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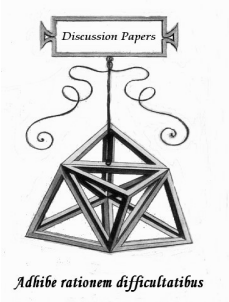

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Firms' R&D cooperation strategies: the partner choice

Abstract

The aim of this paper is to provide empirical evidence on the issue of firms' R&D cooperation strategies, examining the topic from the point of view of the partner choice. Literature has deeply analyzed the motivations inducing firms to form research joint ventures, instead, the investigation of partner selection strategies is disregarded even though it is one of the most critical decisions for a firm when forming an alliance. For this reason, by making use of data coming from the fourth Italian innovation survey (2002-2004), we contribute to the the literature by estimating, through the use of a multinomial logistic model, the determinants that affect the firms' choice among different types of potential R&D cooperation partners. We differentiate among three cooperation strategies that are: (i) cooperation with only market partners; (ii) with only science partners; and (iii) with both of them. Our findings provide support to the hypothesis that different variables determine different partner choices according to the sector analyzed. In the manufacturing sector, for example, foreign multinational companies or export oriented firms prefer to cooperate only with market partners. In the services, firms receiving public subsidies for innovation prefer science cooperations to all the other cooperation arrangements leaving room for policy implications.

Classificazione JEL: O32; L10; L8; L6; D78
Keywords: R&D cooperations; partner selection; industry-university linkages; service sector

Contents

I. Introduction

One of the main outcomes of the knowledge based economy is that firms allocate greater resources to R&D activities to broaden their technological capabilities.
In order to successfully innovate firms need to develop and integrate into their production processes technological knowledge coming from external sources that is difficult to generate in-house. This is due to the fact that surviving in market competition has become more challenging than before and the need to rely on more complex technology encourages firms to choose a strategy of R&D cooperation. In this respect, the massive rise in R&D agreements started in the late '80s has spurred both theoretical and empirical investigations to explain this phenomenon (Hagedoorn, 2002).
Different streams of literature have analyzed different aspects inherent to the R&D cooperation strategies. Among them, two are the most important: the first examines the so called R&D cooperation determinants by trying to understand what are the variables that induce firms to cooperate. This aspect is analyzed both under the lens of Industrial Organization literature (IO) that puts special emphasis on imperfect appropriability of innovation activities of the firms calling into question the role played by incoming and outgoing spillovers (e.g. Belderbos et al., 2004a), and under the lens of management oriented literature.
In this last case, by using a theoretical framework grounded in the resource based view of the firm, a greater relevance is given to issues such as, for example, the need for the firm to access to complementary knowledge (Hite and Hesterly, 2001) or the need to share costs and risks with partners (Sakakibara,1997).
However, it is worth underlining that the literature does not frequently explore the motivations that determine the choice among different partners limiting the investigation to the conditions according to which a firm decides or not to cooperate. Very few attempts have been put forward to investigate what determines the partner choice (e.g. Miotti and Sachwald, 2003; Belderbos et al.,

2004a) even tough the approach followed is that of investigating what determines the choice of a specific partner rather than the choice among different partners.
A second strand of literature deals with the ways in which R&D cooperation strategies may affect firms' economic success (Faems et al., 2005). It could result of interest for our study to the extent it allows to theorize about the motivations leading firms' choice to a specific partner instead of another one. A common finding, for example, indicates that if a firm collaborates with university has higher probability of increasing its innovative sales rather than just simply reaching a higher productivity (e.g. Levy et al., 2009).
The fourth Italian innovation survey (CIS4) provides us with firm level data over the period 2002-2004, allowing us to distinguish among different types of cooperation partners such as suppliers, clients, competitors or public research institutes and to explore the R&D cooperation strategies of Italian innovative firms by investigating what determines the selection of cooperation partners once the decision to cooperate has been taken. Our exploratory study gives several contributions to the literature: in the first place, we provide empirical evidence for another country, namely Italy, that contrary to other European countries such as Netherlands, Germany or Spain has not received enough attention so far. Moreover, the analysis of this case is relevant as far as the Italian technological structure is weaker than other European countries due to the low number of large firms performing R&D activities and weak network activities with universities.
Secondly, the novelty of our study is that of employing a multinomial logit estimator in order to analyze in a simultaneous way what influences the choice among three main partner-choice strategies: (i) R&D cooperation with market partners (suppliers, clients or competitors); (ii) R&D cooperation with science partners (public research institutes and universities); and finally, (iii) a mixed cooperation with both market and science partners.
Thirdly, we distinguish between manufacturing and service sectors. This aspect is particularly relevant as the analysis of the innovation

process with respect to service sector is a growing field of study (e.g. Drejer, 2004). Indeed a common feature of this strand of literature is that of focusing mainly on the manufacturing sector as, until recently, services were considered to exert a marginal role in innovative activities. However, new theoretical and empirical contributions have contrasted this view that considered services simply as passive adopters of technology (e.g. Theter, 2003). Only a few attempts have been done to account for this distinction (e.g. Segarra-Blasco and Arauzo-Carod, 2008) that is particularly relevant as European economies are progressively characterized by higher importance of the service sector.

The paper is structured as follows: the following section sets the theoretical stage to better understand the phenomenon of R&D cooperation by briefly reviewing the different streams of literature that deal with this topic. The third section discusses the theoretical hypotheses we make about the motivations for which a firm should choose one partner instead of another one; the fourth section describes the construction of dependent and independent variables together with the empirical approach followed. Section five offers some comments to econometric results and section six concludes.

II. R&D cooperation: literature review

The growing importance of innovation capabilities in fostering firms' growth and competitiveness has reached a considerable threshold since the late '80s. This fact has encouraged firms to allocate more resources to R&D and, in particular, to search for other technological sources even outside their own boundaries. For this reason, as Hagedoorn (2002) recognizes, we can notice an increasing historical trend of R&D cooperation strategies that firms pursue.

Both formal and informal R&D cooperations could favour the exploitation of technological opportunities, such as the poolability of complementary assets or the generation of synergies. Even though, the investigation of informal R&D cooperation strategies has proved to be an interesting field of study (e.g. Bȯnte and Keilbach, 2005),

the focus of this paper will be on the exploration of formal R&D cooperations that, as defined by Community Innovation Survey (CIS) questionnaire, are those firms' explicit arrangements committing parties in an active participation in joint R&D and other innovation projects.

Several authors have offered theoretical arguments to explain why firms should collaborate in R&D partnerships, even though they did it through the lens of different theoretical backgrounds. The underlying motive for which firms may need to cooperate in R&D is that it could be particularly difficult for them to internalize technological knowledge: due to the inherent complexity of the innovation processes, technological resources may not all reside inside the firm itself but they need to be searched in the external industrial environment. In particular, firms may engage in different types of relationships according to the partner they choose, establishing agreements with other firms (e.g. Plunket et al., 2001) or with other institutions that are not part of the industrial sector such as public research labs or universities (e.g.Lee,1996).

Besides input related motives, firms may also choose to cooperate because of output related motives, that is to increase their innovative outcomes. The determinants of the choice of a specific partner is related to the aim that the firm is going to achieve through the cooperation.

For this reason, in this section we revise the main streams of literature dealing with the subject of R&D cooperation strategies analyzing the literature related to the determinants of R&D partnerships and the literature related to the effects of R&D cooperation as they are closely related when the firms choose the type of partners. It should be noted that actually, when carrying out empirical studies, authors do not follow a specific theoretical framework but they all follow an integrated framework as this approach provide enough flexibility in the specification of tested models.

II.A. The Industrial Organization literature: knowledge spillovers and R&D cooperation

In explaining the reasons of the R&D cooperation strategies, the IO approach is focused on the importance of imperfect appropriability of technological knowledge according to which both incoming and outgoing spillovers act as major determinants of R&D cooperation strategies.

Incoming spillovers refer to the external flows of knowledge that a firm may be able to grasp, while outgoing spillovers are relative to the firms' ability to control the stock of knowledge that may eventually flow out of its boundaries. On the one hand, if incoming spillovers are high enough this may induce firms to collaborate as it may result more profitable than non cooperating strategy (D'Aspremont and Jacquemin, 1988;De Bondt and Veugelers, 1991); on the other hand, the possibility of knowledge leakages may increase firms' willingness to take advantage of partners R&D investments (Kesteloot and Veugelers, 1994).

These early theoretical models have been later extended to account for the fact that firms may try to influence spillovers by increasing their R&D endowments:[1] in particular, firms attempt to minimize outgoing spillovers and maximize incoming spillovers. Nevertheless this literature has not enough taken into consideration the issue of the choice of partners. Atallah (2002) develops a theoretical model dealing with multiple choice of R&D partners considering that even a small amount of knowledge spillover induces collaboration with vertical partners. However, empirical evidence on this topic is still almost lacking.

Cassiman and Veugelers (2002), using Belgian CIS data consider the role of incoming spillovers distinguishing the cooperation partners between research institutes and vertical suppliers. They find that the higher probability of collaborating with research organizations is associated with higher incoming spillovers while lower outgoing

[1]The crucial role is played by absorptive capacity that, as first put forward by Cohen and Levinthal (1989), and then developed by Kamien and Zang (2000), help firms to better manage spillovers when they cooperate.

spillovers affect the probability of cooperating only with market related partners, in particular customers and suppliers. By employing the same dataset and confirming previous results, Veugelers and Cassiman (2005) investigate what are the characteristics of the firm conducive especially to the cooperation with universities finding that besides the size and the firm location in high tech sectors, firms' ability to control outgoing spillovers is not crucial.
In line with this findings, Lopez (2008) reports that incoming spillovers affect only the cooperation with universities while finding a negative effect with respect to the same partner as far as the ability of limiting outgoing spillovers is concerned.
Kaiser (2002) analyses the German service sector through the use of a nested logit model. He distinguishes between vertical partners and a mixed cooperation strategy with universities and competitors finding that neither the R&D expenditures of the firm nor the likely spillovers may have impact on the R&D cooperation.
In the same way, Belderbos et al., (2004a) by using a multivariate probit technique, carry out their analysis with respect to the Dutch case. Besides incoming and outgoing spillovers, they test a broad set of R&D cooperation determinants with respect to different partners. They also allow for correlation among the different strategies finding that strategies may be seen as complementary rather than substitute. As they are able to single out income-source specific spillover, they find confirmatory results for the fact that higher ability of reaping spillover from a specific partner increases the probability of cooperating with that partner. In particular, incoming spillovers coming from institutional partners enhance the cooperation with all types of partners.

II.B. The Management literature: costs, risks and complementarities

The second theoretical approach followed to examine R&D cooperation determinant is grounded in the management literature.Under this heading, two main theoretical perspectives can be disentangled:

the first is the transaction cost approach (e.g. Pisano, 1990). It underlines how technology transactions may entail high costs due to the frequent tacit component of technology. The firm is able to lower those costs developing the needed technology inside its own boundaries but at the same time it also needs to search somewhere else complementary knowledge. For this reason, through cooperation with a partner the firm is able to control the process of technology transfer and minimize opportunism as the firms are endowed with complementary capabilities that they need to exploit together[2]. According to this theory, firms may choose to cooperate because of the high uncertainty of the innovation process that may favour the sharing of costs and risks among partnership participants (e.g. Das and Teng, 2000).

The second approach followed by the management literature implies a resource based perspective in which tangible and intangible assets of the firms are considered as a way to obtain a competitive advantage over other firms. In this respect, through cooperation, firms may improve their strategic position because it is a way to pool together and to combine both complementary and similar resources to create value (Hagedoorn et al., 2000).

Both these two theoretical frameworks have provided more insights on the motivations for which firms may choose a specific partner with respect to another. In particular, it is recognized that collaborating with suppliers may be a strategy more focused on cost reduction while collaborating with customers may help firms to introduce a complex product on the market because it mitigates possible risks associated with uncertainty. Instead, institutional partners such as universities are chosen when firms need generic technologies in order to exploit favourable technological opportunities.

Following this theoretical background, more empirical efforts have been carried out to show how firms choose different partners. A paper that distinguishes among the different cooperation partners

[2]However, as Arranz and Fdez de Arroyabe (2008) point out, this theory does not fully explain the advantages of cooperation such as for example learning when the firm has to choose the partner

is by Tether (2002) who uses UK CIS data running independent logistic regressions: he finds that while firms' size has a positive impact only on the choice of universities and suppliers, higher R&D expenditures are beneficial for all types of cooperation.
Miotti and Sachwald (2003), with regard to the case of France, find that cooperation with rivals is more likely in high tech sectors while the opposite is true for vertical cooperation. A second important conclusion they reach is that firms cooperating with public institutions usually face less cost constrains while it is not the case for firms cooperating with rivals. This fact supports the view that cooperation with rivals is mainly aimed at pooling similar resources while cooperations with universities are targeted in order to pool complementary resources together.
A different point of view is taken by Arranz and Fdez de Arroyabe (2008) who, by examining the Spanish case, make the hypothesis that smaller firms will cooperate more with universities because of their limited technological resources. They find that the choice of different partners is moved by different determinants: firms are motivated to choose market partners if they are bigger, if they are part of a group and have higher R&D expenditure, while, the main aim of collaboration with public partner is that of overcoming high costs.

II.C. The effects of R&D cooperation

The literature examined above mainly deals with the so called input-relative motives to search for R&D cooperation. However, this topic has been examined also from the point of view of what it may produce on the side of firms' output, both in terms of higher productivity or higher innovation. Indeed, the choice of different partners could be affected by a large number of reasons such as the nature and the aim of R&D projects as well as the expected effects of R&D cooperation. First of all, it has to be noted that earlier studies dealing with the impact of cooperation strategies on innovation performance were mainly concerned about the study of

the role of R&D investment including only a cooperation variable inside the determinants of innovation output and disregarding to investigate whether different partners could affect the final outcome. Only a few papers control for this effect: for example, Monjon and Waelbroeck (2003) find that firms cooperating with universities are more likely to introduce innovations that are new to the market. Loof and Hesmathi (2002) by focusing on the Swedish case, find that firms are going to receive more benefits in term of higher output if they cooperate with universities or with competitors rather than with suppliers and customers. Belderbos et al.,(2004b) recognize that Dutch firms cooperating with suppliers and competitors reach a higher labour productivity growth, whereas the cooperation with customers and universities may lead to higher number of new to the market products. Loof et al., (2009) recognize that firm's collaboration with universities may have a positive impact non only on patentability but also on innovation sales per employee. Some studies differentiate their approach: for example, Cincera et al., (2003) distinguish between collaboration with foreign and domestic partners finding negative result on firms' productivity when collaborating with foreign partners. Becker and Dietz (2004) analyze whether the R&D cooperation has effect both on the "input" side and on the "output" side of the innovation process finding that joint R&D increases the firm's R&D intensity and the probability of introducing new products raises the higher the number of parties involved in R&D cooperation.

Nevertheless, examples of negative outcomes can be found as well: Janz et al., (2004) who analyzes the determinants of the innovation performance in Sweden and Germany find that R&D cooperation has even a negative effect on innovative sales. Adding to these studies, Aschhoff and Schmidt (2008) disentangle further the analysis by considering the type of innovation produced: they find that on an aggregate level R&D cooperations lead to lower costs only with regard to process innovation. Moreover, they find that the cooperation with universities and research organizations produce higher share of market turnover than firms cooperating with customers and

suppliers.
To sum up, results are quite unanimous in confirming that firms willing to introduce products new to the market are more likely to cooperate with science partners rather than with market partners.
Instead of examining the determinants of successful outcomes, a parallel stream of literature deals with the possible determinants of R&D cooperation failures: as a matter of fact, collaborative agreements besides leading to positive outcomes may also lead to unstable and thus negative results (e.g. Okamuro, 2007). As Park and Ungson (2001) argue, some key characteristics need to be present to ensure a certain degree of cooperation stability. Among them, the most important are the degree of market rivalry between partners, the complementarity of their skills and the cultural distance between them. In this regard, the role played by the partner is considered particularly outstanding: for example, Lhuillery and Pfister (2009) discuss how collaboration with competitors may induce failures differentiating among vertical partners, public research organization and foreign partners. Through their empirical application using French CIS data the most interesting results they get is that firms cooperating with their suppliers bear a higher risk of failures rather than cooperating with public research organization. In this last case, risks of failures may be mitigated if the firm has a longer past experience with the same partner. Again, this result reinforces the idea that cooperating with universities may lead to more stable and innovative R&D cooperation agreements.

III. Research hypotheses

The approach we would like to follow in this paper to analyze R&D cooperation links the "why" question with the "with whom" analysis. In this section we will present some theoretical arguments that try to shed light on the motivations for which firms could prefer a specific partner with respect to another.
The approach followed is that of taking into consideration an integrated framework in which we will deal with most of the deter-

minants already explored in the literature related to motivations of R&D cooperation, but trying to draw some lessons with respect to the partner choice.
In particular, our approach is that of distinguishing among three types of cooperation strategies: namely, partnerships with institutional actors (namely, universities and research labs), with market actors (customers, suppliers and competitors) and with both of them. This choice is due to the fact that cooperations in R&D activities with universities or other research institutions and cooperations with market partners present some important differences: on the one hand, industry-university R&D cooperations are often aimed to have a rapid and privileged access to new knowledge and to increase the firms' understanding of scientific developments (Belderbos *et al.*, 2004a and 2004b). On the other hand, cooperation with market partners is rather oriented to share cost or risk of innovations or to establish technical standards that cannot be established without the consensus of the main actors in the field. Moreover, cooperations among private firms, above all if competing in the end-product market, are more complex than cooperations between firms and public institutions because they can lead to potential anti-competitive behaviors. Public support is also less frequent in this last kind of cooperative arrangements, since it may cause policy concerns in terms of restriction of the degree of product market competition ex post (Caloghirou *et al.* 2004; Abramovsky *et al.*, 2009). However, we will explain in detail the differences between these types of cooperation in the remainder of this section.

III.A. Why do firms cooperate with science partners ?

To understand why a firm should prefer to engage with a science partner rather than with market partners we first need to delineate the characteristics of knowledge that can be shared among the two partners: as Fritsch and Lukas (2001) find, firms that are prevalently devoted to product innovations are more prone to cooperate

with universities than firms oriented to process innovations.
Indeed, the main aim of industry-university R&D cooperations is to gain a rapid access to new knowledge by increasing the firms' understanding of scientific developments (Belderbos et al., 2004a).
In the second place, by simply looking at the resource profile of the firm it should be pointed out that science institutions offer a different knowledge profile to be (possibly) shared with firms. Indeed, they are usually concerned with new technological knowledge that appears to be particularly relevant in producing innovations that are new to the market.[3] This is also confirmed by studies related to the effect of R&D cooperations surveyed above.
As Veugelers and Cassiman (2005) underline, the main characteristics of the R&D cooperation between industry and university are the high uncertainty caused by the specific types of innovation produced through this alliance and high transaction costs that force firms to invest more in R&D.
Going into deeper details, some key determinants are important to determine the choice of a science partner: in first place, as pointed out by Fontana et al., (2006) larger firms are more prone to engage into partnerships with institutional partners. More specifically, the size of the firm positively influences the choice of science partner as they have greater ability in interacting and absorbing more complex and broader technologies to successfully modify them by applying to innovation needs.[4] This is due to fact that, as Laurensen and Salter (2004) describe, large firms may allocate more time and efforts to build links with universities and they are also more likely to employ high qualified staff in science and engineering.
Moreover, as since '80s many countries have started to implement policies aimed at promoting university-industry collaborations, subsidies are usually a variable that should positively affect the choice of science partners. Indeed, Miotti and Sachwald (2003) find that

[3]These types of innovation activities will be present most of all when the innovation uncertainty is high and especially when the demand for the new product is still low.

[4]Nevertheless, even though most of the literature claims that larger firms are more prone to engage in R&D cooperation some small high-tech firms may have the suitable capabilities to interact with universities.

public subsidies for innovation will have a greater effect especially on the increase of partnerships with scientific institutions.
Another motivation for which firms may choose to cooperate with science partners is represented by their level of internal R&D expenditure. As it is considered in most studies, firms endowed with higher R&D activities are more likely to cooperate than firms with limited R&D activities (e.g. Fristch and Lucas,2001; Laurensen and Salter, 2004)). The explanation lies in the fact that firms through higher level of R&D are able to raise even their absorptive capacity (e.g. Cohen and Levinthal, 1990). Moreover, a firm needs to offer a certain amount of internal technological capabilities to share with the other partners.
Partly following Leiponen (2001) who recognizes the need of high R&D engagement to benefit from cooperation with universities and research organization, we expect the permanent R&D variable to affect more the cooperation with research institute and organizations rather than the cooperation with other firms.

- Hypothesis 1.1: The probability that a firm chooses to cooperate with science partners increases in its size.

- Hypothesis 1.2: The probability that a firm chooses to cooperate with science partners increases in the level of its internal R&D capabilities.

- Hypothesis 1.3: The probability that a firm chooses to cooperate with science partners increases if the firm has received an innovation subsidy.

III.B. Why do firms cooperate with market partners ?

Actually, we can distinguish between two different market partners: a firm may be vertically related with customers and suppliers and/or may be horizontally related with competitors. The reasons pushing firms to look for a particular type of partner could be a bit different. In particular, a firm could prefer to engage in a vertical

relationship when the aim is that of improving the involvement of the firm into the host market and this is particularly the case as far as firms belonging to multinational groups are concerned. Tether (2002) and Busom and Fernandez Ribas (2008) provide empirical evidence for that. The main reason is that those types of firms need to gain higher knowledge of intermediate goods' technology of production and in particular of users's need in order to adapt them to the local context.

With respect to the horizontal cooperation partners, the aim of those firms is that of internalizing the possibly leakage of knowledge coming from the other firms by minimizing their own outward flows. Moreover, horizontal cooperations, as shown by Miotti and Sachwald (2003), could be important for firms that need to share costs especially when products are easy to copy but costly to develop. The size of the firm, instead, is not a crucial determinant of horizontal choice as this type of strategy could be used by newer and smaller firms to develop new technologies.

However, the choice between vertical and horizontal partners goes beyond the aim of this paper that broadly analyzes the choice of market partners as an opposite strategy with respect to the choice of research partners, like universities and research institutes. The need to cooperate with another market partner, in fact, is especially relevant when firms need complementary skills in areas of applied research rather than basic research. Indeed, the crucial motivation for which a firm could prefer to engage in R&D cooperation with market partners is that beside the need to introduce into the market new or improved products,they want to extend the range of products in which they are involved in (Hagedoorn, 1993). In particular, cooperating with this type of partners allows firms to complement their own technological base with different technological capabilities, but most of all, it complements firms' knowledge of the market of the new product.

Firms' market orientation may result another key determinant: most of the literature is concentrated on the explanation of the relationship between exports and productivity finding results that mainly

confirm the hypothesis of self selection into exports markets (e.g. Melitz, 2003). These firms have a productivity advantage over domestic firms and besides self-selection effect they may also benefit from learning by exporting effect: for this reason, they are less worried about potential leakages of knowledge that market cooperations could cause.
In the same way, foreign ownership structures may positively affect the probability that the favorite partner for R&D cooperation was a market one. This could be due to the fact that foreign multinational companies investing in developed countries are often inclined to cooperate with host countries' market partners in order to integrate and improve the knowledge of the local demand.

- Hypothesis 2.1: The probability that a firm chooses to cooperate with market partners increases if it is a foreign multinational company.

- Hypothesis 2.2: The probability that a firm chooses to cooperate with market partners increases if it is an exporter company.

III.C. Why do firms cooperate with mixed partners ?

The reasons for which a firm could be engaged both with market and science partners are manifold. In the first place, the results found by Becker and Diez (2004) offer a first hint: they find that the number of partners may actually positively stimulate the potential for innovative outputs. Even though these types of partnerships may be affected by problems relative to coordination costs, firms who are going to choose this type of partnerships are those that are willing to create a more related network through which they can benefit from externalities coming from other partners. Indeed, the role played by incoming spillover may be relevant to explain this type of partnerships since the public pool of relevant knowledge that firms can exploit in order to increase the productivity of their innovation processes, often defined as incoming spillovers, is

generally expected to increase the technological competence of partners increasing the expected profitability of cooperative agreements (Cassiman and Veugelers, 2002; Lopez, 2008).
Another reason which could push firms to choose these types of partnership, as it is emphasized by the management literature, is the scope for sharing as much as possible the burden of innovation costs. If a firm suffers from cost constrains it is limited in its innovative behaviour. This may cause a higher involvement in R&D partnership. Actually, costs may hamper the innovation process and could spur the willingness of this firm to actively search for partners to alleviate financial problems that may become particularly relevant in early stages of technological development.
In the end, the role played by the degree of firms' capability to appropriate the results of innovation is relevant with regard to the choice of this partner. While the aim of the firm in the case of incoming spillovers is that of maximizing those flows of knowledge, in the case of likely outgoing spillovers firms try to minimize them as they represent an involuntary leakage of knowledge. If this ability is greater the probability the firm chooses mixed cooperation is higher as the firm is not worried by the fact that many partners may "steal" its technology.

- Hypothesis 3.1: Firms will choose mixed cooperation if they benefit from high incoming spillovers.

- Hypothesis 3.2: Firms that are more able to appropriate results will more likely choose mixed cooperation.

- Hypothesis 3.3: Firms will choose mixed cooperation if they face high costs of innovation.

IV. Data and Variables

The empirical analysis is carried out using the Fourth Italian Community Innovation Survey (CIS-4). It contains firm level data collected for the period 2002-2004 that are useful to describe the

manifold characteristics of the innovation behaviour.[5] The question about whether firms innovated or not between 2002 and 2004 allows us to distinguish between innovating and non innovating firms. In particular, we define as innovating firms those that introduced new or improved products, services or processes into the market and, at the same time, those that have specified a positive amount spent on innovation (Cassiman and Veugelers, 2002). To the aim of our analysis we restrict the sample to consider only innovating firms that claim to have been engaged at least in one cooperative agreement during the period analyzed.

According to Table 1 that reports the percentage of innovating firms by sectors, we can recognize that the manufacturing sector is the most innovative. However, we can also notice that the percentage of innovating firms in service sectors is nevertheless relevant confirming that innovation processes are becoming progressively more important. This lead us to explore the manufacturing and the service sectors in order to understand if the cooperative behaviours of firms present some important differences. As described in Table 2, the 50% in manufacturing and nearly the 40% in services claimed to be engaged in at least one R&D cooperative agreement, while in the other sectors cooperation seems to be a marginal phenomenon. Firms belonging to different sectors seem to have also different preferences with regard to cooperation partners. Manufacturing firms are inclined to perform R&D in cooperation especially with universities and research institutions. This is a similar behaviour as the one found in Spain by Segarra-Blasco and Arauzo-Carod (2008) who recognize that cooperation with universities predominate over collaboration with other firms. Instead, service firms, that in order to provide innovative services have to improve the knowledge of potential users' needs, are more inclined to cooperate with vertical related firms.

[5]The CIS is a compulsory survey for firms that takes place every four years in European countries to shed light on firms innovation activities. Only firms with more than 10 employees can be part of the sample.

Finally, Table 3 presents some descriptive statistics on the sample. In the manufacturing sector about the 50% of the innovative firms choose a mixed cooperation type while while the remainder of the firms is equally distributed between those that choose to cooperate only with market partners and those that cooperate only with science partners. What drives these strategic decisions?
In the services, similarly, more than the 50% of the innovative firms choose to cooperate with both market and science partners, while 33% of the one-partner cooperating firms choose market partners while only the 13% choose science partners.

Table 1: **Descriptive statistics on the Italian CIS4 database**

Sectors	N. of firms Tot sample	N. innovative firms	% Innovative/Tot
Manufacturing	7480	2583	34.53
Services	8329	1436	17.24
Constructions	5317	482	9.07
Mining and Quarrying	335	50	14.93
Electricity, gas and water supply	287	50	17.42
Total	21748	4601	

Table 2: **Cooperative behaviour of innovative firms (by sector)**

Sectors	Vertical R&D coop (N. of firms)	Horizontal R&D coop (N. of firms)	Research R&D coop (N. of firms)	Pooled R&D coop (N. of firms)
Manufacturing	34%	15%	37%	50%
Services	29%	17%	26%	39%
Constructions	4%	2%	4%	6%
Mining and Quarrying	0.6%	0.4%	1%	1%
Electricity, gas and water supply	1%	0.6%	1%	2%
TOT	70%	36%	71%	100%

Table 3: **Descriptive statistics on the sample**

	Only market coop	**Only science coop**	**Mixed coop**	**Total**
Manufacturing	121 (26.54)	118 (25.88)	217 (47.59)	456
Services	117 (32.77)	47 (13.17)	193 (54.06)	357

Notes: % on the total sample of the sector's innovative firms are in parenthesis

IV.A. Variables

As explained in the previous section, the main aim of the present paper is the exploration of the factors which drive firms, once they have decided to cooperate, to choose a particular cooperation type among others. Bearing in mind the theoretical framework outlined above, we describe the way we built the dependent and independent variables.

Dependent variable

- *R&D cooperation type*: in the CIS questionnaire, firms were asked to reveal whether they had at least one cooperative agreement in R&D during the period 2002-2004, and to indicate the type of partners they cooperate with. The R&D cooperation type variable takes three values: [1] if the firm decides to cooperate only with market operators like suppliers, customers or competitors (market cooperations); [2] if the firms decides to cooperate only with universities or research institutions (science cooperations); and [3] if the firm decides to cooperate with both these actors (mixed cooperation type).

Independent Variables

-*Incoming Spillovers*: In the CIS-4 questionnaire, firms rated the importance of three sources of publicly available information

for their innovation process[6] , using a four-point scale from not relevant (0) to crucial (3). The information sources were: specialist conferences, exhibitions and trade shows, business associations. To generate a firm-specific measure of incoming spillovers, we aggregate these answers by summing the scores on each of these questions and rescaled the total scores to a number between 0 and 1.
Although this variable has the limit to be subject to measurement errors typical of qualitative variables as respondent may different in the way they use the 4-point scale, it has also the advantage of jointly measuring the extent of the public pool of relevant knowledge and its productivity for the firm's innovation process. For this reason, we do not build industry specific variables to account for this determinant. Indeed, even though some studies like Cohen and Levinthal (1989) have found that including industry variable may alleviate the problem, we nevertheless assume that firm specific measures are the best choice because, as pointed out by Cassiman and Veugelers (2002), they raise the explanatory power of the model.
Another limit that should be underlined is that this variable measures only what is the amount of knowledge available outside the boundaries of the firm and it can be considered as a way to identify the channel of the spillover rather than the source.

-*Appropriability*: this variable is used as a proxy for outgoing spillovers: the more a firm is able to appropriate the results of its innovating activities, the less will be its involuntary outgoing flows of information.
In the questionnaire, firms declared whether they adopt four different methods for protecting product and processes: patents, registration of industrial designs, trademarks and copyrights. We define appropriability equal to 1 if the firm uses at least one of these methods of protection, equal to 0 otherwise.
The limit of this measure is to give to all the protection methods

[6]According to Kaiser (2002) even though other measures of spillovers have been used, such as, for example, Euclidean or geographic distance, the use of a direct measure should capture more fully the spillover effect. Moreover, we need to note that this measure is relevant to identify the channel of the spillover rather than the source.

the same importance in avoiding involuntary leakages of knowledge. However, since in the analysis this index is simply used as an indicator of firms' practices in terms of knowledge management during innovation activities, we think it could be informative in explaining R&D cooperations.

- *Size*: in order to measure the size of firms, we use firm's turnover in 2002. We take the natural logarithm in order to avoid potential non-linearities. Moreover, Z-score is computed for this measure. Data on firms' turnover in 2004 were also available, but the use of the lagged variable avoids some simultaneity biases which could take place.

-*Costs of Innovation*: in the questionnaire firms are asked to rate, on a four-point scale from not relevant (0) to crucial (3), the importance of some factors as barriers to innovation like: (i) innovation costs too high; (ii) lack of internal source of finance; (iii) lack of external source of finance. To generate a firm-specific measure of innovation costs, we aggregate these answers by summing the scores on each of these questions and rescaled the total scores to a number between 0 and 1.

-*Subsidies*: local, regional, national and European innovation policy instruments are important driving factors in inter-firms R&D cooperations (Miotti and Sachwald, 2003). In particular the EU's Framework Programme for Research and Technological Development provides subsidies only to cooperating firms. The variable is a dummy equal to 1 if the subsidy is achieved, and 0 otherwise.[7]

-*Participation in a multinational group (MNG)*: this acronym stands for foreign multinational company and it is a dummy equal to 1 if the firm operates in Italy but belongs to a foreign group, and 0 otherwise. Unfortunately, CIS dataset does not allow the distinction

[7]We control only for local, regional and national subsidies excluding those from European Union.

between Italian business groups without foreign subsidiaries and Italian multinational companies. Hence, we are not able to control for a *multinational company* variable broadly defined, since such variable may include also Italian business groups without foreign affiliates which cannot be defined as multinational.

-*Exporter*: it is a dummy variable equal to one if the firm's prevalent market is outside the national boundaries, 0 otherwise

-*Permanent R&D*: we include in the model specification the firms' level of absorptive capacity (Cohen and Levinthal, 1990) that we proxy with this variable which captures the characteristics of the firms' R&D activities. It is a dummy equal to one if the firm constantly carry out R&D activities, 0 otherwise.

-*Manufacturing*: it is a dummy variable equal to one if the firm belongs to the manufacturing sector, 0 otherwise.[8]

IV.B. Empirical Methodology

In our empirical model firms have to choose among three different cooperation strategies to maximize their profits (π).
Accordingly, a firm will choose a specific cooperation strategy instead of another if the profits of this strategy are considered to be higher with respect to the streams of profits coming from the other sources.[9] Following Bonte and Keilbach (2005) we represent the model in this way:

$$\pi_{ij} = Max(\pi_{i0}; \pi_{i1}; \pi_{i2}) \tag{1}$$

where i is the firm and j represents the strategy chosen. As we have assumed that firms consider the three cooperation strategies simultaneously we propose to adopt a multinomial logit model

[8]We consider for the manufacturing sector, activities coded with two-digit NACE between 15 and 36 excluding some particular sectors like NACE 16 of the manufacture of tobacco products and NACE 37 of Recycling.

[9]However, we need to point out that we cannot directly observe the profits of each firms that are determined by specific firms characteristics.

(MNLM)[10]. Formally the MNLM can be written as:

$$ln\Omega_{m/b}(x) = ln\frac{Pr(y = m/x)}{Pr(y = b/x)} = x\beta_{m/b} \quad (2)$$

where b is the base category or comparison group. Our model is validated through the use of Hausman-McFadden test which proves that the irrelevant alternatives are stochastically independent from each other. This is also called hypothesis of Independence of Irrelevant Alternatives (IIA) as it assumes that the probability of engaging in one types of cooperative agreement needs to be independent from the probability of engaging in all the other forms of cooperations.

We do not consider an alternative specification like the nested logit model used by Kaiser (2002) as that methodology implies a sequential process in which firstly firms decide whether to cooperate or not and, in the second stage,they eventually decide the cooperation partner. In the same way, our approach is different from the one used by Beldebors et al., (2004a) who employ a multivariate probit estimation. They account for systematic correlations among different cooperation partners due to complementarities or substitutability but they are not able to make comparisons about why firms choose a partner instead of another.

V. Empirical results

The empirical analysis is carried out in two steps: in the first baseline regression (Table 4) the choice of cooperating with a single type of partner is first compared with the choice to be engaged in a mixed cooperation. In particular, we compare:(1) the choice to cooperate only with market operators like suppliers, costumers or competitors against a mixed market-science cooperation; (2) the

[10]This method is used in the analysis of the choice among nominal outcomes with case-specific data. Outcomes are nominal when the categories are assumed to be unordered, and the fact that data are assumed to be case-specific by the model means that each independent variable has one value for each individual.

choice to cooperate only with universities and research institutions against the mixed-cooperation type. In column (3), instead, we use as a comparison group the science partner allowing us to show a sort of rank among the different alternatives.

Table 4: **Results of multinomial logit estimation: benchmark model**

Cooperation type	**(1)** Market coop	**(2)** Science coop	**(3)** Market coop
Base outcomes:	vs mixed cooperation	vs mixed cooperation	vs science coop
size	-0.322***	-0.011	-0.311***
	(0.100)	(0.093)	(0.116)
subsidies	-0.611***	0.209	-0.820***
	(0.174)	(0.195)	(0.214)
incoming spillovers	-1.193***	-1.228***	0.034
	(0.341)	(0.379)	(0.422)
appropriability	-0.367**	0.053	-0.421*
	(0.186)	(0.203)	(0.226)
permanent R&D	-0.462**	0.021	-0.484**
	(0.181)	(0.217)	(0.231)
costs	-0.167	-0.350	0.182
	(0.276)	(0.306)	(0.340)
MNG	0.417	0.120	0.297
	(0.261)	(0.273)	(0.304)
exporter	0.532*	0.524*	0.007
	(0.295)	(0.287)	(0.313)
manufacturing	0.294*	0.556***	-0.261
	(0.176)	(0.202)	(0.220)
Constant	0.424*	-0.756***	1.181***
	(0.238)	(0.258)	(0.288)
N.		882	
χ^2		112.97***	
Pseudo R^2		0.06	

Notes: In (1) and (2) the Mixed cooperation category is the base outcome. In (3) the base outcome is the the science cooperation category
Robust standard errors in parenthesis.

Relative risks ratio are reported in Table 5, providing an alternative way of interpreting coefficients of a multinomial logit estimation. If the relative risk ratio coefficient is greater than one it implies that the risks of being in the comparison group rather than falling in the referent group increases as the variable increases. The opposite way of reasoning needs to be used when the relative risk ratio is less than 1.
First of all, we notice that the Pseudo R^2, that is the McFadden likelihood ratio index (1974), is satisfactory high, and most of all,

Table 5: **Results of multinomial logit estimation: Relative risks**

Cooperation type	**(1)** Market coop	**(2)** Science coop	**(3)** Market coop
Base outcomes:	vs mixed cooperation	vs mixed cooperation	vs science coop
size	0.724***	0.989	0.732***
	(0.069)	(0.097)	(0.085)
subsidies	0.542***	1.232	0.440***
	(0.094)	(0.236)	(0.094)
incoming spillovers	0.303***	0.292***	1.034
	(0.104)	(0.110)	(0.437)
appropriability	0.692**	1.055	0.656*
	(0.129)	(0.212)	(0.148)
permanent R&D	0.629**	1.021	0.616**
	(0.114)	(0.220)	(0.142)
costs	0.845	0.704	1.200
	(0.236)	(0.213)	(0.408)
MNG	1.518	1.127	1.346
	(0.392)	(0.305)	(0.409)
exporter	1.702*	1.689*	1.007
	(1.497)	(0.477)	(0.315)
manufacturing	1.342*	1.743***	0.770
	(0.241)	(0.343)	(0.170)
N.		882	
χ^2		112.97***	
Pseudo R^2		0.06	

Notes: In (1) and (2) the Mixed cooperation category is the base outcome. In (3) the base outcome is the the science cooperation category. Coefficients are relative risks
Robust standard errors in parenthesis.

the likelihood ratio test rejects the joint insignificance of coefficients at 1% significance level.

In the first place we recognize that the hypothesis 1.1 made about the size of the firm prove to be true, i.e. the probability that a firm decides to cooperate with science partners increases in its size (see Table 4, Column 3). Moreover, the larger is the size of the firm the lower the possibility that firms will choose market cooperation to mixed cooperation, while they are indifferent between science and mixed cooperation.
This could be due to two reasons: the first is that bigger firms may have the technological capabilities needed to interact with science partners and the second pertains to the fact that larger firms are endowed with the suitable managerial skills and the internal organization needed to face the coordination costs of multiple partners cooperations. Moreover larger firms are likely to have also a rep-

utational benefit that may attract a number of potential partners thus rising the probability of cooperation at all.
Similarly, Hypothesis 1.2 is supported since the probability that a firms chooses to cooperate with science partners seems to increase in the level of its internal R&D capabilities proxied by the variable "Permanent R&D" (see Table 4, Column 3). Firms constantly performing R&D activities are also likely to be endowed by a certain level of absorptive capacity that makes them able to benefit from cooperations with universities or other research institutions. However, these firms with systematic R&D activities remain indifferent between cooperate with science partners or perform mixed cooperations showing a behaviour similar to larger firms. This could be due to the fact that larger firms are also those that generally perform higher levels of R&D activities.
Hypothesis 1.3 is also supported since the probability that a firm chooses to cooperate with science partners increases if the firm has received an innovation subsidy (see Table 4, Column 3). However, even in this case these firms are indifferent between cooperate only with science partners or perform mixed cooperations.

Hypothesis 2.1 seems not confirmed since foreign multinational companies (MNG) do not significantly prefer market partners to other types (see Table 4, Columns 1 and 3). On the contrary Hypothesis 2.2 is partially supported since exporters have a certain preference toward market partners if compared with the chance of a mixed cooperation, but they are indifferent between the choice of cooperating only with market or science partners (see Table 4, Columns 1 and 3). Exporting firms may choose just market partners if they need similar resources to expand their international activities, while they need complementary resources if they want to introduce a novel technology to maintain their competitive advantage abroad; moreover these firms could be less afraid from potential leakages of knowledge and consequent losses of competitiveness in the local market since they mainly operate in the international one.

Finally, Hypothesis 3.1 is highly supported since high levels of incoming spillovers increase the probability that firms choose mixed cooperations to the other cooperations types (see Table 4, Columns 1 and 2). Incoming spillovers, in fact, are generally expected to increase the technological competence of partners increasing the expected profitability of cooperative agreements.
Hypothesis 3.2 is supported since high levels of appropriability increase the probability that a firm chooses mixed cooperations if compared with single market cooperations (see Table 4, Column 1) making the firm indifferent between mixed cooperation and science cooperation types. This result is in line with our theoretical expectations since as in case of good appropriability conditions firms are less worried by the fact that many partners may "steal" their technology, the same reasoning could be due if the partner is a research institutions or a university that are generally less interested in increasing their competitiveness within the market.
Finally, Hypothesis 3.3 is not significantly supported since high innovations costs do not lead firms to look for multi-partners cost-sharing aimed cooperations.

Table 4 also shows that manufacturing firms are more inclined toward single-partner cooperations and they are indifferent if this partner is a market operator or a research institution. Hence, the following section tries to further analyze this point and to disentangle how belonging to a particular sector may affect firms' behaviour.

V.A. Cooperation strategies in the manufacturing and service sectors

Different sectors may display divergent technological trajectories and, as a consequence, their partner choices may be influenced in a different way. Accordingly, we split up the sample dividing manufacturing and service sectors. The results are reported in Table 6 while in Table 7 relative risks ratio are shown.
We first recognize that the size variable seems to differently affect

manufacturing and service firms cooperative behaviour. Indeed, in the last case size coefficient results only weakly significant, pointing to a preference for mixed cooperation. Moreover, in the manufacturing sector, larger firms prefer single-partner cooperations with science operators if compared with single-partner cooperations with market operators (see Table 6, Column 3 for manufacturing) while in the services larger firms are found to be indifferent between these two cooperation types (see Table 6, Column 3 for services). Results show that in services single-cooperations with science partners are chosen only by firms receiving a subsidy or with systematic R&D activities; subsidies are often oriented to stimulate industry-university linkages so it is not surprising that they push firms in this direction even though it is worth to underline the important impact of this variable in the service sector. One reason could be that generally service firms tend to cooperate often with customers because their innovations are generally demand driven and, in addition, universities' research activities are often less tuned to service needs (Miles, 2007) therefore, for service firms subsidies act as a trigger to switch firms' interests toward a kind a cooperation that they would not have chosen otherwise.

The case of the coefficient indicating incoming spillovers points to a similar behaviour between manufacturing and service sector. Manufacturing firms absorbing high levels of spillovers are strongly inclined toward a mixed cooperation type instead of a singular-type one whatever the partner; in the same way the service firms benefiting from high spillovers prefer a mixed cooperation type if the alternative is a market cooperation but they are indifferent between mixed and science cooperation types as well as between market and science partners.
A quite striking different result is that high appropriability levels affects only the manufacturing firms' decision between market cooperations and mixed cooperations as they choose the latter, while no coefficient is statistically significant in the case of service sector. This result confirms that manufacturing and service sector fol-

low two different technological trajectories making use of different types of technologies. Hence, each of them may be characterized by a different need of protection according to the role played inside the innovation process.

Finally, costs of innovation push only manufacturing firms to expand the number of R&D partners. Hypothesis 3.3 is therefore supported only in the manufacturing sector where the cost-sharing motivation of cooperation seems to be particularly relevant. The explanation lies in the different nature of the innovation processes in service sectors that is less demanding in term of costs and resources.

Other two variables that affect only manufacturing firms behaviour are:(i) the ownership structure of the firm (i.e. if they are foreign owned); and (ii) the degree of internationalization. In both the cases, manufacturing firms foreign owned or export oriented, facing the two alternatives to collaborate only with market operators and with both the types of partners, choose the first alternative significantly supporting in this sector Hypotheses 2.1 and 2.2. A reasonable explanation could be that operating on foreign markets can potentially raise firms' ability in avoiding potential drawbacks in terms of loss of competitiveness or involuntary leakages of knowledge that cooperations with locals could cause.

Table 6: **Results of multinomial logit estimation by splitting the sample into manufacturing and service sectors**

	MANUFACTURING			SERVICES		
	(1)	(2)	(3)	(1)	(2)	(3)
Cooperation type	Market coop	Science coop	Market coop	Market coop	Science coop	Market coop
Variables:	vs mixed coop	vs mixed coop	vs science coop	vs mixed coop	vs mixed coop	vs science coop
size	-0481***	0.023	-0.504***	-0.220*	-0.087	-0.133
	(0.156)	(0.141)	(0.173)	(0.133)	(0.169)	(0.190)
subsidies	-0.425*	0.073	-0.499*	-0.996***	0.677*	-1.673***
	(0.257)	(0.256)	(0.287)	(0.284)	(0.370)	(0.411)
incoming spillovers	-1.262**	-1.186**	-0.076	-1.582***	-0.832	-0.749
	(0.530)	(0.510)	(0.586)	(0.521)	(0.701)	(0.771)
appropriability	-0.553**	-0.069	-0.484	-0.064	0.072	-0.136
	(0.264)	(0.266)	(0.296)	(0.292)	(0.367)	(0.415)
permanent R&D	-0.175	-0.214	0.039	-0.663**	0.375	-1.040**
	(0.297)	(0.305)	(0.329)	(0.265)	(0.370)	(0.401)
costs	-0.283	-0.686*	0.402	0.278	-0.142	0.420
	(0.399)	(0.388)	(0.444)	(0.457)	(0.594)	(0.659)
MNG	0.787**	0.278	0.509	-0.023	0.245	-0.268
	(0.344)	(0.327)	(0.368)	(0.429)	(0.558)	(0.614)
exporter	0.715**	0.388	0.327	0.113	0.935	-0.821
	(0.341)	(0.332)	(0.359)	(0.611)	(0.602)	(0.709)
Constant	0.526	0.291	0.234	0.649**	-1.746***	2.396***
	(0.384)	(0.383)	(0.407)	(0.327)	(0.491)	(0.516)
N.		447			346	
χ^2		53.12***			55.32***	
Pseudo R^2		0.05			0.08	

Notes: In regressions (1) and (2) the base outcomes are the mixed cooperation category.
In regressions (3) the base outcomes is the science cooperation category
Robust standard errors in parenthesis.

Table 7: **Results of multinomial logit estimation by splitting the sample into manufacturing and service sectors. Relative risks.**

	MANUFACTURING			**SERVICES**		
	(1)	(2)	(3)	(1)	(2)	(3)
Cooperation type	Market coop	Science coop	Market coop	Market coop	Science coop	Market coop
Variables:	vs mixed coop	vs mixed coop	vs science coop	vs mixed coop	vs mixed coop	vs science coop
size	0.610***	1.023	0.603***	0.802*	0.916	0.874
	(0.096)	(0.144)	(0.104)	(0.107)	(0.155)	(0.166)
subsidies	0.653*	1.076	0.607*	0.369***	1.969*	0.187***
	(0.167)	(0.276)	(0.174)	(0.105)	(0.729)	(0.077)
incoming spillovers	0.282**	0.305**	0.926	0.205***	0.434	0.472
	(0.149)	(0.155)	(0.543)	(0.107)	(0.305)	(0.364)
appropriability	0.575**	0.933	0.616	0.937	1.074	0.872
	(0.152)	(0.248)	(0.182)	(0.274)	(0.395)	(0.362)
permanent R&D	0.839	0.807	1.039	0.514**	1.455	0.353**
	(0.249)	(0.246)	(0.342)	(0.136)	(0.538)	(0.142)
costs	0.753	0.503*	1.495	1.320	0.867	1.522
	(0.300)	(0.195)	(0.665)	(0.604)	(0.515)	(1.003)
MNG	2.197**	1.320	1.663	0.976	1.277	0.764
	(0.755)	(0.431)	(0.613)	(0.419)	(0.713)	(0.469)
exporter	2.045**	1.475	1.386	1.120	2.548	0.439
	(0.699)	(0.491)	(0.497)	(0.685)	(1.534)	(0.312)
N.		447			346	
χ^2		53.12***			55.32***	
Pseudo R^2		0.05			0.08	

Notes: In regressions (1) and (2) the base outcomes are the mixed cooperation category.
In regressions (3) the base outcomes is the science cooperation category. Coefficients reported are relative risks
Robust standard errors in parenthesis.

VI. Conclusions

Inside the innovation process the role played by R&D cooperation is considered quite crucial for a firm to achieve a successful outcome. For this reason, innovation studies has focused much attention on the theoretical and empirical investigation of this subject.
Firms are engaged in cooperative agreements with many different partners such as suppliers, customers, competitors, universities or research organizations. Two different streams of literature have offered theoretical insights to frame the topic: both management literature and IO literature has discussed about the different motivations that could provoke firms R&D cooperation, even though a topic that remained quite under searched is relative to the determinants of the partner choices: on this argument only Belderbors et al. (2004) and Miotti and Sachwald (2003) provide some empirical evidence with regard respectively to the Dutch and Belgian firms.
Due to the scarcity of empirical studies on the issue, our paper analyze R&D cooperation partner selection in Italy using the data of the fourth Italian Innovation Survey (CIS-4) and a multinomial logit estimation technique.
Some of the findings that we can single out confirm that larger firms or firms benefiting from high levels of incoming spillovers are generally inclined toward mixed cooperations. On the one hand, big firms have, in fact, the managerial skills and resources to coordinate multiple cooperative agreements. Moreover they could benefit from a reputation effect that may attract a number of potential partner to select. On the other hand, high incoming spillovers are generally expected to increase the technological competence of partners increasing the expected profitability of cooperative agreements. This result is robust in both the sectors analyzed.
Nevertheless, we found some important differences between the manufacturing and the service sectors' firms cooperative bahaviour. In the manufacturing sector foreign multinational companies or export oriented firms prefer to cooperate only with market partners. In the services, instead, the internationalization of the firms does not af-

fect their partner choice.
Science partners are chosen by large manufacturing firms or firms receiving a subsidy. In particular, in the services, subsidized firms prefer science cooperations to all the other cooperation arrangements. This last result suggest the important role that subsidies may have in increasing industry-university cooperations in the service sector although, up to now, service-sector firms are under-represented in existing innovation programs and the share of firms indicating the achievement of public funding is considerably lower in the service sector than in the manufacturing (OECD, 2005).
Finally multi-partner cooperations are preferred by manufacturing firms in case of good appropriability conditions and to share costs of innovation while in the service sector these variables have not any significant impact on partner selection underlining both the low use of legal methods of protection in services and the different nature of the innovation processes in service sectors that is less demanding in term of costs and resources.
In the end, some limitations of the study and avenues for further research could be mainly three: in the first place it is possible to account for further disentanglement of both manufacturing and service sectors. As a matter of fact, the literature on innovation in services puts special emphasis on the heterogeneity of a set of activities performed within services and for this reason the variety of patterns of innovation strategies is particularly relevant pointing to the fact that sectoral specificities need to be taken into account. In the second place, a further disentanglement between horizontal and vertical partners could shed light on the fact that firms may differentiate the search for market partners. In the end, the analysis we conducted is mainly of an exploratory nature: indeed, we assume the exogeneity of all explanatory variables as the dataset available does not allow to control for a time dimension. In further research, the endogeneity issue arising mainly because of simultaneity and reverse causality problems, needs to be taken into consideration to compare the results of the two methodologies.

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