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The Research Joint Ventures: A Critical Examination of the Dominant Doctrine

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Abstract
More and more companies are joining or promoting the establishment of RJV. Business cooperation involves not only the innovative phase, but also the subsequent stages of development and commercialization. The literature has devoted ample space to the analysis of the phenomenon, identifying models and theories that affect many of the crucial aspects of the phenomenon. The work, after introducing the topic of collaborative research, analyzes the reasons that push companies to join a research joint venture, addressing the issue of internal and external spillovers to the joint venture. Subsequently, the effects of RJV on welfare and the risks associated with this form of collaboration are analyzed.
Keywords: RJV, spillovers, innovation, collaborative research, collusion

INTRODUCTION

Research joint ventures (RJV) are forms of collaboration between companies, which are associated to carry out joint research activities. Through this tool, companies are able to internalize the positive externalities deriving from investment in research, contributing to improve the results obtainable individually by the members of the agreement and eliminating, at least partially, and under certain conditions, the distortions present in the knowledge market.
These distortions, as we know, derive from the nature of a public good, or almost, of knowledge, which is the product of research and the engine of innovation (Martin, 2002a). Through the RJV partners coordinate the research activities by implementing common projects, sharing the 'knowledge' and information, so as to produce greater benefits than those that would result from an activity conducted independently. In fact, cooperation between organizations that have different knowledge bases allows for better quality results (Inkpen 1998).
The fact of being able to internalize knowledge spillovers, with consequent private return equal to social performance, justifies the approval and the incentive to these collaborative forms (Hagedoorn, 2002).
The companies that participate in an RJV decide to sacrifice part of the benefits deriving from the research activity in order not to fully support the very high costs of the research and development process: in this way the costs involved in the research and development of a new product and / or process are distributed over multiple production units, avoiding, or limiting, duplications in the research activity, allowing access to complementary knowledge and resources, exploiting economies of scale and scope , gaining in terms of efficiency , thanks to the exploitation of possible synergies and distributing the risk of an investment often with uncertain outcome on a greater number of subjects.
Collaboration in research may concern basic research, which aims to acquire scientific-theoretical knowledge whose direct applicability may not initially be identified; applied research, which uses the knowledge acquired with basic research showing its application potential, or for technological development, which focuses on the design and / or production of a new commodity.
In terms of knowledge, the three phases of the research process involve different levels of the learning process. While technological development allows knowledge to develop starting from existing knowledge, basic research "builds", and allows acquiring new knowledge. Technological change, in fact, can derive from knowledge already acquired or from newly identified knowledge (March, 1991).
In the current economic landscape, organizations that intend to maintain, or realize, a competitive advantage in a global scenario must invest in their capacity for innovation, because increasingly the dominant paradigm links growth and development to innovation that originates from research processes. Precisely for this reason companies are called to reorganize, or to organize, their own research activity by adhering to collaborative forms. All organizations, even companies, need to continuously access new knowledge and information in very different fields, in order to better cope with market developments and the expectations of increasingly informed consumers (Roller et al, 2004).
Companies can not base competitive advantage only on internal skills and acquired knowledge: they must continually update this knowledge and learn, becoming more and more innovative. Research partnerships are one of the tools through which these goals can be achieved. Joining an RJV, in other words, allows the company to expand its knowledge and develop new skills.
Cooperative research among companies is a common practice in all economic sectors, especially in high tech, or in any case in those areas where continuous learning is required and the combination of very

heterogeneous resources. RJVs allow companies to exploit the synergies deriving from sharing experiences, previous knowledge, information, routines, tangible and intangible resources, which, if combined in an appropriate manner, can allow the achievement of better results in quality and quantity.
With the creation of RJV, companies, in addition to exploiting synergies, share risks, internalize spillovers, make the exploitation of available resources more efficient, in a process of continuous innovation that allows to maintain, or realize, a competitive advantage in the global markets .
In general, even if the topic will be analyzed later in the work, the collaborations in research also produce benefits for consumers, therefore in terms of social well-being, because the resulting innovation allows to expand the range of products and / or services to available, reduces production costs and part of this advantage has positive effects, in terms of price reduction, on the final product market.
The RJVs allow companies, through the sharing of knowledge and skills, to access new skills and new technologies to face more consciously the technological and market uncertainty: in other words, through collaborative research it is used the increase in value obtained with the sharing of knowledge and information (Katz 1986).
The positive effects, for the individual companies, and for the social well-being are evident, both in terms of better use of available resources, therefore of efficiency in the allocation of resources, and in terms of improvement, potential, of the results obtainable; such collaborations, however, are also potentially restrictive of competition, and this may result in losses of well-being, as happens in any form of collusion. The impact, and the nature, of collaborations in research change according to the organization of the market, the strategies adopted by the companies, the interaction between the different actors, and the process of technological accumulation of the specific industrial sector.
RJVs are a hybrid form of economic organization, through which transaction costs can be saved. In the field of research and development, these costs can also be very high, given the high spillovers and the possibility of opportunistic behavior. In order to avoid opportunism, one of the best tools is the incentive for cooperation.
RJVs are more easily formed and more likely to succeed when partners have an integrable knowledge (Inkpen, 1998). In this regard, economic theory suggests that private companies are encouraged to enter into an RJV mainly to gain access to basic knowledge when internal investment incentives are low. As mentioned, having access to further scientific frontiers, accelerating the innovation process, reducing development costs, 'using' spillovers within the collaborative relationship allows more financial and human resources to be available, determining a strong advantage in adherence to cooperative research.
The formation of an RJV is not a simple process because incentive and free riding problems often arise. The latter is a particularly relevant phenomenon in collaborative research because the partners' contributions are provided in the form of human resources and know-how, the quantity and quality of which is difficult to evaluate for the members. Moreover, the results obtainable from the research are stochastic and make it practically impossible to distinguish, and precisely identify, the causes of a possible failure: in other words, it is very difficult to determine if the failure of the project is due to specific causes, perhaps imputable to one or more members of the agreement, or to randomness.
The two elements, the unverifiable input and the strong randomness in the results, increase the opportunism: in an RJV, in fact, the partners are often tempted to provide inputs other than those provided for by the initial agreement (Shapiro, Willing , 1990).

REASONS FOR COOPERATION IN R&D

Research agreements can be distinguished in ex-ante R & D agreements, ie agreements that aim to share the benefits of future research projects, and ex-post research agreements with R & D results occurring after the R & D has been undertaken (Katz, Ordover, 1990).
The motivations that drive companies to join an RJV can be defensive or offensive: in the first case they are strategies that attempt to bridge, with the cooperation, a weakness of the single enterprise in the research; in the second case, the choice to cooperate arises from the desire to increase market power by imposing times and ways of technological change.
As regards the defensive strategies, the Arthur model (1988) deals with competing technologies, stating that both the technologies passively compete, and that compete strategically, as in the case of different products offered by different companies, the solution that determines it is not of static equilibrium, because the market evolves continuously, initially at random, and subsequently following a path defined by the technology adoption mechanism.
Once the race between different technologies has begun, the definition of the path is influenced in a decisive way by the intensity of adoption of the technology itself: the more widespread it is adopted by a growing number of consumers, the more it develops and becomes attractive for consumers, and the spread will increase. In this regard, Arthur (1988) talks about *'increasing returns to adoption*': the existence of these increasing yields of adoption determines the nature of the competition

A company that is able to gain an advantage over its competitors, in the presence of increasing adoption returns, can retain a large number of consumers through a process of accumulation lasting over time. Of course this process is not deterministic, since it is not possible to establish *a priori* which technologies will dominate the market and which, on the contrary, simply will survive, or even be destined to disappear: the process is therefore stochastic.
In sectors where product innovation is the main strategic variable, cooperation that stops at the pre-competitive stage of research reduces the qualitative differentiation of the product in the future, increasing competition in the market. The participants of the agreement, in fact, will offer similar products, the result of the common research. The possibility of extending cooperation to the production and marketing stages would solve the problem by making possible the joint exploitation of innovation, avoiding the dispersion of profits, through a price war.
If the collaborative research project has the function of converging different and competing technologies, for example by making them compatible, the effects on the final market can be very similar to those realized by a cartel of companies that work jointly both in the research and product market.
Ultimately, in the research aimed at the convergence of competing technologies there are two main effects: the change in the relative weight of each product and the change in the expectations of adopters.
The introduction of a new technology created through the collaboration between competing companies, has the effect of modifying the relative weight of each product, because it can be assumed that the market share of the new product is equal to the sum of the market shares of the products from which it derives. In the presence of increasing adoption returns, the greater weight on the market of the new technology, therefore its greater diffusion, makes the product more attractive for consumers who for the first time have access to that market, but also for those who in the past had used the technological solutions offered by the competitors, who shift to the new product as a result of increasing adoption returns.
On the other hand, the realization of a collaboration in research in order to make compatible two technologies up to then competitive modifies the expectations of the adopters on how to develop the market, encouraging such subjects to immediately adopt the new technologies, to the detriment of those not included agreement.
Furthermore, cooperation in R & D can exploit adoption returns not only after the introduction of the new technology, but anticipating its effects, through a play on the expectations of adopters.
The returns of adoption derive from many factors, which in turn are influenced by the nature and characteristics of technology and potential users of this
The learning by using, for example, according to which the more a technology is adopted, the more it is used and therefore the more it is known: this makes technology susceptible to further developments and improvements with greater chances of success. Furthermore, the network externalities, the scale economies in production, the informational increasing returns and the technological interrelatedness.
The success of a cooperation agreement in R & D contributes significantly to the presence of adoption returns deriving from the presence of network externalities, economies of scale, the existence of risk-averse consumers that require widespread and known products, and possibility of a technology in terms of relationships with other technologies and products.
The success of a cooperation agreement in R & D depends crucially on the presence of adoption returns, which derive from network externalities, economies of scale, the existence of risk-averse consumers that require widespread and known products, and possibility of a technology in terms of relationships with other technologies and products.
In this regard, reference can be made to the numerous collaboration agreements for computer development. The technology in question presents many of the characteristics that underlie increasing adoption returns and that achieve a lock-in effect to the advantage of the most widespread technologies.
The model developed by Vickers (1988) is inspired by the work of Gilbert-Newbery in which it was argued that, since competition reduces profits, the monopolist's incentive to remain the only player in the market is much stronger than the incentive of new potential entering a market that would turn into a duopoly.
The model developed by Vickers (1988) provides that, if initially a number of incumbent firms are present on the market does not mean that the main justification of pre-emptive patenting, ie the fact that monopoly profits are certainly lower than the sum of profits of duopoly, is still valid. This is because the reduction of the profits of an incumbent, in the case of entry of a new company, cannot exceed the increase in profits of a new entrant. In other words, a new entrant could have a greater incentive than the incumbent in the patent race. Moreover, for incumbents, entry deterrence has some characteristics of the public good: who is already present in the market could underestimate the deterrence at the entrance, thus increasing the probability of entry (Tirole, 1988).
In this context Vickers introduces the presence of RJV as tools to prevent access to the market to potential entrants. In fact, the RJV strengthens, adding them, the incentives to invest in research of those already on the market, allowing to reach a threshold that allows to overcome the incentive of new entrants; it also avoids the consequences of the free riding of the incumbents because the decisions taken are valid for everyone. As

Vickers notes, however, the RJV will produce these effects only under certain conditions, ie only if the new technology is not dramatically higher than that already in use (Laino, 2016).
It is interesting to note that cooperation in R & D is a very effective deterrent against new companies' attempts to enter the market. By creating an RJV, incumbents create a barrier to entry that is a public good for them.
Sometimes the monopolist, in order to preserve its position and the related advantages, could patent an innovation even if it does not exploit it commercially, with the sole purpose of preventing the incoming potential from competing: this can happen when a product innovation does not is able to sufficiently differentiate the product offered by the monopolist so as to justify the support of the costs of introduction. The monopolist can, however, decide to patent it to stem the competition. And this same result can be achieved by an RJV in a market in which many companies operate (Tirole, 1988).
The two models, therefore, believe that the creation of an RJV is a strategy that allows companies to increase and consolidate the monopoly power on the market, especially when technological opportunities are very substantial and research takes on the role of key strategic variable.
Among the reasons that can push a company to join an RJV some depend, as well as elements of weakness inherent in the structure, even the existence of dysfunctions, real failures in the innovation market. The presence of these elements makes the company unable to independently manage all phases of the innovative process.
In fact, in some cases the company cannot bear the very high costs of R & D; at other times it presents technological delays compared to competitors, or lacks specific resources and / or information and skills that reduce its innovative potential. Furthermore, the company may not be able to compete in certain competitive contexts that characterize the research market, and often produce duplications or excessively risky portfolio choices. Last but not least, weakness may depend on the inability to completely internalize the benefits deriving from innovation (Katz, Ordover, 1990).
In addition to a problem of financing research and development projects due to capital market imperfections, the nature of the indivisible and irrecoverable cost of the investment in R & D leads to further difficulties for companies. In other words, there are minimum thresholds to be exceeded for R & D inputs that vary depending on the specific input and depending on the different industrial sectors. Obviously the convenience of facing an investment to overcome the problem of indivisibility comes from the quantity of new product that the company will be able to place on the market.
The possibility to collaborate in the research involves lower costs compared to the assignment to external research bodies because the costs related to the indivisible inputs can be distributed among the different partners, with consequent reduction of the per capita burden; start-up costs for R & D are more limited, and in any case proportionate to the scale of companies involved; also the costs of using the results are generally lower (Dodgson, 2018).
Many studies have shown that often under the cooperation there is the attempt by one or more partners to fill the accumulated technological delay towards the leading companies. This catching-up phenomenon has characterized the behavior of many European companies towards US partners, especially in the electronic-IT sector and in aerospace. In other words, the agreements, especially at international level, arise from the imbalances, and from the asymmetries, existing in the world technology market (Allen Link, 2015).
Another line of studies attributes the incentive to cooperate in research to the impossibility to find in the company specific resources, skills and knowledge crucial for the complete realization of each phase of the innovative process. Innovation is an economic activity that requires very specific exchanges of information and coordination activities. Access to complementary resources is necessary in order to successfully market the new product or process, so to generate economic value. The more the development of the new technology requires the availability of specialized and co-specialized assets, the more it will be necessary for the company to acquire these resources through forms of collaboration (Teece et al., 2016).
Ultimately, the need for complementary assets, lackness of specific research competencies, coordination along the vertical chain, is an important factor in trying to explain the phenomenon of collaborative research through RJV.
In this regard, the case of the numerous agreements concluded between small companies in the biotechnology sector with multinationals in the pharmaceutical sector is particularly illuminating, due to the need to ensure the availability of more funds to be allocated to R & D, to guarantee the experience of a partner in possession of experience and competence, difficulties in approvals and authorizations required (Osarenkhoe, 2010).
Many economists believe that research cooperation agreements are functional both to businesses and to the overall economic system, as they avoid the damaging duplication in research that results in waste of resources. In fact, cooperation is a tool to remedy the problem, and to allow the experimentation of several research paths in the same area or in contiguous areas, as well as allowing an acceleration of the time to obtain results (Tirole, 1988).
We will discuss the 'need' to cooperate in order to internalize the spillovers in the next paragraph.

It is worth mentioning the reasons that push companies to keep the opposite behavior, that is not to join collaborative research.
First of all, not all companies in the same sector share the same technological paths, in addition to the fact that there may be asymmetries so obvious among companies that they do not make the membership potentially profitable.
Non-adherence sometimes derives from the fact that RJV unites the most advanced companies in the sector, which do not agree to share projects, and resources with technologically less developed companies.
Non-adherence sometimes derives from the fact that RJV unites the most advanced companies in the sector, which do not agree to share projects, and resources with technologically less developed companies.
Or, on the contrary, the RJV can be formed by technologically less developed companies, which tighten the agreement just to fill the gap with the leading companies, which, therefore, will have no interest in joining the agreement (Grindley et al., 1994)

RJV: SPILLOVERS AND WELL-BEING

Through the creation of RJV we try to overcome the aforementioned distortion in the knowledge market, which is imperfect first of all due to the nature of good (almost) public knowledge. Precisely for this reason investment in R & D can often result in sub-optimal levels with respect to social desirability (Spence, 1984).
The difference between social optimum and private good derives essentially from three factors: research and development costs are essentially fixed, and sometimes even irrecoverable, and companies decide to invest dedicating resources to research for obtaining process innovations and / or produced only if this is economically profitable, and not because it is socially desirable; investments in R & D are very expensive, and their profitability is extremely difficult to predict, so they preferentially support themselves in highly concentrated markets of imperfect competition, with consequences that are not always desirable for consumers; investments in R & D suffer from little or no total appropriation of results, generating spillovers, which can be considered positive externality, which discourages companies to invest in innovation (Martin, 2002b).
Spillovers are socially desirable because they reduce the social costs of innovation, even if they disincentive investment in R & D. If spillovers are high, public intervention in the form of a subsidy may be necessary (Spence, 1984). This policy, however, does not solve the problem of inefficiency in the case of low spillovers: in this case, in fact, companies may have the convenience to account for purely productive expenses, under the item 'R & D expenses', so as to increase the amount of the subsidy. In other words, industry-level distortion mechanisms could be created with respect to research incentives. Precisely for this reason we encourage the creation of collaborations in research through the creation of RJV, although this may create risks of collusion, which we will deal with later.
Katz is the first to formalize the problem of the presence of knowledge spillovers, in order to understand if the cooperation in R & D allows realizing the social good. And through a four-stage game with 'n' companies and functions with symmetrical payoffs demonstrates how an RJV can increase well-being, keeping in mind four essential factors: the degree of competitiveness of the final market of goods, the level of spillovers within the RJV, the level of spillovers outside the RJV, ie the level of industry spillovers, the number of companies participating in the RJV (Katz, 1986).
As far as competitiveness on the final market of goods is concerned, the higher it is, the more companies will be induced to use RJV to reduce, through collaboration, investments in R & D, to make competition in the final market less harsh. With reference to the level of spillovers within the RJV, greater coordination of research activities improves internal communications and reduces R & D costs.
Lastly, even if not less important, the number of companies participating in the joint venture: if the industrial consortium, which includes all the companies of a given industry, certainly determines an improvement in terms of well-being, when the RJV includes only a few companies it does not necessarily create a benefit. It is true that collaboration increases the quantity and quality of the research carried out, but the companies that remain outside the agreement could react by reducing their investments in research, with a clear deterioration in social well-being. A priori it is almost impossible to determine which of the two effects is prevalent.
Already starting from the model of d'Aspremont and Jacquemin of 1988 we study the levels of spillovers for which the cooperation between two companies is socially efficient, developing a model characterized by a two-stage game, in which in the first stage the companies must establish their own level of R & D, while in the second stage they have to decide how much to produce: ultimately they face each other in a game at Cournot (Martin, 2003).
If cooperation in both stages is assumed, three cases can be presented: competition, cooperation only in R & D, collusion in R & D and determination of output. The model allows us to reach the conclusion that as long as the spillover is low, the benefits that a company obtains from R & D investments outweigh the advantages enjoyed by competitors outside the agreement. For levels of high spillovers, companies know that the greatest benefits of their research efforts fall largely on their competitors, so the incentive for research is contracted.

As mentioned, with the RJV we internalize the positive externality generated by spillovers, so cooperation in research is socially desirable only for high levels of spillovers: for low values the competition is to be preferred both in terms of commitment in research and in terms of output achieved. The model also shows that collusion is always inefficient, because, while allowing greater investment in research, it minimizes the level of output, due to the monopoly power that companies can exercise on the final market of goods.
We could ask how the spillovers are evaluated within the RJV. In Katz's model, companies can maximize the level of internal spillovers, as opposed to what happens in the D'Aspremont and Jacquemin model, where the level does not vary with cooperation.
According to Kamien (1992), hypothesizing a two-stage game, it can be shown how the maximization of internal spillovers improves the efficiency of cooperation, encouraging further investments by companies. If there is no coordination, the benefits of cooperation are minimal, unless companies decide to reduce R & D investment to ease competition on the final asset market. Therefore, greater coordination in R & D is always socially desirable, for any level of spillovers. Recall that d'Aspremont Jacquemin believe that cooperation without coordination can reduce welfare in the event of low spillovers.
In the model of Katsoulacos and Ulph (1998) the effects of spillovers are studied, assuming that the two companies considered can compete operating in a single market, or in two different but complementary markets. The model underlines that the more targeted and specific research is, the less the other companies will benefit from it. It also shows that, even in a cooperation regime, companies may not be able to maximize cooperative spillovers out of fear that this will lead to excessive competition in the final market. In other words, companies maximize or not the cooperative spillover depending on the situation in which they operate.
Kamien and Zang (2000) have different opinions, confirming the conclusions of the 1992 analysis, but they face the problem of the endogenisation of spillover purely in the form of absorption capacity and show how, contrary to what happens with competition, with the cooperation in R & D companies are always induced to maximize the level of internal spillover, adopting generic projects that can be easily implemented by the other partner.
In 2003, Amir shows that cooperative spillovers may not maximize when they are unidirectional, or when there is a perfect balance in the symmetrical subgames of two-stage game.
The literature aims to give greater validity to Kamien's approach, even if this approach may not be adaptable to cases of non-competitive behavior and in the presence of asymmetry deriving from the fact that companies*, ex ante*, they enjoy different levels of spillovers and that the symmetrical equilibrium found in two or more stages games can be unstable and replaced by symmetrical equilibrium. The first asymmetry is of an exogenous nature, while the second is induced by symmetrical *ex-ante* companies.
In the first hypothesis cited, of exogenous asymmetry, De Bondt and Henriques (1995), they show that in many industrial sectors companies are different in terms of structure and ability to adapt to new technologies, so they can have asymmetric spillovers precisely because of differences between companies. The proposed model is a three-stage game where, in the first stage of pre-development, the companies face a technological competition at the end of which the winner will be provided with more experience in basic research.
In the second phase the innovation develops, and in the third one it realizes the product. It is shown that the different level of spillover influences the strategic complementarity of investments so as to induce companies not to move simultaneously, seeking a balance in the investments at Stackelberg. If the company with the greatest absorption capacity is the leading company, the asymmetric choice of investments guarantees greater profits for both, compared to the case of symmetry.
The final effect is the reduction of industrial output, with a consequent increase in the market price, consequently higher profits for both companies. The model does not analyze the implications in terms of social welfare, and the effects of asymmetric spillovers are taken into account only in the case of non-cooperation.
In Amir-Wonders (2000) model we consider a game in two stages, R & D and output, with the hypothesis of unilateral spillover, for which the company with less commitment in R & D can enjoy the benefits of the activity carried out by the other company. In the model, two identical companies decide two different levels of R & D, and, subsequently, different levels of output. The model considers the hypothesis that companies cooperate in a single laboratory or in different laboratories that communicate perfectly with each other. Therefore, there is always an innovator-imitator model. It is shown that the choice to cooperate is socially desirable under certain conditions such as a fairly high demand and fairly convex R & D costs. It is shown that from the point of view of the consumer the joint lab is always preferable.
In the case of endogenous asymmetry, the possibility that two identical companies may choose asymmetric strategies is hypothesized by Salant, Shaffer (1998). These show that starting from the models of d'Aspremont and Jacquemin, but also in the following theories, the symmetrical equilibrium models may be inaccurate because, in case of cooperation, companies could improve profits by investing asymmetrically in research, while maintaining constant joint commitment. As the joint research production does not change, the consumer gets the same benefit. But from the point of view of companies, the choice to invest asymmetrically

leads to an increase in costs, because, due to the decreasing returns on investment in R & D, symmetric investments would lead to a minimization of commitment, increasing profits at the level of industry, due to the increased asymmetry in the final market. In fact, asymmetry allows a greater reduction in production costs, so the less efficient company leaves production entirely, or almost, to the most efficient company, in exchange for a compensatory transfer.
This equilibrium is sustainable only if the most efficient company transfers part of the profits to the partner. The growth of profits at the industry level is the dominant effect in the presence of low spillovers and for certain values of research costs. In this case the symmetrical equilibrium is never reached because it would be sub-optimal. Moreover, as cooperative profits are higher with asymmetric investments, cooperation in R & D improves social well-being, even for low spillovers, contrary to what is expected from the D'Aspremont Jacquemin model. Finally, asymmetric equilibrium leads to greater concentration in the final market of goods, without a collusive pattern.
On the basis of what has been said, and what has been shown by other models, it would seem that the hypothesis of a symmetrical R & D equilibrium is rather stringent, even though Leahy and Neary (2005) contest this position, analyzing the conditions in which emerges an asymmetrical equilibrium like the one hypothesized by Salant and Shaffer.
In a two-stage game the concept of cooperatives substitutes and complements is introduced, demonstrating that the asymmetric equilibrium of the D'Aspremont Jacquemin model is stable only for very low values of spillover parameters and R & D effectiveness.
R & D is considered a substitute, or complement, depending on how its variations influence the marginal contribution of the other partners on the overall profit of the RJV.

OPTIMAL SIZE OF COLLABORATIVE RESEARCH

In the analysis of collaborative research via RJV it is worth asking if we can identify an optimal size of the RJV.
In most of the models after the one developed by d'Aspremont Jacquemin considers a duopolistic market, even if this hypothesis is not realistic and the results obtained considering a duopoly cannot always be extended to an oligopoly with a higher number of companies (Martin, 2003).
In a duopoly, the RJV coincides with the concept of an industrial consortium, and this does not allow us to assess how the different size of companies affects the performance of the joint venture and its competitors. We have already mentioned that according to Katz industrial consortia are always desirable, while exclusive RJVs have ambiguous effects on well-being.
Suzumura (1992) demonstrates the validity of D'Aspremont Jacquemin's model in an oligopoly with 'n' firms, under the hypothesis that cooperation in research involves all competitors. Simpson and Vonortas (1994) simplify the model, demonstrating how a consortium is always better in terms of well-being, compared to the hypothesis that each individual company invests independently in research. In other words, the level of spillover below which the consortium is sub-optimal is very low and decreasing as the number of companies increases.
Martin (1994) considers a Patent Race context, in which the winner, ie the one who obtains the patent, can transfer it to a third party. With the model, it is able to demonstrate that well-being is not maximized with the consortium, but through an RJV that excludes at least one company. Moreover, given that an open RJV achieves greater social well-being than an exclusive one, the social optimum is not always achieved if companies are free to prevent the entry into the joint venture of a new partner.
Poyago-Theotoky (1995), through a two-stage game, R & D and output, with 'n' companies of which 'k' partner in an RJV, assuming that the participating companies maximize the level of internal spillover, demonstrate the social desirability of the consortia, given the perfect communication between the partners, which leads to a reduction in research costs, encouraging a greater commitment of the participants compared to companies not participating in the agreement.
In the model it is assumed that cooperation presupposes the maximum sharing of information. In other words, the greater the number of companies present in the consortium and the greater the commitment to research should be, the greater the diffusion of knowledge and innovative technology will be.
However, this social optimum is never achieved, because the entry of a new entity into the joint venture not only reduces research costs, but also profits, given the presence of a greater number of efficient competitors. In other words, given that an RJV is created to have a competitive advantage over external companies, the more we reduce the number of outsiders, the less it makes sense to cooperate.
In this regard we can cite the work of Grenlee-Cassiman (1999), which analyze a cooperative game in which companies can join more than one RJV: they show that companies never choose the industrial consortium, but form at least two asymmetric RJVs, at least with reference to the number of partners. Model simulations suggest that cooperation in R & D always increases well-being in the presence of high spillovers.

We can therefore say that the consortium is almost unanimously recognized as a socially optimum form of cooperation, even if it is difficult to train (Deroian, Gannon 2006).
The size of the RJV is also important for evaluating opportunism. If an RJV is composed of many companies, the contributions of each will be relatively unimportant, so the fact of not keeping the agreement by subtracting from the obligations will have a limited impact on the outcome of the project.
Therefore, if the partners are numerous, the incentive to 'defection' is greater, but it causes more limited damages than the hypothesis of small joint ventures. However, the greater number of partners generates greater synergies and internal spillovers, contributing to the reduction of per-capita research costs, with a consequent reduction in opportunism (Hernan t al., 2003).
The size of the RJV depends on the combination of coordination effect, information sharing effect and competition effect: depending on the relative weight of these effects the size of the RJV can increase or decrease.
The coordination effect derives from the increase of internalized externalities in the RJV connected to the entry of a new partner: this therefore leads to a size increase of the RJV.
The effect of sharing information derives from the possibility of better use of information among the partners of the RJV, net of possible dispersions to the outside. The effect of competition is linked to the fact that a new partner becomes a more tenacious competitor in the outlet market. This discourages the acceptance of new members.
There is a direct link between the effect of information sharing and the effect of competition: given that the sharing of information strengthens the competitive position of the members of the RJV with respect to outsiders, it also strengthens competition (Perez Castrillo et al 1997).
From the point of view of the company outside the joint venture that evaluates a possible entry, all three effects reinforce the potential profitability of the accession. The competition effect shows that as the size of the RJV grows, membership becomes almost an obligation: in this case, in fact, the advantage of collaborative research grows, at least as regards cost reduction.
The bigger the joint venture, the more inefficient the new entrant is, and the greater the gain that these portrays from membership, the greater the competition effect.
If the loss of information deriving from sharing increases, companies respond by increasing the size of the RJV, because a larger size allows greater tolerance of negative effects. Thus, a new partner can be seen as a tool to increase the appropriateness of the results because both the increase in the size of the RJV and the reduction of the dispersion of information to the outside, with a benefit compared to the sharing of information.
The profits of insiders decrease if information dispersion increases, because the net benefit deriving from sharing is reduced: in response the partners dedicate fewer resources to collaborative research, and production costs increase. As mentioned, with the increase in the dispersion of information, it tends to increase the size of the RJV, but this increase is not always sufficient to offset the overall reduction in investment in R & D. This situation leads to a reduction in costs, with a consequent increase in profits for outsiders, which, paradoxically, derive a benefit in terms of competitive position.
The final (net) effect on well-being depends on the net effect on production costs, ie the effective reduction of production costs, changes in R & D investments, changes in the levels of information dissemination and the residual level of sharing (Combs 1993).
What is the relationship between information asymmetry and information sharing, and therefore of technology?
Some models demonstrate that disclosure of information reduces the costs involved in research: in other words, an RJV could be formed due to the moral hazard resulting from the difficulty of negotiating on the transfer of information outside of a formalized agreement such as the RJV (Perez Castrillo 1997). The presence of information asymmetry reduces the payoff expected from non-cooperative research, therefore the incentives for cooperation increase.

SUBSIDY POLICIES TO RJV

Experience teaches us that often, to incentivize the establishment of an RJV, the governing bodies intervened with the subsidies.
An RJV subsidy policy is more effective, and socially desirable, in non-commercial sectors, such as aerospace research, or military research, in which the state appears as the sole customer (Cohen, 1994).
This position is not shared in a unanimous way, as some models show that whenever cooperation is socially desirable there is no need for incentive, as it is already the best choice for companies: in other words, a subsidy policy would be redundant.
It is also shown that cooperation in research without strategic behavior by companies always leads to greater investments in R & D, greater output and, therefore, greater well-being. If we had strategic behavior on the part of companies, research collaboration, as we have already seen, would improve welfare only for high spillovers.

Recall that we talk about the strategic behavior of the company when it takes decisions, and takes actions, taking into account the advantages that its investments have on its partners (Leahy, Neary, 1997).
The model of Hinlooper (2000), starting from the contribution of Suzumura in 1992, and assuming that the government authorizes the formation of the RJV and dispose of subsidies, shows that these have the same effects on welfare regardless of the presence of other RJVs. But since the RJV can pose problems in order to collude, a subsidy policy is preferable.
Cassiman (2000) notes that often the actual level of spillover in an industry can be unknown to the government, which in the model is considered the Principal that must push the Agents, ie the companies, to declare the levels of spillovers they enjoy. If it is assumed that the government has access to the RJV training authorization tool, and a lump-sum grant, the model makes it possible to conclude that the grant can improve the control capacity of the institutional bodies, which will have greater awareness of the actual level of spillovers, avoiding, through the refusal of authorization, the RJV damaging of well-being.

THE RISKS OF COOPERATION IN RESEARCH

Sometimes the undeclared intent of the RJV is to reduce and / or facilitate collusion in the final market. Already Kamien (1986) noted that companies cooperating in research can reduce investments for anti-competitive purposes.
This brings out two conflicting effects: on the one hand cooperation allows cost reduction and internalization of the positive externalities generated by spillovers; on the other hand it also internalizes a negative externality, as the RJV reduces profits in the final market of goods because it makes the competitors / partners stronger.
Which of the two effects is prevalent depends on the level of competitiveness of the market: if this is very competitive, companies can use most of the gain resulting from lower costs to lower prices, creating an effective benefit for the consumer, despite the company realize lower profits. And this phenomenon is more likely to increase the number of companies on the market.
Sometimes, in this regard, we talk about a strategic effect, seen as the influence that a variation of R & D has on the strategic choices in the final market (Kline, 2000). Since this effect can compensate for the effect of spillovers, an RJV may not be the best solution in terms of well-being, even in the case of high spillovers. In other words, the possible anti-competitiveness of the RJVs is confirmed in the event of strong competitiveness in the final market (Ziss, 1994).
Already d'Aspremont and Jacquemin (1988) underline how collaboration through RJV, while encouraging greater commitment by companies, can lead to an inefficient output level.
Authorizing cooperation also in the final market can be socially desirable only when there are high spillovers, or when the research activity is a pure, non-rival and non-excludable public good.
In this hypothesis the only way to restore the incentive to innovate, and therefore to invest in research activities, is to guarantee a monopolistic return to companies that invest together. In other words, authorizing the creation of the RJV can be an alternative tool to the recognition of the rights of privation (Ziss, 1994).
There are however divergent positions that support the social profitability of the RJV for any level of spillovers, and they consider cooperation in the market of goods always inefficient, as it leads in any case to a reduction of consumer surplus, and therefore of its well-being (Brod, Shimakuvar, 1997).
There are however divergent positions that support the social profitability of the RJV for any level of spillovers, and they consider cooperation in the market of goods always inefficient, as it leads in any case to a reduction of consumer surplus, and therefore of its well-being (Brod, Shimakuvar, 1997).
This position is justified by the fact that the monopolistic power deriving from collusion encourages greater investments in R & D, but the benefits are mostly in favor of companies, lacking real competition on the final market of goods.
Ultimately, it is quite peaceful in doctrine that it is very difficult to identify the hypotheses of cooperation on the final market that are not detrimental to well-being. Only Jorde and Teece (1990) propose to loosen the antitrust rules against all forms of joint venture, arguing that innovation is not a serial process, but involves all stages of the production process: the creation of a joint venture, therefore, always stimulates, under any conditions, the innovative potential of companies.
Some hypothesize that RJV could be the tool to create a real cartel on the asset market, rather than to reduce competition. In this regard, Martin (1999) proposes a Patent race model in which two companies compete to obtain the exclusive use of a new, non-drastic technology: it is shown that tacit collusion in the final market is more sustainable if companies are allowed to create a RJV.
Another important contribution is that of Lambertini (2003) which takes into consideration two companies that invest in product innovation: if they decide to cooperate they reduce the costs of research and development, but the development of substitutes creates a cannibalization effect that reduces the profits of both. In other words, only if the products are not substitutes facilitates collusion in the final market, regardless of the type of competition.

The stability of collusive agreements is a highly debated issue. It is negatively influenced by the possibility of new companies entering: in fact, when a new company enters the RJV at a time after the creation, it is less likely that the RJV has collusive intent, while the suspicion of collusion is particularly relevant for large-scale collaborations, especially if companies belong to the same sector (Vasconcelos, 2004).
Already Stigler (1950) understands that companies outside the RJV have incentive to behave like free riders, undermining, at least partially, the impact of agreements on the market. In other words, the greater the number of participants, the more the RJV is stable, even if very inclusive RJVs, in very concentrated industries, often give rise to suspicions of collusive behavior. In fact the greatest benefits that potentially derive from collusion are the most effective way to detect defections, or 'betrayals', making these situations particularly incentive where there is a willingness to collude (Levinstein, Suslow, 2016). And the studies conducted in this field confirm the hypothesis that RJVs are more stable in highly concentrated sectors, provided that the majority of companies adhere to RJV, thus confirming the suspicion of a collusive intent (Seldeslachts et al., 2008).
There are many ways in which collaborations in R & D can lead to collusive behavior. By creating a joint venture it is possible to centralize the decision-making process, combining research cooperation with the control of strategic assets, imposing restrictions that limit competition between partners, exchanging sensitive information. The collusive potential is even higher if the members of the RJV are competing on the final product market, as often happens.
It is true, however, that the use of RJV for collusive purposes presupposes its stability (Cabral, 2000). RJVs, in fact, 'facilitate' collusion only when the partners are able to use the tool as coordination or a sanction. For this reason, if there are frequent changes in the structure of the RJV, with companies that leave and / or enter frequently, it is unlikely that the agreement is concluded with collusive purposes.
The suspicion of collusion is particularly relevant for large-scale collaborations that develop within the same sector. The greater the number of participants in the RJV, in fact, and this is more stable.
Studies show that RJVs are more stable in high concentration sectors, but only if they welcome a large number of members. Ultimately, large RJVs can be a collusive tool on the market for the final product, and the stability of these broad forms of collaboration is a necessary condition for this to happen. In contrast, the presence of a non-profit organization within the RJV, such as a university, or a public research center, greatly diminishes the suspicion of collusive purposes (Seldeslachts et al., 2008).

SHARING INFORMATION IN COOPERATIVE RESEARCH

It is reasonable to suppose that information sharing is better in a cooperative context, even if there is no evidence to say with certainty that such sharing is perfect. Katz's model (1986) provides that companies decide on the composition of the RJV, on how to allocate research burdens, on information sharing and on output. The model demonstrates that cooperation is beneficial when competition in the product market is limited, when spillovers are relevant and when cooperation leads to an improvement in information sharing. It is clear that if the collaboration affects the entire industrial sector, information sharing is complete.
The likelihood of a wider sharing of information increases with the size of the RJV, because when the collaboration concerns a large number of companies the benefits of sharing are greater than the secrecy, and this is a strong incentive to share. In fact, if the spillovers to the outside are contained, the companies are pushed to share information, because it takes full advantage of the cooperation, without having significant losses.
On the other hand, if the 'migration' of the information to the outside is very high, the outsiders benefit from it, such as to deteriorate the competitive position of the members of the RJV. In this case, therefore, the lack of sharing is due to obstacles of a competitive nature, ie the dispersion of information to subjects outside the RJV (Combs, 1993).
Sometimes the idiosyncratic nature of technology can impose constraints on the extent of cooperation and information sharing, as well as a certain level of discretion on information that partners decide to share, even within an RJV. Precisely for this reason, the regulation of the RJV often establishes which, and how many, information should be shared (Folster 1993).
Studies show that companies choose extreme levels of information sharing: that is, they choose maximum sharing when the efficiency effect, which allows the minimization of costs, dominates, while they opt for non-sharing when the effect of asymmetry is relevant, in how much this effect determines very different cost structures between companies (Amir and Wooders, 2000).

CONCLUSION

RJVs are a complex and widespread reality for the common development of research activities for innovative purposes. They are a useful and effective tool in order to internalize the high levels of spillovers connected to the production of knowledge. In particular, the realization of this objective, in addition to favorable legislation

and, in some cases, the public subsidy, represent the best incentive to favor the birth and expansion of this form of collaborative research.
RJVs are particularly widespread and useful in areas where research burdens are very substantial, research embraces many areas of knowledge and the results of the process are uncertain. The positive effects concern both individual companies and social well-being. They often represent the only form of incentive for the development of knowledge.
The theory and the empirical evidence show that, under certain conditions, the RJV that welcomes all the companies of a given sector, also called industrial consortium, is the best form of association for research.
Like any form of collaboration, especially if very extensive, the RJV presents high risks of collusion, highly detrimental to the competition rules on the market of final goods, especially when the members are companies belonging to the same sector that, through this tool, can consolidate a significant market power.

REFERENCES

Allen S.d., Link, A.N., (2015), U.S. *Research Joint Ventures with International Partner*, International Entrepreneurship and Management Journal, 11(1)

Amir R., Wooders J., (2000), *One Way Spillovers, Endogenous Innovator/Imitator Roles and Research Joint Ventures,* Games and Economic Behavior, 31(1)

Arthur W.B.,(1988) Competing Technology: an Overview , Pinter, London

d'Aspremont C., Jacquemin A., (1988), *Cooperative and Noncooperative R&D in Duopoly with Spillovers,* The Amercian Economic Review, 78(5)

Brod A., Shivakumar R., (1997), *R&D Cooperation and the Joint Exploitation of R&D,* The Canadian Journal of Economics, 30(3)

Cabral L., (2000) R&D *Cooperation and Product Market Competition*, International Journal of Industrial Organization, (18)

Cassiman B., (2000*) Research Joint Ventures and Optimal R&DPolicy with Asymmetric Information*, International Journal of Industrial Organization, 18(2)

Cohen L., (1994), *When Can Government Subsidize Research Joint Ventures?Politics, Economics and Limits to Technology Policy*, The American Economic Review 84(2)

Combs K.L., (1993), *The Role of Information Sharing in Cooperative Research and Development*, International Journal of Industrial Organization (11)

De Bondt R., Henriques I., (1995), *Strategic Investments with Asymmetric Spillovers*, The Canadian Journal of Economics, 28(3)

Deroian F., Gannon F., (2006), *Quality Improving Alliances in Differentiated Oligopoly*, International Journal of Industrial Organization, 24(3)

Dodgson M., (2018), *Technological Collaboration in Industry*, Routledge, London

Folster S., (1995), *Do Subsied to Cooperative R&D Actually Stimulate R&D Investment and Cooperation?,* Research Policy 24

Grenlee P., Cassiman B., (1999), *Product Market Objectives and the Formation of Research Joint Venture,* Managerial and Decision Economics, 20(3)

Grindley P., Mowery D., Silverman B., (1994*), SEMATECH and Collaborative Research: Lessons for the Design of High Technology Consortia,* Journal of Politcy Analysis and Management, (35)

Hagedoorn J., (2002), *Inter-firm R&D Partnerships: an Overview of Major Trends and Patterns since 1960,* Research Policy (31)

Harrington J., (2006), *How do Cartels operate*?, Foundations and Trends in Microeconomics 2(1)

Hinloopen J., (2000) *Subsidizing Cooperative and Non Cooperative R&D: An Equivalent Result?,* Economics of Innovation and New Technology, 9(4)

Inkpen G.P., (1998), *Learning, Knowledge Acquisition and Strategic Alliances*, European Management Journal 16(2)

Jorde T.M., Teece D.J., (1990), *Innovation and Cooperation: Implication for Competition and Antitrust*, The Journal of Economic Perspectives, 4(3)

Kamien M.I., Muller E., Zang I., (1992), *Research Joint Ventures and R&D Cartels*, The American Economic Review 82(5)

Kamien M.I., Zang I., (2000), *Meet me Halfway: Research Joint Ventures and Absorptive Capacity*, International Journal of Industrial Organization, 18(7)

Katsoulacos Y., Ulph D., (1998), *Endogenous Spillovers and the Performance of Research Joint Ventures*, The Journal of Industrial Economics 46(3)

Katz M., (1986), *An Analysis of Cooperative Research and Development*, Rand Journal of Economics, 17(4),

Katz M., Ordover J., (1990), R&D *Cooperation and Competition*, Brooking Papers on Economic Activity: Microeconomics, 17(4

Kline J., (2000), *Research Joint Ventures and The cost Paradox*, International Journal of Industrial Organization, 18(7)

Laino A., (2016), *L'innovazione nell'analisi economica*, Franco Angeli, Milan

Lambertini L., Poddar S., Sasaki D., (2003), *RJVs in Product Innovation and Cartel Stability*, Review of Economic Design, (7)

Leahy D., Neary P., (1997), *Public Policy Towards R&D in Oligopolistic Industries*, The American Economic Review 87(4)

Leahy D., Neary P., (2005*), Symmetric Research Joint Ventures: Cooperative Substitutes and Complements*, International Journal of Industrial Organization, 23(5-6)

Levinstein M.C., Suslow V.Y., (2006), *What Determines Cartel Success*, Journal of Economic Literature, (44)

March J.G., (1991*), Exploration and Exploitation in Organizational Learning*, Organization Science, 2(1).

Hernan Gonzales H., Siotis G., Marin P.L., (2003), *An Empirical Evaluation of the Determinants of Research Joint Venture Formation,* Journal of Industrial Economics, 51(1)

Martin S.,(2002a) *Advanced Industrial Economics*, Blackwell Publishers 2002

Martin S., (2002b), *Spillovers Appropriability and R&D*; Journal of Economics 75(1)

Martin S., (2003), *The Evalutation of Strategic Research Partnership*, Technology Analysis and Strategic Management 15(2)

Miyagiwa Kaz ., Sissoko A., Song H.,(2015) *The Free Rider Problem and the Optimal Duration of Research Joint ventures: Theory and Evidence from the Eureka Program,* Hitotsubashi University Repository

Osarenkhoe A.,(2010) *A study of Inter-firm Dynamics between competition and Cooperation. A coopetition Strategy,* Journal of Database Marketing & Customer Strategy Management, 17(3-4)

Perez-Castrillo J.D., Sandonis J., (1997), *Disclosure of Know-how in Research Joint Ventures*, International Journal of Industrial Organization 15(1)

Poyago-Theotoky J., (1995), *Equilibrium and Optimal Size of a Research Joint Venture in an Oligopoly with Spillovers,* The Journal of Industrial Economics, 43(2)

Reuer J., Zollo M., (2005), *Termination Outcomes of Research Alliances*, Research Policy, 34(1)

Roller L.H., Siebert R., Tombak M.M., (2000), *Strategic Choice partners: Research Joint Ventures and Market Power*, WP 2617 CEPR

Salant W.S., Shaffer G., (1998), *Optimal Asymmetric Strategies in Research Joint Ventures*, International Journal fo Industrial Organization, 16(3)

Seldeslachts J., Duso T., Pennings E., (2008), *On the Stability of Research Joint Ventures: Implications for Collusion,* Discussion Paper 240 GESY

Shapiro C., Willing R., (1990), *On the Antitrust Treatment of Production Joint Ventures*, Journal of Economic Perspectives, (4)

Simpson D., Vonortas N.S., (1994), *Cournot Equilibrium with Imperfectly Appropriable R&D*, The Journal of Industrial Economics, 42(1)

Spence M., (1984), *Cost Reduction, Competition and Industry Performance* , Econometrica 52(1)

Stigler (1950), *Monopoly and Oligopoly by Merger*, American Economic Review Papers and Poceedings, 40(2)

Suzumura K., (1992), *Cooperative and Noncooperative R&D in an Oligopoly with Spillovers*, The American Economic Review 82(5)

Teece D., Peteraf M., Leih S., (2016), *Dynamic Capabilities and Organizational Agility: Risk, Uncertainty and Strategy in the Innovation Economy,* California Management Review, 58(4)

Tirole J., (1988), *The Theory of Industrial Organization*, MIT Press

Yi S., Shin H., (2000), *Endogenous Formation of Research Coalitions with Spillovers*, International Journal of Industrial Organization, 18(2)

Vasconcelos H., (2004), *Entry Effects on Cartel Stability and the Joint Executive Committee*, Review of Industrial Organization, (24)

Vickers J., (1988), *Pre-emptive Patenting, Joint Ventures, and the Persistence of Oligopoly*, International Journal fo Industrial Organization, (3)

Ziss S., (1994), *Strategic R&D with Spillovers Collusion and Welfare*, The Journal of Industrial Economics, 42(4)