market transactions are expected to be affected by moral hazard and adverse selection. Indeed the domain of R & D and innovation is a typical case where the agent's action is not directly observable by the principal and the outcome is a random variable whose distribution depends on the action taken. A cooperative research arrangement can then reduce the problems of asymmetric information and opportunism, as well as the vagueness of monitoring by relying on easily measured R & D inputs.

A second potential advantage of cooperative R & D is to accelerate the speed of invention and innovation with less risk. On the one hand, what often matters is the speed at which firms can deploy the necessary resources and enter into new markets, first over advantage depending upon an ability to do it more quickly than rivals; on the other hand the absence of a complete and perfect set of contingency markets makes useful joint actions which 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, spread the high fixed costs of technology development, and produce synergetic effects by the combination of research information, teams of scientists, technological and marketing know-how, etc.

Despite the previous arguments, cooperative agreements in R & D are not very frequent. When they exist, empirical evidence shows that they are fragile and unstable arrangements confronted with various difficulties, which generally lead to early break-ups, buy-outs or mergers. This situation is aggravated within Europe where the majority of R & D arrangements

are multicountry and where divergent objectives, strategies, domestic regulations, and institutions often combine with socio-psychological factors such as nationalistic feelings, fear of a loss of identity, and clash of corporate cultures.

Arrangements relating only to R & D have a number of important handicaps. At a first stage, partner selection and the possibility of defining well-balanced contributions is an important barrier. The fear is that one partner will be strengthened by the technological cooperation in such a way that it will become a dangerous competitor at the level of the product market. This situation is of course more probable for horizontal agreements than for vertical ones. In the later case, complementarities allow the benefits to be distributed according to the respective activities and products. In the case of cooperation between competitors geographical partition is the most obvious way of trying to solve the problem but it has a side-effect on existing competition. The compromise between collaboration and independence is reflected in the organizational structure of the arrangement, which is often ambiguous, complex and implying heavy transaction costs of negotiation.

At a second stage, the management of existing cooperative agreements and the sharing of the benefits are also difficult. First, in the absence of an efficient system of management, the transaction costs of coordination and cooperation may outweight the benefits, especially when a large number of actors is involved. Second, even with lengthy contracts containing explicit clauses concerning confidentiality and transmission of information, patent licenses, trademark, and copyright, there are fundamental limits on the ability to protect intellectual property, given that scientific knowledge has many aspects of a 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. Von Hippel (1982) and Flaherty (1980) have shown the multiple interactions of technological advantages with conventional business resources in various fields. Their analyses imply that the full exploitation of the results of cooperative

marketing to sell products which embody these results. Successful achievement of first-mover advantages in research depends upon an ability to bring quickly new products and techniques to the market where the greatest potential strategic payoffs are encountered.

Limiting cooperation to pure R & D or to the so-called "precompetitive level" will then exercise a strong deterrent effect on the emergence of such cooperative arrangements[23]).

Secton 2: Public Cost-Benefit Analysis of Cooperative R & D and the European Regulation

The main arguments in favor of socially beneficial effects of cooperative research is based on a problem of market failure, bound to the appropriability of returns[24]). The starting point is that the amount of research made by private firms and the diffusion of the knowedge generated by them may be socially inefficient over a broad range of market structure including competition. Two situations can be distinguished.

Assume first that there are no spillovers or externalities so that each firm's R & D influences only its own costs. Nevertheless, as long as firms in the pre-innovation market would not expect a perfect discriminating monopoly in the post-innovation market, appropriation of the entire social value from innovation will not be expected. Even the pre-innovation monopolist would not generally invest the socially optimal amount in R & D.

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23) The characteristics of the industry play also an important role in the propensity to cooperate. In a case such as biotechnology which is in an early and highly competitive stage, in which patentable processes and know-how are of great importance, even basic research can lead to commercial concepts that companies can quickly connect to final products. There is then a limited interest in cooperative activity, non cooperative strategies being often more rewarding. On the contrary, in a more mature sector like semiconductor industry, cooperative efforts are frequent.

24) This is an essential distinction between R & D and capital, suggesting the danger of modelling R & D expenditures like investment in capital.

A fortiori when price competition in the post-innovation market intensifies as the number of R & D competitors in the pre-innovation market increases, it is more likely that the value of the surplus of total R & D revenues above post-innovation costs will fall short of the social value. Moreover, the knwoledge generated by the R & D of the individual firm will be priced incorrectly. Given the existing degree of appropriability, diffusion of this knowledge will not be priced at the marginal cost of its dissemination (which is often close to zero), but at higher prices. This may lead competing firms to wasteful duplication of research.

Now suppose that there are substantial R & D externalities or spillovers: the benefits of each firm's R & D flow without payment to other firms. This leads to underinvestment in R & D relative to the social optimum and to a structure of knowledge supply which is determined by the different degrees of appropriability of the various types. Incentives to innovate will also be reduced as the potential innovator knows that competitors will be freely strengthened by its own R & D investments.

It can then be argued that cooperative R & D can improve both situations and alleviate the trade off identified by Spence (1984).

According to this trade-off, the incentives of a firm to do R & D requires 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 spillovers of the results of R & D to other firms, at no-cost, and hence does not allow a sufficient decrease in aggregate R & D costs for achieving a given level of cost reduction.

Cooperative 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[25]).

Katz (1986) has rigourously established the conditions under which a cooperative agreement could raise welfare through its effects on the equilibrium level of R & D and on the cost of achieving a given R & D level.

- "cooperative R & D is most likely to have beneficial incentive effects in markets that have strong spillovers in the absence of cooperation;

- when firms have flexibility in their choices of both R & D cost-sharing and R & D output-sharing rates, cooperative R & D arrangements are most likely to have beneficial effects in markets where a high rate of between-member spillover or R & D sharing is feasible, such as in basic research" (p. 542).

This leads us to mention briefly a second argument for permitting or encouraging cooperative R & D.

In certain high technology industries, such as the next generation of mainframe computers, firms are producing, under increasing returns of scale, differentiated products on which basic research can lead to production of a higher quality product. In such industries, equilibrium is characterized by the presence of a limited number of firms, each of which makes positive profits (net of any fixed costs). In this case the neo-classical competitive paradigm does not apply, as "natural" oligopolies are dictated by the exogenous conditions of supply and demand. If certain potential entrants in such markets enjoy an advantage as a result of a cooperative agreement, this may then favour equilibrium outcomes in which the

25) Compared with the patent system, cooperative R & D leads to a large diffusion of knowledge. Industry-wide cooperative research laboratories (especially important in Scandinavia) and industry-university cooperation are especially useful as they allow the results of individual development projects from firm to firm to be generalized and transferred, "thus providing a degree of economies of scope to innovation programmes across an industry or activity as a whole", Ergas (1986). Relying on subsidies meets several limits: it does not solve the diffusion problem, it can introduce new distortions and it is not easy to control.

cooperating firms are able to enter while certain of their independent rivals decide otherwise.

By promoting R & D cooperation between European firms, the European authorities could then succeed in giving these firms a better base for oligopolistic competition against foreign rivals and in getting a larger share of high-return industries.

Contrasting with these potential advantages of cooperative R & D, effects leading to a harmful reduction of competition must also be considered. This question could be explored on the basis of a model having the standard two-stage form, with R & D expenditures in period one affecting the parameters of the second period output/price game. Solving the latter yields profit functions (gross of R & D costs) that are dependent upon the earlier R & D choices. The shapes of these functions depend, among other things, on the nature of competition: for instance non-cooperation in R & D and in output, cooperation in R & D and in output, cooperation in R & D and non-cooperation in output, non-cooperation in R & D and cooperation in output[26]).

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26) A possible model is the following one. Let us assume a two stage game played by two competing firms. At the second stage (say the choice of output) in which R & D levels are treated as exogenous, firm 1 (respectively firm 2) produces output q_1 at unit production cost $c_1(x_1,x_2)$ where x_1 and x_2 denote the R & D level of respectively firms 1 and 2. Profit π_1 of firm 1 is then

$$\pi_i(q_1,q_2,x_1,x_2) = R_i(q_1,q_2) - C_i(x_1,x_2)\, q_i - v_i(x_i) \qquad i = 1,2$$

with $\partial c_i / \partial x_1 < 0$, $\partial c_i / \partial x_2 < 0$ and $dv_i/dx_i > 0$.

The solutions, q_1^* and q_2^*, at the cooperative or non-cooperative equilibrium, can be written as

$$q_1^* = q_1(x_1,x_2); \quad q_2^* = q_2(x_1,x_2)$$

The first stage in which firms choose R & D levels is then considered. Using the second stage solution, profits of each firm are written as a function of the pair of R & D levels

$$f_i(x_1,x_2) = R_i\, q_1^*(x_1,x_2), q_2^*(x_1,x_2) - c_i\, q_i^*(x_1,x_2), x_1, x_2 - v_i(x_i) \qquad i=1,2$$

The cooperative or non-cooperative solutions to this first stage can be obtained by maximising profit with respect to x_i. This gives rise to a subgame perfect equilibrium in the two stage game. For preliminary results, see the appendix.

In the absence of a model reflecting the complete picture, let us simply distinguish between two situations.

First, let us assume that it is feasible to limit the extent of the agreement solely to aspects of R & D and to exclude coordination at the level of the final product (**pre-competitive level**). The dangers of anticompetitive consequences are then strongly reduced. Still, one danger is that cooperative 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 (Reinganum, 1983). Coordinating 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, incumbent firms with market power can, through concerted pre-emptive operations, excessively accelerate their programmes of R & D and innovation in order to exercise a dissuasive impact on potential entrants (Gilbert and Newbery, 1982). In the situation of integrated firms, cooperative agreement for the purpose of knowledge exchange could also lead to barriers to entry downstream and foreclose firms who are not members of the agreement from some segment of the market. Firms being at the frontier of technological change could for example jointly determine standards for future products and processes, making new entry more difficult.

A second situation involves an extended collusion between partners, resulting from their action in R & D and creating common policies at the product stage (**competitive level**). Discussions about R & D can for example spill over into illegal discussions of pricing policy. Cooperative R & D can also provide a ready mechanism for side payments in the event that it is useful for cartel members to redistribute the revenues earned by the firm as a result of product market division. What makes these dangers probable is again the difficulty of appropriating technological breakthroughs. As discussed in section 1 of Part II, partners who have achieved inventions want to control the processes and products which embody the results of their collaboration, in order to recuperate jointly, and as

quickly as possible, their R & D investments. If the firms are prevented from such a joint exploitation and if the benefits of cooperative R & D are expected to be very quickly dissipated through intense product market competition, firms will be tempted either to avoid R & D cooperation and to maintain wasteful competition in the pre-innovation market or to use their cooperation to limit unduly their R & D[27]). If this is true, **a regulation of R & D cooperation excluding any cooperation at the level of the final markets could discourage or destabilize many valuable agreements. However, allowing an extension of cooperation from R & D to manufacturing and distribution encourages collusive behaviour which impedes competition** . This is precisely the dilemma faced by the European Antitrust Authorities.

The text of the regulation 418/85 expresses the compromise that has been adopted. It covers joint research and development of products or processes and joint exploitation of the results of that R & D.

Art. 1(2)(d) specifies that "exploitation of the results" means the manufacture of the joint venture product or the licensing of intellectual property rights to third parties. But joint marketing is not covered.

Among various conditions, the exemption applies if:

(i) the work is carried out within the framework of a defined programme;

(ii) all the parties have access to the results;

(iii) where there is no joint exploitation, each party is free to exploit the results independently;

(iv) the know-how and the patents which result from the research contribute substantially to technical and economic progress and are indispensable for the manufacture of the joint venture product.

By imposing conditions concerning the duration of the venture and market shares, the regulation also aims to prevent agreements that might result in the elimination of competition in the relevant market. If the joint venture is of the conglomeral or vertical type, i.e. if the participants do not

compete on the relevant product market, the exemption applies for five years, regardless of market share. If the joint venture is of the horizontal type, the exemption also applies for five years, but only if the parties' combined share of the relevant product market does not exceed 20%.

A comprehensive list of permissible clauses (the so-called white list) and prohibited (the so-called black list) is also included.

The main aspect of the Regulation is that the European authorities, confronted with the dilemma mentioned above, consider that cooperation in R & D, in many cases, cannot be limited to the sole level of pure R & D, and that it will generally lead to joint exploitation of the results in order to stabilize the agreements and to solve the appropriability problem. Moreover the Regulation gives priority to basic research and tends to secure an efficient sharing of information. Finally it rejects arrangements able to monopolize the market.

However, several problems remain. From the businessmen's point of view, the Regulation is complex; it is necessary to overcome its opacity by issuing new guidelines. The 20% threshold market share for horizontal joint ventures is disputable, especially in high technology. The exclusion of joint selling and marketing is an important limitation, given the close interconnections between the various phases of the activities[28]). From the point of view of public interest, the Regulation might have the unwanted side-effect of exempting many production joint ventures from notification, especially given the broadness of some concepts and criteria used in the text. The drafters of joint venture contracts could indeed be tempted to include an R & D element in their agreements in order to fall within the scope of the block exemption. In this context, the Commission must be conscious of the dangers of any further relaxation of its antitrust policy, which until now has been a powerful instrument for the survival of a competitive common market.

Finally, one wonders whether modifications to the competition rules are the crucial tool needed to prod industry into forming new R & D joint

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28) But, an exemption could still be obtained on the basis of Art.85 para.3, following a notification.

ventures. As long as antitrust rules in the field of R & D cooperation reflect a form of industrial policy to foster innovations and improve ventures. As long as antitrust rules in the field of R & D cooperation reflect a form of industrial policy to foster innovations and improve international competitiveness, more positive incentives would seem appropriate. One of them could be specific tax deductions and/or subsidies like those provided by the Esprit programme. A complementary one would be transnational legal structures, such as the recently adopted **European Interest Grouping** [29]), which provides firms with flexible instruments for pooling some business functions, while retaining their economic and legal independence.

[29]) Unhappily, the European form does not provide fiscal incentives, contrary to the French system.

CONCLUSION

The European Commission **White Paper** (1985) on "Completing the Internal Market" underlines the role played by cooperation among firms, which is viewed as an important means of improving European competitiveness.

Our analysis has shown that contrary to the conventional wisdom, various factors facilitate the adoption and the stabilization of collusive behaviour. But in some areas such as R & D, the effects of these factors can be more than compensated by the role of specific characteristics, mainly the difficulty of appropriating the results of the joint effort. It follows that too much collusion tend to occur in activities where non-cooperative, non-collusive behaviour would be more socially efficient. Inversely insufficient cooperation can occur in domains where such a behaviour could lead to socially desirable outcomes. An important case is R & D where cooperative agreements can internalize externalities created by R & D spillovers, limit wasteful duplication and provide a more efficient sharing of information.

These considerations stress the importance of a pragmatic competition policy. Article 85 of the Treaty of Rome, its efficiency defence and the Regulation on R & D cooperation, seem globally well adapted to this role, but more transparency and explicit precommitments could increase the credibility of such a policy.

APPENDIX

In a recent paper, C. d'Aspremont and A. Jacquemin (1987) have considered an industry with two firms facing an inverse demand function $D^{-1}(Q)$, where $Q=q_1+q_2$ is the total quantity produced. Each firm has cost of production $C_i\ (q_i,x_i,x_j)$ which is a function of its own production, q_i, of the amount of research x_i that it undertakes and the amount of research x_j undertaken by its rival. Both D^{-1} and C are assumed linear, so that

$$D^{-1} = a - b\,Q$$

with a, b > o, and

$$C_i\ (q_i,x_i,x_j) = \left[A-x_i-\gamma x_j\right] q_i \quad i = 1,2 \quad j \neq i$$

with $a > A > 0$, $1>\beta>0$, $x_i + \beta x_j \leq A$, $Q \leq \frac{a}{b}$

The R & D externalities or spillovers imply that some benefits of each firm's R & D flow without payment to other firms. In our specification the external effect of firm j R & D is to lower firm i's unit production cost. The cost of R & D is assumed to be quadratic, reflecting the existence of diminishing returns to R & D expenditures

$$\phi\ (x_i) = \delta\ \frac{x_i^2}{2} \qquad i = 1,2$$

Firms' strategies consist of a level of research and a subsequent production strategy based on their R & D choice. At the second stage in which R & D are treated as exogenous, firms choose noncooperatively or cooperatively, their optimal production q_1 and q_2. The preceeding stage in which firms choose, noncooperatively or cooperatively, their R & D level is then solved.

Using this framework d'Aspremont and Jacquemin have computed and compared the corresponding subgame perfect equilibria. Defining x^{**}, x^{*}, $\hat{x}$, and $\tilde{x}$, as the equilibrium levels of R & D obtained in the case of, respectively, the maximization of social welfare (consumer surplus + producer surplus), the fully non-cooperative game, the cooperation limited to R & D, and the cooperation occuring in both R & D and output, they obtain the following classification

$$x^{**} > \tilde{x} > \hat{x} > x^{*},$$

for large spillovers. For the total quantity produced, Q, the classification is the following

$$Q^{**} > \hat{Q} > Q^{*} > \tilde{Q}.$$

One clear conclusion is that cooperation in R & D increases both R & D and quantities of production with respect to the noncooperative solution.

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