Bilateral inter-organizational learning in corporate venture capital activity

Governance characteristics, knowledge transfer, and performance

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Abstract

Purpose – The purpose of this paper is to investigate impacts of governance characteristics and bilateral inter-organizational learning on performance in the context of corporate venture capital (CVC) activity.

Design/methodology/approach – Based on a dataset of 232 CVC investments, the author examined how characteristics such as autonomy, incentive scheme, and broad representation of a CVC program and the knowledge inflows and outflows of the corporate investors impacted the corporate investor's innovativeness and the portfolio company's performance.

Findings – The results show that knowledge outflows from corporate investors can help enhance their portfolio companies' performance. In addition, incentive scheme and autonomy may facilitate knowledge inflows from portfolio companies to corporate investors, and influence the performance of both corporate investors and portfolio companies.

Originality/value – The paper's findings contribute to the inter-organizational learning literature by empirically analysing the mutual learning processes in the context of corporate venturing. The paper extends corporate venturing literature by linking governance characteristic to the underlying mechanism of inter-organizational learning between the corporate investors and the portfolio companies, as well as their performance.

Keywords Venture capital, Investors, Governance, Corporate venture capital, Knowledge transfer, Performance, Innovativeness

Paper type Research paper

1. Introduction

Learning new knowledge has been regarded as one of the most important objectives of corporate venturing (Covin and Miles, 2007; Keil, 2000; McNally, 1997; Schildt *et al.*, 2005). As one mode of corporate venturing, corporate venture capital (CVC) activities provide vehicles to not only exploit extant knowledge but also explore new development (Benson and Ziedonis, 2009; Birkinshaw and Hill, 2005; Dushnitsky, 2004; Dushnitsky and Lenox, 2006; Schildt *et al.*, 2005). In particular, CVC investments enable firms to monitor the development of markets and technologies (Keil, 2004; McNally, 1997),

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to assimilate technologies previously used by the portfolio companies (Dushnitsky, 2004), and more generally to become more innovative (Chesbrough and Tucci, 2003; Dushnitsky and Lenox, 2005a, b).

A number of studies have empirically analyzed the learning implications focusing on the relation between CVC investments and parent performance (Chesbrough and Tucci, 2003; Maula *et al.*, 2003; Dushnitsky and Lenox, 2005a). For instance, prior studies have found a positive relationship between CVC investments and parent company's innovativeness (Dushnitsky and Lenox, 2005a; Maula *et al.*, 2003). Instead of substituting traditional R&D activities, CVC investments could effectively stimulate additional corporate innovation activities (Chesbrough and Tucci, 2003; Sahaym *et al.*, 2010). In addition, CVC investments have been found to assist in recognition of technological discontinuities (Maula *et al.*, 2003) and offer opportunities of "disembodied experimentation" (Keil *et al.*, 2008).

These studies have furthered the understanding of the learning function of CVC investments with respect to innovation. However, they largely focused on the outcome of learning and typically treated the learning process as a "black box". In fact, interaction between the portfolio company and the corporation is usually mediated by the CVC program. Thus, in this study, we extend these studies by revealing the mediating role of CVC programs in the interorganizational learning process. Specifically, we empirically examine how knowledge flows impact performance and the extent to which the structural characteristics of CVC programs will influence the knowledge transfer processes and performance.

On the other hand, the interorganizational learning is not unidirectional in a CVC investment. To add value and create wealth for both the entrepreneurs and VC fund investors, venture capitalists should act as advisors in addition to risk financial sponsors (Norton, 1995). A number of studies have investigated the value-added roles of venture capitalists from the knowledge perspective (Fried and Hisrich, 1995; Steier and Greenwood, 1995). In the context of CVC investment, knowledge transfer from the corporation to the portfolio company is an important value-added mechanism as corporate investors have more knowledge resources to share with their portfolio companies (Maula *et al.*, 2009). Besides general business knowledge, corporate venture capitalists are superior in providing technology and marketing supports (Maula *et al.*, 2009).

Although interorganizational learning is bilateral throughout CVC investments, the extant literature has examined the learning in each direction separately. So far, no study has been carried out to inspect the mutual learning processes between the corporation and the portfolio companies. Research focusing exclusively on either side of the story may generate biased conclusions. For example, the factors found to be beneficial to knowledge transfer from the portfolio companies to the parent may impede knowledge transfer in the reversed way. Thus, it is necessary to inspect the two-way learning processes simultaneously, and the question of how to build a reciprocated learning relation is worth further investigation.

To fill the gap in the literature, this study will investigate performance outcomes of interorganizational learning from both the parent and the portfolio company's perspectives. In addition, we examine how the structural characteristics of CVC programs facilitate knowledge transfer processes through the theoretical lens of agency theory.

In sum, this study makes two main contributions. First, this study contributes to the interorganizational learning literature by empirically analyzing the mutual learning processes as well as the factors that may lead to a reciprocated situation. Second, we extend the prior literature of corporate venturing by revealing the underlying mechanism of interorganizational learning between the corporation and the portfolio companies. Specifically, we investigate to what extent the structural characteristics of CVC programs can facilitate interorganizational knowledge flows based on agency theory, as well as the strategic consequences for both the corporation and the portfolio companies.

2. Theory and hypotheses

2.1 Overview of organizational learning literature

The literature on organizational learning has grown rapidly in the past decade. Researchers have made significant contributions to the understanding of organizational learning from several disciplines, including psychology, sociology, and strategic management. Organizational learning is commonly defined as an iterative, dynamic process, in which firms can engage in experiences (either their own or others'), draw inferences from them, and store the inferred material for future experience (Levitt and March, 1988). In general, organizational learning can be classified according to the origination of information (Huber, 1991; Zahra *et al.*, 1999) including experimental learning and acquisitive learning. Experimental learning is similar to experiential learning, or learning-by-doing, where knowledge is derived within the organization; that is, firms can learn from their own experience. Indeed, the majority of research has reported a positive relation between gains in experience and organizational performance (Haleblian and Finkelstein, 1999; Hayward, 2002). On the other hand, firms can borrow experience from others. Acquisitive learning refers to a process through which a firm acquires and internalizes knowledge that pre-exists externally to its boundaries (Zahra *et al.*, 1999). There are three major factors that impact the acquisitive learning process:

(1) the availability of external knowledge sources (Steensma and Lyles, 2000);
(2) interorganizational knowledge flow (DeCarolis and Deeds, 1999); and
(3) absorptive capability of knowledge receivers (Zahra and George, 2002).

Learning exhibits path dependency due to the local search tendency; that is, existing knowledge forms the starting point of the search process for new knowledge, and the potential learning process is a function of previous knowledge (Keil, 2004). Thus, initial conditions such as organizational structure and resource endowment define the learning trajectory (Holbrook *et al.*, 2000), and affect learning effectiveness (Levinthal and March, 1993). For example, Levinthal and March (1993) suggested that appropriate organizational structures as well as incentive schemes may help firms avoid such learning myopia and keep a balance between exploitative and explorative learning.

From the perspective of the knowledge-based view, firm's knowledge status can be conceptualized by both stocks and flows of knowledge (Dierickx and Cool, 1989). Stocks of knowledge refer to accumulated knowledge inventory internal to the firm. The heterogeneity in knowledge bases among firms is the main determinant of sustainable competitive advantage and corporate performance (DeCarolis and Deeds, 1999). On the other hand, to adapt to environmental changes, firms also need to update their knowledge inventory by assimilating and developing knowledge flows into stocks of knowledge (DeCarolis and Deeds, 1999). Thus, as a process related to how to effectively create, transfer, and apply knowledge, organizational learning is viewed as an effective means to achieve and sustain competitive advantage, and contribute to superior firm performance (Easterby-Simith, 1997).

2.2 Interorganizational learning in CVC activities

In the era of the New Economy where new knowledge generation is occurring at a rapid pace, firms cannot rely solely on internal knowledge accumulation. Thus, obtaining new knowledge across organizational boundaries is of importance for all companies in the context of CVC activity. However, the learning may have different focus for CVC investors and portfolio companies. As well-established firms, CVC investors typically face problems of strategic inertia and find that they lack the knowledge stocks necessary to innovate rapidly (Dushnitsky and Lenox, 2005a). Through CVC investments, corporate investors aim at learning valuable, rare and hard-to-imitate knowledge of new technology/market, which can contribute to sustainable competitive advantage (Barney, 1991). On the other hand, portfolio companies are entrepreneurial startups that are formed based on brilliant inventions and innovative technologies (Kortum and Lerner, 2000; Shane, 2001), but lack of a broad range of resources and capabilities to commercialize these new technologies. Thus, the learning focus of portfolio companies falls in new knowledge that contributes to the development of dynamic capabilities and effective routines.

2.2.1 Portfolio companies. As discussed previously, entrepreneurial companies typically are formed based on brilliant inventions and innovative technologies (Kortum and Lerner, 2000; Shane, 2001). However, the possession of such knowledge *per se* cannot lead to the company's survival. More importantly, the survival of an entrepreneurial company depends upon how successfully it can commercialize those brilliant inventions and technologies. Technology commercialization is a complex and multi-disciplinary process. As young ventures, entrepreneurial companies typically do not have the broad range of skills, expertise, and capabilities to accomplish this task alone (Deeds and Hill, 1996; Teece, 1986). One of the solutions to this problem is the access to external knowledge resources (Deeds *et al.*, 1999). For example, Deeds *et al.* (1999) reported that strategic alliances are positively related to the new product development capabilities of biotech companies. Through these external linkages, entrepreneurial companies obtain access to complementary capabilities that technology commercialization requires; in the meanwhile, they can build capabilities through observation.

CVC investments provide entrepreneurial companies a unique opportunity to access such external resources. Typically, corporations with CVC branches are well-established, prestigious companies. With years of investments in knowledge accumulation, those big companies possess huge knowledge stocks related to R&D, marketing, human recourse management, etc. Thus, having a corporate investor, entrepreneurial companies would access a wide range of complementary knowledge assets (Block and MacMillan, 1993; Pisano, 1994; Teece, 1986), such as technological and marketing supports (Maula *et al.*, 2003), that are critical to their technology commercialization and firm performance. In addition, some corporate investors are leaders in the marketplace. Thus, entrepreneurial companies can learn the best practices by observation and benchmarking. Indeed, empirical evidence indicates that CVC-backed ventures fair better than those solely backed by independent VC firms (Gompers and Lerner, 1998; Maula and Murray, 2001). In sum, through CVC investments, entrepreneurial companies can learn from their corporate investors and enhance their performance:

H1. The knowledge outflow from a corporate investor to its portfolio companies increases the performance of the portfolio companies.

2.2.2 Corporate investors. A number of researchers have pointed out that established firms have difficulties in generating innovations through internal knowledge development (Henderson, 1993; Tushman and Anderson, 1986). Innovation largely requires the integration of diverse knowledge assets (Arrow, 1974). However, the tendency of searching knowledge locally makes firms trapped by their existing knowledge stocks (Levinthal and March, 1993). The learning myopia might cripple firms' ability to explore new areas (Levinthal and March, 1993). Thus, there are constraints on the creation of new knowledge within a single organization, and established companies may find that they lack the knowledge stocks necessary to innovate rapidly (Dushnitsky and Lenox, 2005a).

Learning from external knowledge sources is an alternative to overcome these constraints (Cohen and Levinthal, 1990). Henderson and Cockburn (1994) have found that the recombination of knowledge across organizational boundaries is positively related to research productivities in the biotech industry. The potential sources of external knowledge include regional networks of employees and firms (Almeida and Kogut, 1999; Saxenian, 1990), universities and government labs (Cohen *et al.*, 2002), alliance partners (Gulati, 1995; Powell *et al.*, 1996; Schildt *et al.*, 2005), and acquisition targets (Ahuja and Katila, 2001; Capron *et al.*, 1998; Schildt *et al.*, 2005). Recently, entrepreneurial ventures have been regarded as a particularly important source of highly innovative ideas (Kortum and Lerner, 2000). Empirical evidence has shown that new venture formation is associated with entrepreneurial inventions (Shane, 2001).

Therefore, some scholars have suggested that CVC investments provide established companies with an important avenue to access this collection of external knowledge (Chesbrough and Tucci, 2003; Dushnitsky and Lenox, 2005a; Gans and Stern, 2003; Poser, 2003; Schildt *et al.*, 2005). Through equity investment, established companies are authorized access to the entrepreneurial company's technologies and practices (Chesbrough and Tucci, 2003). The exposure to novel and pioneering technologies may increase the likelihood that established firms would create breakthrough innovation (Ahuja and Katila, 2001). Indeed, Dushnitsky and Lenox (2005a) reported that CVC investments are positively related to increases in the investing firm's innovation rate. Maula *et al.* (2003) also found that CVC investments help established management to recognize technology discontinuity. In other words, CVC investments provide established companies with an opportunity to learn from entrepreneurial companies, thereby improving their innovation capability:

H2. The knowledge inflow into a corporate investor from its portfolio companies increases technology innovativeness of the corporate investor.

2.3 Impacts of CVC programs' governance structure

2.3.1 The role of CVC programs. Both the corporate investor and its portfolio company could be benefited from interorganizational learning through a CVC investment (Weber and Weber, 2007). On the side of the corporate investor, the CVC investment opens a window into new technology/market, and knowledge inflows from the portfolio company can simulate innovation in its existing business units. On the other side, the portfolio company looks forward to technological and marketing support from their corporate sponsors to assist its new product development. However, neither the corporate investor nor the portfolio company learns from each other directly. Typically, CVC programs play the role of facilitating the interorganizational learning.

On one hand, corporations normally delegate the task of CVC investments to their CVC programs, and moreover depend upon their venturing branches to collect and deliver knowledge from the entrepreneurial company. Dushnitsky and Lenox (2005a) have identified three channels through which established companies could learn from their portfolio companies by CVC activities. First, the appraisal and valuation process allows the firm to learn about entrepreneurial ideas and new technologies even prior to committing capital. Second, a corporate investor may learn about novel technologies by maintaining board seats as well as utilizing dedicated monitoring. Finally, a failing venture may also constitute a learning experience to the extent that it offers technological insights, or conversely points at market unattractiveness. Most of the learning tasks are largely carried out by CVC managers who appraise and evaluate target companies by reading business plans and other resources, act as the board of directors to observe and monitor the entrepreneurial companies' operation, and summarize lessons from investment failure for their future investments as well as convey the information back to the parent.

Some researchers have observed that CVC managers often work closely with other business units (Henderson and Leleux, 2002). The involvement of other business units in CVC investments will also contribute to learning from the portfolio company (Dushnitsky and Lenox, 2005a). However, to what extent other business units can be engaged in this process is largely determined by CVC managers' judgment and efforts.

On the other hand, knowledge outflow to the portfolio company from the corporate investor is mostly controlled by CVC managers. First, most CVC managers are veterans in the corporation and possess abundant industrial experience. By directly monitoring and assistance of the new venture's business, CVC managers pass on their knowledge to the entrepreneurial company. In addition, some corporations encourage their business units to establish liaisons with the portfolio companies post-investment in attempt to learn about the portfolio companies' technology. On the other hand, these liaisons also offer the portfolio companies an opportunity to communicate with the business units and observe their operations. Likewise, to what extent the interaction with the business units can facilitate knowledge flows mostly relies on CVC managers' coordination ability as well as their efforts.

In this study, we focus on the impact of CVC programs' governance structural on the role of CVC managers during interorganizational learning. In particular, we identify three CVC program structural characteristics from the agency theory perspective, including incentive schemes, autonomy, and monitoring mode that could stimulate or mitigate CVC managers' agency behaviors. Furthermore, we propose that these agency behaviors may change the dynamics of knowledge flows between the corporation and the portfolio company, and ultimately influence the strategic performance for both parties.

2.3.2 Incentive schemes. How to provide incentives to agents to behave in the principals' interests has long been discussed in the literature of agency theory (Eisenhardt, 1989; Roth and O'Donnell, 1996). It is believed that an appropriate compensation package would align the agents' interests with those of the principals, and then limit the agency problems (Jensen and Meckling, 1976). In general, compensation systems can be classified into two groups: behavior-based and outcome-based. Numerous studies have argued that outcome-based incentive schemes are more appropriate when agent behaviors are costly or difficult to observe due to information asymmetry (Conlon and Parks, 1990).

This kind of information asymmetry commonly occurs in venture capital investments. As the limited partner, fund investors are away from daily operations and usually do not have specialized knowledge about venture capital investments. In addition, venture capital investment decisions are complex and require a high level of managerial discretion. Thus, under the circumstances, especially when financial returns are the sole objective for both of the parties, the "carried interests" incentive scheme presents an excellent example of outcome-based compensation system that effectively mitigates the principal-agent conflicts.

Indeed, a number of corporations have adopted VC-like incentive schemes in their CVC programs (Birkinshaw and Hill, 2003). However, this adoption is a double-edged sword. On one hand, with the incentives of as high as 20 percent of profit-sharing, CVC managers will pay more attention to the success of their portfolio companies, and thus devote time and knowledge to nurture them. In addition, they would make use of the parent's resources including knowledge to leverage the portfolio company's product development. Thus, we would expect that under the VC-like incentive scheme, CVC managers become willing to commit resources to their portfolio companies, and are dedicated to knowledge transfer from the parent to these portfolio companies.

On the other hand, CVC investments also should pursue strategic objectives in addition to financial returns. It is well understood that incentive schemes signal the principle's objectives and directly influence the actions and behavior of their agents (Galbraith and Merrill, 1991). Thus, the financial outcome-based compensation would send CVC managers misleading messages, and encourage them to perform to the incentives offered, rather than in the more general interests of their principals (Hendry, 2002). Thus, under the VC-like incentive scheme, CVC managers may pay less attention to strategic objectives, and devote less to transfer knowledge back to the parents. In addition, the VC-like incentive schemes could cause goal conflicts between CVC managers and their parent corporations. To chase their personal financial success, they may be reluctant to transfer knowledge back to the corporation, for this kind of knowledge sharing would expose the portfolio companies' technology secrets and disadvantage them in the competition.

In contrast, traditional salary-bonus-option incentive schemes would motivate CVC managers to better serve the strategic objectives. First, the outcomes of strategic objectives are hard to predict and difficult to measure, and therefore behavior-based compensation, like salary, is more appropriate (Eisenhardt, 1989). Second, bonuses and options connect CVC managers' income with the parent's performance, and motivate them to consider the long-term strategic benefits. Thus, we would expect that under the traditional incentive scheme, CVC managers are willing to facilitate knowledge transfer from the portfolio companies, and are dedicated to the longstanding strategic contribution to their parent companies. However, the traditional incentive scheme would also discourage CVC managers' commitment to their portfolio companies, in particular when the parent company has learned about new technologies (Alvarez and Barney, 2001). Based on the above analysis, we propose:

H3a. The VC-like incentive scheme is positively related to the knowledge flow from the parent to the portfolio companies, and increases the performance of the portfolio companies.

H3b. The traditional incentive scheme is positively related to the knowledge flow from the portfolio companies to the parent, and increases innovativeness in the parent company.

2.3.3 Autonomy. When the principals delegate the tasks to their agents, they simultaneously grant a certain level of autonomy for their agents to accomplish the tasks. The low level of autonomy helps the principals to better monitor and verify agent behaviors, thereby tightly controlling the agency problem. Yet, this will increase monitoring costs. In addition, excess intervention from the principals may deeply frustrate their agents, and decrease efficiency particularly when the agents need to make decisions in a timely fashion (Gompers and Lerner, 2001). Thus, facing environmental and strategic complexities, the principals tend to empower their agents with a high level of autonomy. However, autonomy is typically associated with managerial discretion, low task programmability, and ambiguous cause-effect relationships, all of which give rise to information asymmetries (Eisenhardt, 1989; Gerhart and Milkovich, 1990; Gomez-Mejia, 1992; Rajagopalan and Finkelstein, 1992). Thus, high levels of autonomy may stimulate agency problems unless other controlling mechanisms exist.

In the context of CVC investments, corporations face the same dilemma when designing their CVC programs. In order to obtain the desired strategic information, corporations will insist on close oversight of their CVC programs. The tight control will mitigate CVC managers' agency behaviors, for instance, pursuing personal financial interests by sacrificing corporation's strategic benefits. Nevertheless, the tight control would keep CVC managers from quickly responding to environmental changes. Thus, a number of studies have advocated that corporations replicate flexibility and freedom of the VC model to design their CVC programs (Gompers and Lerner, 2001; Hardymon *et al.*, 1983). However, as discussed in the precedent paragraph, the high level of autonomy creates information asymmetries, and makes corporations difficult to monitor CVC managers' behaviors. So, we propose that:

H4. High levels of autonomy leads to lower knowledge flow from portfolio companies to parent and negatively affects corporate innovation.

2.3.4 Board representation. Board representation is the major monitoring mode post CVC investments (Gompers and Lerner, 2001). A study of 91 US-based ventures that operated in the computer and communication industries during the late 1990s, finds that in 31 percent of the cases the corporate investor held a board seat and in 40 percent of the cases it did not have a seat but did hold observer rights (Maula, 2001). These results were repeated in a recent survey of European venture capital practices (Bottazzi *et al.*, 2004) that reports 68 percent CVC investors serve on portfolio companies' boards.

This is not surprising. In line with the literature on agency theory, the board of directors is considered an effective information mechanism in control of managers' agency behaviors (Fama and Jensen, 1983). In the context of CVC investments, board seats, at least the right of board observation, allow corporate investor access to inside information about a portfolio companies' operation. This information not only protects corporate investments, but more importantly, provides vital insights into industry trends and new technology secrecy (Gompers and Lerner, 2001). To a certain extent, board representation is essential because entrepreneurial companies are typically unwilling to share knowledge with their corporate investors for fear the corporate investors might unfairly exploit their knowledge assets and appropriate their ideas (Gompers and Lerner, 2001; Masulis and Nahata, 2009). Thus, we would expect that board representation should be positively associated with knowledge transfer from the portfolio companies to the parent.

On the other hand, board representation also demonstrates a corporate investor's commitment to the focal entrepreneurial company. As board directors, CVC managers have the responsibility of consulting and advising in addition to monitoring. Thus, we would expect that board representation would also increase knowledge flow to the portfolio companies.

All this analysis leads to the following hypotheses:

H5a. Board representation of CVC managers in their portfolio companies is positively related to the knowledge flow from their parent to the portfolio companies, and increases the performance of the portfolio companies.

H5b. Board representation of CVC managers in their portfolio companies is positively related to the knowledge flow from the portfolio companies to their parent, and increases innovativeness of the corporate investors.

3. Methodology

3.1 Data collection

The unit of analysis for the study is the portfolio company- corporate investor dyad. VentureXpert was primarily used to construct the panel data. VentureXpert is a database compiled by Venture Economics, a division of Thomson Financial. It has been extensively used in earlier research on independent VC and CVC activities (Dushnitsky, 2004; Dushnitsky and Lenox, 2005a, b; Gompers and Lerner, 2004; Maula, 2001; Maula *et al.*, 2003), and has been recognized as the leading source of US venture capital investment data (Gompers and Lerner, 2004). Other archival sources such as COMPUSTAT and the patent database from the United State Patent and Trademark Office were used to collect financial data and patent implication information.

Survey instruments were also used to collect data on incentive schemes and the autonomy of CVC programs, as well as data on the knowledge flows between corporate investors and their portfolio companies. The survey contained two questions pertaining to the incentive scheme the CVC program employed during the period 1996-2000, eight questions pertaining to the autonomy of CVC programs, and six questions pertaining to the knowledge flows between the corporate investors and their portfolio companies. The relevance and clarity of these questions were examined using a pilot survey with several venture capitalist.

The target companies for the survey were selected in accordance with whether they undertook any CVC investment during the period 1996-2000 based on the VentureXpert database. As a result, a total of 208 US public companies were identified, of which 11 firms had dissolved and 27 companies had ceased their CVC operations by the survey time.

The first mail-in survey was addressed to CVC managers or executives in charge of new business development in the survey companies. The mailing addresses used to contact the participants were obtained from multiple sources: VentureXpert, *The 2000 Corporate Venturing Directory and Yearbooks*, Corporations' web sites, and Hoover's. Two weeks later, reminder e-mails were sent out as suggested by Dillman (2000). Four weeks after the original surveys, we mailed a follow-up survey using the same questionnaire. One week later, a second reminder e-mail was sent out. Eight weeks after the surveys were administered, 18 surveys had been received reflecting a 10.6 percent response rate.

The descriptive statistics show that the average age of the 18 companies' CVC programs was 10.56 years in 2000. Their assets averaged \$30,449.75 million, and ranged from \$1,006.58 million to \$242,223 million at the end of 2000. In addition, sales averaged \$19,955.52 million in 2000. In total 13 of the 18 respondents had very few staff working on CVC programs (0-5 people), two respondents had six to ten CVC staff, and three respondents had 11-20 CVC staff. Most of the CVC programs used traditional compensation packages (base salary/bonus/stock option), and only two companies had adopted carried interests in their incentive schemes. The 18 companies cover eight major industries according to their SIC codes. An average corporate investor in the sample applied for approximately 386 new patents per year. On average, these corporate investors made CVC investments for ten years and managed approximately 13 companies per year.

Using the VentureXpert database, we identified a total of 238 portfolio companies under the management of the 18 corporate investors. The portfolio companies were in the different stages according to the VentureXpert database: 15 in the stage of seed/startup, 53 in the early stage, 126 in the expansion stage, 38 in the later stage and six in the stage of buyout. The six companies in the stage of buyout were excluded because buyout transactions do not reflect company's development status. Thus, the remaining sample includes 232 portfolio companies. Among them, 202 companies were in the information technology (IT) industry, and 30 companies were in non-IT industries. Five years after receiving the CVC investment, 57 portfolio companies went IPO, 53 were acquired, 106 kept private, and 16 were defunct (Tables I and II).

We also compared the 18 respondents with the 152 non-responding firms using the Mann-Whitney test[1]. Results indicated that respondents had significantly

Variables	n	Min.	Max.	Mean	SD
Citation-weighted patent count$_{t+1}$	232	0	7,255	370.66	906.83
Patent count$_{t+1}$	232	0	1,390	240.64	310.88
Portfolio company's sales	90	0	4,562,310	147,850	556,641
Incentive scheme – financial	232	0	8	2.30	2.73
Incentive scheme – strategic	232	0	10	2.55	1.77
Autonomy	232	1.25	5.57	3.48	1.75
Knowledge inflows	232	1.00	6.00	3.73	1.74
Knowledge out flows	232	1.00	6.00		
Board representation	232	0	1	0.70	0.46
Industry relatedness	232	0	4	0.86	1.46
Technology distance	142	0	0.9	0.19	0.18
Portfolio company age	232	0	22	2.73	6.38
CVC portfolio size	232	1	42	13.55	11.84
CVC age	232	0	20	10.42	4.46
Corporate investor's size	232	170.34	242,223	26,915	49,713
Corporate investor's technology competency	232	0.00	4,060.84	1,056.36	1,252.71

Table I.
Descriptive statistics

Table II.
Portfolio company industry and status distribution

Industries	
Information technology	202
Non IT	30
Development status when receiving CVC investments	
Seed/startup	15
Early stage	53
Expansion	126
Later stage	38
Status five years after receiving CVC investments	
Public company	57
Acquired	53
Private	106
Defunct	16

more assets, more sales and older CVC programs than non-respondents. To rule out the possibility of strong sample bias, we constructed a large sample with 1,379 portfolio companies invested by both respondents and non-responding firms. Similar regressions were applied using the same variables except for those collected from the survey. Most of the results were consistent with those obtained from the survey sample.

3.2 Measures

3.2.1 Dependent variables. Innovativeness of a corporate investor There are a number of measures of a firm's innovativeness identified in the literature, such as R&D expenditures (Henderson and Cockburn, 1994), new product announcement (Acs and Auretsch, 1988), or patents (Griliches, 1990) and patent citations (Trajtenberg, 1990; Harhoff *et al.*, 1999, Dushnitsky and Lenox, 2005a, b). Among these measures, patent citations are perhaps most popular (Dushnitsky and Lenox, 2005a). Previous studies have employed patents and citation-weighted patents to gauge innovative output in the chemical (Ahuja, 2000), pharmaceutical (Henderson and Cockburn, 1994), information (Stuart, 2000) and devices (Brockhoff *et al.*, 1999) sectors, among others. Built upon these previous studies, the present study measured innovativeness of a corporate investor in two ways: the unweighted patent counts, and the citation-weighted patent counts, that is, the total number of citations to patents it applied for in a given year.

Performance of a portfolio company. In the strategy literature, firm performance is typically measured by accounting indicators. Thus, in this study, sales were used as the indicator of portfolio company's performance. The data were collected from VentureXpert. However, this information is not available for most portfolio companies due to their private status, which results in a large number of missing data. Thus, in the present study we also constructed a categorical variable according to the four possible statuses of a portfolio company after the CVC investment as another proxy for company performance. The categories include IPO, being acquired, keeping private, and defunct. Indeed, the literature has suggested that going IPO and being acquired are two exit strategies for successful portfolio companies in the venture capital market (Gompers and Lerner, 1998). This categorical variable was used in the multinomial logistic regressions.

3.2.2 Independent variables. Incentive scheme In order to measure the characteristics of CVC managers' compensation during the focal period, respondents were asked:

- the extent to which the compensation and incentive scheme for CVC managers was dependent upon the financial returns of the CVC investments for the years 1996-2000; and
- the extent to which the compensation and incentive scheme for CVC managers was dependent upon the strategic benefits of the CVC investments for the years 1996-2000.

The items were rated on an 11-point scale ranging from 0 – not at all to 10 – always.

Autonomy. There are four primary dimensions which were used to evaluate the autonomy of a CVC program:

(1) funding source;

(2) investment objective;

(3) staffing; and

(4) the decision-making process.

Two items assessed the funding source of the CVC operation, including "CVC investments are managed by closed venture capital funds with outside investors" and "Funding is project-based rather than budget-based". Two items assessed the autonomy of determining the investment objective. These items were, "Investment objectives are determined by the parent company" and "Investment objectives are determined by the CVC program". Two items assessed the staffing autonomy in the CVC program. The two items included, "Staffing decisions in the CVC program must be approved by your parent company" and "The CVC program has the authority to hire anyone it needs". Finally, two items were used to examine the autonomy of the investment decision-making process, including "CVC managers have the authority to make investment decisions on their own." and "All investments made by the CVC program must be approved by the parent company". These items were measured using a seven-point Likert scale ranging from 1 – strongly disagree to 7 – strongly agree.

A factor analysis in STATA was conducted on all eight autonomy items. One dominant factor emerged that accounted for 73.24 percent of the variance (eigenvalue = 5.07). The factor loadings in Table III show that 6 items were related to the first factor while neither of items nos 1 and 2 was related to it. Thus, we excluded the two irrelevant items and used an average of the six related items to measure the autonomy of CVC programs. The reliability of the six items is 0.93. A list of the eight items, as well as the factor loadings and Cronbach's α are shown in Table III.

Monitoring mode. A dummy variable was used to capture the monitoring mode. The dummy took on the value of 1 if the CVC managers held board seats in the portfolio companies; otherwise a value of zero was assigned. This information was collected from VentureXpert.

Knowledge flows. Given the rich variety of knowledge present in an organization, Schulz (2001) categorized organizational knowledge into three general, but different, domains: knowledge related to sales and marketing, knowledge related to technology, and knowledge related to strategy. Using this categorization, he created a set of survey

Table III.
Factor loadings for autonomy and knowledge flows

Items		Loadings	
	F1	F1	F2
Autonomy (α = 0.93)			
1. CVC investments are managed by closed venture capital funds with outside investors	−0.178		
2. Funding is project-based rather than budgeting-based	−0.481		
3. Investment objectives are determined by the parent company	*0.961*		
4. Investment objectives are determined by the CVC program	*0.856*		
5. Staffing decisions in the CVC program must be approved by your parent company	*0.793*		
6. The CVC program has the authority to hire anyone it needs	*0.938*		
7. CVC managers have the authority to make investment decisions on their own	*0.877*		
8. All investments made by the CVC program must be approved by the parent company	*0.938*		
Knowledge outflows (corporate investors to portfolio companies) (α = 0.93)			
1. The parent company provides a great deal of knowledge about sales and marketing to the portfolio companies, e.g. knowledge about advertisement, public relations, service delivery)		*0.907*	0.174
2. The parent company provides a great deal of technological knowledge to the portfolio companies, e.g. knowledge about R&D, information systems, production process)		*0.940*	−0.024
3. The parent company provides a great deal of strategic knowledge to the portfolio companies, e.g. knowledge of competitors, suppliers, government regulations)		*0.944*	0.145
Knowledge inflows (portfolio companies to corporate investors) (α = 0.82)			
1. The portfolio companies provide a great deal of knowledge about sales and marketing to your organization		−0.145	*0.913*
2. The portfolio companies provide a great deal of technological knowledge to your organization		0.222	*0.850*
3. The portfolio companies provide a great deal of strategic knowledge to your organization		0.590	*0.720*

instruments to measure horizontal and vertical knowledge outflows and inflows among sub-units within an organization. His scales demonstrated strong convergent and discriminant validity. Thus, this study adapted this scale to measure the knowledge flows between corporate investors and portfolio companies. The current study modified the original measure to better reflect the CVC programs examined.

For knowledge flows from corporate investors to portfolio companies, the respondents were asked to indicate the extent to which they agreed with the following statements:

(1) The parent company provides a great deal of knowledge about sales and marketing to the portfolio companies (e.g. knowledge about advertisement, public relations, service delivery).

(2) The parent company provides a great deal of technological knowledge to the portfolio companies (e.g. knowledge about R&D, information systems, production process).

(3) The parent company provides a great deal of strategic knowledge to the portfolio companies (e.g. knowledge of competitors, suppliers, government regulations).

For knowledge flows from portfolio companies to corporate investors, three similar items were asked. These items were measured using a seven-point Likert scale ranging from 1 – strongly disagree to 7 – strongly agree. Both of the scales had strong internal consistency ($\alpha = 0.93$, and $\alpha = 0.82$, respectively).

In order to validate the measures of knowledge flows in both directions, a factor analysis of the six items was conducted, and two factors emerged. The first factor had an eigenvalue equal to 3.44 (accounting for 57 percent variance) representing the knowledge flows from corporate investors to portfolio companies. The second factor had an eigenvalue equal to 1.70 (accounting for 28 percent variance) representing the knowledge flows from portfolio companies to corporate investors. The correlation between the two variables is not significant ($\rho = 0.374$, $p = 0.11$). Table I shows the factor loadings for both of the scales.

3.2.3 Control variables. Prior studies have suggested that macroeconomic factors, industry attributes, or firm characteristics may influence the financial and strategic outcomes of CVC investments (Dushnitsky and Lenox, 2005a; Gompers and Lerner, 1998, 2001). Thus, three groups of control variables were included in the present study: portfolio company control variables, corporate investor control variables, and environment control variables.

Portfolio company control variables. Consistent with prior research, some characteristics associated with portfolio companies were controlled due to their effects on portfolio companies' performance. First of all, industry relatedness and technology distance between portfolio companies and their corporate investors were used as controls. Both of the variables influenced not only the propensity to learn between portfolio companies and their corporate investors, but also their abilities to absorb the new knowledge and turn it into competitive advantage for future performance. In line with the literature, industry relatedness was measured based on the extent to which the 4-digit SIC of a portfolio company overlapped with that of its corporate investor. Technology distance is measured as the ratio of common technological domains between a portfolio company and its corporate investor divided by the geometric mean of the numbers of their total technological domains (Podolny *et al.*, 1996; Vassolo *et al.*, 2004). The technological domains were identified according to the US Patent Classification[2]. In addition, the development stage of a portfolio company and the industry in which it operates are viewed as factors that may influence its valuation and success (Gompers and Lerner, 1998). Thus, a series of dummy variables was used to measure a portfolio company's industry and development stage according to classifications in VentureXpert. Finally, the age of a portfolio company when receiving the investment was controlled.

Corporate investor control variables. There are many factors that may influence a firm's innovativeness. First, organizational size may approximate resource endowments of corporate investors, thereby reflecting their innovativeness (Dushnitsky and Lenox, 2005a). Firm size in the present study was measured as the logarithmic transformation of assets (in millions). Second, a corporate investor's absorptive capacity obviously influences its innovativenesss (Dushnitsky and Lenox, 2005a, b). It was measured by the patent stock in this study (Dushnitsky and Lenox 2005a). Finally, the age of the CVC and the annual number of CVC investments per corporate investor were controlled according to Dushnitsky and Lenox (2005a).

Environment control variables. Different industries may possess different technological opportunities. In addition, some industries at some points in time may experience greater technological ferment that may drive both the opportunities to invest in new ventures and the opportunities to innovate internally. To eliminate the potential confounding effects caused by the differences in the industries and the years, the average number of citation-weighted patents applied to by firms in a given year in a given industry was used as a control (Dushnitsky and Lenox, 2005a). The industry was defined by each 4-digit standard industrial classification (average industry citation). In addition, the year in which the investment relationship was initiated was controlled.

3.3 Data analysis

The present study employed OLS regressions, multinomial logistic regressions, and negative binomial regressions depending upon the nature of the dependent variables. Specifically, OLS regressions were used to test the impacts of CVC characteristics and knowledge outflows on portfolio company sales; multinomial logistic regressions were used to test the impacts of CVC characteristics and knowledge outflows on portfolio company status since the dependent variables are categorical; negative binomial regressions were used to the impacts of CVC characteristics and knowledge inflows on corporate investor's innovativeness because the dependent variables (*Patent counts and citations*) is a count of patent and its citations for patents applied for by a firm in a given year, and as such is bounded at zero and assumes only integer values. In order to test the mediator effect, knowledge flows were added after the variables of CVC characteristics into the regressions to examine whether the direct effects of CVC characteristics on performance is reduced. All of the analysis was conducted using STATA.

4. Results

Table IV presents the intercorrelations among the variables in the study. The intercorrelations among the study's independent variables ranged from -0.66 to 0.63. Larger than desirable intercorrelations were found between autonomy and incentive scheme ($\rho = 0.63$, $p < 0.001$). Thus, to investigate potential multicollinearity problems, we examined variance inflation factors (VIFs). The maximum VIF obtained from the linear regressions was 3.71, which is substantially below the rule-of-thumb cutoff of 10 for multiple regression models.

Table V presents the results of the multinomial logistic regressions regarding the impacts of CVC characteristics and knowledge outflows on the likelihood of different portfolio company statuses: IPO, acquired, private and defunct. The group of portfolio companies that kept independent and private was used as the reference group. As seen in Model 1, the direct effects of financial and strategic incentives were not significant; broad representation was negatively related to the likelihood of going IPO ($b = -2.64$, $p < 0.1$) while autonomy was negatively related to the likelihood of being defunct ($b = -1.02$, $p < 0.05$). Model 2 showed that knowledge outflows from corporate investors to their portfolio companies increased the latter's likelihood of going IPO ($b = 1.81$, $p < 0.05$), which is consistent with *H1*. When knowledge outflow was added into the regression (Model 2), the effects of financial and strategic incentives became significant for the group of going IPO but the signs were the opposite (financial: $b = 1.12$, $p < 0.05$; strategic: $b = -1.22$, $p < 0.05$). Similarly, both broad representation and autonomy were negatively related to the likelihood of going IPO ($b = -6.28$,

Table IV. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Citation-weighted patent count$_{t+1}$	1																				
2. Patent count$_{t+1}$	0.77**	1																			
3. Portfolio company's sales	0.02	–0.00	1																		
4. Incentive – financial	–0.58**	–0.32**	0.08	1																	
5. Incentive – strategic	–0.18**	–0.06	0.27**	0.18**	1																
6. Broad representation	0.14*	–0.05	–0.18	0.32**	–0.37**	1															
7. Autonomy	–0.49**	–0.25**	–0.13	0.63**	–0.07	0.17**	1														
8. Knowledge inflow	0.36*	0.25**	0.39**	–0.27**	0.43**	–0.58**	–0.43**	1													
9. Knowledge outflow	0.33**	0.14*	0.27*	0.15	0.21**	–0.01	0.02	0.59**	1												
10. Industry relatedness	–0.04	–0.02	–0.24	–0.06	–0.11	0.07	0.34**	–0.36**	–0.13*	1											
11. Technology distance	0.10	0.15	0.14	–0.33**	0.10	–0.29**	–0.04	0.13	0.03	0.11	1										
12. Is portfolio a startup	–0.03	0.00	–0.04	–0.06	0.14*	–0.15*	–0.06	0.03	–0.10	–0.05	–0.09	1									
13. Is portfolio in early stage	0.13*	0.11	–0.08	–0.05	–0.03	–0.05	0.00	0.09	0.11	–0.01	–0.07	–0.13*	1								
14. Is portfolio in expansion	–0.06	–0.09	0.05	–0.03	–0.02	0.09	–0.07	–0.09	–0.14*	0.03	0.01	–0.27**	–0.54*	1							
15. Is portfolio in IT	0.17**	0.11	0.29**	–0.06	0.28**	–0.24**	–0.39**	0.61**	0.27**	–0.54**	–0.05	0.00	0.04	–0.01	1						
16. Portfolio company age	–0.02	–0.03	0.17	0.01	–0.07	0.10	–0.02	–0.10	–0.07	0.01	0.06	–0.09	–0.10	0.08	–0.03	1					
17. CVC portfolio size	0.26**	–0.15*	0.17	–0.29**	–0.33**	0.26*	–0.37**	0.03**	0.37**	–0.18**	–0.04	–0.13*	0.12	0.09	0.30**	–0.04	1				
18. CVC age in years	–0.08	–0.13*	–0.11	–0.21**	–0.17**	0.16**	–0.03	–0.48**	–0.58**	0.21**	0.05	0.09	–0.06	0.08	–0.38**	0.12*	–0.17**	1			
19. corporate investor's size (log assets)	0.15*	0.07	0.12	–0.32**	–0.22**	–0.21**	–0.14*	0.43**	0.40**	–0.10	0.11	–0.05	0.10	–0.02	0.23**	0.02	0.30**	0.28**	1		
20. corporate investor's technology competency	0.92**	0.54**	0.08	–0.66**	–0.24**	0.15*	–0.59**	0.43**	0.40**	–0.10	0.11	–0.05	0.10	–0.02	0.22**	–0.01	0.48**	–0.07	0.24**	1	
21. Industry control	0.01	–0.17**	0.10	0.00	0.11	0.14*	–0.01	0.09	0.33**	0.05	0.09	–0.07	0.00	0.04	–0.03	–0.02	0.03	–0.43	–0.48**	0.14*	1

Note: Correlation is significant at: *0.05, **0.01 level (two-tailed)

Table V. Results of multinomial logistic regressions examining the impacts of CVC governance characteristics and knowledge outflows on portfolio company status after investment

	1			2			3			4		
	IPO	Acq.	Def.	IPO	Acq.	Def.	IPO	Acq.	Def.	IPO	Acq.	Def.
Incentive – financial	0.49	0.27	0.51	1.12*	0.23	−0.14	1.26****	0.38	−1.03	1.37	0.26	−2.93
Incentive – strategic	−0.24	0.16	−0.02	−1.22*	−0.03	0.46	−0.57	0.50	0.15	−2.02	−0.11	4.18*
Broad representation	−2.64****	−1.34	−0.71	−6.28*	−1.73	3.46	−6.47*	−2.16	11.36	−9.25	−3.52	46.57**
Autonomy	−0.24	−0.12	−1.02*	−0.62*	−0.24	−0.11	−0.58****	0.08	−1.51	−1.10	−0.39	1.06
Knowledge outflow				1.81*	0.74	−1.69				3.98	2.28	−14.03***
Industry relatedness	0.22	0.03	−0.06	0.30****	0.03	−0.27	0.42	0.38	−0.48	0.33	0.39	−0.59
Technology distance							4.74*	0.54	2.72	4.42*	0.53	3.09
Is portfolio a startup	−2.40****	−0.30	0.92	−2.79****	−0.36	1.11	−1.00	−0.54	1.07	−0.93	−0.46	1.39
Is portfolio in early stage	−2.58***	−0.81	−0.05	−2.92**	−0.85	0.11	−2.43*	−1.60	−0.52	−2.51*	−1.60	−0.27
Is portfolio in expansion	−0.97*	−0.06	0.35	−0.96*	−0.05	0.38	−0.73	−0.31	−0.45	−0.56	−0.24	−0.16
Is portfolio in IT	0.02	0.94	1.24	0.52	1.06	1.32	−0.16	1.55	0.72	0.23	1.74	0.88
Portfolio company age	−0.01*	−0.01	0.04	−0.02	−0.01	0.04	−0.01	−0.15	−0.22	0.01	−0.14	−0.20
CVC portfolio size	−0.06	0.04	−0.01	−0.08*	0.02	0.01	−0.05	0.11	−0.09	−0.10	0.07	0.00
CVC age in years	0.10	0.12	−0.11	0.70*	0.31	−0.64	0.18	0.26	−0.85	1.16	0.79	−5.48***
Corporate investor's size	−0.05	0.17	0.31	0.26	0.25	0.39	−0.14	0.80	−0.23	0.45	0.61	−0.15
Corporate investor's technology competency	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry control	0.48****	0.25	0.49	0.48****	0.19	0.35	0.37	0.52	−0.43	−0.15	0.12	0.07
Year	−0.09	−0.33****	0.01	−0.68*	−0.50*	0.43	−0.11	−0.43	1.00	−1.07	−0.88	5.63***
No. of observations	232	232	142	142								
Pseudo R^2	0.142	0.166	0.257	0.281								
χ^2	82.19**	96.08***	87.21**	95.42***								

Notes: Significant level at: *0.05, **0.01, ***0.001 and ****0.1 levels; the reference group is the portfolio companies that kept independent and private

$p < 0.05$; $b = -0.62$, $p < 0.05$). Although the mediator effects were not found in the regressions, the results demonstrated knowledge outflows were negatively correlated to broad presentation and autonomy but positively corrected to the VC-liked incentive scheme, which is consistent with *H3a*. In Models 3 and 4, we added one more control – technology distance, and the results were similar to those in Models 1 and 2.

Table VI presents the results of the OLS regressions examining the effects of the VC-like incentive scheme, autonomy, the board representation and knowledge outflows on portfolio company sales. The hypothesized positive relationship between the VC-like incentive scheme and portfolio company performance was supported as the coefficients were significant in the regression analyses (financial: $b = 1.213$, $p < 0.01$). The hypothesized positive relationship between the board representation and portfolio company performance was not supported. On the contrary, the relationship was negative and significant ($b = -5.775$, $p < 0.01$). Combining the results from both the OLS regressions and the multinomial logistic regressions, the evidence indicates partial support for *H3a*, but fails to support *H5a*.

Table VII reports the results of the negative binomial regressions testing the relationships between CVC characteristics, knowledge inflows and corporate investors' innovativeness. Corporate investors' innovativeness was measured by both citation-weighted patent counts and non-weighted patent counts. In general, a one-year lag between the regressors and dependent variables was assumed (Dushnitsky and Lenox, 2005a). That is, the following year's patent level was used in the regressions. As expected, the VC-liked incentive was negatively related to corporate investor's innovativeness (financial: $b = -0.210$, $p < 0.001$, Model 9; strategic: $b = 0.167$, $p < 0.01$, Model 10). However, the relationship between knowledge inflows and corporate

	5	6	7	8
Incentive – financial	1.213**	1.363**	1.858	1.769
Incentive – strategic	−0.100	−0.381	−0.296	−0.311
Broad representation	−5.775**	−6.651**	−8.261	−7.941
Autonomy	−0.115	−0.207	−0.302	−0.276
Knowledge outflow		0.630		0.159
Industry relatedness	−0.151	−0.107	0.071	0.058
Technology distance			2.041	1.982
Is portfolio a startup	−2.624	−2.851	–	–
Is portfolio in early stage	−0.090	−0.332	−0.334	−0.371
Is portfolio in expansion	0.117	0.073	−0.029	−0.029
Is portfolio in IT	−0.824	−0.354	−0.766	−0.692
Portfolio company age	0.092	0.083	0.038	0.037
CVC portfolio size	0.042	0.032	0.057	0.050
CVC age in years	0.303	0.513*	0.454	0.463
Corporate investor's size	0.223	0.223	−0.106	−0.027
Corporate investor's technology competency	0.002*	0.002*	0.003	0.003
Industry control	0.563	0.487	0.504	0.440
Year	0.102	−0.089	0.022	0.012
No. of observations	90	90	55	55
Adjusted R^2	0.261	0.265	0.222	0.202
F test	2.97***	2.89***	1.96*	1.80****

Note: Significant level at: *0.05, **0.01, ***0.001 and ****0.1 levels

Table VI. Results of linear regressions examining the impacts of CVC characteristics and knowledge outflow on portfolio company sales

Table VII. Results of negative binomial regressions examining the impacts of CVC characteristics and knowledge inflow on corporate investor's innovativeness

	Patent counts$_{t+1}$ 9	10	11	12	13	Patent citation$_{t+1}$ 14	15	16
Incentive – financial	−0.210*	−0.033	−1.160***	−1.150***	0.320	0.417	−2.763**	−16.725*
Incentive – strategic	−0.143	0.167*	0.062	0.084	−0.219	0.086*	−0.344	0.254
Broad representation	−3.733***	−5.602***	−2.626***	−2.743***	−5.022***	−6.718***	−1.272	6.008
Autonomy	1.073***	1.006***	2.072***	2.048***	0.783***	0.784***	2.283**	8.313*
Knowledge inflow		−0.814***		−0.073		−0.754***		−4.255****
Industry relatedness	0.172***	0.133**	0.062	0.059	0.050	0.022	0.029	0.041
Technology distance			−0.056	−0.068			−0.361	−0.408
Is portfolio a startup	0.146	−0.059	0.062	0.063	0.334	0.095	−0.143	−0.128
Is portfolio in early stage	0.055	0.045	0.299*	0.301*	0.110	0.105	0.129	0.098
Is portfolio in expansion	0.071	0.073	0.119	0.125	−0.003	0.006	−0.094	−0.102
Is portfolio in IT	0.331****	0.459**	0.255****	0.262****	0.162	0.277	0.230	0.247
Portfolio company age	−0.009	−0.006	0.011	0.011	−0.003	0.001	0.020	0.020
CVC portfolio size	0.050***	0.070***	0.061***	0.062***	0.061***	0.079***	0.035*	0.024
CVC age in years	0.265***	0.190***	0.089*	0.089*	0.387***	0.297***	0.304****	0.073
Corporate investor's size	−0.531***	−0.395***	−0.847	−0.809***	−0.306***	−0.241**	−0.755**	−1.541**
Corporate investor's technology competency	0.003***	0.003***	0.003***	0.003***	0.003***	0.004***	0.002***	0.002***
Industry control	0.360***	0.437***	0.392***	0.399***	0.314***	0.386***	0.206****	0.133
Year	−0.277***	−0.244***	−0.094****	−0.101****	−1.092***	−1.038***	−0.900***	−0.557*
No. of observations	232	232	142	142	232	232	142	142
Pseudo R^2	0.184	0.200	0.252	0.252	0.232	0.244	0.268	0.271
χ^2	490.04***	532.39***	432.84***	433.02***	584.75***	612.31***	427.28***	431.03***

Note: Significant level at: *0.05, **0.01, ***0.001 and ****0.1 levels investors' innovativeness was significant but negative (citation-weighted patent counts: $b = -0.754$, $p < 0.01$; non-weighted: $b = -0.814$, $p < 0.01$), a result contrary to *H2*. The impacts of board representations and autonomy were also opposite to what were in *H4* and *H5b*.

5. Discussion

Learning new knowledge has been regarded as one of the most important objectives of corporate venturing (Keil, 2000; McNally, 1997; Schildt *et al.*, 2005). This study investigated outcomes of interorganizational learning from both the corporate investor's and the portfolio company's perspectives. Through the theoretical lens of agency theory, we examined how the autonomy, types of incentive scheme, and monitoring mode of a CVC program influenced the knowledge flows between the corporate investor and its portfolio companies, thereby impacting the corporate investor's innovativeness, and the portfolio company's performance.

The study provided support for the positive impact of knowledge flows on portfolio companies' performance, in particular the likelihood of a portfolio company to go IPO. This finding reinforced the unique value of corporate investors for young ventures. That is, they are not only financial sponsors, but more importantly support portfolio companies with knowledge resources. Such resource would be a key success determinant for the young ventures. Indeed, Maula and Murray (2000) found that CVCs enhanced the IPO valuation of the portfolio companies compared to those only backed by independent VCs. For future research, it would be interesting to investigate whether such IPO premium is associated with knowledge transfer in CVC activities.

Opposite to the positive effect of knowledge outflow on portfolio companies, a negative relationship was found between knowledge inflow and corporate investors' innovativeness in this study. This finding implied that corporate investors might have issues with new knowledge absorption and integration. Researchers in organizational learning have pointed out that learning does not always improve the learner's effectiveness because firms might learn something incorrect, particularly under complicated and ambiguous conditions (Huber, 1991). Some studies have found that under ambiguous conditions like acquisitions, firms may draw inappropriate generalizations from experience and/or make incorrect discrimination of information (Haleblian and Finkelstein, 1999; Hayward, 2002). This study provided another example of organizational learning inefficiency under complicated conditions. Different from portfolio companies that attempted to learn standardized best practice and routines from corporate investors, corporate investors face more challenging to absorb information with respect to technology innovation that is typically new to everybody.

Our study provided mixed results pertaining to the impacts of CVC governance characteristics. Consistent with the expectations of *H3a* and *H3b*, the results showed that a VC-like incentive scheme would enhance its portfolio companies' performance, but was negatively related to corporate investors' innovativeness. The finding implies that corporations should be cautious when adopting VC-like incentive schemes in their CVC programs especially when the strategic benefits (i.e. technology innovation) are its major goal. Although the results did not support a mediator effect of knowledge outflows between the VC-like incentive scheme and portfolio company performance, it may be due to the relatively small sample size and the limited variation in different incentive scheme. The negative correlation revealed in the study suggested that a VC-like incentive might discourage CVC managers to transfer knowledge from portfolio companies to corporate investors, which deserves future investigation with a large sample.

Interestingly, the relationship between autonomy and corporate investors' innovativeness was positive. This finding suggested that the level of autonomy is another issue a corporate investor has to balance: On one hand, it may trigger CVC managers' agency behavior putting less effort to transfer knowledge back to the parent; on the other hand, it may allow them to explore new technologies/markets, which in turn can increase the parent's innovativeness.

The study did not provide evidence pertaining to the positive relationship between the board representation and performance. On the contrary, board representation had significant negative impacts on both portfolio companies' performance and corporate investors' innovativeness. In the literature, researchers have suggested that corporate investors favor board representation because board service lets them protect their investments, and more importantly, may gain vital insights into industry trend or new technology secrecy (Gompers and Lerner, 2001). However, our finding provided a different story; that is corporate investors primarily use the board representation to learn new technologies from portfolio companies, rather than to transfer knowledge to them. Furthermore, the request for board representation may even drive good deals away as many entrepreneurs fear that board services provide corporate investors with opportunities to appropriate their ideas (Gompers and Lerner, 2001; Masulis and Nahata, 2009). Indeed, Dushnitsky and Shaver (2009) suggested that many CVC relationships did not form because the corporate investor would not invest unless the entrepreneurial company discloses its invention while the entrepreneurial company might be wary of doing so. As a result, CVC investors may find themselves with fewer opportunities to access new technologies. Thus, CVC investors may need to reconsider their post-investment monitoring strategy, and shift the focus from representing in the board of their portfolio companies to bridging the existing business units and their portfolio companies.

5.1 Limitations and future research

The use of surveys as a method of data collection can be considered a limitation to the study as self-report questionnaires have the potential for allowing response bias to affect the results. For example, the corporate respondents may exaggerate the knowledge flows from corporate investors to portfolio companies, and underestimate the knowledge flows from portfolio companies to corporate investors. Future studies may consider collecting data from both sides to eliminate such potential bias. In addition, the low response rate has caused selection bias in the sample that consisted of larger and older corporate investors. Although additional analyses have shown that most of the controls had consistent effects on the dependent when including non-responding corporate investors in the sample, it should be cautious to generalize the results to all CVC activities.

Second, some of the data such as knowledge flows, were collected at the level of corporate investor rather than the level of individual dyadic relationship. Such a data structure reduces the power of the analysis. To enhance the reliability, a significant number of firm specific dependent variables and controls were used in the regressions, including the portfolio company's sales and performance status after CVC investment, industry relatedness and technology distance between portfolio companies and their corporate investors, the development stage, industry, and age of a portfolio company, CVC program age and size, and corporate investor size and absorptive capacity. Even with these additional variables introduced into the analysis, caution should be used when interpreting the results. A more complete data collection process could be enhanced in future research to address and validate these interpretations.

Third, the study primarily investigated the impacts of incentive scheme, autonomy, and monitoring mode. However, there are other factors that also influence the interorganizational learning processes between corporate investors and portfolio companies. For example, the literature has found that the strategic fit and the involvement of the business unit were positively related to the transfer of resources between the new ventures and the parent (Henderson and Leleux, 2002; Rajagopal, 2006). Thus, future research should extend this line research to other factors. In particular, the relationship between a CVC program and existing business units deserves further investigation.

6. Conclusion

This study investigated the impacts of interorganizational learning in CVC activities. In addition, a CVC program's governance characteristics – autonomy, incentive schemes, and monitoring mode were linked to on the corporate investor's innovativeness, and the portfolio company's performance from the perspective of knowledge flows As expected, the results showed the knowledge outflow from corporate investors could help enhance their portfolio companies' performance. The mixed findings about the impacts of CVC governance characteristics suggested that corporate investors carefully design the structure of their CVC programs. The findings of the study contributed to the interorganizational learning literature by empirically analyzing the mutual learning processes in the context of corporate venturing. The study extended prior literature in corporate venturing by revealing the underlying mechanism of interorganizational learning between the corporate investors and the portfolio companies.

Notes

1. As nonparametric test, a Mann-Whitney test is more appropriate than a *t*-test since the sample size is only 18.
2. Some patent categories covering very similar technological domains were combined together according to Hall *et al.* (2001).

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