

# Patents as Measure of Exploration and Exploitation

## Strategy: The Case of CVC Investments

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### Abstract

This paper enlarges the scope of inter-organizational learning and strategic renewal research to the ongoing debate on whether companies should mainly try to exploit current trajectories rather than explore new opportunities. Scholars studying exploration and exploitation have been highlighting for long the essential trade-offs firms make in undertaking these activities offering significant support for models in which exploration and exploitation need not always be competing activities, but can and should be complementary. Little is known, however, about the specific mechanisms that drive firms' tendencies to engage in either activity or about whether and how they actually balance the two across organizational boundaries. Being an assortment of boundary spanning operations, the Corporate Venture Capital (CVC) context allows us to analyze how focal firms can articulate explorative and exploitative activities through *internal* and *external* resources. More precisely, we propose that firms could use CVC investments to resolve the exploration-exploitation tension overtime across their organizational boundaries. We test our theoretical model using patent and financial performance data for the entire population of U.S. public firms active in CVC investments over the period 1996-2006.

**Keywords:** Exploration, Exploitation, Corporate Venture Capital, Patents, Tobin's q, Longitudinal Study

## INTRODUCTION

Innovation researches increasingly recognize resources residing outside firm's boundaries as vehicles of new knowledge to foster strategic change (Sobrero & Roberts, 2001; Cassiman & Veugelers, 2006). Indeed, various forms of collaborations such as alliances (Gulati, 1998; Lavie & Rosenkopf, 2006), joint ventures (Kogut, 1991), M&As (Ahuja & Katila, 2001) and equity investments (Dushnitsky & Lenox, 2005a, 2005b; Schildt et al., 2005) have been analyzed under this perspective. However, little research has been carried out regarding *Corporate Venture Capital* (CVC) and no studies, to our knowledge, have yet investigated the relationship between this form of external venturing and the set of investments pursued internally by corporations.

To address this gap, we take a “search” perspective (Katila, 2000; Katila & Ahuja, 2002; Katila & Chen, 2008) where firms look for opportunities in two distinct sectors of a knowledge space. One is knowledge familiar to the firm and the other is knowledge that is new to it (e.g., Levinthal & March, 1981; Katila & Ahuja, 2002). The former allows firm to *exploit* its current knowledge base to create new outputs, while the latter is focused on the *exploration* of unfamiliar knowledge.

Under this framework, we analyze the potential embedded in CVC activities for balancing exploration and exploitation both *within* the firm and *beyond* its organizational boundaries. More precisely, we consider the focal firms (i.e. corporations owning a CVC fund) vis a vis their related portfolios of CVC-backed companies to examine the proportion of exploration and exploitation in both the domains. *Internally*, the focal firm may shift from exploitation to exploration or vice versa (i.e., transitioning overtime from prior to new knowledge). *Externally*, the focal firm can run a portfolio of CVC-backed firms which, as a whole, may also interchange exploitation and exploration overtime (i.e., transitioning from prior to new knowledge).

Under this perspective, the blend of exploration-exploitation pursued through *external* CVC investments can complement a more traditional form of exploration-exploitation pursued *internally* through R&D expenditures and/or corporate diversification. As suggested by the previous literature (e.g. Gupta, Smith & Shalley, 2006; Raisch & Birkinshaw, 2008), corporations could encounter challenges in balancing exploration and exploitation within boundaries. We posit that they could use CVC investments to reconcile these conflicting pressures.

The contribution of this paper is threefold. First, we consider CVC investments as a tool to create not only explorative opportunities, but also exploitative opportunities. Most previous studies emphasized the role of CVC investments as conduits for novel knowledge from innovative start-ups to corporate investors (i.e. Siegel, Siegel, & MacMillan, 1988; Wadhwa & Kotha, 2006), by conceptualizing CVC investment as an exploratory process through which firms attempt to acquire new capabilities. Taking a somewhat different course, we offer theory and empirical evidence to

demonstrate how CVC investments are conduits not only for explorative, but also for exploitative learning. Second, we foster the idea that the balance between explorative and exploitative strategies needs to be analyzed overtime within and beyond the focal firm. In the CVC context, this can be translated into the investigation of the interplay between internal and external sources of knowledge. The former based on R&D projects, the latter focused on knowledge embedded in highly potential start-ups. Finally, we clearly assess the performance implications of disentangling exploration and exploitation across the organizational boundaries of firms. More specifically, we use *Tobin's q* (the market valuation of a firm over the replacement value of its assets) to assess the market response towards alternative exploration-exploitation configurations pursued by the focal firms through CVC activities (Lang & Stulz, 1994; Oriani & Sobrero, 2008).

The remainder of the paper is organized as follows. First, the theoretical underpinnings of balancing exploration-exploitation are summarized. Second, we explain how exploration and exploitation may cross the firms' organizational boundaries in the context of CVC investments. Third, we describe the sample, data sources and operationalization of the constructs. Forth, we present some preliminary results of our regressions. Finally, implications and avenues for future work are discussed.

## **THEORETICAL UNDERPINNINGS**

### **The Exploration-Exploitation Tension**

The behavioral theory of the firm, developed by Cyert and March (1963) assumes that firms have some degree of control over their market environment and that they adapt to their habitat through learning processes. Learning takes place after that feedback loops bring new market knowledge to the organization, which confronts the firm with particular problems. Firms respond to such problems through what is called "search" behavior, by which they pursue new or alternative ways of doing (Huygens et al., 2001). Accordingly, firms display two basic types of search behavior: they can search in the neighborhood of current knowledge, or they can search for radically new alternatives. Cyert and March (1963) treated this distinction primarily in organizational terms, but stressed its applicability at the competitive level (Huygens et al., 2001). Nelson and Winter (1982) also embraced this dichotomy by referring to it as local and distant search and, finally, this dual nature of search has been argued to closely resemble March's (1991) paradox of *exploitation* versus *exploration* (Nerkar, 2003; Katila & Chen, 2008).

In particular, an exploitation strategy includes such things as refinement, choice, production, efficiency, selection, implementation, execution. Exploration, on the other hand, includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation (e.g. Gupta, Smith & Shalley, 2006; Raisch & Birkinshaw, 2008). Levinthal and March similarly stated that exploration involves “a pursuit of new knowledge,” whereas exploitation involves “the use and development of things already known” (1993: 105).

Scholars studying exploration and exploitation have been highlighting for long the essential *trade-offs* firms make in undertaking these activities offering insights on the subject across a wide variety of theoretical disciplines and empirical focuses (Cyert & March, 1963; Mintzberg & McHugh, 1985; Rosenkopf & Almeida, 2003). Many scholars argued, in particular, that firms generally experience difficulties in combining exploration and exploitation. As a consequence, they prefer one over the other search mode as exploration and exploitation cannot be undertaken simultaneously (March, 2006).

However, a second group of studies pointed out that focusing only on one of the two searches could not be the right solution for the firm’s growth. On one hand, undertaking only an exploitative strategy risks to create the so called “competence traps” (March, 1991; Levinthal & March, 1993). Namely, when the need to adapt to major changes in the competitive environment arises, organizational inertia and lack of absorptive capacity have been proposed to preclude the firm’s effective adaptation to the new circumstances by not being able to absorb the required new external knowledge (Volberda, 1996; Van Den Bosch et al., 1999) and stifle a firm’s ability to alter its course in a changing market (Cyert & March, 1963; Lavie & Rosenkopf, 2006). Similarly, a strategy over-emphasizing exploration can lead firms to innovate without exploiting their advances for profit (Levinthal & March, 1993; Gupta, Smith & Shalley 2006).

Starting from these considerations, researchers started to agree in favor of a *concurrent* need for both exploration and exploitation, thus, suggesting that too little of either might reduce firm’s performance over time (Levinthal & March, 1993; Ancona et al., 2001; Benner & Tushman, 2002; Gupta, Smith & Shalley, 2006). This implies that exploration and exploitation need not always be competing activities, but can be also complementary (Katila & Ahuja, 2002; Lavie & Rosenkopf, 2006; Gupta, Smith & Shalley, 2006; Katila & Chen, 2008). The main contribution introduced by this stream of research has been to abandon the representation of exploration and exploitation as two extremes of a *continuum* in favor of an *orthogonal* view where the two can coexist.

Within this last stream of literature, researchers proposed the concept of *ambidexterity* (Benner & Tushman, 2003; Burgelman, 1996; Christensen, Suarez & Utterback, 1998; Levinthal, 1997) as a mechanism to help organizations realizing the above-mentioned balance. Accordingly, if

exploration and exploitation occur in different domains, the two may be thought as orthogonal tasks. Hence, exploration can be pursued in one module of a modular system while exploitation is pursued in another, enabling ambidextrous strategies (Lavie & Rosenkopf, 2006). Research on inter-organizational learning, for instance, points to the fact that organizations have access not only to internally owned resources but also to resources in their external environments (Powell, Koput & Smith-Doerr 1996) through alliances (Gulati, 1998; Lavie & Rosenkopf, 2006), joint ventures (Kogut, 1991), M&As (Ahuja & Katila, 2001) and equity investments (Dushnitsky & Lenox, 2005a, 2005b; Schildt et al., 2005). By considering internal and external resources as two distinct domains (i.e. modules), these studies suggest that the former can be used for exploitative goals, while the latter can be seen as vehicles of new knowledge to foster strategic change and thus exploration.

Summarizing, scholars generally agree that balancing exploitation and exploration makes sense and may even be necessary for survival (e.g., Christensen, 1998; Lewin & Volberda, 1999). More precisely, organizations can sustain their competitive advantage by managing for short-term efficiency by emphasizing stability and control, as well as for long-term innovation by taking risks.

However, these researchers have been mainly focused on the mechanics to balance exploration and exploitation by studying a single domain<sup>1</sup>, located only inside or outside organizational boundaries, thus, disregarding the possibility that conflicting pressures may influence search processes across boundaries. Furthermore, the few studies analyzing the interactions between an internal and an external dimension have seen exploitation bounded within the firm and exploration exclusively pursued through external collaborations (Koza & Levin, 1998; Wahdwa & Kotha, 2006). A comprehensive framework where exploration and exploitation coexists both within and beyond the firm's boundaries and where the interactions between the two dimensions are analyzed yet misses.

## **CONCEPTUAL FRAMEWORK**

### **Disentangling the Exploration-Exploitation Tension across Organizational Boundaries**

The pace and complexity of technological change create many uncertainties for organizations and these, in turn, force organizations to innovate continuously to be competitive. In technology-intensive industries, often organizations do not possess the knowledge required to produce innovations and are limited in their ability to produce knowledge purely through internal R&D

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<sup>1</sup> For a recent exception see Lavie & Rosenkopf, 2006.

investments. To accumulate the necessary knowledge, many organizations turn therefore to external activities such as alliances, joint ventures, mergers and acquisitions, and CVC investments (Schildt, Maula, & Keil, 2005).

In this complex environment, Raisch & Birkinshaw (2008) recognized the need of a “granular” view of innovation where (i) a firm’s innovation stream consists of various innovation initiatives (Benner & Tushman, 2003), (ii) the exploitation and exploration requirements may differ significantly from initiative to initiative (Lawrence & Lorsch, 1967) and (iii) even within each initiative, some elements may be produced by re-implementing existing capabilities, whereas developing others may rely on the exploration of new capabilities (Gatignon, Tushman, Smith, & Anderson, 2002).

BMW’s new Rolls-Royce Phantom model, for example, consists of components that were taken from BMW’s existing 7-series cars (i.e., the V12 engine), components that were adapted to the luxury model’s specific requirements (i.e., the aluminum space frame body), and components that were radically new to the firm (i.e., the rear-hinged doors). Given this variety, the analysis of boundary contexts at the business unit or corporate level may be misleading. Research should thus complement a system-level analysis with a more fine-grained investigation of external environments and their interrelations with exploration-exploitation structures, contexts, and characteristics (Raish & Birkinshaw, 2008).

Under this lens, a firm can be represented as the locus where the recombination of internal (Fleming, 2001; Nerkar, 2003) and external knowledge elements (Katila & Chen, 2008) takes place towards the creation of new innovative propositions. Firms can explore in some domains of action while exploiting in others, hence multilevel concepts and measures may be required to fully capture their exploitation and exploration activities. Prior research has demonstrated, indeed, that firms can coordinate exploration-exploitation efforts overtime and in different areas, such as across technological and organizational boundaries (Rosenkopf & Nerkar, 2001) or across technological and geographical domains (Rosenkopf & Almeida, 2003). Conversely, studies that focus only on one domain of exploration-exploitation have been claimed to be sensitive to the choice of domain and to depict only a partial picture of firms’ balancing efforts (Lavie & Rosenkopf, 2006).

Expanding previous research on exploration-exploitation, we propose that accessing external knowledge may enable a focal firm to balance exploration and exploitation overtime (Lavie & Rosenkopf, 2006) by combining new elements with past elements (Katila & Ahuja, 2002) within and beyond the boundaries of the firm (Koza & Levin, 1998). More precisely, the search efforts of firms to innovate, as interplay between exploration and exploitation, may vary along three main dimensions: *within*, *beyond* and *across* firm’s boundaries.

## **Corporate Venture Capital as Vehicle to Resolve the Exploration-Exploitation Tension across Boundaries**

In this study, we examine the role of Corporate Venture Capital (CVC) investments as vehicle of exploration and exploitation across organizational boundaries.

The general definition of corporate venturing available in the literature is based on the classification which distinguishes between internal and external venturing, in accordance with whether the new ventures invested reside within or outside the existing corporation (Sharma & Chrisman, 1999). Following this criterion, firms can be split between those nurturing opportunities that are already in-house and primed to leverage corporate competencies (*internal venturing*) and, on the other hand, those financing autonomous organizational entities that reside outside the boundaries of the corporation (*external venturing*). In line with this literature, *Corporate Venture Capital* (CVC) investments are viewed as boundary spanning operations (Maula, 2001) and, thus, they belong to the class of external corporate venturing (Keil, 2004).

More precisely, CVC is defined as minority equity investments in small, young and independent entrepreneurial ventures where the investors are established, non-financial firms with both financial and strategic goals (Chesbrough & Tucci, 2004, Dushnitsky and Lenox, 2005a and 2005b). The typical structure of CVC investments is depicted in Figure 1 where the *focal firm* (i.e. *corporation*) creates a *CVC fund* beyond its boundaries and directly supplies it with a certain stock of capital to finance a portfolio of *companies* (i.e. *new ventures*), which in turn contributes to the corporation's financial and strategic goals (Ernst, Witt & Brachtendorf, 2005).

---- Insert Fig. 1 Here ----

Some key elements univocally identify CVC activities from other external collaborations:

1. The portfolio companies receiving the investment are *separate* legal entities from the corporation making the investment.
2. The purpose for the corporate investment is not purely financial, but also *strategic*.
3. The form of investment in the portfolio companies is *equity*, rather than debt or other modes of financing.

A firm's portfolio of ties with other external entities can be a key factor to firm's success. External ties enabled Apple leaders, for instance, to focus on their strengths, such as architectural design, while leveraging their partners' resources and market positions. And the Apple story is not unique: many firms rely on building portfolios of external ties to enhance learning and performance (Ozcan & Eisenhardt, 2009).

From an organizational learning perspective, being able to access a portfolio of external companies is not only advantageous for the search of new knowledge, but also for the productive recombination of old elements. Some examples of strategic benefits embedded in CVC investments are the exposure to new markets and technologies, identification of acquisition targets, brand extension possibilities and knowledge spillovers from innovative start-ups to corporate investors (Siegel, Siegel, & MacMillan, 1988). Established corporations such as Xerox, Lucent, Nokia, Novartis, Pfizer and Intel have explicitly formalized their CVC activities by setting up investment programs motivated by the search for strategic benefits, such as exploiting current knowledge developed internally, learning from outside new ventures and creating new knowledge.

This is particularly relevant when firms face industry uncertainties, such as marketing (i.e., Who are our clients?) or technical issues (i.e., Which technical standards will prevail?). Uncertainty makes it challenging to anticipate the best moves, boosting the value of external sources of exploration and exploitation both at the intra- and at the inter-organizational level. As argued by Wahdwa and Kotha (2006: 819), for instance, "CVC investment represented a strategic approach that incumbents employ to avoid being blindsided by technological change".

Being an assortment of boundary spanning operations (Maula, 2001), the CVC context perfectly fits with the focus of our research. Specifically, it allows us to analyze the performance implications of articulating explorative and exploitative strategies across internal (i.e. R&D investments, diversification) and external resources (i.e. portfolio companies financed through CVC funds).

The peculiar processes underlying CVC investment activities facilitates the access to external knowledge that, in turn, can influence the process of knowledge creation within corporations. Corporations may address established problems using new approaches or approaches that combines old and new perspectives that have been internally developed (Ahuja & Katila, 2001). Also, corporations may use their portfolios of CVC-backed firms to support, complement or augment their internal R&D capabilities, enter new markets or introduce new products earlier than competitors who lack access to external knowledge (Chesbrough & Tucci, 2004; Schildt, Maula & Keil, 2005). Indeed, empirical evidence shows that an increase in CVC investments is positively associated with increased future innovation by the investing firm (Dushnitsky & Lenox, 2005).

Furthermore, CVC activities allow corporations to align external investments with their strategic goals, thus allowing them to balance exploration and exploitation across boundaries in a systematic manner. Indeed, before investing, corporations generally undertake extensive due diligence activities related to proposed companies and accompanying details such as business plans, intellectual propriety rights, technology resources, proposed products and market prospects. This process provides a firm with a unique opportunity to learn about all aspects of a company before making a capital commitment (Dushnitsky & Lenox, 2005). Also, after investing, firms usually institute various mechanisms for interacting with the company and for learning from it.

In summary, since investing firms can leverage the patterns of idea combinations of a portfolio of CVC-backed firms, we propose that CVC investments may be used to resolve the exploration-exploitation tension across organizational boundaries.

---- Insert Fig. 2 Here ----

Our framework adopts a search perspective (Katila, 2000; Katila & Ahuja, 2002; Katila & Chen, 2008)), considering firms' operations as a series of search processes, occurring within and beyond their organizational boundaries. When searching for new technologies, firms and managers are constantly dealing with the fundamental question behind a broader discourse on exploration-exploitation: *something old or something new?*

Our suggestion to resolve this paradoxical requirements is to disentangle overtime the exploration-exploitation tension across organizational boundaries. Figure 2 shows the different strategic configurations resulting from the contextual articulation of exploration and exploration across the organizational boundaries of a focal firm. *Cross-boundary Exploitation* represents a strategy focused at maximizing exploitation in both the internal and external environments of the corporation. *Cross-boundary Exploration* represents a strategy profile mainly oriented towards the exploration of new possibilities in both the internal and external environments of the focal corporation. *Cross-boundary Ambidexterity (1)* represents an internal exploitation orientation of a corporation paired to an external explorative orientation by a portfolio of CVC-backed companies. *Cross-boundary Ambidexterity (2)* represent an internal focus on exploration by a corporation paired to an external focus on exploitation delegated to a portfolio of CVC-backed companies.

Our approach results being quite different from the answers provided by previous works that suggested to externalize either exploitative or explorative activities through outsourcing or by establishing alliances (Grant & Baden-Fuller, 2004; Holmqvist, 2004; Lavie & Rosenkopf, 2006; Rothaermel & Deeds, 2004). Our approach is also different from the idea to temporarily cycle

through periods of exploitation and periods of exploration (Eisenhardt & Brown, 1998; Nickerson & Zenger, 2002; Siggelkow & Levinthal, 2003; Venkatraman, Lee, & Iyer, 2007).

Classic examples of the proposed way of reasoning can be found at the intersection between the pharmaceutical and the biotechnology industry. Here the investing firms are the pharmaceutical corporations, founded under the technology paradigm of chemical screening, and the CVC-backed companies are biotechnology ventures founded under a new technology paradigm based on molecular biology. The relatively new field of biotechnology embodies a scientific base (molecular biology) that is significantly different from the knowledge base of pharmaceuticals (organic chemistry) so that a scientist who is trained in the framework of drug discovery and development based on chemical synthesis loses on the average around 80–100 percent of his or her skills when attempting to transition to the emerging framework of drug discovery and development based on molecular biology (Rothaermel & Boeker, 2008). In this example, pharmaceutical firms are experiencing an inherent internal trade off between exploration-exploitation: the knowledge and technologies characterizing biotechnology are competence destroying for pharmaceutical firms (Stuart, Hoang, and Hybels, 1999), but biotechnology companies possess capabilities that traditional pharmaceutical firms can profitably draw upon to maintain their innovative presence.

Considering exploration and exploitation as two distinct dimensions of search that can be pursued across the organizational boundaries of a focal firm, we also propose that the choice to pursue one or both of these dimensions affects a corporation's financial performance. Theory and empirical evidence suggest that too little of either might reduce performance (Levinthal & March, 1993; Ancona et al., 2001; Benner & Tushman, 2002; Gupta, Smith & Shalley, 2006) and significant support has been provided for models in which exploration and exploitation need not always be competing activities, but can be complementary (Katila & Ahuja, 2002; Lavie & Rosenkopf, 2006; Gupta, Smith & Shalley, 2006; Katila & Chen, 2008).

Some studies have been investigating the impact of exploitation and exploration on performance by surveying business-units (Gibson & Birkinshaw, 2004), tracking financial markets (Kyriakopoulos & Moorman, 2004; Uotila et al., 2009) and sales growth (He & Wong, 2004), claiming that a balance of exploration and exploitation is needed because both excessive depth (exploitation) and scope (exploration) of search lead to negative effects. In this study we argue that in the CVC context the presence of different environments (i.e. internal versus external) may enable the classic trade-off between exploration-exploitation to be managed across different resource spaces, but the performance implications of cross-boundary exploration-exploitation strategies have never been considered. Also, current empirical studies mainly relied on cross-sectional survey data on managers' perceptions to measure constructs and boundary conditions (e.g., Gibson &

Birkinshaw, 2004; Jansen et al., 2006). However, surveys are prone to many problems when acquiring longitudinal data due to the limited reliability of informants' retrospective accounts (e.g., Golden, 1992). To address this issue, we focus on the actual realization of strategies by deploying archival data on financial performance vis a vis exploitative and explorative moves that have been implemented by the focal corporations and their portfolios of CVC-backed firms.

In the following sections we describe our sample, data sources and variables. <financial performance will be defined as the market valuation of a firm (V) over the replacement value of its assets (A); search depth (exploitation) as the degree to which search activities revisits a firm's prior knowledge and search scope (exploration) as the degree of new knowledge that is employed.

## **METHODS**

### **Sample and Data Gathering**

We test our theoretical model on the population of U.S. public firms active in CVC investments over the period 1996-2006. We focus on this time span as it represents the last and biggest wave in CVC history (Gompers & Lerner, 1998) with 2,382 financial rounds and 74% of global investments in the five quarters up to April 2008 (Ernst & Young, 2008).

To build up our sample, we first identified all the CVC funds created in the U.S. over the period of analysis through the VentureXpert database by Thomson Financial. This corresponds to a total number of 281 CVC funds created by 239 corporations.

Then, we refined this initial sample by dropping CVC firms with missing data for our main variables (reducing our sample to 239 funds and 202 corporations) and private corporations which do not have a matching code on financial databases like Worldscope. After this cleaning process, the sample included 221 CVC funds originated by 186 U.S. public firms in the period 1996-2006, with 1,616 funded companies and 2,382 rounds.

Finally, after considering the sets of patent applications corresponding to each corporation and each CVC-backed firm, our final sample consists of 58 individual corporations and 58 portfolios composed by a total of 1,101 funded companies in the period 1996-2006.

Each individual corporation generated on average 204 patent applications per year (the top patenting firm is HP with 1,543 patent applications per year in 2003) while each portfolio of CVC-backed firms contributed on average 8 patent applications per year (the portfolio of CVC-backed firms linked to the CVC Fund "Intel Capital" tops the list with 77 patent applications in 2003).

For each investor, we collected from VentureXpert information on the number of funds managed, the companies belonging to their investments portfolio, the amount invested in each company and in each round and the date of each round. For each CVC-backed company, we extracted data about the main industry in which it operates, funding year, stage of development, country, public status (private, public, subsidiary, defunct, government owned) and investment status (active, LBO, defunct, acquisition), total amount of financing obtained by CVC firms, CVC firms involved, corresponding funds, number of financing rounds received and date of each round.

To measure the amount of exploration and exploitation for each firm, we chose patents as data source for several reasons. First, since patents by definition include a description of a problem and a solution to that problem (Walker, 1995), they provide an accurate description of search activities to understand how firms solve problems or undertake search across ideas by navigating the exploration-exploitation tension overtime. Second, patent data are one of the few sources that give us a detailed and consistent chronology of search (Almeida, Song & Grant, 2002; Katila, 2002). Citation patterns in patents track the knowledge used over time and, because of their legal nature, are precise (Walker, 1995). Third, patent measures are particularly appropriate for testing hypotheses that include learning and knowledge creation. Because one of the requirements for patenting is novelty, each time an existing patent is cited as an antecedent for a new patent, it is used in a different context than before. Thus each repeated use of a citation serves as a distinct source for learning. Using prior art citations as a measure of search also has some limitations. Previous studies have shown that the propensity for patenting varies considerably across industries (e.g., Cockburn & Griliches, 1988). However, this is not a problem in this study because we focus on technology based firms for which patents have been shown to be an important appropriability mechanism (Arundel & Kabla, 1998).

We used the third version of the NBER database<sup>2</sup> (Hall, 2009)) to retrieve the patent publication numbers of any firm. Ultimately, we downloaded from the U.S. Patent and Trademark Office database 239,921 patents granted between 1990 and 2006, of which 203,436 held by the U.S. public firms of our sample and 36,485 held by their CVC-backed companies.

We also used the Who Owns Whom directories to track subsidiaries of the corporations under investigation so that patents could be perfectly assigned to each firm. We then used custom-programmed ASP and VB.net code to assemble the patent citation data into the independent variables. These programs were particularly time-consuming to design and run because they combined a large number of citation variables, interactions, and long time periods. We referred to

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<sup>2</sup> See Hall et al., 2001 for a detailed description of contents.

the period 1990-2006, instead than the above-mentioned period of analysis 1996-2006, to allow a five year lag for computing the exploration-exploitation indicators and avoid left censoring biases.

Finally, through the Worldscope dataset we gathered financial data for the corporations to construct our dependent and control variables. In particular, we collected the following data: equity value, book value of long-term debt, net current liabilities, book value of equity and total assets, useful to construct our dependent variables – Tobin's  $q$ , in addition to total sales and level of corporate R&D expenses used as control variables in the econometric model.

## **Dependent Variables**

**Tobin's  $q$ .** To test our hypotheses we need to assess the value created through CVC investments, hence our dependent variable is a measure of firm's changing value. The Tobin's  $q$  is defined as the market valuation of a firm ( $V$ ) over the replacement value of its assets ( $A$ ). This is a good proxy and it is extensively used in the literature. A Tobin's  $q$  greater than 1 suggests that the market value reflects some unmeasured or unrecorded assets of the company and that the firm has great growth opportunities. We use two different proxies to assess the numerator: in the first,  $V$  is the sum of firm equity value (given by the product of a firm's share price and the number of common stock shares outstanding), book value of long-term debt and net current liabilities (see Chung and Pruitt, 1995); in the second  $V$  is the sum of firm equity value, and the difference between total assets and book value of equity.  $A$  represents the sum of total current assets, long term receivables, investment in unconsolidated subsidiaries, other investments, net property plant and equipment and other assets. Because Tobin's  $q$  incorporates growth values of equity, it explicitly includes not only investor valuations of current operations but also investor expectations for future growth. Thus, it captures the lag between CVC investment and realized benefits.

## **Independent Variables**

Several authors have used patent data as an indicator of search activity (see Stuart & Podolny, 1996; Katila, 2000; Rosenkopf & Nerkar, 2001; Katila & Ahuja, 2002; Katila & Chen, 2008). The basic idea is to measure how much a firm exploits existing items versus explores new items in its innovation search overtime. In this study, we used firms' prior art patent citations to measure the depth and scope of search for each focal firm and its corresponding portfolio of CVC-backed companies.

Our data consists of a panel of observations on firm-year. Depth (i.e. exploitation) and scope (i.e. exploration) and measures are computed on a yearly basis by pooling and partitioning data for each focal firm and its related portfolio of CVC-backed companies. “Within-boundaries” indicators of depth and scope have been computed to describe the exploration-exploitation configuration of each corporation, while “beyond boundaries” indicators have been computed considering overtime the portfolio of CVC-backed companies related to a specific corporation.

The *depth measure* corresponds to the theoretical concept of exploitation. It describes how deeply a firm redeploys its existing knowledge and is measured by counting how often each element in the current domain of analysis has occurred in the  $n$  years before:

$$(1) \quad \text{Depth}_{it} = \frac{\sum_{a=t-n}^{t-1} \text{Repetition Count}_{it}}{\text{Total Items}_{it}}$$

The *scope measure* corresponds to the theoretical construct of exploration and describes how widely a firm explores new knowledge by counting how many of the current elements have never occurred before:

$$(2) \quad \text{Scope}_{it} = \frac{\text{New Item}_{it}}{\text{Total Items}_{it}}$$

Our software calculates depth and scope indicators by considering prior art patent citations in the analyzed time span. These data represent each firm’s citations bases yearly (see also Nelson & Winter, 1982) and to control for the expanding risk set (Stuart & Podolny, 1996), we used fractions when constructing the variables by dividing the citation counts in each indicator for the firm’s total number of citations that year. Also, organizational memory in high-technology companies has been found to be imperfect so that knowledge depreciates sharply, losing significant value within approximately five years (Argote, 1999). To account for this problem we computed all measures across a lifespan of 5 years in the past starting from the focal year<sup>3</sup>.

***Corporate Depth (Corporate Exploitation).*** This variable considers the patents of the focal firm and describes accumulation of search experience with the same knowledge elements. We argued above that the more frequently a firm has used knowledge, the more deeply it knows it. Thus,

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<sup>3</sup> The use of these measures can be illustrated by considering a firm with ten patents. Each of the ten patents further cites ten other patents. On the average, eight out of the ten citations are new to the firm: that is, it has not used them during the past five years (we considered this lag-time period because a CVC fund has, on average, a life of five years in which the established firm can finance its portfolio companies through several rounds). In this example, the firm’s search scope is thus 0.8. Of the remaining two “old” citations in each patent, on average, the firm has used one of them twice and the other three times. Thus, the search depth for this firm is 0.5.

search depth was measured as the average number of times a firm repeatedly used the citations in the patents it applied for. We created the depth variable by calculating the number of times that, on the average, each prior art citation in year  $t-1$  was repeatedly used during the past five years.

***Corporate Scope (Corporate Exploration).*** This variable considers the patents of the focal firm and corresponds to the theoretical notion of exploration of new knowledge. It was computed as the proportion of previously unused citations (new citations) in a firm's focal year's list of citations. We assessed the share of citations in a focal year's citations that could not be found in the previous five years' list of patents and citations by that firm. Values for this variable range from 0 to 1.

Following a similar approach, we consider overtime the portfolio of CVC-backed companies related to a specific focal firm to calculate “beyond boundaries” indicators of exploration-exploitation. Taking a portfolio perspective is important as firms form ties with a number of external entities in the context of building partnerships, making the logic of inter-organizational learning central to understand tie formation. Portfolios are significant because they have aggregate properties (such as partner diversity and mix of peculiar strengths) that could impact learning and performance as a whole (Uzzi & Lancaster, 2003) while being less meaningful for single ties.

***Portfolio Depth (Portfolio Exploitation).*** This variable represents the average search depth of all the CVC-backed companies in a given portfolio. To obtain this variable we first considered each one of the 1,101 funded companies in our sample on a yearly basis and computed individual depth indicators as the number of times that, on the average, each prior art citation in year  $t-1$  was repeatedly used during the past five years. Then, we considered the list of CVC-backed firms tied to a specific corporation in a given year and computed the average depth across that list of companies.

***Portfolio Scope (Portfolio Exploration).*** This variable represents the average search scope of all the CVC-backed firms in a given portfolio. To obtain this variable we first computed individual scope indicators for each one of the 1,101 funded companies in our sample as the share of citations in a focal year's citations that could not be found in the previous five years' list of patents and citations by that firm. Then, we considered the list of CVC-backed companies tied to a specific investor in a given year and computed the average scope across that list of companies.

***Cross-boundary Exploitation.*** This variable is calculated as Corporate Depth\*Portfolio Depth and represents a strategy focused at maximizing exploitation in both the internal and external environments of the corporation.

***Cross-boundary Exploration.*** This variable is calculated as Corporate Scope\*Portfolio Scope and represents a strategy profile mainly oriented towards the exploration of new possibilities in both the internal and external environments of the focal corporation.

***Cross-boundary Ambidexterity (1).*** This variable is calculated as Corporate Depth\*Portfolio Scope and represents an internal exploitation orientation of a corporation paired to an external exploration orientation by a portfolio of CVC-backed companies.

***Cross-boundary Ambidexterity (2).*** This variable is calculated as Corporate Scope\*Portfolio Depth to represent an internal focus on exploration by a corporation paired to an external focus on exploitation delegated to a portfolio of CVC-backed companies.

### **Control Variables**

Since larger firms possess greater resources for investing in research and, thus, are more likely to pursue more internal R&D as well as external CVC (Dushnitsky and Lenox, 2005: 957), we control for *corporate size*. We construct this variable using the logarithm of corporate sales in the same year in which the portfolio has been funded (Log(Corporate Size)). To take into account the variance in inputs for innovation activity which impacts on a firm's propensity to innovate (Wodhwa and Kotha, 2006) and, thus, to invest in diversified CVC programs, we also controlled for R&D expenses, which represent all direct and indirect costs related to the creation and development of new processes, techniques, applications and products with commercial aim. Since our measure of R&D expenditure can be highly correlated with firm size, we use *R&D Intensity* (instead of only R&D expenses), measured as the ratio of R&D expenditure to corporate investors' sales in the fund vintage year. We gather these data on firm's sales and R&D expenditures from Worldscope.

Finally we use a dummy variable (DUM\_activelink) to control for the years in which the relationship between the corporation and its portfolio may be strengthened by the presence of one or more rounds of financing.

## RESULTS

Testing our theoretical model with a dynamic longitudinal panel data research design required us to account for endogeneity when assessing strategy financial performance. “In strategic management research, we often wish to draw conclusions about the superiority of one strategy compared to alternatives so that we can aid managers with their business decisions. A difficulty in making such assessments is that firms purposely choose their strategies based on their capabilities and industry conditions. Because firms self-select the strategies we observe, we are not able to make the comparison of strategy performance in an experimental setting where firms are randomly assigned strategies”. (Shaver, 1998:572). Empirical models that do not account for this and regress performance measures on strategy choice variables are potentially misspecified and their conclusions incorrect. We did so by using a GMM estimator (Arellano and Bond, 1991) via the `xtdpdsys` Stata module.

--- Insert Tab. 1 Here ---

--- Insert Tab. 2 Here ---

We first present some descriptive statistics for our variables. The corporations in the sample differ widely in R&D Intensity (13.069 and s.d. 10.353) but not in size (15.790 and s.d. 1.998) and performance (0.474 and s.d. 0.276). Second, we observe that the average level of exploration for corporations (0.671) is lower than the level obtained for the portfolio companies (0.728). Conversely, corporations tend to be more focused on exploitation (1.281) than their CVC-backed companies (1.100). Third, Table 1 allows to compare the levels of Cross-boundary Exploitation with the levels of Cross-boundary Exploration. Our statistics suggest that the former is greater than the latter (1.534 versus 0.492) and that the tendency to use both internal and external resources to exploit previous knowledge differs more among firms (s.d. 4.046) than the behaviors towards cross-boundary explorative research (s.d. 0.272). Finally, our statistics point out that the combination of internal exploitation orientation of a corporation and the external exploitation orientation by a portfolio of CVC-backed companies is, on average, more common (0.916) than the opposite combination where internal focus on exploration by a corporation is paired to an external focus on exploitation delegated to a portfolio of CVC-backed companies (0.718).

After inspecting descriptive statistics, we set out to run the GMM regression model. The results from the system GMM regression model appear in Table 3. The first column reports the baseline model in which Tobin's  $q$  at the year  $t-1$ , sales, sales at the year  $t-1$ , R&D intensity and the dummy

are included as control variables. In model 2, we introduced search depth and search scope for both corporations and CVC-backed companies to assess those variables' effects on market valuation. Finally, in model 3, we included all the possible combinations of interaction between search depth and search scope for corporations and portfolio companies. We base our discussion of the results on the full model, represented in column 3.

Regarding the main effects, pursuing explorative efforts through CVC investments is positively related to the corporation performance (Tobin's q). That is, the amount of exploration generated by a set of CVC-backed firms has a positive impact upon the market valuation of the underlying corporation. Conversely, the interaction between the amount of exploration pursued internally by a corporation and the explorative effort of a portfolio of CVC-backed firms has a negative effect upon the corporation's financial performance. Indeed, the regression result for Portfolio Exploration shows a positive and significant coefficient (0.543\*\*, s.d. 0.230) while "Cross-boundary Exploration" display a negative and significant coefficient (-0.604\*\*, s.d. 0.256).

Cross-boundary Ambidexterity, the interaction between the amount of exploitation pursued internally by a corporation and the corresponding amount of exploration pursued by its portfolio of CVC-backed companies, impacts negatively upon the corporation's financial performance. The coefficient is negative and significant (-0.103\*\*, s.d. 0.051). Quite surprisingly, this result contradicts the lion's share of ambidexterity related literature, suggesting a bump in performance for those firms that concurrently pursue exploration and exploitation.

--- Insert Tab. 3 Here ---

The lag term of Tobin's q is positive and significant (1.218,  $p < 0.01\%$ ) suggesting that the market valuation in the year before (t-1) the time of interest positively impacts on the market valuation registered during time t. The opposite effect, instead, has been found for sales (-0.0632,  $p < 0.1$ ). Surprisingly, the effect of R&D Intensity at the year t-1 on our dependent variable seems to be negative on the level of performance of the subsequent year (-0.00187,  $p < 0.5$ ). As a robustness check, we also estimated our model using the market-to-book ratio as our dependent variable, defined as the market value of the ordinary (common) equity divided by the balance sheet value of the ordinary (common) equity in the company. Estimates from these models were consistent to those using Tobin's q.

## **DISCUSSION**

This study set out to empirically test the relationship between a corporation's exploration-exploitation activities and its market-based performance in presence of CVC investments. Past research claimed that a balance of exploration and exploitation is needed because both excessive depth (exploitation) and scope (exploration) lead to negative effects. Limits to improvement and rigidity have been associated with high levels of exploitation (Gupta, Smith & Shalley, 2006) while knowledge integration costs and decreasing reliability have been proposed for extremely high levels of exploration. In the CVC context the presence of different environments (i.e. internal versus external) may enable the classic trade-off between exploration-exploitation to be managed across different resource spaces, yet the performance implications of cross-boundary exploration-exploitation strategies have never been studied.

Past research on inter-organizational learning pointed to the fact that organizations may use various mechanisms, such as alliances (Gulati, 1998; Lavie & Rosenkopf, 2006), joint ventures (Kogut, 1991), M&As (Ahuja & Katila, 2001) or equity investments (Dushnitsky & Lenox, 2005a, 2005b; Schildt et al., 2005) to enact their external environments. This stream of studies often suggested that internal resources might be used for exploitative goals, while external resources can be seen as vehicles of new knowledge to foster strategic change and thus exploration.

Our preliminary results show that a strict focus on exploration confined in a portfolio of CVC-backed firms may have a positive impact upon the focal firm's financial performance. However, when this logic is translated into an inter-organizational context where both an internal and an external dimensions interact, the positive effects exerted by confining exploration in the external environment will be eroded. Indeed, when a set of redundant efforts in exploring new knowledge occurs both within and beyond the organizational boundaries of the focal firm, the ultimate result is a homogenous orientation toward exploration that may be prone to the same issues usually predicated for extreme within-boundaries orientations.

A one-sided focus on exploration in both the internal and external environment of a corporation may hamper its ability to translate the amount of new knowledge into viable products or services. With this respect, our result is consistent with past research arguing that the wider the scope of the knowledge to be integrated, the more complex are the problems of creating and managing integration (Grant, 1996: 377). Thus, eventually, the costs of integration will exceed the benefits of exploring new knowledge. Furthermore, corporations that principally pursue exploration run an inherent risk because their returns are difficult to estimate a priori and may take a long time to materialize (Raish & Birkinshaw, 2008).

Finally, the previous ambidexterity literature has been suggesting to resolve the above-mentioned negative effects by combining exploitative and explorative efforts across boundaries so that exploration is pursued in one module of a modular system while exploitation is pursued in another. In the specific case of CVC, a focal firm that searches locally by using knowledge that is closely related to their pre-existing knowledge bases (e.g. Martin & Mitchell, 1998; Stuart & Podolny, 1996; Huygens et al., 2001) can move away from current certainties and explore new opportunities (March, 1991; Miner, Bassoff & Moorman, 2001) through a set of investments in external companies. Contrary to expectations, our results point to a negative effect of Cross-boundary Ambidexterity (the interaction between the amount of exploitation pursued internally by a corporation and the corresponding amount of exploration pursued by its portfolio of CVC-backed companies) upon the corporation's financial performance. A possible explanation for this result may be related to the peculiar nature of our performance measure. Since Tobin's q explicitly includes investor expectations for future growth (capturing the lag between corporate strategy and realized benefits), negative expectations about firms that implemented ambidextrous strategies may reflect that a "compromise" between exploration and exploitation is perceived as a signal of weakness by the investment community. That is, attempting to reconcile exploration and exploitation strategies may raise the risk of being perceived as a firm being good at neither or "stuck in the middle" (Gupta, Smith & Shalley, 2006). With this respect, most of the ambidexterity related literature suggests balancing exploitation and exploration makes sense for many firms and may even be necessary for survival (e.g., Christensen, 1998; Lewin & Volberda, 1999), yet other scholars say the opposite: specialization rather than duality might be entirely viable and long-term survival may be feasible without balance by pursuing only exploration or exploitation (March, 1991; Benner & Tushman, 2003). With this respect, our results stress the need for future endeavors to focus on the crucial role of inter-company learning in disentangling the exploration-exploitation tension across organizational boundaries.

## **FINAL REMARKS**

### **Preliminary Conclusions and Main Contributions**

Maula, Keil and Zahra (2003) showed that, as corporations invest in start-ups, they enhance their ability to recognize potentially destructive discontinuities in the marketplace faster than rivals who fail to make such investments. The aim of this research has been to investigate how firms can

balance over time their explorative and exploitative behaviors not only through internal investments, but also referring to resources which reside beyond their organizational boundaries.

We contributed to extant research in different ways. First, previous studies generally analyzed the trade-off between exploration and exploitation either within the firm by using knowledge developed through internal projects (Katila & Ahuja, 2002; Nerkar, 2003) or outside the firm through collaborations with external partners (Powell, Koput & Smith-Doerr, 1996; Koza & Lewin, 1998; Lavie & Rosenkopf, 2006). No attempts, to our knowledge, have been performed to combine and integrate the two dimensions in a systematic manner.

Second, we contributed to the literature on CVC by analyzing how equity investments in young, small and high potential companies impact on the knowledge base of the firm in terms of balance between exploration and exploitation. Previous studies in this field could not directly test knowledge flows between corporate investors and their portfolio firms. Research generally focused on CVC as a collaborative mode used by corporations to explore new opportunities and open new technological windows (Chesbrough & Tucci, 2004, Dushnitsky & Lenox, 2005a and 2005b; Wadhwa & Kotha, 2008), disregarding the other critical goal that drives corporations to become active in CVC investments, that is, the exploitation of existing knowledge in more efficient ways. In this work, instead, we integrated the two dimensions by representing CVC as a mechanism which sustains the strategic growth of a firm through both a local and a distant search of knowledge creation.

Finally, also our method is novel and extensive as we were able to develop more comprehensive and detailed measures of search than prior studies. In particular, our measures made it possible to accurately express central features of internal vis-à-vis external search processes.

### **Avenues for Future Research**

Extant literature tended to resolve exploration-exploitation trade-off focusing on a specific knowledge domain in isolation (i.e. technologies, on one hand, or markets, on the other hand). Instead, in the next steps of the paper, we will analyze how the interplay between exploration and exploitation performed outside the firm can impact the interaction between exploration and exploitation within the firm in different ways, depending on the domain under observation such as ideas, technologies or markets.

Furthermore, measures of technological knowledge include not only patent citations but also the technological domains (IPCs). We will use both these types of data and we will combine them with measures of commercialization like trademark classifications, in order to track the innovation

process from upstream to downstream activities. Usually, longitudinal studies focus on one end of the process or the other, but do not link the two. Nevertheless, as argued by Schumpeter (1939: 85) "the making of the invention and the carrying out of the corresponding innovation are, economically and sociologically, two entirely different things". To accomplish this goal we will collect an original database where both patents and trademarks will be used as proxies to capture two different nuances of the innovative process.

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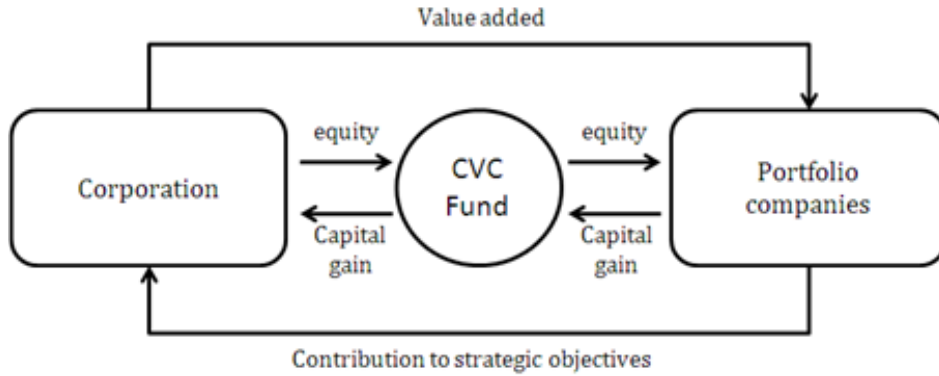
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**FIGURES**

**Fig 1. Typical Structure of Corporate Venture Capital (adapted from Ernst et al., 2005).**



**Fig. 2 – Conceptual Framework: Exploration-Exploitation across Boundaries and Domains**

Focal Firm (Corporation)	Scope	Cross-Boundary Ambidexterity (2)	Cross-Boundary Exploration
	Depth	Cross-Boundary Exploitation	Cross-Boundary Ambidexterity (1)
		Depth	Scope
		Portfolio (CVC-Backed Firms)	

**TABLES**

**Table 1 – Main Descriptive Statistics (Continuous Variables)**

VARIABLE	Obs.	Mean	Std. Dev.	Min	Max
Corporate Exploitation	328	1.281	1.421	0	10.547
Corporate Exploration	328	0.671	0.202	0.133	1
Portfolio Exploitation	328	1.100	2.248	0	15.601
Portfolio Exploration	328	0.728	0.322	0	1
Cross-boundary Exploitation	328	1.534	4.046	0	30.246
Cross-boundary Exploration	328	0.492	0.272	0	1
Cross-boundary Ambidexterity (1)	328	0.916	1.221	0	10.547
Cross-boundary Ambidexterity (2)	328	0.718	1.504	0	11.688
Tobin's q	328	0.474	0.276	0.015	3.100
R&D Intensity	328	13.069	10.353	0	104.860
Log(Corporate Sales)	328	15.790	1.998	6.365	19.150

**Table 2 – Correlations**

VARIABLE	1	2	3	4	5	6	7
1 Corporate Exploitation	1						
2 Corporate Exploration	-0.7371***	1					
3 Portfolio Exploitation	0.0392	-0.0459	1				
4 Portfolio Exploration	-0.0359	0.0546	-0.6414***	1			
5 Tobin's q	-0.0333	0.0695	0.0293	0.0693	1		
6 R&D Intensity	0.0389	-0.0092	-0.071	0.0078	-0.3545***	1	
7 Log(Corporate Sales)	-0.1016*	0.0163	0.0176	-0.0283	0.1602***	-0.4799***	1

**Table 3 – GMM Estimation**

VARIABLES	(1) Tobin's q	(2) Tobin's q	(3) Tobin's q
L.Tobin's q	1.077*** (0.0424)	1.229*** (0.0467)	1.218*** (0.0471)
Log(Corporate Sales)	-0.0190 (0.0233)	0.00486 (0.0240)	0.0162 (0.0244)
L.Log(Corporate Sales)	-0.0153 (0.0215)	-0.0515** (0.0226)	-0.0632*** (0.0230)
Corporate Exploitation		-0.00922 (0.00803)	0.0745 (0.0485)
Corporate Exploration		-0.119** (0.0512)	0.342 (0.236)
Portfolio Exploitation		0.00221 (0.00622)	0.0468 (0.0535)
Portfolio Exploration		0.00400 (0.0457)	0.543** (0.230)
Cross-boundary Exploitation			-0.0143 (0.0140)
Cross-boundary Exploration			-0.604** (0.256)
Cross-boundary Ambidexterity (1)			-0.103** (0.0512)
Cross-boundary Ambidexterity (2)			-0.0408 (0.0581)
DUM_activelink	0.0129 (0.0135)	0.00401 (0.0139)	0.00426 (0.0139)
R&D Intensity L1	0.000207 (0.000713)	-0.00180** (0.000837)	-0.00187** (0.000845)
Constant	0.492*** (0.110)	0.737*** (0.127)	0.332 (0.246)
Observations	472	328	328
Number of Corporations	59	58	58

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1