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Hybrid alliances and radical innovation: the performance implications of integrating exploration and exploitation

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Abstract In this paper we examine the innovation performance of hybrid alliances, that is, alliances that combine exploration and exploitation activities. While previous research has emphasized the tensions engendered by the combination of exploration and exploitation, we claim that the integration of these two types of activities can generate synergies as well. We argue that, in the case of alliances involving academic spin-offs (ASOs), these synergies may outweigh the tensions under specific conditions, and thus improve alliance innovation performance. Specifically, we hypothesize that the relative performance of exploitation activities is greater in hybrid alliances when the alliance has radical innovation outcomes. Conversely, the relative performance of exploration activities is greater in hybrid alliances when the alliance has incremental innovation outcomes. These hypotheses are tested using fine-grained data on a sample of 149 alliances involving European ASOs.

Keywords Alliances · Exploration · Radical innovation · Academic spin-offs · Ambidexterity

JEL Classification L26 · O31 · O32

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1 Introduction

Prior studies in the innovation literature have shown that start-ups play a key role in the generation of radical innovations. Start-ups' small size and absence of established market positions provide these firms with incentives and capabilities for innovation which incumbents may lack (Ács and Audretsch 1990; Utterback 1994; Henderson 1993; Chandy and Tellis 2000). Nonetheless, it is agreed that start-ups tend to lack sufficient capital to finance innovation, the skills and routines to assemble, organize, and monitor the manufacturing resources that are needed for innovation (Katila and Shane 2005), and the complementary assets to profit from innovation (Teece 1986). These resource and competence gaps encourage small and young firms to collaborate with other firms to manage the whole innovation process (Edwards et al. 2005). As a result, inter-firm alliances are regarded as crucial for start-ups to pursue radical innovation and scholars have started examining under which circumstances the innovation performance of alliances is enhanced (for a review, see de Man and Duysters 2005).

Although it has already been shown that the innovation impact of alliances is contingent on a series of factors, such as the organizational form of the alliance and the characteristics of the partner firms and of the networks in which partner firms are embedded (e.g., Sampson 2007; Stuart 2000; Schilling and Phelps 2007), research on the drivers of alliance innovation performance is far from being exhausted. In this paper, we add to this research. In the spirit of the present special issue, we contribute to advance the knowledge about the antecedents of radical innovations by investigating the association between the degree of radicalness of alliance innovation outcomes and the specific activities performed within alliances involving start-ups based on technology derived from academic research.

We adhere to the view that firms engaging in innovation need to conduct both exploration and exploitation activities (March 1991). However, we recognize that the synchronous pursuit of these two types of activities (hereinafter, *ambidexterity*) is far from simple. Exploration and exploitation exhibit conflicting characteristics and their combination may result in significant tensions (Andriopoulos and Lewis 2009). The recognition of these tensions led many ambidexterity scholars to emphasize *differentiation* (Raisch et al. 2009), that is, the separation of exploration and exploitation into distinct domains (i.e., individuals or organizational units). In this "differentiation approach", balance between exploration and exploitation is then achieved across domains (Gupta et al. 2006). The alliance literature has traditionally adhered to this approach. Following Koza and Lewin (1998), scholars have typically separated *exploration alliances,* which deal with knowledge-generating research-related activities, from *exploitation alliances*, which are devoted to knowledge-leveraging activities such as production, commercialization and marketing activities (Lavie and Rosenkopf 2006).[1] The balance between the two types of activities is then achieved on the level of the firm's portfolio of alliances (Lavie and Rosenkopf 2006; Lin et al. 2007).

In this paper, we consider an alternative configuration for balancing exploration and exploitation which has received much less attention in the literature: *hybrid alliances*, in which exploration and exploitation activities are combined, and partner companies "seek

[1] Lavie and Rosenkopf (2006) adopt a multi-dimensional view of exploration and exploitation alliances, which considers three domains: function exploration–exploitation (i.e., defined on the basis of the value-chain function that the alliance serves), structure exploration–exploitation (i.e., defined on the basis of partners' network positions), and attribute exploration–exploitation (i.e., defined on the basis of partners' organizational attributes). In this paper, we focus on the first domain: function exploration–exploitation.

to simultaneously maximize opportunities for capturing value from leveraging existing capabilities, assets, and the like, as well as from the opportunity to create new value through their joint learning activities" (Koza and Lewin 2000, p. 149). This combination of exploration and exploitation is in line with an *integration* approach to ambidexterity (Raisch et al. 2009), according to which, under certain conditions, the two types of activities can be successfully conducted within a single domain. Here, we contribute to the studies that focused on integration by applying this approach to the alliance domain and examining how the combination of exploration and exploitation in hybrid alliances can create synergies that overweigh the tensions between these two types of activities. In particular, we claim that hybrid alliances provide coordination benefits which facilitate knowledge transfer processes. We also investigate under which conditions these coordination benefits render exploration (respectively, exploitation) activities more productive than if these activities were isolated in alliances specialized in exploration (respectively, exploitation).

As we mentioned above, we investigate the benefits of integrating exploration and exploitation in the case of alliances involving academic spin-offs (ASOs), i.e. new ventures initiated within a university or another public research center and based on technology derived from academic research (for a similar definition see Rasmussen and Borch 2010).[2] We focus our research on ASOs for two reasons. First, alliances with these firms are particularly likely to generate radical innovations because ASOs are more focused on R&D and are more likely to possess leading-edge technological competencies than other types of firms (Colombo and Piva 2008). They also possess superior technical competences and have strong links with the scientific community (Mustar 1997; Murray 2004) which provide them with privileged access to new knowledge developed by universities and other public research centers. Second, as we explain below, the specific characteristics of ASOs are likely to provide favorable conditions for synergies to overcome tensions in the combination of exploration and exploitation activities within the same alliance.

We rely on the peculiarities of ASOs to develop predictions about the innovation performance of hybrid versus specialized alliances with these firms. We argue, in particular, that the relative performance of exploitation activities in hybrid alliances as compared to alliances specialized in exploitation is greater when the alliance has radical innovation outcomes. Conversely, the relative performance of exploration in hybrid alliances as compared to alliances specialized in exploration is greater when the alliance has incremental innovation outcomes. In the empirical part of the paper, these arguments are tested through econometric estimates on a sample of 149 alliances involving European ASOs. The results of the econometric analyses lend support to our predictions.

The paper proceeds as follows. In the Sects. 2 and 3, we describe how exploration and exploitation activities intervene in alliances with ASOs, and provide a theoretical discussion of the tensions and synergies that can be generated through the combination of exploration and exploitation in hybrid alliances. Then, we formulate hypotheses on the innovation performance of alliances that involve ASOs. In the subsequent section, we present the methodology of the empirical analysis. We then illustrate the econometric results and several robustness checks. A discussion of the original contribution of our

[2] Most ASOs are established by an entrepreneurial team (at least partially) formed by PhD students or research personnel of universities or other public research centers. However, ASOs may have no academic founders but obtain the right to exploit the knowledge developed within a public research organization and received through a formal transfer (e.g., a license agreement).

results to the extant literature and of their limitations, and some synthesizing remarks highlighting managerial implications, conclude the paper.

2 Exploration and exploitation in alliances with academic spin-offs

The creation of ASOs represents a central route to academic research commercialization (Debackere and Veugelers 2005; Wright et al. 2008). Hence, these firms have become the object of an abundant academic literature (for reviews, see: Mustar et al. 2006; Djokovic and Souitaris 2008; Rothaermel et al. 2007). Works on ASOs have revealed that these firms display peculiar features that make them different from other types of new ventures. First, it has been recognized that ASOs tend to stay small (Degroof and Roberts 2004) and possess limited amounts of resources (Mustar and Wright 2010). Second, it has been highlighted that ASOs exhibit unique "genetic characteristics" (Colombo and Piva 2012): their founding teams tend to be composed of academics who work on similar research topics and seldom include individuals with prior work experience in the private sector. As a consequence, these firms are more focused on R&D and are more likely to possess leading-edge technological competencies than other types of firms (Colombo and Piva 2008).

In addition, ASOs have strong links with the scientific community (Mustar 1997; Murray 2004) which provide them with privileged access to new knowledge developed by universities and other public research centers. They are also better equipped than other firms to absorb this knowledge and to translate it into applied knowledge that may be more easily transferred to and used by other firms (Colombo et al. 2010). At the same time, as ASOs emanate from a non-commercial environment, they are short of commercial and managerial competences and, as any other technology-based new ventures, they lack the complementary assets that are vital in successfully bringing new products to the market (Vohora et al. 2004; Wright et al. 2004).

As described by Colombo et al. (2006) for new technology-based firms, the characteristics of ASOs drive the formation of alliances with other firms to pursue both exploitation and exploration activities. Their small size, their newness, and their lack of market-related competences and resources urge ASOs to establish exploitation alliances in order to gain access to the complementary assets needed to commercialize the technologies that they have transferred from public research (Teece 1986). Such complementary assets include funding (Coombs et al. 2006), diverse information and competences (Baum et al. 2000), social status and recognition (Stuart 2000), or knowledge of and presence in foreign markets (Leiblein and Reuer 2004).

Moreover, ASOs' leading-edge technological competences and their ties with the public research environment turn them into attractive partners for firms that aim at learning and extending their capabilities (Powell et al. 1996). ASOs' scientific and technological expertise may also allow realizing considerable synergistic gains if combined with the application-oriented, industry-specific technological competences possessed by partner firms. The wish of ASOs and their partners to internalize or pool each other's technological competencies in order to build new shared competencies that could not be developed in isolation leads the formation of exploration alliances.

The biotechnology industry provides a good example of the system of alliances that links together ASOs and their partners in the conduct of their exploitation and exploration activities. As described by Rothaermel (2001), incumbent pharmaceutical companies have entered into alliances with biotechnology start-ups (a large part of which are actually

ASOs) both in order to commercialize the drugs resulting from biotechnology research, thereby strengthening their downstream value chain activities, and to learn new technologies, thereby building new upstream value chain activities. Hence, an alliance-based "system of new product development" appears (Rothaermel and Deeds 2004) where exploration activities lead to the creation of new knowledge and capabilities, and the need to combine this new knowledge with complementary assets calls for exploitation activities, which in turn result in the introduction of new products on the market.

3 The integration of exploration and exploitation in hybrid alliances

3.1 Organizing exploration and exploitation activities: differentiation versus integration

Similar to the system of new product development analyzed by Rothaermel and Deeds (2004), most studies of alliances have assumed that the exploration and exploitation activities in which high-tech start-ups engage are distributed across different organizational units that are specialized in either exploration or exploitation (Lavie and Rosenkopf 2006; Colombo et al. 2006; Park et al. 2002). Because exploration implies a trial-and-error process and presents great variability in performance, while exploitation focuses on choice and selection (He and Wong 2004; March 1991; McGrath 2001), these two activities call for idiosyncratic management processes and organizational arrangements that cannot easily co-exist in the same alliance. First, exploration requires continuous revision and updates of objectives that are mainly of a qualitative nature, while exploitation activities are monitored through the definition of measurable objectives (Koza and Lewin 2000). Accordingly, control systems for exploration and exploitation differ by being oriented towards processes or outputs, respectively (Koza and Lewin 1998). Second, autonomy and delegation of authority foster learning in a regime of exploration, while these same attributes may be counterproductive in a regime of exploitation (McGrath 2001).

Although the vast majority of studies on ambidexterity have emphasized the tensions between exploration and exploitation (for a review of this literature, see Raisch and Birkinshaw 2008) and have therefore adhered to the "differentiation approach", recent developments in the literature have noted the shortcomings of differentiation and have suggested an alternative approach which focuses on the integration of exploration and exploitation activities (Raisch et al. 2009). On the intra-organizational level, Gibson and Birkinshaw (2004) have highlighted that single business units can create a context that induces their individual members to engage in exploration and exploitation as well. On the inter-organizational level, Im and Rai (2008) and Tiwana (2008) have described the capacity of an alliance to ensure both alignment with objectives and adaptation to unforeseen changes. "Hybrid" alliances (Koza and Lewin 2000), which combine exploratory activities aimed at generating new knowledge and exploitative activities aimed at leveraging existing knowledge, are another instance of an integration approach to ambidexterity.

In what follows, we examine the characteristics of hybrid alliances by contrasting them to the differentiation alternative in which exploration and exploitation are separated in distinct alliances. Our argument proceeds in two steps. First, we highlight the complementarities between exploration and exploitation. These complementarities stem from the iterations between exploration and exploitation in the cycle of innovation (Gilsing and Nooteboom 2006), which require effective knowledge transfers between the individuals involved in exploration and those involved in exploitation (hereinafter, exploring and exploiting agents, respectively). Second, we analyze hybrid alliances as a particular type of organizational design that allows for tackling the interdependencies (Thompson 1967) between exploration and exploitation activities. In particular, we argue that this type of alliance offers coordination benefits associated with the transfer of knowledge between exploring and exploiting agents. These benefits help generate synergies between exploration and exploitation in hybrid alliances.

3.2 Complementarities between exploration and exploitation

The literature on innovation highlights several complementarities between exploration and exploitation. First, exploitation serves as a *focusing device* for exploration: it contributes to "formulating technical problems and … focusing attention upon them in a compelling way" (Rosenberg 1969, p. 20). This helps to address one of the major challenges of exploration, which lies in the difficulty of defining ex ante the outcomes of exploration activities as well as the paths that may lead to these outcomes (March 1991). An exploration team faces a wide range of possible trajectories pointing towards a loosely specified end. Uncertainty (Knight 1921) and bounded rationality (Simon 1976) impede the calculation of the odds of success and the expected returns of these different trajectories, making it impossible to compare them and to select the most profitable one. Teams involved in exploration then run the risk of dispersing their efforts by simultaneously embarking on several research paths, none of which can be assessed quickly (and, if necessary, abandoned) due to the time distance that separates exploration from its results (March 1991). It is here that the focusing effect of exploitation plays a crucial role: it helps save cognitive resources by "framing" exploration, that is, by drawing a boundary between the entities and trajectories that are to be taken into account and the ones that are to be left, at least temporarily, unconsidered (Callon 1998; Leonard and Sensiper 1998).

Second, the association of exploration and exploitation triggers the *feedback loops* that lie at the heart of the innovation process (Kline and Rosenberg 1986). As exploration progresses on a selected trajectory, new technical knowledge is generated, the relevance of which can hardly be assessed according to predefined objectives. An effective way to evaluate the results of exploration is to put them to the test of future users. While shedding light on the relevance of the solutions developed through exploration, as well as of the problems that they address (e.g., does the technical artifact indeed solve the problem that it is supposed to solve? Is this problem of any practical relevance?), user feedback is critical to deciding whether the selected search trajectory should be pursued, adjusted or abandoned.

Iterations between exploration and exploitation are not necessarily triggered by research; their starting point may also lie in manufacturing- or market-related activities. In particular, the application of an existing technological artifact in a novel user environment may reveal problems which have not been anticipated during research (von Hippel and Tyre 1996), as well as "puzzles" or "anomalies" from which useful questions arise (Nelson and Winter 1982, p. 129). Moreover, it may highlight new opportunities, such as different user needs that the technology being developed happens accidentally to encounter (Shah and Tripsas 2007). Solving the puzzles and pursuing the opportunities uncovered through exploitation call for additional exploration, thereby triggering the cycle of iterations.

3.3 The specificity of hybrid alliances

The integration of exploration and exploitation does not engender only the tensions that have been widely discussed in prior studies. In the case of hybrid alliances, it also provides unique coordination benefits associated with the transfer of sticky information (von Hippel 1994) and the creation of “common ground”, that is, “knowledge that is shared and known to be shared” (Srikanth and Puranam 2011, p. 850; Clark 1996; Postrel 2002) between exploring and exploiting agents. In order to highlight these benefits, in the following we compare hybrid alliances with an organizational configuration where exploration activities are performed in a specialized alliance, while alliance partners conduct exploitation activities independently (alone or in alliances with other partners). This latter configuration addresses the interdependencies between exploration and exploitation through differentiation.

In this differentiated configuration, exploiting agents from both partner firms can act as advisors to the joint research activities, providing initial focus and subsequent feedbacks. Technical knowledge (e.g., embedded in a prototype) then moves from the exploration alliance to the organizational units in charge of exploitation, and manufacturing- or market-related knowledge (e.g., in the form of an evaluation report) moves from these latter units back to the exploration alliance. These knowledge transfers incur two types of inefficiency. First, part of the knowledge transferred across organizational boundaries is lost (Carlile 2004). In particular, tacit knowledge, which cannot be fully articulated and codified at reasonable cost (Polanyi 1967) due to its embeddedness in the skills of individuals and in their physical and organizational context, might remain outside the feedback loop. Second, there are few opportunities for the unplanned and informal interactions between exploring and exploiting agents through which serendipitous combinations of knowledge may take place.

Similar coordination failures arise when exploitation activities are performed jointly in a specialized alliance while exploration activities are conducted by partners separately. Hybrid alliances allow the above inefficiencies to be dealt with by deleting the organizational boundary between exploring and exploiting agents, increasing the frequency of their interactions, and enriching available communication channels between them. Such benefits are particularly relevant when the alliance team is co-located, so that inter-individual communication overflows formal channels and takes place in spontaneous day-to-day interactions. Grouping exploring and exploiting agents within the boundaries of the same alliance has an additional advantage: they familiarize themselves with their respective cognitive schemes and thought worlds. Exploring and exploiting agents are then in a favorable situation to develop common orientations, convergent expectations and mutual understanding of the idiosyncrasy of their activities (Camerer and Knez 1996). The ensuing common ground allows for coordination to be achieved through tacit mechanisms (Srikanth and Puranam 2011).

4 Hypotheses

We have shown that the integration of exploration and exploitation in a hybrid alliance can generate synergies. However, as emphasized in the literature on exploration and exploitation, these two activities have idiosyncratic, and sometimes conflicting, characteristics. Hence, their combination in a single alliance can generate tensions as well. In this section, we argue that, in the case of alliances involving ASOs, given the peculiarities of these firms, synergies are likely to overweigh tensions. Moreover, we develop hypotheses comparing the performance of exploration (respectively, exploitation) activities in hybrid alliances with the performance in alliances specialized in exploration (respectively, exploitation).

We extend the cycle of innovation depicted by Rothaermel and Deeds (2004) by taking into account the two configurations for tackling the interdependencies between exploration and exploitation which we have outlined above (i.e., integration vs. differentiation). We claim that, in the case of alliances involving ASOs, the benefits provided by the integration of exploration and exploitation within a hybrid alliance are likely to be amplified because the peculiar characteristics of ASOs tend to exacerbate the knowledge transfer and coordination problems discussed in Sect. 3. First, as ASOs are science-based firms that possess leading-edge technological competencies, the knowledge to be transferred from them to their partners is likely to be particularly sticky (von Hippel 1994). Second, as a large proportion of ASOs' founders are former university employees and have scientific background (Colombo and Piva 2008), these firms may have little common ground with the industrial firms with which they partner. Therefore, the expected benefits of hybrid alliances should be particularly high in alliances involving ASOs. However, we posit that the likelihood that, in hybrid alliances involving ASOs, the synergies generated from the combination of exploration and exploitation overweigh tensions is contingent on the degree of radicalness of the innovation outcomes of exploration and exploitation activities.

Let us start by considering exploitation activities. In line with Rothaermel and Deeds (2004), we define the introduction of new products or services on the market as the innovation outcome of exploitation. To capture the degree of radicalness of this innovation outcome, we transpose to our domain the definition of radical innovation proposed by Dahlin and Behrens (2005). The two authors argued that one can *ex ante* claim that an invention is radical if it is 'novel' and 'unique', i.e. it is dissimilar from both prior and current inventions. Similarly, we argue that the launch of a new product (service) is a radical innovation if the product (service) is *new to the market*, i.e. it is dissimilar from the products (services) already made available on the market. Conversely, the launch of a new product or service is an incremental innovation if the product is only new to the firm.[3]

We expect that the performance of exploitation activities is similar in hybrid alliances and in alliances specialized in exploitation when the products or services resulting from the alliance, albeit new for the focal firms, already exist on the market. When the new products or services are incremental innovations, feedback loops have already been triggered and their implications have certainly been taken into account in improved versions. In this case, the contribution of complementary exploration activities (meant to solve the problems or pursue the opportunities raised by exploitation activities) is less valuable, and the transfer of knowledge between exploring and exploiting agents is less crucial. As a consequence, the coordination benefits provided by hybrid alliances tend to vanish when alliances result in products or services new to the firm but not new to the market. Conversely, these benefits are maintained when the products or services are new to the market, for feedback loops are yet to unfold. Therefore, in this case, the performance of exploitation activities is

[3] Dahlin and Behrens (2005) also argued that, once a 'potentially radical' invention has been identified, one can *ex post* claim that this invention is a 'successful change agent' if it influences the content of future inventions. In this paper, for the sake of simplicity, we explore the degree of radicalness of alliance innovation outcomes without considering this 'future impact' criterion. This choice is not unconventional in the innovation literature. In particular, distinguishing between new to the market and new to the firm products and services to discriminate between radical and incremental innovation is quite common (Schneider and Veugelers 2010; Czarnitzki et al. 2011).

greater in hybrid alliances than in specialized alliances. These arguments are synthesized in the following hypothesis:

H1 In alliances involving ASOs, the likelihood of launching a product (service) new to the market is greater in hybrid alliances than in alliances specialized in exploitation.

Let us now turn to exploration activities. We subscribe to the view that the innovation outcome of exploration is the development of technological knowledge and capabilities that are new compared to a firm's existing stock of knowledge and capabilities (Rosenkopf and Nerkar 2001; Benner and Tushman 2002). Accordingly, we define the *entry into novel technological fields*, or branching (Kotha et al. 2011), as the innovation outcome of exploration.[4] To capture the degree of radicalness of this innovation outcome, we transpose the distinction between products new to the firm and new to the market. Specifically, we consider the entry into existing technological fields as an incremental innovation and the creation of new technological fields as a radical innovation. We expect the performance of exploration activities to be similar in hybrid alliances and in alliances specialized in exploration when the technological field that partner firms enter is not existing yet. In this case, there is little, if any, market-related knowledge (e.g., as to the identity or needs of future users) to be transferred. Hence, the contribution of complementary exploitation activities (meant to focus exploration in a given direction or to provide user feedback) is less valuable, and the transfer of knowledge between exploring and exploiting agents is less crucial. Therefore, the coordination benefits provided by hybrid alliances tend to vanish when alliances result in radical innovation outcomes, i.e. the creation of new technological fields. Conversely, these benefits are relevant when the technological fields are new to the firm but already existing (i.e., the alliances result in incremental innovation outcomes), because the advice of exploiting agents is important here. Hence, in this case, the performance of exploration activities is greater in hybrid alliances than in specialized alliances. Hypothesis 2 follows:

H2 In alliances involving ASOs, the likelihood of branching into a novel but already existing technological field is greater in hybrid alliances than in alliances specialized in exploration.

5 Methods

5.1 Sample

We constructed a sample composed of 149 alliances involving European ASOs. The first step of the sample-building process was the identification of the population of European ASOs that were in operation in January 2007. As there is no official list of ASOs in Europe, we resorted to a number of sources, including lists of ASOs published on the websites of European universities, public research organizations and university incubators; lists

[4] We are aware that branching is an unconventional measure of the innovation outcome of exploration activities. Most previous studies used patent-based indicators, that reflect the extent to which a firm's patenting activity builds on technological knowledge that it did not previously have, and notably patenting in technological classes in which it did not previously patent (e.g., Phelps 2010). In the present study, we do not use patent-based indicators because of the cross-industry nature of our analysis. We indeed aim to develop hypotheses valid also for ASOs that operate in industries where patenting activity is scarce (e.g., service industries).

provided by national industry associations; lists of new technology-based firms applying for public support; lists of participants in industry trade shows and exhibitions; and a survey of prior studies. Altogether, 780 ASOs were identified. We have no presumption that this list is exhaustive. However, as we combined many different sources of information, we are confident that there is no relevant bias in it.

Second, we collected information on the alliances in which these ASOs were involved. For the innovation performance of these alliances to be measured, enough time must have passed since their formation. Hence, we did not consider alliances that were less than 2 years old. In addition, to limit retrospective bias, we did not consider alliances that were more than 10 years old. We compiled a list of alliances using both public sources (i.e., ASOs' web sites and the *Lexis Nexis* and *Cordis* databases) and contacts with ASOs' top managers. Altogether, we identified 1,337 alliances between the sample ASOs and partner firms. Each alliance involved either the whole partner firm or one organizational unit (be it a subsidiary, division or business unit) within the partner firm.

Third, for each alliance we sent a written request for cooperation to the manager who was in charge of the alliance in the ASO's partner firm. As we clearly show below, this individual was ideally placed to provide reliable information on the innovation performance of the focal alliance. 175 managers accepted our request for collaboration and agreed to be interviewed. Through the 175 interviews, which were conducted either face-to-face or by phone, between May 2007 and November 2008, we collected 149 complete and usable questionnaires. The response rate (13 %) was satisfactory for this kind of research, especially when one considers the status of the respondents, the issue of confidentiality, and the detailed nature of the questions we asked.

We are aware that, like the samples used in prior studies on alliances, our sample is not random. Indeed, as in all previous studies in this domain, we could include in the sample only those alliances for which information was disclosed by partner firms and the managers in charge of alliances who accepted to be interviewed. This process may have created a selection bias, as firms are generally eager to disclose information on successful alliances, while they are reluctant to advertise failures. However, we are interested here in assessing the differential effect on innovation produced by hybrid alliances in comparison to the effect produced by alliances specialized either in exploration or in exploitation. As there is no reason to presume that the above-mentioned selection bias depends on the type of alliance, the results illustrated later in the paper are very unlikely to have been driven by this bias.

Most of the alliances in our sample are in the following industries: software (43 %), information and communication technology (ICT) manufacturing (28 %), and biotechnology and pharmaceutics (23.5 %). Cross-border alliances (i.e., alliances between partners located in different countries) account for 33.6 % of sample alliances. 21.5 % of sample alliances were terminated at the time of the interview. Lastly, only 4 % of sample alliances are of the equity type.

5.2 Interviews with key informants

As is common in research on these topics (e.g., Carson et al. 2006; Hoetker and Mellewigt 2009), we adopted a key informant methodology (Campbell 1955; John and Reve 1982). For each alliance, we undertook considerable effort to identify the manager in charge of the collaboration in the firm that partnered with the ASO. This manager was identified through both our reading of the public data related to the alliance (e.g., press releases, alliance announcements) and our preliminary contacts with the ASO and its partner. Although this methodology restricted the number of respondents to one per alliance, the manager whom we interviewed was the most knowledgeable and appropriate person for providing information on the focal alliance. S/he had been personally involved in the alliance (in most cases since its formation) and possessed reliable information on the activities performed within the alliance and on its innovation performance.

The face-to-face and phone interviews were based on a structured questionnaire and lasted between 30 and 120 minutes. The questionnaire was pre-tested through pilot interviews with five business managers who had previous alliance experience. In addition, we relied as much as possible on prior published works to develop the questions and items that were included in the questionnaire and the variables that were used in the empirical analysis.

Personal interviews have three main advantages. First, the information that we collected is much more fine-grained than that used by previous studies which relied on secondary sources. Second, and more importantly, the interviewed manager was directly asked to provide information on the innovation performance of the focal alliance (for a similar approach, see Cassiman et al. 2005). Conversely, most previous studies regress aggregate firm-level performance indicators on the number and characteristics of the alliances established by focal firms. This type of research design is clearly inadequate for detecting the causal connection between a given alliance and its innovation performance, and for disentangling this effect from other confounding effects (e.g., those generated by other alliances established by the focal firm). Here, we partially overcome reverse causality and unobserved heterogeneity problems by asking the manager in charge of each alliance to identify the alliance innovation impact at the level of the partner organizational unit involved in the collaboration. The partner organizational unit might be either the whole partner firm or one of its subsidiaries, divisions, departments or business units. As many alliances affect only the activities of a limited portion of the partner firms, especially when these firms are large incumbents that operate in different countries and have diversified product portfolios, collecting primary data at the level of the organizational unit involved in the alliance has clear advantages. Third, all interviews were conducted by researchers who had been involved in the discussion of the conceptual background of the present study, had helped develop the questionnaire, and were aware of the objectives of the research.

Therefore, even if we rely on the subjective judgment of interviewed managers to assess the causal link between the alliance under examination and innovation performance, we are confident that the information provided by the respondents on this aspect is reliable. Moreover, we cross-checked this subjective information with documents published by the partner firms (e.g., annual reports and product release announcements) and other publicly available information (e.g., press articles) whenever possible. More generally, we used publicly available information (e.g., the Scopus, Amadeus and Euridile databases) to cross-check the data collected through the interviews whenever possible. The discrepancies that we found were very limited.

We also addressed the possibility of common methods bias using Harman's (1967) single-factor test. If a significant amount of common method variance existed in our data, a factor analysis of all of the variables would generate a single factor that accounts for most of the variance (Podsakoff and Organ 1986). Unrotated factor analysis on all variables revealed three factors (using the eigenvalue-greater-than-one criterion), and the first factor explained only 28.4 percent of the variance in the data.

5.3 Variables

5.3.1 Dependent variables

In order to test our hypotheses, we needed measures of the innovation output of exploitation and exploration activities. Regarding exploitation, to build a measure of the introduction of products and services new to the firm or new to the market, we drew inspiration from the questions used in the fourth community innovation survey (CIS4).[5] In particular, we asked the interviewed managers whether the focal alliance resulted in the introduction of any products and services that were: (1) new to the partner organizational unit involved in the alliance, or (2) new to the market. As to exploration activities, we asked the interviewed managers whether the alliance: (1) enabled entry in a technological field new to the partner organizational unit, or (2) led to the creation of a new technological field.

Relying on these questions, we built two categorical variables ranging from 1 to 3 and capturing the innovation output of the exploitative activities (*ProductInnovation*) and of the explorative activities (*Branching*) performed within the alliance. *ProductInnovation* distinguishes whether the alliance: did not lead to the introduction of any new products or services (value 1), resulted in the introduction of products or services new to the partner organizational unit, but not new to the market (value 2), or led to the launch of products or services new to the market (value 3). Similarly, *Branching* distinguishes whether the alliance: did not lead the partner organizational unit to enter new technological fields (value 1), enabled entry into a technological field new to the partner organizational unit, but did not lead to the creation of a new technological field (value 2), or led to the creation of a new technological field (value 3).

5.3.2 Explanatory variables

The explanatory variables are two dummies (see Table 1). *DExplorationOnly* (respectively, *DExploitationOnly*) equals 1 when the alliance specialized in exploration (respectively, exploitation) activities. Hence, *DExplorationOnly* (respectively, *DExploitationOnly*) equals 0 when the alliance involved either) *no* exploration (respectively, exploitation) activities, or ii) *both* exploration and exploitation activities. As any activity can be classified as either exploration or exploitation, no alliance may involve neither exploration nor exploitation activities. As a result, when both *DExplorationOnly* and *DExploitationOnly* equal 0, the alliance involved *both* exploration and exploitation activities and, thus, is to be considered as a hybrid alliance. In other words, the three categories of alliances (exploration, exploitation, and hybrid alliances) are mutually exclusive and hybrid alliances are the baseline in our estimates.

To assign a focal alliance to one of the three categories, we asked respondent managers to indicate which activities were performed within the alliance. Specifically, we asked whether the alliance dealt with: (1) R&D aimed at the joint investigation of a new research field and/or the joint development of a new technology, product or service, or (2) the acquisition, use, or commercialization by one (or more) partner(s) of a technology, product, or service developed by another partner, or the joint investigation or creation of a new market for an existing technology, product or service. The activities of the first type

[5] In the CIS4 (http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis), respondents are asked: i) whether during the last three years their company introduced any new or significantly improved goods/services, and ii) whether any of these goods/services were new to the firm's market or new to the firm.

Table 1 Definition of independent variables

Variable	Definition
Explanatory variables	
DExplorationOnly	Dummy equal to 1 if the alliance was specialized in exploration activities (i.e. it included research-related activities, but did not include any manufacturing or market-related activity), and 0 otherwise
DExploitationOnly	Dummy equal to 1 if the alliance was specialized in exploitation activities (i.e. it included manufacturing- or market-related activities, but did not include any research-related activity), and 0 otherwise
Control variables (* all time-varying variables were measured at the time of alliance formation)	
DPriorRelations	Dummy equal to 1 if either personnel of the ASO had had informal relationships with personnel of the partner organization, or the ASO and the partner organization had already established an alliance, and 0 otherwise*
DCrossBorder	Dummy equal to 1 if the ASO and the partner organization were not located in the same country, and 0 otherwise
DMultiPartners	Dummy equal to 1 for alliances that involved more than two partners, and 0 otherwise
TechnologicalProximity	Predicted value of the factor extracted from the factor analysis of three items measuring, through a 1–7 Likert scale, the extent to which the partners: had common technological expertise; operated in the same technological fields; operated in technological fields that shared the same knowledge base. Due to space constraints, details on the operationalization of this variable and on the factor analysis are not included here, but are available from the authors upon request
DDifferentMarket	Dummy equal to 1 if the market of the ASO and that of the partner organization were different as to their lines of business, product portfolios, geographical markets, and/or customer bases, and 0 otherwise*
DNEUnilateralContract	Dummy equal to one if the alliance was *not* of the following type: equity joint venture, minority shareholding, cross-licensing, technology sharing, joint R&D agreement, cross-selling and cross-distribution agreements
TimeFromAllianceFormation	Logarithm of the number of years that elapsed between the establishment of the alliance and the interview date
DEnded	Dummy equal to 1 for terminated alliances, and 0 otherwise
PartnerUnitAge	Logarithm of the age of the partner organization*
PartnerUnitSize	Logarithm of the total number of employees in the partner organization*
PartnerUnitR&D	Percentage of employees of the partner organization who were engaged in research, development, engineering and design activities
DIndependentUnit	Dummy equal to 1 when the partner organization coincided with the partner firm, and 0 otherwise
ASOAge	Logarithm of the age of the ASO*
DASOPublication	Dummy equal to 1 for ASOs that had published at least one article in a scientific journal, and 0 otherwise*
DSoftware	Dummy equal to 1 for ASOs in the software industry, and 0 otherwise
DICTManufacturing	Dummy equal to 1 for ASOs in ICT manufacturing industries, and 0 otherwise
DBioPharma	Dummy equal to one for ASOs in the biotechnology and pharmaceuticals industries, and 0 otherwise

are clearly aimed at discovering something new, while the activities of the second type are aimed at leveraging something that already exists. Therefore, in accordance with the literature on exploration and exploitation alliances (Lavie and Rosenkopf 2006; Park et al. 2002; Rothaermel and Deeds 2004), the first type of activity indicates the presence of exploration, whereas the second type of activity indicates the presence of exploitation. When both types of activity were selected by the respondent, the alliance was considered a hybrid one.

5.3.3 *Control variables*

We considered a long list of control variables (see Table 1), which can be classified in two groups. The first group includes eight measures of alliance-specific characteristics (calculated at the time of alliance formation). Variables indicating whether the partners had prior collaborative relations (*DPriorRelations*), whether they were located in different countries (*DCrossBorder*), whether the alliance included other partners (*DMultiPartners*), whether the partners had similar technological specializations (*TechnologicalProximity*), whether they operated in different product markets (*DDifferentMarket*), and whether the alliance had non-equity unilateral governance (*DNEUnilateralContract*), have been used in prior studies on alliances. We added two other control variables: a measure of the time that had elapsed since the formation of the alliance (*TimeFromAllianceFormation*) and a dummy identifying the alliances that had already ended at the time of the interview (*DEnded*). One could of course argue that longer-lasting alliances are more likely to be hybrid because it requires time to move from an exploration to an exploitation phase (and vice versa) in the innovation process. Longer relations are also more likely to influence innovation activity than shorter ones. Hence, a spurious correlation may arise between the hybrid nature of alliances and their innovation performance. The inclusion of *TimeFromAllianceFormation* and *DEnded* allows us to control for this effect.[6]

The second group of control variables included six measures of firm-specific characteristics, which are related to partner organizational units and ASOs, and were calculated at the time of alliance formation. We considered the age and the size of the partner organizational unit (*PartnerUnitAge* and *PartnerUnitSize*), its R&D intensity (*PartnerUnitR&D*), and a dummy variable capturing whether the partner organizational unit coincides with the partner firm (*DIndependentUnit*). As to the ASOs, we considered age (*ASOAge*) and science orientation (*DASOPublication*).

Finally, we inserted into the model specification three dummies (*DSoftware*, *DICTManufacturing* and *DBioPharma*) that identify the sector of the alliance, as proxied by the industry in which the ASO operated at the time of the establishment of the alliance. The baseline is "other high-tech services".

5.4 Descriptive statistics

Our sample includes 63 hybrid alliances (42 %), 52 alliances specialized in exploitation (35 %), and 34 alliances specialized in exploration (23 %). The three types of alliance have similar industry distribution [$\chi^2(6) = 5.44$].

[6] We also performed an ANOVA on the length of the relationship against the type of alliance (exploration, exploitation, or hybrid). The results indicate the absence of any correlation ($F(2, 144) = 1.44$): in our sample, hybrid alliances did not last longer (or shorter) than specialized alliances.

64 % of the sample alliances (i.e., 95 alliances) resulted in the introduction of one or more new products or services (i.e., *ProductInnovation* equal to 2 or 3), while in 54 % of sample alliances (i.e., 80) we observed branching (i.e., *Branching* equal to 2 or 3). These values reflect the innovation-seeking orientation of the alliances under consideration (and possibly the selection bias mentioned previously). In most alliances that resulted in the introduction of new products or services, the products (services) were new to the market (66 out of 95 alliances). Conversely, the number of alliances where partner firms entered a non-existing technological field is lower than the number of alliances where partner firms entered a field new to the firm but already existing (28 vs. 52 alliances). It is worth to acknowledge that a (weak) positive relationship exists between the two dependent variables. In particular, radical branching tends to be associated with radical product innovation. Out of the 28 alliances where *Branching* equals 3, 19 alliances resulted in the introduction of products or services new to the market, while 2 alliances resulted in the introduction of products or services new to the firm and 7 alliances resulted in no product innovation).

Table 2 reports descriptive statistics and correlations related to the independent variables (with the exception of the industry dummies). The correlations between the explanatory and the control variables are weak. This observation is confirmed by the VIF (maximum VIF is 2.05, below the 10 threshold, while the average of the VIFs is 1.31, which is below the 6 threshold).

6 Results

6.1 Specification of the econometric model

In order to test our theoretical hypotheses, the following econometric model is specified:

$$Innovation_i = \alpha + \gamma DExplorationOnly_i + \beta DExploitationOnly_i + \delta' Z_i + \eta_i \qquad (1)$$

$Innovation_i$ is the dependent variable (be it *ProductInnovation* or *Branching*) measuring the innovation outcomes of the alliance *i*. $DExplorationOnly_i$ and $DExploitationOnly_i$ are the explanatory variables. Z_i are controls. Finally, η_i are i.i.d. disturbance terms with assumed Normal distribution. As previously noted, *ProductInnovation* and *Branching* are categorical response variables with multiple levels. As the levels of the dependent variables have no natural ordering, we estimate Eq. (1) through a multinomial probit model.[7] Since both *ProductInnovation* and *Branching* have three levels, two functions for each dependent variable were estimated. We chose *ProductInnovation* and *Branching* equal to 1 as our base categories. Hence, for both dependent variables, the first functions respectively refer to *ProductInnovation* and *Branching* equal to 2 compared to the base categories, while the second functions refer to *ProductInnovation* and *Branching* equal to 3.

[7] As one may argue that the values of our dependent variables may be ordered according to the radicalness of the innovation outcome under scrutiny (1 = no innovation outcome, 2 = incremental innovation, 3 = radical innovation), we estimated Eq. (1) also through an ordered probit model. The results are in line with those presented below. For the sake of synthesis, we do not include these alternative estimates in this paper. However, they are available from authors upon request.

Table 2 Descriptive statistics and correlation matrix

	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) *DExplorationOnly*	0.23	0.42	0.00	1.00	1.00							
(2) *DExploitationOnly*	0.35	0.48	0.00	1.00	−0.40	1.00						
(3) *DPriorRelations*	0.56	0.50	0.00	1.00	−0.10	−0.09	1.00					
(4) *DCrossBorder*	0.34	0.47	0.00	1.00	0.19	−0.04	−0.24	1.00				
(5) *DMultiPartners*	0.40	0.49	0.00	1.00	0.17	−0.43	0.06	−0.03	1.00			
(6) *TechnologicalProximity*	0.00	0.88	−1.41	1.69	−0.11	0.12	0.12	0.09	−0.07	1.00		
(7) *DDifferentMarket*	0.39	0.49	0.00	1.00	0.06	0.02	−0.02	−0.01	0.07	−0.23	1.00	
(8) *DNEUnilateralContract*	0.72	0.45	0.00	1.00	−0.23	0.37	0.02	−0.19	−0.28	0.09	0.10	1.00
(9) *TimeFromAllianceFor*	1.39	0.44	0.69	2.30	0.05	−0.03	0.06	−0.09	−0.02	0.04	0.11	0.06
(10) *DEnded*	0.21	0.41	0.00	1.00	0.22	−0.28	0.00	0.11	0.30	−0.06	0.02	−0.33
(11) *PartnerUnitAge*	2.67	0.88	1.10	5.14	0.07	−0.06	−0.17	0.13	0.12	0.03	0.03	0.00
(12) *PartnerUnitSize*	3.32	2.19	−0.29	10.93	0.08	−0.18	−0.16	0.13	0.04	−0.05	0.02	−0.02
(13) *PartnerUnitR&D*	0.42	0.38	0.00	1.00	−0.04	−0.15	−0.03	−0.05	0.08	0.15	−0.09	−0.13
(14) *DUnitIndependent*	0.35	0.48	0.00	1.00	0.01	−0.06	−0.07	−0.13	0.12	0.07	0.08	0.21
(15) *ASOAge*	2.16	0.33	1.39	3.22	0.02	−0.12	0.13	−0.01	−0.01	−0.11	0.05	0.01
(16) *DASOPublication*	0.52	0.50	0.00	1.00	−0.05	−0.03	−0.17	0.29	−0.06	0.00	−0.14	−0.04

	Mean	SD	Min	Max	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) *DExplorationOnly*	0.23	0.42	0.00	1.00								
(2) *DExploitationOnly*	0.35	0.48	0.00	1.00								
(3) *DPriorRelations*	0.56	0.50	0.00	1.00								
(4) *DCrossBorder*	0.34	0.47	0.00	1.00								
(5) *DMultiPartners*	0.40	0.49	0.00	1.00								
(6) *TechnologicalProximity*	0.00	0.88	−1.41	1.69								
(7) *DDifferentMarket*	0.39	0.49	0.00	1.00								

Table 2 continued

	Mean	SD	Min	Max	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(8) *DNEUnilateralContract*	0.72	0.45	0.00	1.00								
(9) *TimeFromAllianceFor*	1.39	0.44	0.69	2.30	1.00							
(10) *DEnded*	0.21	0.41	0.00	1.00	0.09	1.00						
(11) *PartnerUnitAge*	2.67	0.88	1.10	5.14	0.20	0.02	1.00					
(12) *PartnerUnitSize*	3.32	2.19	−0.29	10.93	−0.03	0.06	0.44	1.00				
(13) *PartnerUnitR&D*	0.42	0.38	0.00	1.00	0.06	0.03	−0.11	−0.12	1.00			
(14) *DUnitIndependent*	0.35	0.48	0.00	1.00	0.04	−0.04	0.15	0.15	0.17	1.00		
(15) *ASOAge*	2.16	0.33	1.39	3.22	0.15	0.09	0.07	0.07	−0.13	−0.05	1.00	
(16) *DASOPublication*	0.52	0.50	0.00	1.00	−0.33	−0.12	0.01	0.10	0.05	0.00	0.08	1.00

6.2 Econometric results

The results of the econometric analysis are illustrated in Tables 3 and 4. Instead of reporting the values of the coefficients, we report the marginal effects in order to better understand the direction and the magnitude of the impact of the variables under scrutiny. For the sake of synthesis, in the following we will not discuss the results concerning the control variables.

The estimates reported in Table 3 are aimed at comparing the performance of exploitation activities, as captured by *ProductInnovation*, in hybrid alliances and in alliances specialized in exploitation. Therefore, we focus on the results regarding *DExploitationOnly* and treat *DExplorationOnly* as a control variable. The marginal effect of *DExploitationOnly* on the probability to introduce products or services new to the market is negative, significant at 99 % and of large economic magnitude (−41.4 %). Conversely, there is no significant difference between hybrid alliances and alliances specialized in exploitation as to the probability to introduce products or services that are new to the firm (but not new to the market): in this case the marginal effect of *DExploitationOnly* is not significant at conventional confidence levels. This finding provides support for hypothesis H1 which predicts that in alliances involving ASOs, the likelihood of launching a product (service) new to the market is greater in hybrid alliances than in alliances specialized in exploitation.

The estimates reported in Table 4 are aimed at comparing the performance of exploration activities, as captured by *Branching*, in hybrid alliances and in alliances specialized in exploration. Therefore, we focus on the marginal effects of *DExplorationOnly* and treat *DExploitationOnly* as a control. *DExplorationOnly* has a negative and significant (at 99 %) marginal effect on the probability to enter a technological field that is new to the firm (but already existing); this effect is also of large economic magnitude (25.6 % points). Conversely, there is no significant difference between hybrid alliances and alliances specialized in exploration as regards the probability to create a new technological field. This finding provides support for hypothesis H2 which predicts that the likelihood of branching into a novel but already existing technological field is greater in hybrid alliances than in alliances specialized in exploration.

6.3 Robustness checks

In order to ensure the reliability of our results, we performed several robustness checks.[8] First, we estimated the regressions on two subsamples. For *ProductInnovation* (indicator of the innovation outcome of exploitation), we estimated the model in Table 3 on a sample composed only of hybrid alliances and alliances specialized in exploitation (i.e., alliances specialized in exploration were excluded from this analysis). Conversely, for *Branching* (indicator of the innovation outcome of exploration), we restricted the sample to hybrid alliances and alliances specialized in exploration. By restricting the sample, we reduce the potential noise in estimating the parameters of the key explanatory variables (but we also substantially reduce the efficiency of the models). The results are perfectly in line with those illustrated above.

Second, as in any analysis based on survey data relating to past events, our results may be influenced by a retrospective bias. In order to control for the possible effects of such bias, we

[8] For the sake of synthesis, the results of these checks are not reported here. They are available from authors upon request.

Table 3 The innovation outcomes of exploitation activities in hybrid and specialized alliances: a multinomial probit model

	ProductInnovation		
	No new products or services were introduced	Introduction of products or services new to the firm	Introduction of products or services new to the market
DExplorationOnly (D)	0.122 (0.129)	−0.023 (0.100)	−0.099 (0.124)
DExploitationOnly (D)	0.315*** (0.122)	0.099 (0.100)	−0.414*** (0.105)
DPriorRelations (D)	0.013 (0.100)	−0.033 (0.083)	0.019 (0.107)
DCrossBorder (D)	0.029 (0.106)	−0.153** (0.075)	0.124 (0.112)
DMultiPartners (D)	0.190* (0.107)	−0.075 (0.082)	−0.115 (0.108)
TechnologicalProximity	−0.046 (0.056)	0.023 (0.046)	0.022 (0.058)
DDifferentMarket (D)	0.052 (0.101)	−0.039 (0.078)	−0.013 (0.104)
DNEUnilateralContract (D)	−0.091 (0.122)	−0.183 (0.116)	0.275** (0.110)
TimeFromAllianceFormation	−0.228** (0.114)	−0.125 (0.095)	0.353*** (0.124)
DEnded (D)	0.225* (0.123)	−0.100 (0.084)	−0.126 (0.119)
PartnerUnitAge	0.052 (0.060)	−0.022 (0.049)	−0.030 (0.062)
PartnerUnitSize	0.038 (0.024)	−0.001 (0.019)	−0.037 (0.025)
PartnerUnitR&D	0.275** (0.133)	−0.111 (0.109)	−0.164 (0.144)
DUnitIndependent (D)	0.020 (0.101)	0.093 (0.088)	−0.113 (0.105)
ASOAge	−0.074 (0.148)	0.029 (0.110)	0.045 (0.151)
DASOPublication (D)	0.158 (0.100)	0.021 (0.081)	−0.180* (0.104)
Number of Observations	149	149	149

(D) for discrete change of dummy variable from 0 to 1. We report marginal effects and standard errors in round brackets. All the models include the three industry dummies

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

included in the equations a dummy variable *DOld03*, which is equal to 1 if the alliance was established before 2003 (i.e., the average year of alliance formation in our sample). This variable allows us to discriminate older alliances from more recent ones. We also included the interactive terms *DExploitationOnly*DOld03* and *DExplorationOnly*DOld03*. The test of the joint significance of the two interactive terms and of the dummy *DOld03* is not significant in any of the models, which alleviates our concerns about a systematic retrospective bias.

Table 4 The innovation outcomes of exploration activities in hybrid and specialized alliances: a multinomial probit model

	Branching		
	No change in the technology portfolio	Entry in a technological field new to the firm	Creation of a new technological field
DExplorationOnly (D)	0.287*** (0.109)	−0.256*** (0.092)	−0.031 (0.077)
DExploitationOnly (D)	0.312*** (0.114)	−0.087 (0.111)	−0.225*** (0.070)
DPriorRelations (D)	0.219** (0.101)	−0.215** (0.099)	−0.003 (0.076)
DCrossBorder (D)	0.006 (0.110)	−0.028 (0.106)	0.022 (0.082)
DMultiPartners (D)	−0.176* (0.106)	0.128 (0.105)	0.049 (0.082)
TechnologicalProximity	−0.041 (0.057)	0.105* (0.056)	−0.064 (0.041)
DDifferentMarket (D)	0.011 (0.099)	0.036 (0.097)	−0.047 (0.071)
DNEUnilateralContract (D)	−0.144 (0.117)	0.074 (0.109)	0.070 (0.074)
TimeFromAllianceFormation	0.101 (0.117)	−0.232** (0.114)	0.131 (0.088)
DEnded (D)	0.033 (0.126)	0.080 (0.125)	−0.113 (0.069)
PartnerUnitAge	0.110* (0.062)	−0.121** (0.060)	0.011 (0.045)
PartnerUnitSize	0.005 (0.025)	−0.002 (0.024)	−0.003 (0.018)
PartnerUnitR&D	0.240* (0.137)	−0.210 (0.132)	−0.030 (0.101)
DUnitIndependent (D)	0.048 (0.103)	−0.026 (0.097)	−0.022 (0.073)
ASOAge	−0.160 (0.150)	0.281** (0.142)	−0.122 (0.115)
DASOPublication (D)	−0.050 (0.104)	0.081 (0.097)	−0.031 (0.076)
Number of Observations	149	149	149

(D) for discrete change of dummy variable from 0 to 1. We report marginal effects and standard errors in round brackets. All the models include the three industry dummies

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

Third, as we expected data obtained through face-to-face interviews to be more reliable than those obtained through phone interviews, we checked whether the use of these two different data collection methods had had any impact on the results. For this purpose, we conducted an analysis similar to that used to check for retrospective bias. Specifically, in all the equations we included a dummy, *DF2F*, equal to 1 for data collected through face-to-face interviews and to 0 for data collected through phone interviews, as well as the interactive terms *DF2F*DExplorationOnly* and *DF2F*DExploitationOnly*. We then tested for the joint significance of these interactive terms and *DF2F*. The tests show that there is no significant difference between data collected through the two methods.

7 Discussion and conclusions

7.1 Synthesis of the key findings of the study

This paper examined the innovation performance of alliances involving ASOs. We hypothesized that the relative performance of exploitation activities in hybrid alliances, as compared to alliances specialized in exploitation, is greater when the alliance has radical innovation outcomes. Conversely, the relative performance of exploration activities in hybrid alliances, as compared to alliances specialized in exploration, is greater when the alliance has incremental innovation outcomes. Our hypotheses are based on the following argument: hybrid alliances improve the transfer of knowledge between personnel involved in exploration and exploitation activities, facilitating the coordination of their actions; these benefits are more likely to overweigh the tensions arising from the combination of exploration and exploitation, and thus improve alliance innovation performance, when the transfer of knowledge between exploring and exploiting agents is more crucial.

To test our hypotheses, we examined the relationship between being involved in hybrid alliances and (1) the introduction of products or services new to the firm and new to the market, in comparison with alliances specialized in exploitation, and (2) branching into novel but already existing technological fields and into not yet existing technological fields, in comparison with alliances specialized in exploration. We used an original dataset composed of 149 alliances established by European ASOs and took advantage of fine-grained information obtained through interviews with the managers in the partner organizations in charge of the focal alliances.

Overall, the results confirm our hypotheses. We find that exploitation exhibits greater innovation performance, as captured by the introduction of new products or services, in hybrid alliances than in alliances specialized in exploitation when the alliances result in radical product innovations (i.e., the introduction of products or services new to the market).We found no difference between these two types of alliances as to the introduction of products or services new to the firm. Conversely, exploration exhibits greater innovation performance, as captured by entry into new technological fields, in hybrid alliances than in alliances specialized in exploration when it comes to less radical innovation, that is, entry into technological fields that are new to the firm but existed previously. No difference was detected between these two types of alliance as to the creation of new technological fields. This lends support to our more general hypothesis that function exploration and exploitation (Lavie and Rosenkopf 2006) can be effectively balanced within a single alliance and enhance its performance.

7.2 Limitations

We are aware that this study has several limitations. First, as we recognize in footnote 3, we have explored the degree of radicalness of alliance innovation outcomes by distinguishing incremental from ‘potentially radical’ innovations. Exploring how the specific activities performed within an alliance influence the likelihood of developing an innovation that may influence future inventions would be a valuable addition to our study. Second, data availability limits our empirical analysis. In particular, our econometric results highlight an *association* between the degree of radicalness of alliance innovation outcomes and the specific activities performed within the alliance. In spite of the fact that the interviews we conducted suggested the existence of a causal relation, we had no valid instruments, hence we were not able to check for causality.

Another limitation of this study stems from the inability of our research design to account for the additional costs that partner firms may incur in managing hybrid alliances. These costs are probably quite high, due to the tensions that the combination of exploration and exploitation is likely to generate. Prior studies have indeed shown that exploration and exploitation activities call for idiosyncratic management processes and governance structures. For example, features that improve the performance of exploration activities—such as autonomy and delegation of authority (McGrath 2001), control systems oriented towards processes instead of outcomes (Koza and Lewin 1998)—may not be appropriate in the case of exploitation. Further research should thus examine whether the higher innovation performance of hybrid alliances that we have detected is achieved at the expense of increased costs necessary to design and to implement complex organizational arrangements.

More research is also needed to investigate *when* hybrid alliances achieve a better innovation performance than specialized alliances. First, our study has focused on alliances involving a particular type of firms whose peculiar characteristics were expected to provide favorable conditions for hybrid alliances. Future studies could investigate the innovative performance of hybrid alliances focusing on different types of firms and check under which circumstances our results can be generalized. We expect that hybrid alliances might achieve better innovation performance than specialized alliances whenever the knowledge transferred between exploring and exploiting agents is complex and there is little common ground between the partners.

Second, the literature on ambidexterity, which has investigated the combination of exploration and exploitation on the intra-organizational level, has put forward a number of moderating factors, such as environmental dynamism and resource endowment (Raisch and Birkinshaw 2008). Our theoretical discussion hints at additional characteristics that are likely to affect the extent to which synergies between exploration and exploitation can be generated in hybrid alliances. For example, market proximity between partners will certainly bear on the issue of focusing exploration. Moreover, the coordination benefits of hybrid alliances are likely to increase with the technological and geographical distance between partners. Besides taking into account the direct effects of geographical distance and market and technological proximity on the performance of alliance exploration and exploitation activities, as we did in this paper by including these factors in the list of controls, further research might therefore examine how these factors moderate the innovation performance of hybrid alliances versus specialized ones.

7.3 Contributions

In spite of its limitations, our study provides several original contributions. First, heeding the call of this special issue, we advance knowledge about the antecedents of radical innovations by investigating the role of the activities performed within the alliances from which innovations result. While alliances have generally been recommended as a means to foster firm innovation in general, and radical innovation in particular, we have shown that their design, in terms of the distribution of complementary activities across organizational units, affects their innovation performance.

Second, by considering the balance of exploration and exploitation in inter-organizational relationships, our study contributes to the literature on ambidexterity which has mainly focused on the intra-organizational level (for rare exceptions see Im and Rai 2008; Tiwana 2008). It also offers a theoretical grounding and an empirical test of the innovation performance implications of integrating exploration and exploitation. As noted by Raisch and Birkinshaw (2008), the empirical evidence on this issue remains limited and mixed on the intra-organizational level (see, for example, He and Wong 2004), and it is even scarcer on the inter-organizational level. Despite our focus on alliances involving firms with peculiar characteristics, the test of the relative innovation performance of hybrid alliances proposed in this paper is a first step towards filling this gap.

Moreover, while the extant literature on ambidexterity posits the need to sustain both exploration and exploitation for the sake of survival, it remains unclear whether, as Raisch and Birkinshaw (2008) put it, the simultaneous pursuit of exploitation and exploration within the boundaries of the same organizational unit compromises or improves the potential value of each activity on its own. To our knowledge, there has been no discussion on the potential synergies between these two types of activity. We have shed light on this issue by theorizing why the integration of exploitation and exploration creates unique synergies through coordination benefits.

Third, our study contributes to the literature on alliances. Scholars have shown that the impact of alliances on innovation is contingent on a number of factors, such as the organizational form of the alliance and the characteristics of the partner firms and of the networks in which they are embedded (e.g., Sampson 2007; Stuart 2000; Schilling and Phelps 2007). In this paper, we have taken a step forward and documented how the specific activities performed within an alliance (exploration, exploitation, or both) may influence its innovation performance. In addition, while testing the innovation impact of alliances, most empirical studies considered aggregated firm-level indicators of innovation, such as the number of patents or new products, and linked them to the alliances of the focal firm (e.g., Deeds and Hill 1996; Shan et al. 1994). An exception is provided by Rothaermel and Deeds (2004), who argued that exploration and exploitation alliances respectively lead to new products in development, and to new products introduced on the market. Here, we have extended this line of reasoning by considering idiosyncratic innovation indicators relating to the exploration and exploitation activities performed by the focal alliances. In addition, we have taken into account the degree of radicalness of the innovation outcome produced by alliances.

Fourth, by investigating the effects of hybrid alliances on branching, our analysis contributes to an interesting line of research that has examined the strategies of incumbent firms facing periods of rapid technological change (Mitchell 1989; Tripsas 1997). Scholars in this stream of literature have emphasized the virtues of using inter-organizational collaborations as a means to enter new technological fields (Colombo and Garrone 1998; Mitchell and Singh 1992; Rothaermel 2001). We have identified different types of alliances (hybrid vs. exploration) that can be instrumental for that purpose, and have assessed their relative contributions.

Apart from its contributions to the literature, our study has important managerial implications. While the fact of combining exploitation and exploration and building alliances has been shown to play a crucial role in organizational survival and renewal, little is known about the linkages between them. Our paper sheds new light on these linkages. We have shown that, when the synergies between exploration and exploitation overweigh the tensions between these two types of activity, hybrid alliances can outperform specialized alliances in terms of product innovation and branching. The superior innovation performance of hybrid alliances highlights the fact that iterations between exploration and exploitation are a key driving force in the innovation process, and that organizational boundaries are a major obstacle to knowledge transfer and coordination of interdependent tasks. This finding opens a new path in the search for a balance between exploration and exploitation in the context of increasing use of external knowledge sourcing and open innovation strategies.

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