

EXPLORATORY INNOVATION, EXPLOITATIVE INNOVATION AND INNOVATION PERFORMANCE: THE MODERATING ROLE OF ALLIANCE PARTNER DIVERSITY

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ABSTRACT: *Addressing the mixed findings in the literature, we distinguish between two distinct types of innovations, exploitative and exploratory innovations, and study their relationships with innovation performance. Organizational ambidexterity, the ability of a firm to simultaneously pursue both explorative and exploitative innovations, has been highlighted as increasingly important for the sustained competitive advantage of firms. By using the Community Innovation Survey 2006 micro data for innovation from twelve countries, we showed that simultaneously pursuing exploratory and exploitative innovation hinders firms' innovation performance. Furthermore, we proposed that firms' collaborations with different types of partners (suppliers, customers, competitors, research institutions and universities) would moderate the impact of exploitative and exploratory innovations on firm innovation performance differently. Our study also reveals that the use of diverse collaborators is beneficial to the contradictory pressures for explorative and exploitative innovations.*

Keywords: *ambidexterity, exploration, exploitation, collaboration, alliance portfolio partner diversity, innovation performance*

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INTRODUCTION

A growing number of studies argue that successful firms cope with changing environments by being ambidextrous – able to simultaneously exploit their existing competencies and at the same time adapt to the changing environment by exploring new opportunities (Raisch, Birkinshaw, Probst, & Tushman, 2009). To respond to this environmental uncertainty, firms innovate. In the organizational learning literature, on which the distinction between the premises of exploration and exploitation are primarily grounded, this two activities are known as the two types of innovation (March, 1991). Exploitative innovation is crucial for short-term success, and because of its low level of uncertainty (Garcia & Calantone,

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2002), it is often preferable by firms because of its desirable outcomes, which are positive, proximate and predictable. Exploitative or incremental innovations are designed for existing customer and market needs (Danneels, 2004). However, long-term gains become questionable without exploration. Hence, explorative innovations are designed to produce new products that differ significantly from the existing ones and serve emerging markets and customers (Levinthal & March, 1993; March, 1991).

Firms' ability to simultaneously pursue both explorative and exploitative innovation is known as organizational ambidexterity (O'Reilly & Tushman, 2004). Consistent with the resource-based view, this ability is a key to superior firm performance because it exhibits rare attributes and thus enables a firm to gain and sustain a competitive advantage (Simsek, 2009). Although the performance effects of exploratory and exploitative innovation have drawn researchers' attention respectively, there is no strong and coherent support for a relationship between them (Gupta, Smith, & Shalley, 2006). Firms are faced with the struggle of how to sustain themselves on the turbulent market with the help of exploration or exploitation innovation or by ambidextrous innovation (Xu, 2015).

The prior literature recognized the importance of external knowledge for innovation. Past research found that exploring beyond organizational boundaries is more important than exploring within a firm (Rosenkopf & Nerkar, 2001). Other studies show that breadth of external knowledge sources contributes to the reconfiguration of the existing knowledge base (Kogut & Zander, 1992). On the other hand, scholars are still fuzzy on the pros and cons of exploratory and exploitative innovation effects, although simultaneous pursuit of both, the ambidextrous approach, has been more coherent and is often considered the optimal solution (Cao, Gedajlovic, & Zhang, 2009; He & Wong, 2004). For example, Lin and Chang (2015) showed that a higher level of ambidextrous innovation leads to better performance effects.

Yet, other scholars have found opposite effects of such relationships. A study showed that exploratory and exploitative innovations inhibit each other, as too much focus on either dimension of innovations may lead to poorer performance effects (Lavie & Rosenkopf, 2006). Moreover, because of the opposing nature of innovation activities, firms may reach better performance outcomes by balancing the two distinct dimensions of innovation across other dimensions (Lavie, Kang, & Rosenkopf, 2011; March, 1991; Zhang, 2016), such as with external relationships. Despite the proposal that firms' two distinct types of innovations may be sufficient for firm performance, Lavie and Rosenkopf (2006) and Zhang (2016) found empirical support that exploration and exploitation simultaneously lead to poorer performance outcomes. Therefore, an analysis of the interrelationships between often mutually exclusive innovation activities may be complemented by other dimensions beyond firms' boundaries, such as breadth of external diverse knowledge sources.

Thus scholars have recently identified external relationships, i.e., alliances, as drivers of exploration and exploitation innovation strategies, and conversely their joint effect has been examined. Scholars acknowledge the importance of managing firms alliance portfolio (Wassmer, 2010), and the fact that sets of multiple simultaneous alliances

need to be carefully addressed and may not be individually managed (Lavie, Stettner, & Tushman, 2010). Recently, Castro and Roldán (2015) introduced the concept of alliance portfolio management which has three aspects, i.e., portfolio configuration, relationship management, and portfolio configuration, and acknowledge partner diversity as a valuable capability in managing an alliance portfolio.

Due to the increased technological change, the characteristics of portfolios (such as alliance portfolio partner diversity, hereafter APPD) have become more important but are still poorly understood (Faems, Van Looy, & Debackere, 2005; Oerlemans, Knobens, & Pretorius, 2013). The concept of alliance portfolio diversity, as one of the dimensions of alliance portfolio management, considers the heterogeneity of firms' direct external partners (Jiang, Tao, & Santoro, 2010; Oerlemans et al., 2013; Terjesen, Patel, & Covin, 2011; Wassmer, 2010). In general, a sample firm's ego network deals with how the actor, or "ego" (in our case the firm), is "tied" by some type of relationship with other actors (such as alliances). It has been argued as a key vehicle for accessing external resources that are not available within the boundaries of the firm (Lavie & Rosenkopf, 2006), either for exploitation innovation such as input quality improvements, or for cooperating with customers to reduce uncertainty when launching new products or services, i.e., explorative market introductions (de Leeuw, Lokshin, & Duysters, 2014). The main goal of alliance portfolio diversity (hereafter used interchangeably to refer to a wider range of terms such as APPD or breadth of knowledge sources) is to provide a firm with different resources and knowledge (de Leeuw et al., 2014), whether they are needed for the exploitative or explorative nature of innovations.

The performance implications of relationships between two distinct innovations and their interplay is the focal point of this research. The aim of this study is to address two key research questions: (1) How do the interrelationships between the distinct dimensions of innovations influence a firm's innovation outcomes, independently and simultaneously? (2) How do diverse external knowledge sources moderate that influence? Facilitating exploration and exploitation innovation activities may be quite demanding because of the high cost and risk concerns associated with exploration innovation (Uotila, Maula, Keil, & Zahra, 2009). Firms that simultaneously pursue exploratory innovation internally (or in-house) and opt toward optimization of type and number of partners externally (in some sense, they have a less diverse "exploitative" alliance portfolio) can confront an undesirable and perhaps unnecessary level of uncertainty and risk (He & Wong, 2004; Zhang, 2016).

Our study contributes to the literature in several different ways. First and foremost, we contribute to the organizational ambidexterity literature (Birkinshaw & Gupta, 2013) by studying the performance implications of a firm's engagement in both exploration and exploitation innovations. Our second potential contribution is to explore the nuanced effects of alliance portfolio partner diversity in a large dataset of innovative firms in twelve countries. The breadth of diverse knowledge sources has been shown by other authors to be a vehicle to access the external-party resources that are not otherwise available (Das & Teng, 2000; Zhang, 2016). A more heterogeneous or diverse portfolio of external

partners can lead to a larger amount of information and resources, and as a corollary to the performance benefits (Wuyts & Dutta, 2014), too much diversity hinders the exchange and integration of information and resources (de Leeuw et al., 2014). Finally, we address this call and advance the international management research by using a broad dataset, namely the Community Innovation Survey (CIS) 2006 micro data for firm-level innovations obtained from twelve countries.

In the following paragraphs, we explain the theory with respect to (a) the relationship between exploration and exploitation innovation and innovation performance and (b) the effects of alliance portfolio partner diversity on this relationship, preceded by the data and methods section, which explains the empirical approach. The research results are reported and followed by a discussion and conclusion.

1 LITERATURE REVIEW AND HYPOTHESIS

1.1 Exploratory innovation and exploitative innovation

Prior research suggests that to sustain a competitive advantage, firms—besides possessing resources that are unique and inimitable—need to be ambidextrous (O'Reilly & Tushman, 2004). Ambidextrous firms are those that are able to exploit their existing competencies and at the same time avoid obsolescence by exploring new competencies (Leonard-Barton, 1991). Exploitation is associated with aspects such as efficiency and refinement, whereas exploration is related to notions such as variation and discovery (March, 1991). These aspects of exploration and exploitation concur with the dynamic capability view, which demands continuous reconfiguration and transformation of firm competences as an answer to environmental dynamism and market uncertainty (Eisenhardt & Martin, 2000). This represents a rather long-term, strategic view of management of firms' resources (Teece et al., 1997) as opposed to a short-term view on rapid combination and capitalization on them (Kogut & Zander, 1992). However, application of these concepts to innovation has remained ambiguous (Greve, 2007).

Our study suggests that exploration and exploitation as two types of distinct innovations may create substantial performance effects. Exploitative innovation creates value through firms' strengthening existing knowledge base and improvement of existing products or processes, whereas exploratory innovation creates value through firms' development of new domains or shift to different domains with the goal of adopting or creating new products or services (Ozer & Zhang, 2015). Firms need to invest considerable resources to develop exploratory innovation (de Leeuw et al., 2014). Thus exploratory innovations involve high levels of uncertainty (Garcia & Calantone, 2002), although the potential gains of such innovations are high (de Leeuw et al., 2014). While exploitation innovation as a low-risk strategy inhibits returns that are positive, proximate and predictable, exploratory innovation is uncertain and often high-risk, but potentially well rewarded (March, 1991).

Explorative innovations can give a firm the ability to cope with changing environments, open up new business opportunities and thus produce new products that differ significantly from existing ones (Levinthal & March, 1993; March, 1991), which are potentially important in order to harvest long-term gains. Hence exploratory innovations can facilitate innovation performance (Kang, Morris, & Snell, 2007), and firms with high levels of exploratory innovation focus appear particularly well suited to generate positive innovation outcomes. Engagement in exploitative innovations is typically associated with quality improvements, cost and time savings, and productivity gains (Baer & Frese, 2003; Klomp & Van Leeuwen, 2001), which is a necessary condition for achieving performance improvements in the short run. Therefore, both innovations can create positive synergies (Yang, Zheng, & Zhao, 2014).

Moreover, exploitative innovations buffer efficiency through constant reinforcement and improvement of a firm's current operations and product knowledge, whereas exploratory innovations stimulate innovations through the development of new knowledge (Jansen, Van Den Bosch, & Volberda, 2006; Ozer & Zhang, 2015). If a firm maintains high levels of both, it needs to invest a substantial amount of resources to introduce new processes and products and keep its operations efficient (Benner & Tushman, 2002). In turn, these processes that are not easily imitable pose barriers to rivals in the industry (Ho & Lu, 2015), and thus benefit the firm's performance outcomes. In summary, we hypothesize the following:

Hypothesis 1:

There is a positive relationship between exploratory innovation and a firm's innovation performance.

Hypothesis 2:

There is a positive relationship between exploitative innovation and a firm's innovation performance.

1.2 The interaction of exploration and exploitation innovation and its effects on innovation performance

The need for firms to engage in exploratory and exploitative innovation has been frequently emphasized (Birkinshaw & Gupta, 2013; O'Reilly & Tushman, 2013; Gupta et al., 2006), which raises the question of how to successfully balance them. Scholars have predominantly theorized and empirically supported two competing views of ambidexterity, i.e. the joint effects of exploration and exploitation. Following this dual logic of ambidexterity, present research differentiates between the complementary (combined) view (Cao et al., 2009; Cillo, De Luca, & Troilo, 2010; Lubatkin, Simsek, Ling, & Veiga, 2006; Simsek, Heavey, Veiga, & Souder, 2009), in which firms' efforts are directed toward increasing the complementary effect of exploratory and exploitative innovation, and the balanced view, the claim that balance between exploration and exploitation innovation exists when a firm pursues both types of innovation equally (Raisch et al., 2009).

Although the advantages of exploratory and exploitative innovation are evident, as noted earlier, prior studies on the performance effects of the ambidextrous approach, whether from the balanced view or the combined view, have exhibited mixed results (Lavie et al., 2010). Scholars have empirically tested both the complementary effect and the balanced effect (Aspara & Tikkanen, 2013; Vorhies, Orr, & Bush, 2011). The complementary view regards exploration to complement exploitation or vice versa. It implies that exploration and exploitation add value to each other and offset each other's limitations to improve performance (Herhausen, 2016; Venkatraman, 1989). Moreover, exploration innovation helps to overcome the inadequacies of exploitation innovation, such as a firm's lack of ability to quickly adapt to market uncertainty. Conversely, exploitation innovation helps firms to improve and refine current skills and procedures (March, 1991) and thus enhances the effectiveness of exploration innovation in the attempt to address new changes.

Hypothesis 3a:

There is a complementary relationship between exploratory and exploitative innovations in improving a firm's innovative performance.

Although both dimensions of innovations are necessary for firm performance, pursuing both in equal proportion is nearly impossible (Bednarek, Burke, Jarzabkowski, & Smets, 2015) because their outcomes differ in terms of their "timing, and their distribution within and beyond the organization" (March, 1991, p. 71). Both innovation strategies are important to harvest performance gains, but if a firm decides to invest heavily in exploitation, this could result in missing important opportunities (March, 1991) or a situation in which it has fewer resources available for exploration (Stettner & Lavie, 2014). This yields to a trade-off situation known as a competency trap (Levitt & March, 1988), suggesting that investment in exploitative activities drives out exploratory activities and vice versa, whereas exploration activities can lead to the ongoing search for new knowledge (Benner & Tushman, 2002).

Therefore, it is important that firms bridge the tendency overemphasizing exploitation by exploring new ideas and avoiding the so-called success trap (March, 1991; Rosenkopf & Nerkar, 2001). However, too much focus on exploration poses a problem as well; i.e., the failure trap. For instance, He and Wong (2004) found that imbalance between explorative and exploitative innovation strategies is negatively related to firms' performance. Moreover, the resource allocation trade-offs and conflicting organizational routines to which firms are exposed when they explore and exploit simultaneously in equal measure are likely to lead to diminishing their performance (Stettner & Lavie, 2014). Gupta et al. (2006) argued that "the scarcer the resources needed to pursue both exploration and exploitation, the greater the likelihood that the two will be mutually exclusive—that is, high values of one will necessarily imply low values of the other" (p. 697). Rothaermel and Deeds (2004) in the context of strategic alliances showed that exploration alliances must be followed by exploitative alliances for successful introduction of new products or services. Hence, a lack or excess of focus on either dimension would have a negative impact on a firm's innovation performance.

Hypothesis 3b:

There is a balance (imbalance) between exploratory and exploitative innovations in improving a firm's innovative performance.

1.3 Moderating effects of alliance portfolio partner diversity

Although ambidexterity is essential for a firm's survival and prosperity (March, 1991), it is quite challenging to achieve within a single firm (Bednarek et al., 2015; He & Wong, 2004; Raisch & Birkinshaw, 2008). As a response to tensions between exploratory and exploitative innovations in pursuing ambidexterity internally, the use of external relationships in enabling ambidexterity has recently received much scholarly attention (Belderbos, Carree, Lokshin, & Sastre, 2015; Kauppila, 2010; Lavie et al., 2010). For instance, a firm that creates new products and technologies can harvest the benefits of balance by internally developing new advertising and distribution channels for its existing products that are familiar to the market. Hence, resources furnished via exploitation innovation internally can facilitate exploitation by external sources (Rothaermel, 2001). Furthermore, there is no resource spillover and firms can experience the enjoyable benefits of ambidexterity, which conversely enhances performance (Stettner & Lavie, 2014). Despite the growing interest in external relationships as a source of ambidexterity, current research largely neglects the alliance portfolio approach; i.e., interactions across a firm's portfolio.

Previous research highlights suppliers (Belderbos et al., 2015; Ho & Lu, 2015; Laursen & Salter, 2006; Takeishi, 2001) and/or clients as exploitative sources of knowledge and defines R&D institutes as exploratory ones. Universities give access to fundamental knowledge (Laursen & Salter, 2006), while suppliers possess knowledge that could lead to both valuable exploitative and exploratory innovation strategies (Sobrero & Roberts, 2002). Alliance with competitors gives access to industry-specific knowledge (Gnyawali & Park, 2011), whereas private research organizations can also be valuable sources (Oerlemans et al., 2013). While research acknowledges firms' alliance partners as potential sources of ambidexterity stimuli (Bednarek et al., 2015) that can reduce the tensions in the ambidexterity and ultimately enhance performance (Oerlemans et al., 2013), synergetic effects between diverse partners maintained by a firm, have been comparatively neglected. The diversity of alliance external relationships (i.e., partner types) can impact the firm performance beyond the effect of individual relationships (de Leeuw et al., 2014), and as such can be a valuable source for ambidexterity. For example, Lin and Chang (2015) found that technological diversification strongly interacts with absorptive capacity, and innovation performance is enhanced when higher technological diversification is accomplished by higher absorptive capacity. Thus, firms with a high level of absorptive capacity are able to relieve the tension caused by managing multiple and diverse collaborations.

Innovation performance is a result of exploratory innovations or an introduction and acceptance in the market of a firm's new products and services, which extends its competencies significantly (Voss, Sirdeshmukh, & Voss, 2008). Exploration innovations and consequently the generation of products and services preceding this performance ask for novel types of knowledge that are often unavailable in the innovating firm and only possessed by specific specialized external actors, such as specialized universities or lead users (Lettl, 2007). In other words, the creation of more exploratory breakthrough innovations requires an emphasis on access to scarce capabilities and expertise, and the possession of these is unequally distributed by very few specific types of partners.

Secondly, exploratory innovations are unpredictable and high risk. Most firms that pursue exploratory innovation might experience lack of capacity to absorb inflowing knowledge in such projects, and consequently, maintaining less diverse ties and focusing all their attention on those ties may be beneficial for exploratory innovation (Feller, Parhankangas, & Smeds, 2006; Oerlemans et al., 2013). This expectation is empirically supported in prior studies. For example, Hall and Bagchi-Sen (2007) find that in the biotechnology sector exploratory innovation is predominantly affected by one type of external relationships—universities. Similarly, Riggs and Von Hippel (1994) find that a vast number of innovations in the scientific instruments industry have come from lead users. Additionally, Feller et al. (2006) showed that exploratory innovators collaborated with fewer similar and complementary sets of external partners. Sampson (2007) found that exploratory innovations are driven by collaborations with moderate technological diversity. Hence we propose:

Hypothesis 4a:

The relationship between exploratory innovation and innovative performance is moderated by APPD. For firms with lower APPD, the relationship between exploratory innovation and innovation performance is more positive.

We further propose that alliance portfolio partner diversity will also strengthen the effect of exploitative innovation on innovation performance. We base this hypothesis on theory and research on an extended resource-based perspective (Lavie & Rosenkopf, 2006). The literature on the resource-based view of the firm (RBV) shows that firms collaborate with external partners in order to accompany their internal efforts (Deeds & Rothaermel, 2003) and describe how these resources can shape firm outcomes (Barney, 1991). It is likely that resources will vary between different partner type. Different relationships between different partner types can lead to diverse and non-redundant resources (Burt, 1992). For example, an alliance with a university or a research institute could lead to a new product or service, i.e., exploratory activity, while simultaneous alliance with suppliers can produce a development of new or significantly improved methods of manufacturing. In summary, theories of RBV and ambidexterity suggest that by employing increasing APPD, firms that pursue exploitative innovations obtain better innovation performance effects. Since the exploitative innovations entail fine-tuning of an existing product, process, or service for which a dominant design has already emerged and the innovation market expanded, the number of partner types with relevant knowledge increases (de Leeuw et al., 2014). Therefore, with the increasing level of APPD, firms can “handle” more diverse types of partners easily and benefit from their portfolio. More partner types have information that is valuable to the sample firms, and the sample firms therefore do not need to limit the collaboration to a few partner types (de Leeuw et al., 2014). For example, when an exploitative, motivated firm proceeds to perform the strategy of fine-tuning its existing capabilities, a more diverse APPD is likely to focus the firm’s attention on further improvements of the existing possibilities that are the most useful for solving the firm’s problems. We thus expect that higher levels of APPD will enhance the effect of exploitative innovation activities on innovation performance, and we propose the following hypothesis:

Hypothesis 4b:

For firms with higher APPD, the otherwise negative relationship between exploitative innovation and the firm’s performance becomes positive.

2 METHODS

Sample

The hypotheses are tested with the Community Innovation Survey (CIS) 2006 micro data (company level). The data used for this survey cover the years 2004–2006. Anonymized data for the following countries were available and obtained centrally via Eurostat: Bulgaria, Cyprus, Czech Republic, Estonia, Norway, Portugal, Romania, United Kingdom, Slovakia, Slovenia, Spain and Switzerland. The CIS contains data concerning firms' innovation activities and engagement in alliances distinguished by partner type.

The subset was created by the following procedure. The first excluding question was “During the three years 2004 to 2006, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?” This question referred to collaboration that firms had had during a three-year period (2004 – 2006), while the measure of innovation performance included the year 2006 only. A similar procedure was done by Oerlemans et al. (2013). A key rationale for this lag is the “fact that it takes some time before the resources obtained through alliances find their way into innovative products and/ or services” (Oerlemans et al., 2013, p. 238). Secondly, if a firm indicated that it had maintained such a relationship, the respondent proceeded to the matrix table question, which was used to ask about multiple items in a single question. In this type of question respondents could indicate the type of innovation co-operation partner they worked with and its geographical location. The matrix table question consisted of a 7 x 4 matrix (7 rows and 4 columns). Each row in this question (7 rows) represented a certain type of innovation co-operation partner, whereas each column further distinguished the type of partner by its geographical location. Specifically, four types of geographical location were distinguished: (1) respondent's country, (2) other European country, (3) the United States, and (4) all other countries.

Measures

Exploratory and Exploitative Innovations. Like most ambidexterity studies to date (He & Wong, 2004; Lubatkin et al., 2006; Tushman & O'Reilly, 1996), we frame our hypothesis in terms of firms' innovation orientation. To operationalize exploratory and exploitative innovations, we asked firms about the objectives of innovation in their firm, which required them to indicate the importance of the relevant objective on a four-point Likert scale representing “Not relevant,” “Low,” “Medium” and “High.” Four objectives represent exploitation-oriented innovation strategy: “Improve quality of goods or services,” “Improve flexibility for producing goods or services,” “Increase capacity for producing goods or services” and “Reduce labor costs per unit output.” Three objectives represented exploratory innovation: “Increase range of goods or services,” “Enter new markets” and “Increase market share.” Scores of 0, 1, 2 and 3 were allocated to responses on the four-point Likert scale for each objective (with 0 representing “not relevant” and 3 “high”); firms could therefore score a maximum of 12 points for exploitative-oriented innovation strategy and 9 points for exploratory-oriented innovation. We used the same approach as Archibugi, Filippetti, and Frenz (2013) and Derbyshire (2014).

Alliance Portfolio Partner Diversity. The CIS data contain information about the types of alliance partners and their geographical locations. We use a question from the CIS 2006 survey to distinguish whether the firm had any co-operation arrangement on innovation activities with other enterprises or institutions during the period of three years (2004–2006). After responding whether it had any innovation co-operation partnerships, it distinguished whether it had a partnership with one of the following actors: (1) other enterprises within its enterprise group, (2) suppliers, (3) clients or customers, (4) competitors, (5) consultants, commercial labs or private R&D institutes, (6) universities or other higher education institutes and (7) government or public research institutes. Firms were further asked to indicate whether their partner was located either in their home country or in the following geographical areas: another EU country, an EFTA or EU candidate country, the United States or other. Although the list was not fully comprehensive, it was extensive (Clausen, 2014).

In line with Oerlemans et al. (2013), APPD is calculated in several steps. Firstly, as conceptualization of APPD is based on the differences in partner types, and not primarily on the differences in their geographical location, we merged—the *four* lists of distinct partner types distinguished by location into *one* list. Our approach focuses on one aspect of alliance portfolio diversity—the diversity of types of alliances—and not on the diversity of partner types by geographical location. It is important to note that this measure does not indicate alliance portfolio size (de Leeuw et al., 2014). More diverse portfolios purely signal that a more diverse set of external actors possessing diverse knowledge sources are part of the ego network of the firm. Here, we focused on the sample firm's ego network, which included the firm (termed ego), and its direct inter-organizational ties with partners (termed alters) (Wasserman & Faust, 1994). Wassmer (2010) defined an alliance portfolio as the aggregate of all strategic alliances of a sample firm. In the network literature, an alliance portfolio is defined as a sample firm's egocentric alliance network; i.e., *all direct ties with partner firms* (Baum, Calabrese, & Silverman, 2000; Ozcan & Eisenhardt, 2009; Rowley, Behrens, & Krackhardt, 2000).

To capture the diversity of a firm's alliance portfolio we measured partner diversity by the Blau diversity index (1977). The Blau index of diversity has been widely used in the alliance literature (de Leeuw et al., 2014; Oerlemans et al., 2013) (Blau diversity index:

$D = 1 - \sum p_i^2$). The result of this calculation is a diversity score, a continuous variable that takes values between 0 (completely homogenous network or least diverse) and 1 (completely heterogeneous network or highest diversity where partners are equally dispersed among the categories). For example, if a firm has seven alliance partners, of which three are suppliers, two customers and two competitors, the Blau diversity index results in $.65 (1 - (3/7)^2 + (2/7)^2 + (2/7)^2 = .65)$.

Innovation Performance. To operationalize innovation performance, we used items as measures of innovativeness that were developed within the Community Innovation Survey (CIS) (Brouwer & Kleinknecht, 1996). First, firms were asked to indicate whether they had introduced new or improved products or services in the previous two years (2004–

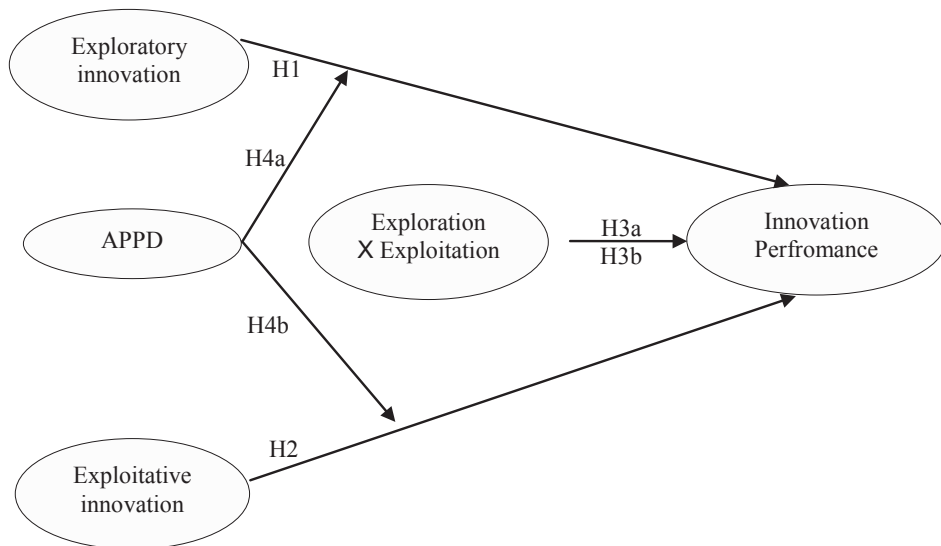
2006). To avoid bias resulting from measuring incidental innovation, a two-year period was chosen (Oerlemans et al., 2013). We used one variable to capture radical innovations and two variables as proxy for incremental innovations. The first variable was measured as the percentage of the firm's turnover (in 2006) generated from products or services that were technologically new to the world market, and the latter two expressed the percentage of the firm's turnover from products or services that were new to the firms and products or services that were significantly improved. We follow the approach of the previous studies that have conceptualized this variable using CIS data (Blindenbach-Driessen & Ende, 2014; Laursen & Salter, 2006), and this perception-based measure of innovation outcomes has shown to be highly reliable (Hagedoorn & Cloudt, 2003).

We included several *control variables* in the analysis. One of them was firm size, which was calculated as the logarithm of the number of employees in 2006. Prior studies find that innovation outcomes and inter-organizational collaborations are size-dependent, whereas larger firms have more abundant resources and it may be easier for them to handle multiple collaborative efforts, as well as multiple objectives of such relationships (Belderbos, Carree, & Lokshin, 2006; Belderbos et al., 2015; Cohen & Klepper, 1996). We also included a control variable that measured the number of factors hampering the firm's innovation activities. These factors hampering to innovation were controlled for because they were proxies for different types of bottlenecks to the firm's innovation activities and were likely to have a strong impact on the firm's decision to seek collaboration partners to overcome some of the bottlenecks (de Leeuw et al., 2014; Duysters & Lokshin, 2011). The "lack of quality personnel" or the "lack of financial resources" is one of *eleven* possible hampering factors, and firms were asked to assess their experience on one or more hampering factors listed on a four-degree importance scale of "high" (3), "medium" (2), "low" (1) or "no effect" (0). We used the same *additive* measure as (Černe, Jaklič, & Škerlavaj, 2013); i.e., the number of cases in which the respondent gave a positive response was *added*, resulting in a measure varying from 0 to 33 (for example, $11 \times 3 = 33$ was the maximum score).

We could not compare firms from different industries, given that different industries have different opportunities to innovate. We controlled the differences between the five NACE (Statistical classification of economic activities in the European Community) sectors. Following Černe et al. (2013), we dummy coded the firms as batch manufacturing, assembly manufacturing, construction and utilities, professional and financial services, and other services. In line with de Leeuw et al. (2014), we included a control variable for firms that were part of a domestic group. A dummy took the value of 1 (otherwise 0) if a firm had headquarters in another country. Prior research has shown that other members of a domestic group can have a similar influence on the innovativeness of a firm (de Leeuw et al., 2014). Experience in establishing and managing partnerships has been shown to be positively correlated with firms' ability to establish new alliance relationships (Dyer & Singh, 1998; Kale, Singh, & Perlmutter, 2000). Firms that are affiliates of a domestic group will have an advantage in such collaborative routines and accumulated experience relative to unallied firms. Moreover, firms may benefit from the technological knowledge available from their international headquarters (Isobe, Makino, & Montgomery, 2000). A control dummy for firms that are part of a domestic group is included.

Finally, we included the use of codified external information sources because these sources provide firms with external information and/or knowledge and can influence innovative performance (Oerlemans & Pretorius, 2006). We used the following question in the CIS questionnaire: “During the three years 2004 to 2006, how important to your enterprise’s innovation activities were each of the following information sources?” This question distinguishes between three main groups of sources, i.e., *internal market sources*, *institutional sources* and *other sources*. Respondents were asked to rate on a scale of 0 (not used) to 3 (very important) to what extent they used the three external information sources for technological innovations. Beside alliances, the use of codified external knowledge sources may be another source of external knowledge, which may have an influence on innovation outcomes and at the same time be a substitute for the use of alliance (Oerlemans & Pretorius, 2006). The control variable is calculated by taking the ratio of the total score and the maximum possible score (de Leeuw et al., 2014). In Table 1, we present the descriptive statistics and bivariate correlations for all variables. With regard to APPD, this table shows that the average APPD is 0.42, which corresponds to about four types of alliance partners (out of a possible seven). Figure 1 presents the conceptual model.

Figure 1: *Conceptual Model*



3 RESULTS

To test our hypotheses, we developed a set of models and tested them with multiple hierarchical linear regression analyses. In order to prevent any multicollinearity problems between the main effect variables and interaction effect variables, we mean-centered the variables before calculating the interaction terms (Aiken, West, & Reno, 1991).

First, the baseline model (Model 1, Table 2) with only the control variables was estimated. The use of external knowledge sources was positively associated with firms' innovation outcomes. The same premise held for the sectors in which firms were active (industry dummies), which were both positively related to firm innovation. Subsequently, the exploration and exploitation variables were added to the model (Model 2, Table 2). This addition led to a highly significant improvement of Model 2 in terms of variance explained; i.e., it demonstrated that these two variables increase the predictive power of Model 2 ($\Delta R^2 = 0.13$, $F = 184.19$, $p < .01$). Model 2 also illustrates the effect of exploration and exploitation on firms' innovation performance.

Firstly, we added exploratory and exploitative innovation as the predictors of innovation performance. The results show a significant positive coefficient ($b = .37$, $SE = .00$, $p < .01$) for the exploratory innovation and a significant negative coefficient ($b = -.07$, $SE = .00$, $p < .01$) for exploitative innovation. These results support Hypothesis 1; however, the effect of exploitative innovation does not support our Hypothesis 2.

Model 3 shows interactive effects between exploration and exploitation on innovation performance and the moderating effect of APPD. First, we find that the interactions between exploration and exploitation are significantly and negatively associated with firms' innovation performance ($b = -.07$, $SE = .00$, $p < .01$). So our results provide support to H3b (i.e., a trade-off relationship), but not to H3a (i.e., a complementary relationship). Furthermore, we find support for the moderating effect of APPD. We find support for H4a, that the relationship between exploratory innovation and the innovation performance is more positive for firms with lower APPD ($b = -.09$, $SE = .00$, $p < .01$), and for H4b, the relationship between exploitative innovation and the firm's performance is a positive one for firms with higher APPD ($b = .07$, $SE = .00$, $p < .01$). In order to interpret the moderating effects of APPD, the relationship between exploration and exploitation and a firm's innovation performance is plotted in Fig. 2 and 3. What emerges from Fig. 2 and 3 is in line with the predicted effects. We examined the interaction effects between exploitative innovation and APPD to see whether APPD might soften the negative effect of exploitive innovation strategy on innovation performance. The results revealed that firms with diverse alliance partners have a positive relationship between exploitation and innovation performance (Fig. 3). In turn, Figure 2 showed that firms whose portfolios include a less diverse set of alliance partners have a more positive relation between exploratory innovation and innovation performance.

Exploitative innovation becomes less negative and statistically significant when we include the interaction effect in the analysis. This might indicate that firms with a higher level of APPD have a better innovation output. Given that the fine-tuning of the existing innovation (i.e., exploitation) is less complex, our results coincide with de Leeuw et al. (2014) research; if we want to improve our innovation performance, we need a broader portfolio that blends a broader set of actors. However, as exploration innovation requires a focus on the knowledge-base for adaption, it benefits from the limited number of partners (de Leeuw et al., 2014).

Table 1: Means, Standard Deviations, and Correlations^a

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 Explorative innovation	4.20	3.27												
2 Exploitative innovation	4.97	3.84	.61**											
3 Innovation performance	0.51	0.50	.55**	.33**										
4 Alliance portfolio partner diversity (APPD)	0.42	0.33	.26**	.21**	.27**									
5 Firm size (log)	0.50	0.67	.10**	.15**	.10**	.18**								
6 Batch manufacturing	0.34	0.47	.16**	.12**	.11**	-.03*	.01**							
7 Assembly manufacturing	0.13	0.34	.13**	.06**	.10**	.03*	.04**	-.28**						
8 Construction and utilities	0.06	0.23	-.11**	-.08**	-.09**	.01	.04**	-.18**	-.10**					
9 Other services	0.25	0.44	-.08**	-.09**	-.04**	-.03**	-.09**	-.42**	-.23**	-.14**				
10 Professional and financial services	0.13	0.34	.02**	-.06**	-.03**	.06**	.02**	-.28**	-.15**	-.10**	-.23**			
11 Part of domestic group	0.23	0.42	.09**	.09**	.04**	.15**	.34**	-.06**	.02**	.00	-.03**	.09**		
12 Innovation bottlenecks	11.56	8.30	.23**	.22**	.10**	.02	-.05**	.12**	.05**	-.05**	-.08**	-.06**	-.10**	
13 Use of codified knowledge sources	0.34	0.29	.40**	.38**	.23**	.30**	.12**	.02**	.03**	-.04**	-.04**	.03**	.05**	.15**

^a n = 7808. ** p < .01, * p < .05

Table 2: Moderation analyses for innovation performance as the explanatory mechanism^a

Variables	Innovation performance		
	Model 1	Model 2	Model 3
<i>Control variables</i>			
Firm size (log)	.06** (.01)	.05** (.01)	.05** (.01)
Batch manufacturing	.31** (.02)	.23** (.02)	.22** (.02)
Assembly manufacturing	.34** (.02)	.24** (.02)	.24** (.02)
Construction and utilities	.05** (.03)	.06** (.03)	.06** (.03)
Other services	.18** (.03)	.13** (.02)	.13** (.02)
Professional and financial services	.28** (.02)	.19** (.02)	.19** (.02)
Part of domestic group	.02* (.01)	-.01(.01)	-.01(.01)
Innovation bottlenecks	-.02 (.00)	-.04** (.00)	-.04** (.00)
Use of codified knowledge sources	.20**(.02)	.06** (.02)	.06** (.02)
<i>Independent variables</i>			
Explorative innovation (x_1)		.37** (.00)	.37** (.00)
Exploitative innovation (x_2)		-.07** (.00)	-.02 [†] (.00)
Alliance portfolio partner diversity (APPD)		.15** (.01)	.18** (.02)
<i>Interaction effects</i>			
APPD × Explorative innovation			-.09** (.00)
APPD × Exploitative innovation			.07** (.00)
$x_1 \times x_2$			-.07** (.00)
Adjusted R ²	.08	.20	.23
Δ Adjusted R ²		.13	.03
F-value	75,63	184,19	158,50
P-value	.00	.00	.00

^aNotes: Standard errors are in brackets. ** $p < .01$, * $p < .05$, [†] $p < .10$

Figure 2: *The moderating effect of alliance portfolio partner diversity on the exploration-innovation performance relationship*

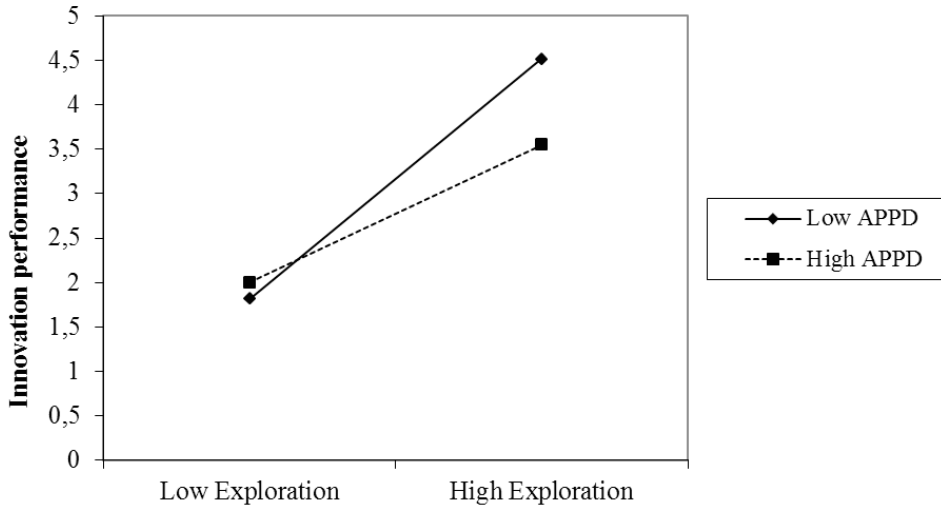
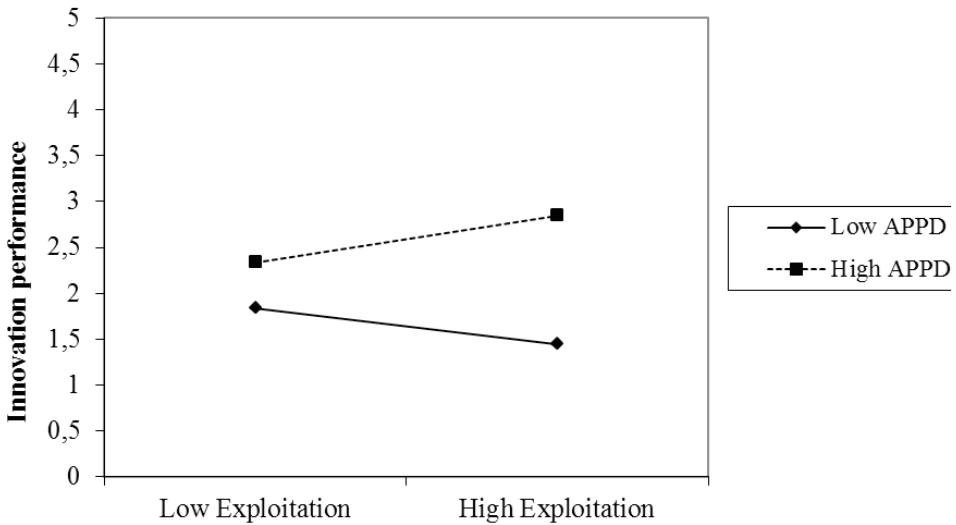


Figure 3: *The moderating effect of alliance portfolio partner diversity on the exploitation-innovation performance relationship*



4 DISCUSSION

Exploration involves developing new knowledge, while exploitation is based on refinement of existing knowledge (Rothaermel & Deeds, 2004). Both activities are essential for organizations, especially organizational performance. March (1991) in his seminal work discussed potential trade-offs of such activities. Most of the literature in the past decade has advocated *ambidexterity*, suggesting that firms could jointly explore and exploit. However, prior research has presented mixed evidence on the merits of ambidexterity. Our research underscores the premise that firms that pursue both exploration and exploitation can enhance their performance. This is consistent with the existing studies on the effects of exploration and exploitation on firm performance (Ebben & Johnson, 2005; Lavie et al., 2010; March, 1991). Moreover, our results suggest that there are inherent trade-offs between these activities; i.e., exploration and exploitation are mutually exclusive.

In line with our hypothesis, we found support for the moderating effect of APPD. Moreover, we hypothesized that firms with a high level of exploratory innovation activities benefit from the enhanced innovation outcomes in contexts that are characterized by lower rather than higher APPD. In turn, high levels of diversity are more suited for fostering exploitative innovation.

4.1 Contributions and Theoretical and Practical Implications

One of the reasons for the potential trade-off situation is the self-destructive nature of those adaptive processes (March, 1991) which may lead to a two-way scenario situation. Either a success (too much focus on exploitation) or a failure trap (too much focus on exploration) situation can lead to overemphasizing exploration or exploitation, eventually resulting in an imbalance (Levinthal & March, 1993). Leiponen and Helfat (2010) argued the potential limitation of having more innovation objectives, which amounted to a potentially unlimited number. Because of cumulative learning (Cohen & Levinthal, 1990), firms may encounter higher marginal cost due to the increased number of innovation objectives (Leiponen & Helfat, 2010), and therefore they may need to trade off the breadth and depth of such innovation objectives. Therefore, we argue that exploration and exploitation innovation objectives can be either complementary or mutually exclusive (they inhibit each other). To overcome an internal trade-off—i.e., a substitution relationship between firms' innovation objectives—external knowledge sources may serve as a key vehicle for balancing innovation objectives. Firms should analyze whether pursuing exploitation innovation objectives internally or exploration objectives in cooperation with others are more important for firm's specific goals. Although exploration objectives play a more important role in the long run for a firm, we want to emphasize that exploitation objectives are not less important. Tensions in innovation can trigger traps, cycles that stem from an increasingly one-sided focus on either exploration or exploitation (Andriopoulos & Lewis, 2010). Hence our study offers some important implications, such as that gravitating toward exploration might lead toward a "failure trap" (Gupta et al., 2006).

As Lavie et al. (2010) argued, exploration and exploitation need to be seen along multiple domains; e.g., exploration becomes more important for one stage of innovation, for instance developing exploration externally or via collaborations, and consequently it may buffer exploitation in another domain, such as internally. This is consistent with the ambidexterity premise, in which exploration provides a starting point for exploitative activities. The results of our study show that imbalance between exploratory and exploitative innovation leads to negative performance outcomes. Along with this fact, it is very possible that firms will not use external knowledge sources or will use broad and diverse ones at a low level. This is perhaps why low-diversity collaborators moderated the effectiveness of the exploratory innovation on performance. Therefore, our results suggest that firms should consider adopting broader and diverse knowledge sources when making decisions about which innovation objectives should be adapted internally or with the help of broader knowledge sources. Our study shows that performance implications from exploitation innovation need to be carefully managed. Firms need to try to leverage their current capabilities to try to prevent firms from being vulnerable to market and technological changes (Atuahene-Gima, 2005).

The prior research separately considered two dimensions of knowledge, breadth of knowledge sources—i.e., diversity of alliance external sources—and innovation objectives. From the knowledge resource perspective, this study finds that diverse knowledge sources contribute differently to the exploration-exploitation performance relationship. Along with the fact that exploration and exploitation are mutually exclusive, interesting results came when we take into account the breadth of diverse external alliance relationships. The findings in this study suggest that firms actually need to pay more attention to exploitation-related innovation objectives. That means that breadth of diverse knowledge sources should be pursued to a high level, while pursuit of exploitation innovation objectives should have more positive effect on innovations. A broad, diverse alliance portfolio provides a firm an opportunity to better leverage its flexibility (Xu, 2015). This is perhaps why broader diverse alliance partners positively moderated the effectiveness of exploitation-related innovation objectives on innovation performance. An additional reason may be found in combining breadth of diverse knowledge sources and complementary knowledge (Leiponen, 2005). As innovation often depends on recombining knowledge (Kogut & Zander, 1992; Schumpeter, 1934) and opting toward more diverse knowledge sources such as clients, suppliers could be beneficial to innovation performance (Leiponen & Helfat, 2010).

Our first theoretical contribution is aimed at the alliance management literature. Previous research has demonstrated that alliance portfolios have to be configured differently depending on the firm's priority with respect to exploratory and exploitative innovation strategies (de Leeuw et al., 2014). Our attempt to obtain a more accurate understanding of the examined multidimensional relationship has unfortunately failed to do so. Our study pointed at the importance of a narrower, more focused alliance partner portfolio diversity by which a firm can effectively pursue an exploratory innovation strategy.

The second theoretical contribution of our study addresses the gaps in the exploration/exploitation literature. Our results revealed that exploratory innovation positively affected

firms' innovation performance. As this is not the case for exploitative innovation, a pre-press ambidexterity research asserted their trade-off relationship (Stettner & Lavie, 2014). To achieve this contribution, our research is rooted in the ambidexterity literature, which has argued different solutions to the exploration/exploitation dilemma (Stadler, Rajwani, & Karaba, 2014). In an attempt to add to the former discussion and research on ambidexterity, we challenge the merits of balancing exploration and exploitation within firms. Regardless of the impact that these two dimensions of innovation strategies have on the ambidexterity literature, the alliance portfolio management literature has proposed that the link between exploration and exploitation can be assessed as one of the dimensions of APD, namely functional diversity (e.g., the range of activities for which the firm uses alliances) (Jiang et al., 2010). Unfortunately, it has neglected the effects of other dimensions on innovation performance.

By contributing to the further advancement of the exploration-exploitation framework in different national contexts, we also made a contribution to the international management literature. As a large portion of our sample consists of international alliances (the CIS 2006 micro data: Bulgaria, Cyprus, Czech Republic, Estonia, Norway, Portugal, Romania, United Kingdom, Slovakia, Slovenia, Spain and Switzerland), we helped to understand the exploration-exploitation tensions along with a mixture of different industries and national contexts. Viewing the APPD not simply in a one-dimensional way provides firms with the ability to handle the complexity of the separation solution to the exploration/exploitation dilemma (Stadler et al., 2014).

What is more, this study has important practical implications. It informs innovation and alliance managers whether they should deploy diversity in their alliance portfolio and which levels of APPD are optimal to undertake in case of this deployment. Our study shows that high levels of a firm's exploration innovation activities might be particularly valuable for alliance portfolios with lower levels of partner diversity. This is particularly relevant for several reasons. Firstly, a firm that favors the balance of explorative and exploitative innovations is advised to pay extra attention when employing external knowledge, especially a diverse one. External knowledge for different innovation purposes, either to exploit or explore, can be overwhelming for firms at first. With regard to the latter, external and diverse knowledge can add much to a firm's innovation performance of exploitative innovation. A regular redesign of the alliance portfolio might help alliance managers to improve their performance outcomes.

4.2 Limitations and Future Research

This study has several limitations that need to be taken into account in future research. First, this study did not test nonlinear effects of organizational ambidexterity on innovation performance. Although we did not formally hypothesize about this nonlinear effect, it would be interesting to further examine the dynamic between exploration and exploitation activities. Instead of looking at them as two parallel strategies and operationalizing them by multiplying (interaction), a worthwhile starting point would be to operationalize them as

one variable and see their nonlinear relationship. Another limitation is operationalization of ambidexterity. In our study we use the multiplication approach, one of the three possible approaches to conceptualize ambidexterity, along with addition and absolute difference. However, a limitation of using the multiplication approach is that it does not determine whether exploration or exploitation contributes more to the magnitude of ambidexterity (Herhausen, 2016).

The same premise holds for the breadth of diverse external knowledge sources. We assume that exploration and exploitation can be substitutes or compliments—often depending on the nature of the operationalization of the concept. Finally, the results of our study show that the relationship between exploitative innovation and firm innovation performance is negative. However, these results could be a little skewed due to the measure of innovation performance (measured as a percentage).

Our study is limited to one dimension of the alliance portfolio management construct. First, alliance portfolio diversity is a multidimensional construct that includes partner, functional and governance diversity. We have theorized alliance portfolio diversity as the degree of variance in partners' purposes. Therefore the APD dimension only shapes a context with a limited impact on innovation. National diversity or industry diversity as part of alliance partner portfolio diversity is theorized, but we have not measured them directly. As an alliance portfolio can vary in diversity along these three dimensions, a future research could attempt to measure these aspects of alliance diversity altogether. Moreover, the study of the influence of these dimensions with respect to firms' explorative and exploitative innovations across different levels of analysis would present a valuable extension of this research.

Although the CIS data might be of a doubtful quality in terms of accuracy of exploration and exploitation innovation activity assessment as well as APPD construct, it leaves room for further research. Although the CIS data may have shortcomings, especially the time period of the sample (2004-2006), they are well accepted by different scholars in exploration/exploitation research as well as in alliance portfolio diversity research. Via the CIS data, it is possible to further validate the research on two streams, balancing exploration and exploitation across different levels and managing their transitions with respect to their alliance portfolio diversity. In other words, items provided in this broad scope survey allow us to test this multidimensional phenomenon. Another useful extension would be decoupling APPD in terms of weak ties (e.g., research institutes) vs. strong ties (e.g., trade shows, suppliers and customers) and see how it benefits organizational ambidexterity. Recently, Paliokaitė and Pačėsa (2015) showed that firms that opt for better explorative innovation outcomes need to pay attention to regularly scanning the environment by using both strong and weak tie sources. Another extension for further research would be to see how specific sets of external partners (strong vs. weak external sources) are related to explorative and exploitative innovation. Therefore, it would be valuable to see whether Granovetter's (1973) theory that weak ties are more effective for exploration innovation is confirmed.

5 CONCLUSION

The main objective of this study is to examine the impact of explorative and exploitative innovation as distinct objectives on firms' innovation performance. Using a multi-country database, we examined the direct effect of exploration- and exploitation-related innovation objectives on firms' innovation performance. In addition, we investigated their interaction—the ambidexterity premise—and how these relationships are moderated by the breadth of diverse external collaboration partners. In our analysis we show that an exploration innovation objective has a positive and linear relationship with innovation performance, while for exploitation objectives this relationship is negative and significant. We also find support for our ambidexterity premise that exploration and exploitation inhibit each other in a trade-off relationship. The results also suggest that the positive effect of exploration innovation objectives on firms' innovation performance is strengthened when external knowledge sources is lower. However, the impact of exploitation-related innovation objectives becomes positive and more rewarding when external relationships are diverse. This study also contributes to the literature on exploration-exploitation ambidexterity. The findings show that partner diversity or breadth of knowledge sources (closely associated with exploration activities) (Xu, 2015) may interact with distinct types of innovation objectives in influencing innovation performance. This is especially important for exploitation activities and adds to the generalizability of the ambidexterity premise.

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