



NOVA SCHOOL OF
BUSINESS & ECONOMICS

Master Thesis

The Effect of Corporate Venture Capital Investments on the Investor's Eco-Innovation Performance

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Abstract

This paper aims at investigating the relationship between firms' corporate venture capital (CVC) investments and firms' propensity to increase corporations' eco-innovation performance. CVC investments may be instrumental in accessing innovative knowledge as well as harvesting eco-innovations from entrepreneurial ventures and, therefore, an essential part of a firm's overall innovation strategy. Using panel data from 71 CVC investors during 2010-2018, this study investigates under which CVC investment conditions firms increase their eco-innovation performance. The empirical analysis suggests that CVC investments are a mechanism to source external knowledge from ventures allowing them to improve their eco-innovation performance. Furthermore, corporations' eco-innovation performance benefits the most when firms' CVC investments particularly target ventures in early investment stages. Additionally, corporations should focus their CVC investments on ventures that have a moderate or even low proximity to their own technological knowledge base. These findings contribute to the corporate entrepreneurship, real-option, and eco-innovation literature by showing how CVC investments improve incumbents' eco-innovation performance through external knowledge sourcing.

Keywords: Corporate venture capital; Eco-innovation; Knowledge sourcing; Real option

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List of abbreviations

bn	Billion
CPC	Cooperative Patent Classification
CVC	Corporate Venture Capital
EIO	Eco-Innovation Observatory
ICT	Information Communications Technology
IRR	Incident Rate Ratio
IT	Information Technology
NAICS	North American Industry Classification System
NVCA	National Venture Capital Association
R&D	Research and Development
ROA	Return on Assets
SIC	Standard Industrial Classification
U.S.	United States
VC	Venture Capital

1. Introduction

The central tenet of the first thesis chapter is to shed light on the relevance of external knowledge sourcing through corporate venture capital investment (CVC) to promote a firm's eco-innovation performance. Thereby, Section 1.1 provides a brief overview of both concepts and describes why eco-innovation and CVC investments have gained in importance in recent years. Section 1.2 briefly reviews the academic literature of the concepts above and elaborates on the gap that this study aims to fill. While Section 1.3 describes the plan of investigation and the added value of this study, Section 1.4 concludes this chapter with the outline of this thesis.

1.1 Promotion of eco-innovation through external knowledge sourcing

David Brower, former executive director of Sierra Club, once said, “there is no business to be done on a dead planet” (Hojnik, 2017, p. 17). Global carbon emissions are set to hit an all-time high in 2018 as the use of oil and gas keeps growing (Quéré et al., 2018). Every year in which countries are not able to reduce harmful emissions put economies and lives of billions of people at risk (Figueres et al., 2018). Not only scientific communities from around the world have declared a climate emergency, but also politicians and distressed citizens around the world emphasize the reality of the danger (Ripple, Wolf, Newsome, Barnard, & Moomaw, 2019). Climate change affects all of us and is the most salient challenge corporations are facing today (McIntyre, Ivanaj, & Ivanaj, 2018). As corporations are one of the primary drivers of global carbon emissions, they are the most affected by climate change regulations, such as the Paris agreement (Griffin, 2017). Corporations are already experiencing pressure from consumers since their behavior is changing to more sustainable lifestyles. A recent study by the research institute Nielsen found out that global consumers seek companies that care about environmental issues (The Nielsen Company, 2018). Corporations are realizing the urge to act on sustainability issues and are proactively working on the reduction of energy usage, waste, and emissions (Bonini & Görner, 2011). More than ever, firms need to find a way to cope with these changes in the market while also remaining competitive to secure their market position against competitors.

One of the tools that enable companies to fuel economic competitiveness while also integrating environmental concerns into their strategies is eco-innovation (De Marchi, 2012; Hojnik, 2017). In contrast to innovation, eco-innovation comprises all forms of innovations, technological or non-technological, that create business opportunities and benefit the environment. Eco-

innovation must prevent or reduce the negative impact on the environment or optimize the use of resources (European Commission, 2012b). Although scholars have attributed various positive effects, such as improved firm performance and environmental performance, to firm's eco-innovations, research about mechanisms that promote corporations' eco-innovations is limited (Doran & Ryan, 2012; Fernando & Wah, 2017). Various researchers have highlighted the diminishing role of internal Research and Development (R&D) in the development and implementation of eco-innovation. Congruently, the fashion giant Adidas has implemented a relevant example of an eco-innovation that was not developed by their internal R&D. The eco-innovation above comprises a technology used in the polyester fabric dyeing process using no water, 50% fewer chemicals, and 50% less energy than the traditional process. Within two years, the technology has saved 100 million liters of water (Adidas AG, 2018). Instead of Adidas's internal R&D, the technology stemmed from a CVC investment in DyeCoo Textile Systems BV, a young Dutch company founded in 2008 (Lunan, 2013). Hence, the question arises whether these corporate venture capital investments could be a mechanism for incumbents to source and assimilate eco-innovation.

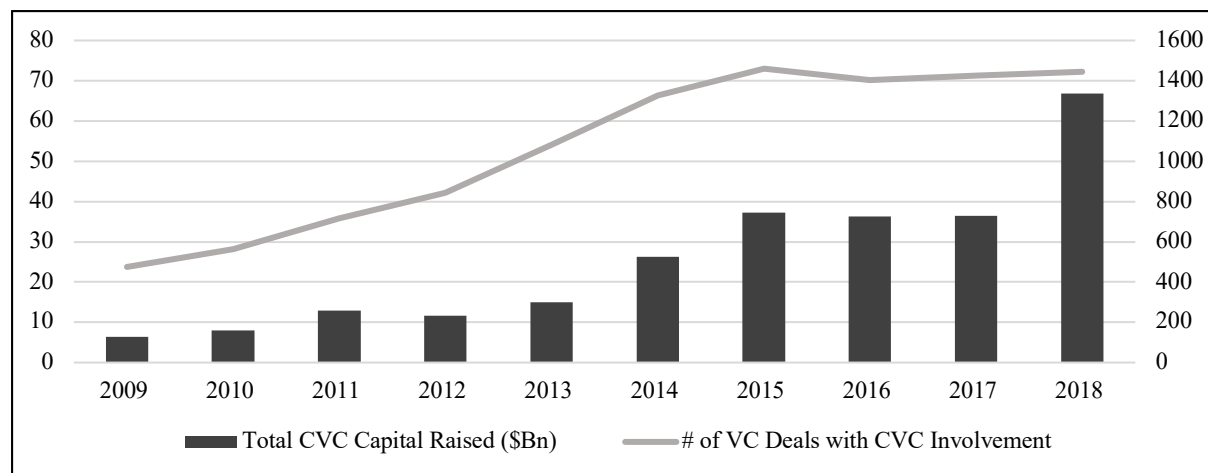
The Adidas example is not an individual case of a corporation shifting towards a more open innovation approach to source external knowledge and competencies. The open innovation approach can be traced back to the fact that sizeable multi-billion dollar corporations are often constrained in their innovation capacity. Bureaucratic structures and sunk costs into lengthy failing projects hinder entrepreneurial orientation and creativity (DeSimone, Hatsopoulos, O'Brien, Harris, & Holt, 1995). In contrast, autonomy, freedom, small team sizes, and a lean startup approach allowing for experimentation are appropriate conditions for novel ideas to flourish (EY Global, 2018). The innovation capacity constraint of incumbents has been acknowledged by scholars who found out that firms not only innovate in isolation (Hippel, 1988; Lundvall, 2010; Teece, 1986). Large firms look outside their corporate walls to source knowledge and competencies from other organizations, universities, competitors, or supply chain partners (Chesbrough, 2003; Laursen & Salter, 2006; Omta, 2002).

Due to corporations' internal innovation constraints, they may choose between different strategies to source external knowledge. These strategies consist mainly of licensing agreements, production and development agreements, joint ventures, mergers and acquisition, strategic alliances, other partnerships, and CVC (Gnekpe & Coeurderoy, 2017; Van De Vrande, Vanhaverbeke, & Duysters, 2011).

This study will focus on the effects of firms' CVC investments, which are often related to corporations' external knowledge sourcing and innovation activities (Dushnitsky & Lenox,

2005b). CVC investment is defined as a “minority equity investment by an established corporation in a privately held entrepreneurial venture” (Dushnitsky, 2012, p. 2).

Figure 1: CVC investments from 2009-2018 in the U.S.



‘Adapted from NVCA 2019 Yearbook,’ by NVCA, 2019

Despite the fact that CVC investments are sensitive to exogenous shocks and trends such as corporate diversification, changes in legislation, growth in technological opportunities, the rise of internet-related new ventures, and stock market crashes, CVC investments have experienced tremendous growth in the last decade (Dushnitsky, 2012; NVCA, 2019; Röhm, 2018). From 2009 to 2018 alone, the number of venture capital (VC) deals with CVC involvement has tripled to 1443 in the U.S. (Figure 1). These 1443 investments aggregate to an annual investments size (including non-CVC) of \$67 billion, which is almost double the size of 2017. Additionally, a BCG study found CVC to be fully entrenched in most corporations’ strategies. Around 57% of the largest ten corporations in innovation-intensive industries are engaging in CVC activities (Brigl et al., 2018). Besides the increasing relevance of CVC investments, reports are showing that firms are tilting their CVC activity towards sustainable investment targets that benefit the environment and society (Price, 2018). Especially traditional oil and gas companies, such as Royal Dutch Shell and Total S.A., are putting additional capital towards clean technologies. Recent data underlines this trend by showing that the five largest oil and gas corporations have focused 80% of all CVC investments in 2019 on clean technology ventures compared to only 18% in 2015 (CBInsights, 2019a)

1.2 Research question

The popularity of CVC investments has prompted scholars to investigate corporations' CVC activities and their effects. Academics agree that CVC is associated with accruing benefits, both financial and strategic, from the ventures they have invested in (Chesbrough & Tucci, 2002; Masulis & Nahata, 2009). Nevertheless, strategic objectives mostly outweigh financial goals as major motivators for firms to engage in CVC activities (Dushnitsky, 2009; Gompers, 2002). The strategic investment objective is one of the significant differentiators to independent venture capital firms that typically have financial returns as their primary objective (Knyphausen-Aufseß, 2005). With respect to the strategic benefits for corporations, the literature remains fragmented due to the multifaceted nature of the phenomenon (Röhm, 2018). In particular, academic literature has identified that CVC investments have three major implications for the corporation's innovation performance. First, CVC investments enable the firm to access complementary technologies as well as provide them with an early window on emerging technologies (Benson & Ziedonis, 2009; Dushnitsky, 2012). Ventures are often perceived as forerunners of emerging technologies since they frequently commercialize innovations ahead of large incumbents (Hill & Rothaermel, 2003). Second, they help corporations to identify the upcoming competition and consumer needs but also to evaluate potential opportunities and threats (Gompers, 2002; Schildt, Maula, & Keil, 2005). Dushnitsky (2012) even describes CVC investments as an early alert system that identifies potentially competing venture technologies. Third, several studies found that CVC investments encourage unique organizational learning opportunities enabling corporations to exploit existing technologies and to complement their R&D activities (Dushnitsky & Lenox, 2005b). Although there have been various studies about the effect of CVC investments on a firm's innovation performance, firm value, and knowledge creation, scholars have not yet captured the impact of CVC investments on a corporation's eco-innovation performance (Dushnitsky & Lenox, 2005b, 2006; Lee, Kim, & Jang, 2015).

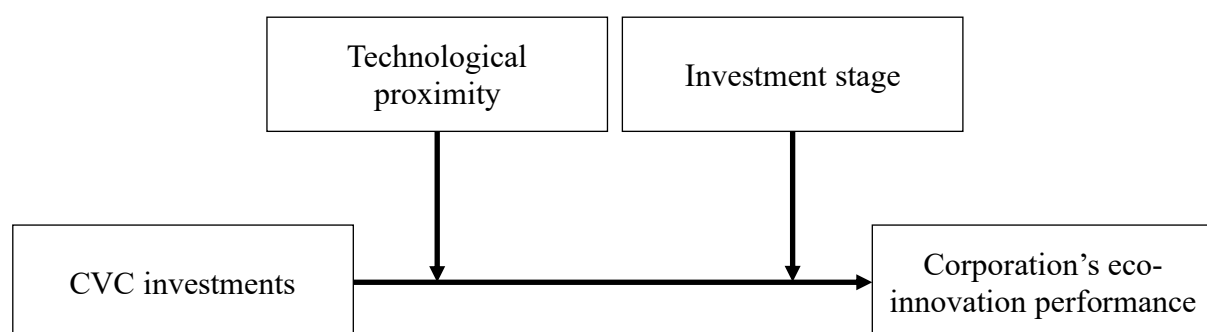
In recent years, several researchers have investigated the antecedents and effects of eco-innovations. In particular, they have identified environmental policy instruments, market demand, competition, society, managerial environmental concerns, and sources of information as main facilitators of corporation's eco-innovation generation (Cai & Zhou, 2014; Govindan, Diabat, & Madan Shankar, 2015; Yina Li, 2014; Tseng, Wang, Chiu, Geng, & Lin, 2013). While the first four are external forces and motivations to adopt eco-innovation, sources of information represent specificities that are required to develop eco-innovation. Concerning

these sources of information, the majority of the literature identifies external knowledge to be more relevant than internal knowledge. In particular, Belin, Horbach, and Oltra (2011) found that sourcing of external information and expertise is considered to be more critical for eco-innovation-related activities compared to internal knowledge generation. Similarly, de Marchi (2012) investigated the development of eco-innovation in the Spanish manufacturing sector and found that environmentally innovative firms engaged with external partners to a greater extent than other innovative firms. The authors of both studies argue that eco-innovations systemic, complex, as well as uncertain character, requires firms to leverage competencies and knowledge of other firms or institutions. Those foreign firms may as well be young ventures that provide an entrepreneurial and autonomous environment in which eco-innovation may flourish. Since CVC investments are a proven instrument to promote a corporation's innovation performance by sourcing external knowledge from ventures, this study investigates whether managers should use CVC investments to facilitate their firm's eco-innovation performance (Keil, Maula, Schildt, & Zahra, 2008). Thus the following research question is raised:

To what extent do CVC investments promote corporations' eco-innovation performance?

To better understand the relationship between CVC investments and a firm's eco-innovation performance, the conceptual scheme in Figure 5 demonstrates various factors that potentially affect this relationship (Appendix A). While the conceptual scheme presents multiple variables that have a potentially moderating role, this study sheds light on two particular ones that are derived from existing literature about the relationship between (C)VC investments, conventional innovation as well as knowledge creation. Both variables, investment stage and technological proximity, have not been investigated in the context of CVC investments and eco-innovation performance yet. They are depicted in Figure 2 and covered by the following two sub-questions.

Figure 2: Simple research model



The first sub-question refers to the venture stage that corporations should invest in to improve their eco-innovation performance. Early-stage ventures are commonly associated with high levels of uncertainty in contrast to later stage ventures that are more advanced in their processes and usually have a finalized product. While Matusik and Fitza (2012) found investments in early-stages to be more beneficial for the learning effect of the investor, Yang, Narayanan, and Zahra's (2009) results suggest that later stages are more effective for corporate's learning capabilities. Hence, this study aims to provide further insights into the impact of the investment stage and its associated uncertainty, on the eco-innovation performance of the CVC investor.

The second sub-question refers to whether the technological proximity between CVC investor and the venture could play a crucial role in the sourcing and assimilation of external knowledge. On the one hand, an investment into a venture that has an entirely different technological knowledge base from the investor's technological knowledge base might be worthless as there is no common understanding between both parties. On the other hand, a too similar technological knowledge base could potentially diminish learning opportunities for both the corporation and venture. When it comes to the technological proximity between investor and venture, literature is rather contradicting, providing further grounds to investigate (Keil et al., 2008; Lee et al., 2015).

This study provides insights into the interaction effect of the investment stage and technological proximity and contributes to the growing literature on CVC and eco-innovation.

- *How does the venture's investment stage affect the relationship between CVC investments and the eco-innovation performance of the incumbent?*

- *How does the technological proximity between corporation and venture affect the relationship between CVC investments and the eco-innovation performance of the incumbent?*

1.3 Plan of investigation and added value

To find compelling answers to the research question as well as sub-questions mentioned above, an empirical analysis with panel data from 71 corporations that engage in CVC activities, is pursued. Different databases such as Thomson One Reuters Eikon, Orbis, as well as Patstat were used to source the relevant data for this study. The different patent classifications in Patstat allowed identifying an appropriate measure for eco-innovations of the incumbent. As a research

method, a negative binomial regression model with random effects is employed to test the impact of CVC investments on the corporation's eco-innovation performance. Furthermore, this study examines the moderating effect of technological proximity and investment stage on the central relationship. This thesis advances academic literature by providing insights into facilitating factors of eco-innovation as well as the effects of CVC investments. Further value for the existing academia stems from the use of both the organizational learning theory as well as the knowledge-based view of the firm, as both concepts build the theoretical foundation of CVC investments and eco-innovation. Furthermore, the adoption of the real options theory contributes to a better understanding of CVC investments under uncertainty. From a more practical standpoint, the findings of this study can help corporate managers to understand better how to promote their firm's eco-innovation performance. Furthermore, it provides managers with insights that should be taken into consideration when targeting particular ventures to promote firms' eco-innovation performance.

1.4 Thesis outline

This research study is structured in five distinct chapters. Chapter 1 provides an introduction, underlining the relevance of the topic as well as introduced the research question of this study. Chapter 2 presents the theoretical background underpinning the relationship between CVC and the firm's eco-innovation performance to derive the underlying hypotheses.

Subsequently, Chapter 3 describes the research design, methodology, the chosen variables, as well as the analysis plan itself. In Chapter 4, the results of the empirical analysis are presented. Lastly, Chapter 5 discusses the results and their implications for both academic and management fields before concluding.

2. Theoretical foundation: CVC investments and firm's eco-innovation performance

The following chapter introduces the theoretical pillars of the study. Section 2.1 introduces the role of CVC investments as a mechanism to promote organizational learning through external knowledge sourcing. Section 2.2 presents the concept and scope of eco-innovation and examines the relevance of external knowledge sourcing for the facilitation of eco-innovation. Based on this examination, a relationship between CVC investments and a firm's eco-innovation performance is hypothesized. Section 2.3 discusses the moderating role of the investment stage on the relationship between CVC investments and corporate's eco-innovation performance. Section 2.4 elaborates on the effect of technological proximity between corporation and venture on the primary relationship. Lastly, the proposed relationships are presented in a conceptual model.

2.1 CVC investments as a means of organizational learning and knowledge sourcing

By saying, "Today knowledge has power. It controls access to opportunity and advancement", Peter Drucker once highlighted the relevance of knowledge in today's world (Di Biase, 2015, p. 19). Knowledge is often considered to be the most critical strategic resource in a corporation that enables the firm to differentiate and achieve a competitive advantage (Grant, 1996). The rising strategic importance of knowledge is reflected by the emergence of the knowledge-based view, which extends the traditional resource-based view (Decarolis & Deeds, 1999).

The knowledge-based view separates knowledge into two major types, tacit and explicit knowledge. Explicit knowledge is characterized by a formal, systematic, and also transmittable language that can be easily identified (Nonaka, 1994). Moreover, explicit knowledge can be easily communicated via traditional ways such as reports, books, and conventional communication (Grant, 1996). Contrary, tacit knowledge has a rather personal touch that entails know-how and learning embedded within the minds of the people. Since tacit knowledge is tough to communicate but also to imitate, it is a valuable asset for companies' sustainable competitive advantage (Freese, 2006). In general, firms have two options to expand their knowledge base. They either generate knowledge internally through their R&D or source it externally from other stakeholders. According to Tushman and Katz (1980), especially in dynamic, fast-paced environments, corporations must span organizational boundaries to sustain

their competitive advantage. Innovation breakthroughs often exceed the capabilities of a single organization, and thus relying solely on in-house learning is not sufficient (Powell, Koput, & Smith-Doerr, 1996). Consequently, instead of only generating knowledge internally, corporations should source knowledge from outside the corporation (Svetina & Prodan, 2008).

Established corporations engage in different types of relationships with external partners to access their knowledge. For instance, research institutions, recruitment of highly skilled human capital personnel, mergers and acquisitions, and strategic alliances comprise different ways to access and assimilate knowledge from other sources (Dushnitsky & Lenox, 2005b). Among those external sources are also entrepreneurial ventures that are acknowledged as a critical source of novel knowledge. In particular, scholars have identified ventures to be a source of highly innovative as well as valuable ideas (Kortum & Lerner, 2000). One of the reasons is the presence of highly skilled human capital in young, competent ventures since many workers tend to leave large corporations to found independent ventures themselves (Dix & Gandelman, 2007; Zingales, 2000).

The importance of incorporating young ventures in a corporation's innovation strategy has not only been discussed in academic literature but has also reached the mindset of managers in organizations. A KPMG study found out that for nearly 90% of corporations, it was not sufficient to entirely rely on their capabilities to innovate but rather required ventures that enable them to do so (KPMG N.V., 2015). Compared to most established corporations, startups provide their employees with an environment that promotes creativity and autonomy, resulting in higher engagement and better innovation performance (Gulati, 2019). Bureaucratic structures may hinder large incumbents from providing such an environment and discourage bringing breakthrough innovations to the market (Stringer, 2000).

Hence, CVC investments provide firms with an instrument to still capitalize on a venture's innovative environment and capabilities. The relationship between CVC investors and ventures is often considered a win-win relationship (Weiblen & Chesbrough, 2015). On the one hand, ventures often benefit from funding, endorsements, access to markets, and other complementary assets (Dushnitsky & Lenox, 2005b). On the other hand, entrepreneurs provide access to their venture's knowledge base enabling corporations to obtain market trends, newest technological developments, venture's practices as well as discontinuities (Wadhwa & Kotha, 2006).

Scholars have shown that CVC investments do provide not only access to venture's information that exposes the corporation to new technologies but also facilitates a firm's organizational

learning (Dushnitsky & Lenox, 2005b; Y. Yang, Nomoto, & Kurokawa, 2013). Organizational learning is considered the process of acquiring information and knowledge that is new for a firm and essential for their product, process, and organizational innovation (Dess et al., 2003). In order to generate innovations, knowledge must not only be acquired but also transformed and integrated into the organization. A critical concept that facilitates the transformation and integration of external knowledge into the corporation is a firm's absorptive capacity (Lee et al., 2015). Benson and Ziedonis (2009, p. 331) define absorptive capacity as “the ability to successfully identify, value, assimilate and commercialize innovative discoveries made by outside parties.” A firm's level of absorptive capacity depends on their existing knowledge base. In particular, Cohen and Levinthal (1990) suggest that when corporations want to capitalize on external knowledge, they should have a strong existing knowledge base. Otherwise, effective organizational learning is unlikely to take place due to a lack of sufficient understanding of the underlying technology. Absorptive capacity is also relevant in the context of CVC investments, as Dushnitsky and Lenox (2005b) pointed out. Their study focuses on the relationship between CVC investments and a corporation's ability to learn from ventures. Their investigation showed that absorptive capacity is a determining factor of a firm's learning ability through CVC investments.

Corporations have multiple opportunities to learn from ventures during the entire CVC investment process. These opportunities arise in four phases during the investment process, namely the screening phase, due diligence phase, direct involvement phase, and monitoring phase (Souitaris & Zerbinati, 2014). The first learning opportunity arises when CVC investors thoroughly screen the venture market exposing them to emerging technologies and trends. Even though corporations do not invest in all ventures, they can gain valuable market insights from the startup-community and also other high-status VCs. For instance, although Microsoft did not invest in the first internet ventures in 1994, their top-tier co-investor “Kleiner Perkins Caufield & Byers” did. In 1995, Microsoft was one of the first incumbent firms that indicated the internet as a key business driver in their shareholder letter. Scholars explain this by the close relationship with high-status VCs and their CVC screening process (Maula, Keil, & Zahra, 2013). The due diligence process is the second opportunity that CVCs exploit to source knowledge. It entails a thorough analysis of the target venture's business model, financials, market, product, and technology. Consequently, it enables the company to access the venture's innovative ideas before making any financial commitments (Dushnitsky & Lenox, 2005b).

After the investment in the venture, the direct involvement phase begins by either securing board seats or board observer rights. This strategy became evident in a European venture capital

practices survey, which showed that 68% of CVC investors sit on the board of their portfolio companies (Bottazzi, Da Rin, & Hellmann, 2004). Board seats enable corporations to track and channel back venture's strategic activities as well as crucial technological developments. In addition, some CVCs establish specific liaisons with the ventures to intensify the relationship and to learn more about a specific technology. These mechanisms intensify the social interaction between the CVC investor and venture, which in turn facilitates inter-organizational learning (Maula, Autio, & Murray, 2005).

The monitoring phase is characterized by frequent and systematic meetings with ventures to evaluate key performance indicators and technological developments (Wadhwa, Phelps, & Kotha, 2016). Especially in the last two phases of the CVC investment process, CVC investors can source valuable tacit knowledge of the venture due to their deep relationship and intensified personal interaction.

Moreover, the exposure to the learning mechanisms depends on the corporation's investment amount as well as their investment diversity. Investments in a diverse set of ventures result in increased exposure to more due diligence processes. Higher equity investments provide corporations with a greater chance to secure board seats or establish dedicated liaisons (Dushnitsky & Lenox, 2005b).

In general, these mechanisms underline knowledge sourcing opportunities through CVC investments enabling firms to combine external knowledge with their internal knowledge base. By increasing their knowledge stock, firms do not only become more innovative but also enhance their absorptive capacity. Absorptive capacity sets the foundation for the assimilation and use of external knowledge in the future (Cohen & Levinthal, 1990). Overall, an increased knowledge base is a crucial determinant for a corporation's innovation output and is, therefore, essential for organizational survival (Dushnitsky & Lenox, 2005b).

2.2 CVC investments as a facilitator of corporations' eco-innovation performance

Nowadays, the economic relevance of innovations that benefit society and the environment are undisputed (Hojnik, 2017). Environmental challenges and natural resource constraints have resulted in an increased demand for environmental technologies and hence facilitated the emergence of eco-innovations. The concept of eco-innovation is a subset of all innovations in an economy (Wagner, 2008). Nevertheless, eco-innovation differs from regular innovation as it is not an open-ended concept and solely focuses on the reduction of adverse environmental impacts (Cainelli & Mazzanti, 2013; Hojnik, 2017).

In the academic literature, eco-innovation can be found under various terminologies such as sustainable innovation, green innovation, environmental innovation, and eco-innovation (Dias Angelo, Jose Chiappetta Jabbour, & Vasconcellos Galina, 2012). This study uses eco-innovation as expression and follows the definition of the Eco-Innovation Observatory (EIO):

“Introduction of any new or significantly improved product (good or service), process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy, water, and land) and decreases the release of harmful substances across the lifecycle” (Eco-Innovation Observatory, 2012, p. 8).

Literature attributes four main characteristics to eco-innovation: Lifecycle perspective, resource efficiency, environmental impact, and independence from any sector (EIO and CfSD, 2013; Hojnik, 2017). First, eco-innovation takes on a lifecycle perspective rather than only focusing on the product or delivery of goods and services. All types of innovation that focus on the reduction of environmental impact in the designing, using, reusing, and recycling stage are considered eco-innovations (EIO and CfSD, 2013). Second, eco-innovations do not necessarily need to be new or better but must be more resource-efficient than existing processes and technologies (Kemp & Pearson, 2007). Third, eco-innovations are characterized by their emphasis on the environmental impact. In particular, eco-innovations need to benefit the environment, either intentionally or unintentionally (Kemp & Pearson, 2007). The effects of the innovation determine whether the innovation is environmentally friendly, rather than the innovation’s intention (Halila & Rundquist, 2011). Lastly, eco-innovation is independent of industries or sectors and can be either technological or non-technological (European Commission, 2012a). Overall, these identified characteristics contribute to the understanding of the concept and the scope of eco-innovation.

As eco-innovation comes in different forms, research institutions and scholars have attempted to classify eco-innovation into different types. The four most common types are product eco-innovation, process eco-innovation, organizational eco-innovation, as well as marketing eco-innovation (Hojnik, 2017). These classifications support the idea that eco-innovation may be found in various forms within an organization.

The first classification is product eco-innovation, comprising both goods and services that are new or significantly improved and tend to minimize the overall negative impact on the environment (Reid & Miedzinski, 2008). Adidas’s cooperation with “Parley for the Oceans”

has led to the development of sports shoes that are made out of recycled plastic bottles collected from the ocean. From a supply chain perspective, Adidas turns the conventional linear process into a circular one, which reduces the sourcing of virgin raw materials and minimizes waste in the value chain (Clancy, 2019). Consequently, Adidas is able to offer a new product that has less negative impact on the environment compared to conventional products.

Furthermore, process eco-innovations instead focus on the introduction or modification of processes that reduce the environmental impact by having low consumption of energy sources such as water, electricity, or petrol (Chen, Lai, & Wen, 2006). Flooring company Desso has improved its recycling processes enabling them to collect customers used carpets and recycle them into new carpet materials. The modification of their operations allows Desso to close the loop in carpet production (EIO and CfSD, 2013). The third classification is called organizational eco-innovation, which aims to improve firms' total environmental performance on their ecological vision. Corporations may achieve their objective by implementing management systems or organizational methods that target environmental issues of their products and lifecycles (Chassagnon & Haned, 2015). Lastly, marketing eco-innovation covers the whole range from changes in product placement, pricing, and packaging to various marketing techniques that promote sustainability (Eco-Innovation Observatory, 2012). These changes must follow sustainability criteria and motivate consumers to buy environmentally friendly products. For instance, a Finish fashion company called Globe Hope has created a "green brand" by positioning itself as an alternative to the fast-paced textile industry. By making use of recycled materials to design their products, they provide customers with the choice to realize a more sustainable lifestyle and mindset (Eco-Innovation Observatory, 2011).

Eco-Innovations multi-faceted nature has resulted in fragmented literature about the antecedents as well as the effects of eco-innovation. Although firms initially hesitated to transform into an environmentally friendly company and adopt eco-innovation, this view has changed due to academics stressing the underlying value of eco-innovations (Hojnik, 2017). Several direct positive effects have been acknowledged as the most pertinent and labeled as: Firm's performance, competitive advantage, internationalization, environmental performance and environmental compliance improvement (Doran & Ryan, 2012; Fernando & Wah, 2017; Leonidou, Leonidou, Fotiadis, & Zeriti, 2013; Martín-Tapia, Aragón-Correa, & Rueda-Manzanares, 2010). Indirect effects include a better image, increased worker satisfaction, and better relationships with their customers (Fernando & Wah, 2017). While eco-innovations are said to benefit the environment through the reduction of harmful substances and the more

efficient usage of natural resources, the benefits also pertain to companies. Horbach (2008) even describes the adoption of eco-innovation as a win-win situation, providing corporations with substantial grounds to adopt.

After having comprised the positive impact eco-innovation may have, several factors determine corporations' eco-innovation performance. Eco-innovation covers a relatively broad set of antecedents since its inspiration is driven by health, environmental, and ethical concerns rather than solely market opportunities (Van den Bergh, 2013). Researchers stress the relevance of environmental policy instruments, market demand, competition, society, managerial environmental concerns, and sources of information for the explanation of eco-innovation activities (Cai & Zhou, 2014; Govindan et al., 2015; Yina Li, 2014; Tseng et al., 2013).

Regulations and environmental policies were found to impact firms' eco-innovation development in several studies. Some scholars even argue that regulations are necessary to promote eco-innovation due to the double externality problem (Testa, Iraldo, & Frey, 2011; Walz & Köhler, 2014). While traditional innovations produce common knowledge spillovers, eco-innovations also produce other positive externalities such as environmental spillovers. These environmental spillovers benefit the society and environment, while the corporation that introduces the eco-innovation bears the costs. Rennings (2000) argues that regulations remedy market failure and push/pull companies to eco-innovate.

Furthermore, customer demand, society, competitors, and managerial environmental concerns are major forces but also motivators for corporations to adopt eco-innovations. Firms are facing changing customer attitudes reflected in customers' willingness to choose environmentally friendly products and to pay a higher price (Chen, 2008). In addition, the entire society puts pressure on large corporations to become more eco-friendly, which strongly affects the way they do business. In fact, public pressure seems to facilitate corporations' eco-innovations and stimulate firms to become more environmentally friendly (Bansal & Roth, 2000; Horbach, 2008). Further, not only public but also competitive pressure pushes corporations to adopt eco-innovations. Li's (2014) study underlines that competitive pressure does have a significant impact on corporations' environmental innovation practices. The development of eco-innovation represents a tool for corporations to achieve a competitive advantage in an intense competition (Dangelico & Pontrandolfo, 2010).

The motivational driver of eco-innovation aims at the managerial level of firms. Naturally, the managerial level provides a strategic direction for the firm and makes decisions based on their own and also others' opinions. Several scholars found that the environmental concern of the

top management team is a major force that influences a firm's adoption of green practices (Qi, Shen, Zeng, & Jorge, 2010).

Overall, as prior research has shown, several forces, as well as motivators, push corporations to adopt eco-innovations. Besides being pushed to adopt eco-innovations, corporations also require different kinds of resources when they want to develop and implement eco-innovations. As referred to earlier, sources of information and knowledge are identified as a key factor enabling firms to generate and implement eco-innovations (Hojnik, 2017).

By now, corporations have realized the benefits of both exploiting internal and exploring external knowledge to become more innovative. Looking outside a corporation's boundaries is especially relevant in the case of eco-innovation since the development of eco-innovation requires corporations to source more external knowledge and information than for regular innovation (Belin et al., 2011). Similarly, another study found firms that cooperated more with external partners on innovation as well as engaged resources for internal R&D activities, demonstrated higher levels of environmental innovativeness (De Marchi, 2012). De Marchi and Grandinetti (2013), discovered that corporations exhibiting a high level of eco-innovation show a higher propensity to purchase R&D developed by other firms. Furthermore, external sources of information were revealed as the main facilitators of the development of environmental innovations within a corporation. Hence, it is in line with the reasoning that external knowledge sourcing is considered more valuable than internal R&D for generating eco-innovation.

These external sourcing approaches may be traced back to the complexity of eco-innovation and the knowledge it requires. Researchers pointed out that eco-innovation is more complex than "non-green" innovation since it is characterized by higher levels of variety, novelty, and uncertainty. This line of research provides evidence that the generation of eco-innovation requires corporations to not only rely on their internal knowledge base but also to seek knowledge from other knowledge bases (Cainelli, De Marchi, & Grandinetti, 2015; De Marchi, 2012).

Earlier, CVC was defined as a vehicle to source external knowledge and to promote organizational learning. The report "Investing in Breakthrough CVC" by Volans, has found that CVCs are often more closely associated with sustainable and impact investing compared to other purely financial investors (Afanasieva, Feldman, & Love, 2014). A potential reason is CVCs strategic nature and that many modern corporations have already communicated corporate social responsibility (CSR) commitments to their customers and other stakeholders (Ahmad, Reed, & Zhang, 2018). Although corporations seem to be interested in sustainable ventures as investment targets, academic literature has yet ignored whether firms can improve

their eco-innovation performance by pursuing CVC investments. Based on researchers' finding that CVC investments have a positive impact on corporations' general innovation performance, a similar positive effect is expected concerning firms' eco-innovation performance (Dushnitsky & Lenox, 2005b). Hence, this study wants to contribute to the gap in past literature by hypothesizing:

Hypothesis 1: There will be a positive relationship between corporation's CVC investments and the corporation's eco-innovation performance.

2.3 The moderating effect of investment stage

When ventures seek funding from investors, they have different kinds of maturity levels, which are reflected in their investment stages. Most of the literature covers four stages, namely seed, early, expansion, and later stage. The seed stage is associated with ventures that are younger than 18 months and usually demonstrate a non-operational prototype. Early stage ventures are in a testing or piloting phase of their product and service. In some instances, the product might be commercially available. Subsequently, in the expansion stage, the venture's product or service is in production and commercially available, resulting in significant revenue growth. The later stage represents the most advanced stage of a venture, as the product or service is widely available and generates ongoing revenue. Furthermore, it is more likely that the venture can demonstrate profitable financials (Macmillan, Roberts, Livada, & Wang, 2008). All four investment stages exhibit an underlying level of uncertainty about the venture's technology and knowledge base. More precisely, early-stage investments usually imply a higher uncertainty level compared to later-stage investments.¹

Typically, CVCs prefer to invest in early investment stages, such as seed and early stages (CBInsights, 2019b). At this investment stage, the CVC has the opportunity to position itself as a strategic partner that helps ventures to achieve product-market fit. However, early-stage investments also have shortcomings as they are perceived riskier than later stage investments (Y. Yang et al., 2009). Since there is no consensus about the impact of the investment stage on the relationship between CVC investments and innovation, two main opinions have been evolved over the last years.

¹ Henceforth, the expression "early-stage" comprises seed and early stage. "Later-stage" represents expansion and later stage.

The first view sees later investment stages as more supportive for corporate innovation since the venture's technology is generally more developed, resulting in a better understanding of the benefits and shortcomings the technology bears. Wadhwa, Phelps, and Kotha (2016) argue that the detection, transfer, and assimilation of the venture's knowledge is easier for the firm in later stages as it exhibits more codified characteristics. Contrary, early-stage investments are oftentimes associated with uncertainty as the venture's technology is usually untested and ambiguous for corporations.

The second perspective instead emphasizes the importance of early-stage investments and turns the uncertainty of young ventures in an opportunity. Especially for firms that would like to respond early to technological threats while also achieving a first-mover advantage, early investments in new knowledge and technologies may be a necessity (Agarwal & Gort, 2001). Although investing in uncertain young technologies is risky, De Vrande and Vanhaverbeke (2013) argue that investing in early-stage ventures provides corporations with more options to learn from various technologies and broader access to radically new knowledge. CVC investments are often associated with the real options theory that has a similar underlying idea to the financial options theory. Several researchers suggest that the real options character of CVC investments is particularly important under uncertainty due to the flexibility it offers the investor (Cossin, Leleux, & Saliassi, 2002; Yong Li, 2008). Upon the initial investment into the venture, corporations have the ability to do one of the following. First, as CVC investments are analogous to call options, they provide the incumbent with the right but not the obligation to defer larger commitments of resources to the future (Higgins, 2008). Hence, the corporation has the flexibility to source knowledge, reassess the situation, and reinvest into the venture to increase its equity stake. Second, CVCs have the opportunity to exit the venture by liquidating their investment. This abandonment option is especially relevant in case the underlying uncertainty of the investment unfolds to the investor's disadvantage (Kaplan & Stromberg, 2003). Hence, risk can be mitigated, and resources allocated to other opportunities (Sahlman, 1990). Third, if uncertainty remains about the technology and future of the venture, the CVC investor has the opportunity to defer any decision about reinvesting into the venture or liquidating the investment. In summary, CVC investors' initial investment provides them with the option to either reinvest, abandon the venture, or defer any kind of commitments.

CVC investment's option character provides the investor with the flexibility to make small-scale investments into early-stage ventures with limited risk. Additionally, it allows corporations to explore a higher number of different ventures while investing a smaller amount compared to acquisitions. Thus, CVC investors can gather investing experience that further

facilitates their absorptive capacity. The increase in firms' absorptive capacity may help them to appropriate more valuable knowledge from entrepreneurial ventures in the future (Cohen & Levinthal, 1990). Overall the ability to invest in different uncertain technologies in early-stages should increase the likelihood of sourcing valuable but also radically new knowledge from ventures.

As outlined in Section 2.2, eco-innovation is often associated with novel but also intricate knowledge. Furthermore, firms' understanding of difficulties surrounding the development, implementation, and commercialization of eco-innovation is still limited (Jakobsen & Clausen, 2014). Thus, eco-innovations exhibit more significant risk and uncertainty than general innovations (Urbaniec, 2015).

Due to the uncertain nature of eco-innovations and the real options character underlying CVC investments, it is expected that early-stage investments promote a firm's eco-innovation performance when pursuing CVC investments. Hence, the following hypothesis is formulated:

Hypothesis 2: The relationship between CVC investments and corporation's eco-innovation performance is moderated by the investment stage. That is, the lower the average investment stage of corporation's CVC investments, the stronger the positive effect on the corporation's eco-innovation performance.

2.4 The moderating role of technological proximity

When corporations are screening the market for ventures to invest in, one key question arises: Who is the right partner that enables the corporation to achieve its strategic objectives? CVC investments are often perceived as win-win situations for corporations and ventures if the interests of both parties are aligned (Weiblen & Chesbrough, 2015). In most cases, the corporation seeks to gain early access to radically new knowledge while the venture expects strategic support as well as financial and other resources.

To enable knowledge exchange and promote learning between both parties, scholars found relatedness between CVC and venture to be a significant factor (Keil et al., 2008; Wadhwa & Kotha, 2006). The relatedness between the two partners has already received much attention in academic literature. Among other things, it is described as technological proximity, strategic fit, and relation fit (Thornhill & Amit, 2001; Van De Vrande & Vanhaverbeke, 2013; B. Weber & Weber, 2007). As outlined in Section 1.2, this study chooses technological proximity as the focus of this study. The degree of technological proximity between the CVC investor's and

venture's technologies, products, and services is of strategic relevance. It has been found to play a role in the facilitation of knowledge transfer as well as knowledge creation (Van De Vrande & Vanhaverbeke, 2013). A similar finding was obtained by Lane and Lubatkin (1998), who argue that the communication and knowledge exchange between both parties is facilitated through similar structures, common skills, and a shared language. Being able to exchange knowledge and communicate properly increases the learning effects for the corporation, which eventually results in increased innovative performance.

Although technological proximity seems to be vital for knowledge transfer, a too similar knowledge base diminishes explorative benefits (Lane & Lubatkin, 1998; C. Weber, 2005). The venture might only have little new knowledge that might be of interest to the firm, resulting in less learning and innovation opportunities (Sapienza, Parhankangas, & Autio, 2004). Hence, recent research suggests that CVC investors should rather target moderately related ventures to increase learning and knowledge transfer (Dushnitsky & Shaver, 2009; Lenox & King, 2004). The explanation for a concave relationship is twofold. Both views argue that a too diverse technological base between the venture and the corporation results in little learning due to a lack of absorptive capacity. They provide different reasons for the lack of learning in case of high technological proximity between both parties (Dushnitsky & Lenox, 2005a).

First, although CVC investors are willing to learn from ventures, they do not always get the opportunity to do so. This issue can be traced back to competitive pressure when both parties are too similar in terms of their resources. Entrepreneurs might avoid CVC investors as they fear to expose their knowledge and technology when competing in the same market (Dushnitsky & Shaver, 2009). Consequently, corporations are missing exposure to novel technologies and have fewer learning opportunities from start-ups that are similar to their core products. These ventures usually prefer to work with independent venture capitals and would never partner up with a CVC investor (Gompers, 2002).

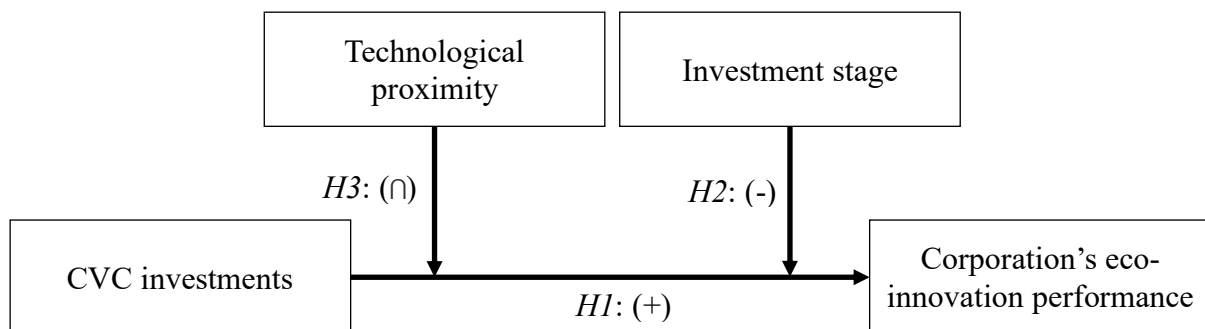
The second perspective argues that when two parties are too closely related in their technological knowledge base, the knowledge of the other party becomes redundant. Hence, little learning is expected to occur. Especially from a radical innovation standpoint, unrelated technological knowledge plays a crucial role since the more unique the pooled knowledge items, the higher the novelty value of the generated new knowledge (Sapienza et al., 2004). Fleming (2001) argues that high technological proximity could be even harmful to the development of radical innovation as most modern technologies require the combination of

knowledge from different sectors. Combining different kinds of knowledge can eliminate knowledge redundancy and can lead to radical new solutions (Fleming, 2001). However, utterly unrelated knowledge would reduce firms' absorptive capacity and thus hinder them from transferring and integrating knowledge from the venture. This effect became evident in Gompers's (2002) study, which found out that the majority of CVC investments in unrelated ventures have failed.

Corporations that strive for radical innovations should focus on partners whose knowledge is suitably unrelated to their own (Katila, 2002). This is also in line with past literature on eco-innovation, arguing that the development of eco-innovation rather requires knowledge and skills that are different from corporations existing knowledge base (De Marchi & Grandinetti, 2013). Therefore, knowledge creation, as well as knowledge transfer, is optimized if both parties share sufficient knowledge but also exhibit an adequate diversity of knowledge (Scholl, 2003). Although investments into unrelated ventures are considered more explorative, they are also riskier than investments into related ventures (Van De Vrande & Vanhaverbeke, 2013). Hence, a moderate overlap may provide the firm with an appropriate balance between risk and exploration. Keil et al. (2008) have found evidence for an inverted U-shaped relationship between CVC investments and the innovation performance of the corporation. In this study, it is expected that the inverted U-shaped moderating effect holds for the relationship between CVC investment and eco-innovation. For that reason, the following hypothesis is examined:

Hypothesis 3: The relationship between CVC investments and corporation's eco-innovation performance is moderated by the technological proximity between corporation and venture. That is, moderate technological proximity has a stronger effect on the relationship than a low or high technological proximity.

Figure 3: Detailed research model



3. Research design and methodology

The upcoming chapter presents the operationalization of the constructs previously introduced and outlines the method to examine the proposed relationships. Section 3.1 elaborates on the sample selection and data collection steps that were pursued. Section 3.2 entails the operationalization of the eco-innovation construct and defines the independent and selected control variables. Table 7 in Appendix 3 provides an overview of the variable operationalization. Section 3.3 discusses the research design, including the steps followed for the statistical analyses.

3.1 Sample selection and data collection

To explore the relationship between CVC investments and the incumbent's eco-innovation performance, a large panel of public firms during the period 2010 to 2018 was constructed. In this study, it was deliberately decided against focusing on a particular industry for two main reasons. First, the objective of this study is to provide cross-industry evidence as eco-innovations are relevant for most large corporations. Second, the inclusion of various industries reduces any industry-specific bias.

For this sample, information about worldwide corporate venturing activities was sourced from Thomson Reuters Eikon. The Eikon database is the successor of Venturexpert and one of the most widely used as well as comprehensive CVC research databases worldwide (Röhm, Merz, & Kuckertz, 2019). In particular, Röhm, Merz, and Kuckertz (2019) have developed a CVC data cleaning procedure that was followed during the data gathering process. First, worldwide investments in the period 2010-2018 were filtered based on the investor type "Corporate PE/Venture" and undisclosed investors were removed. After the first step in the data cleaning procedure, 928 firms with 9346 observations remained. Second, investment year, investment amount, investment stage, and venture industry classification were collected from the Eikon database. Third, after having identified all worldwide CVC investments that meet the requirements mentioned above, the CVC investors were manually allocated to their corporate parents. Fourth, due to data availability, only publicly listed corporations were relevant to this study. Sixth, only corporations that have made a minimum of one CVC investment in four different years during the sample period were taken into consideration. Lastly, CVC investments were compared with the Crunchbase platform that lists information about investments and venture funding (Crunchbase Inc., 2019). In the case of large discrepancy

between the data in the Eikon database and the Crunchbase platform, the missing investments were added to the sample. After cleaning the data through the steps mentioned above, a data sample with 71 public firms with 534 observations remained.

To better understand the relationship between CVC investment and eco-innovation, patent data was retrieved from the Patstat database. Patstat was chosen as the patent database for this study because of four major reasons. First, intergovernmental organizations, as well as academic institutions, rely on the Patstat database as it is optimized for statistical analysis. Hence, it has become a primary source of patent data information (Rollinson & Heijna, 2006). Second, patent data from all major patent offices are covered. Third, it updates the patent database on a regular biannual basis. Fourth, Patstat categorizes its patents with the Cooperative Patent Classification (CPC) system. Especially the last reason is particularly important, as the CPC classification allows to extract patents that are specifically related to climate change mitigation technologies. These subclasses (Y02 and Y04S) cover patents ranging from different kinds of clean energy technologies to smart grids (European Patent Office, 2018). Table 6 in Appendix C provides a more detailed overview of the different environmentally friendly technologies that are covered in this study. Several researchers have already used these sub-classes to reflect firms' eco-innovation performance (Costantini, Crespi, Marin, & Paglialonga, 2017; Laurens, Le Bas, Lhuillery, & Schoen, 2017). For this study, patents with the subclass "Y02" and "Y04S" were manually extracted for each corporation in the sample. Later, these patents were allocated to the CVC investor.

As the last step, the collected dataset was augmented with data from Thomson Reuters Eikon and the Orbis database on all public corporations that have pursued CVC investments. The relevant corporate data, such as R&D expenditures, total assets, and firms' environmental score was available in the databases for the given time frame.

3.2 Operationalization of measurements

3.2.1 Dependent variable

Firm's eco-innovation performance

The dependent variable used in this study is firms' eco-innovation performance measured by yearly patent count data. Nowadays, it is prevalent to use patent data as a proxy for inventive activities in environmental fields (Brunnermeier & Cohen, 2003; Nameroff, Garant, & Albert,

2004). In this particular context, patents that belong to the classification “Y02” and “Y04S” are used to represent eco-innovations. These classifications are widely adopted by researchers using environmentally friendly technology patents (Laurens et al., 2017)

Patents are considered to be robust as well as a valid indicator of knowledge creation (Trajtenberg, 1987). This study uses a patent-based measure as it better captures the actual output of corporation knowledge creation and invention activity. Furthermore, this measure provides a clearer picture of how effectively a corporation has used its innovation input (Chemmanur, Loutskina, & Tian, 2014).

This study chose to use the patent application date rather than the grant date since the main focus lies on measuring the changes to the corporation’s knowledge base rather than a firm’s ability to appropriate rents. The changes in a corporation’s knowledge base do probably not occur within the same year of the investment but rather with a time lag. For this reason, a time lag of one year is assumed and applied to all independent variables. Hence, we consider the relationship between last year’s value of the independent variables and the current year’s patenting applications. The one-year time lag is in line with previous research, as Dushnitsky and Lenox (2005b) have analyzed the effect of CVC investments on patent applications and have applied a one-year time lag. Besides CVC research, Hall and Ziedonis (2001) used a one-year time lag and found a high within-firm correlation between research expenditures and patenting. Hence, both studies provide evidence that supports the use of a one-year time lag.

3.2.2 Independent variables

CVC investments

The variable of interest in this study is the number of CVC investments for each corporation. It is measured as a count of the total number of investments made by firm i in year $t-1$. In case the firm did not pursue any CVC investments in a given year, a value of 0 is assigned. Prior CVC research has already used the same measure (Lee et al., 2015; Wadhwa & Kotha, 2006). In fact, the researchers have adopted the measure to analyze knowledge creation through external venturing as well as inter-organizational knowledge transfer through CVC investment. As both studies show similarities to this study, the measure is deemed to be appropriate.

Investment stage

The investment stage is considered a moderating variable in this study. When a venture seeks funding from investors, it can be mostly categorized into four different stages. The Eikon

database reports the stage of the venture for each CVC investment. As the main focus of this investigation lies on whether managers should invest in early or later-stages, the following process has been applied.

Each CVC investment was assigned a 0 or 1, depending on the investment stage. For CVC investments that were made into a seed or early stage venture, a 0 was assigned. Hence, expansion and late stage CVC investments were assigned a 1.

(0) *Early-stage investments*: Seed stage and early stage

(1) *Later-stage investments*: Expansion stage and later stage

The ascending rank reflects the development stage of a venture. Consequently, the more developed the venture concerning its products and processes, the higher the assigned stage. In contrast, less developed ventures are often associated with higher uncertainty and are assigned a lower stage. The CVC investment stage construct is computed by the yearly average of all the investment stages a corporation has invested in. Thus, the higher the proportion of late stage investments, the closer the value to 1 and vice versa. This construct has been used in the same or a similar form by several authors in VC and CVC research. For instance, Bygrave (1987) has investigated syndicated investments by VC's from a networking perspective and applied a very similar categorization in early-stage and later-stage investments. In CVC research, similar approaches have been found, supporting the use of the above-mentioned investment stage construct (Ma, 2015; Y. Yang et al., 2009).

Technological proximity

The operationalization of technological proximity is based on corporations' and ventures' industry. The industry is represented by the Standard Industrial Classification (SIC) code. Hence, for each investment, the overlap between the SIC codes assigned to the corporate investor and the SIC code assigned to the venture is computed. This approach is based on the idea that if two companies have the same or a similar SIC code, they must have similarities in their production and technology functions (Markides & Williamson, 1996).

Unfortunately, the Eikon database only provides a textual description of firms' and ventures' NAICS (North American Industry Classification System) and SIC codes instead of the actual numeric code. For this reason, the following actions must have been taken to identify the SIC codes of the firms and ventures. First, all relevant corporation and venture names had to be extracted from Eikon and imported into the Orbis database to collect the actual SIC codes. Second, in case the Orbis database did not report the SIC code, the textual NAIC description

from the Eikon Database was transformed into a SIC Code. The transformation was pursued with the official “NAICS to SIC crosswalk” list from the NAICS Association (NAICS Association, 2018).

The transformation procedure, as well as the SIC-based measure itself, do have some weaknesses that need to be noted. In particular, large corporations such as Alphabet Inc can be hardly allocated to one distinct SIC code, as the conglomerate does business in several different industries. Hence, the traditional SIC-based measure ignores the fact that those companies might possess several different SIC codes (Keil et al., 2008; Lee et al., 2015; Wadhwa & Kotha, 2006).

For this reason, this study has adjusted for this limitation by incorporating secondary SIC codes that reflect the firm’s other relevant industries. Instead of comparing the ventures SIC only with the primary SIC of the CVC investing firm, it is compared with the other relevant SIC codes as well. The SIC code overlap between the CVC investor and the venture is categorized as follows.

- (0) If no overlap between venture’s SIC code and firm’s SIC codes exist
- (1) If the first digit of the venture’s SIC code and one of the firm’s SIC codes overlap
- (2) If the first two digits of the venture’s SIC code and one of the firm’s SIC codes overlap
- (3) If the first three digits of the venture’s SIC code and one of the firm’s SIC codes overlap
- (4) If the venture’s SIC code and one of the firm’s SIC codes completely overlap

As most of the CVC investors have pursued several investments in a given year, the average of the overlap with ventures is computed. For instance, if a CVC investor (SIC 3674) invested in two ventures with the SIC codes 3671 and 3021 in a given year, the assigned value is ‘2’.

3.2.3 Control variables

Firm size

Prior studies found that firm size can have a positive (Laursen & Salter, 2006) as well as negative (Makino & Delios, 1996) impact on organizational knowledge transfer. Additionally, a direct negative or positive influence on firm innovation has been detected (Henderson & Cockburn, 1996; Katila, 2002). Hence, this study controls for firm size, measured by firm i ’s total revenue at time $t-1$.

Firm's financial performance

Further, this study controls for firms' financial performance. It is expected that firms with a strong financial performance are able to allocate more resources to the development of environmental technologies. In fact prior research identified a positive relationship between a firm's performance and its propensity to introduce environmental technologies (Murovec, Erker, & Prodan, 2012). Consistent with the literature, this study captures corporation's financial performance by return on assets (ROA) (Benson & Ziedonis, 2009; Chemmanur et al., 2014; Maula et al., 2013). ROA is computed by firm i 's income before extraordinary items as a percentage to assets at time $t-1$.

R&D expenditures

Evidence in the literature demonstrates that firm's R&D expenditure may have an impact on corporation's patenting activity (Ahuja & Katila, 2001). Furthermore, Cohen and Levinthal (1990) suggest that R&D expenditures increase corporations' ability to appropriate external knowledge. Hence, it essential to control for corporation's R&D expenditures. This control variable is measured by firm i 's R&D expenditures at time $t-1$. A small number of unreported R&D values were defined as missing.

Firm's environmental focus

As the dependent variable is the count of firms' eco-patent applications, it expected that corporations' commitment and effectiveness concerning environmentally friendly activities have a positive influence. Thomson Reuters has developed an environmental score that captures corporations' commitment and effectiveness across different themes on a yearly basis. These themes entail corporation's resource use, emissions, and innovation, and are solely based on self-reported data. Thomson Reuters assigned each company a score between 0-100 that categorizes corporations on a scale from "D-" (worst) to "A+" (best) (Refinitiv, 2019). In this study, each corporation got assigned a value between 0 and 2.

- (0) If the firm is rated lower than C+
- (1) If the firm is rated between C+ and A-
- (2) If the firm is rated higher than A-

The use of the prior mentioned score has its weaknesses as it is solely based on self-reported data. Nevertheless, it provides a proper indication of whether a corporation focuses on these environmental topics. Hence, the environmental score is utilized to control for corporations'

environmental focus. The environmental coded score is assigned to each corporation i at year $t-1$.

Year and industry

Since this study entails panel data for the period 2010-2018 and a broader range of industries, control variables have been included. For this reason, this study applies year and industry fixed effects to account for macro-economic changes as well as time-invariant industry characteristics. In CVC research, it is a common approach to use these variables as they allow to control for unobserved effects that are either industry or time-specific (Van De Vrande et al., 2011). Concerning the year control variable, a dummy variable for each year has been created. The industry control variable is computed by creating dummies for all CVC investors that share the same first digit of their SIC codes.

3.3 Research design

The collected data in this sample contains observations of different variables over multiple periods for various firms. Thus, a panel data regression analysis is applied to examine the derived hypotheses. As mentioned in Section 3.2, the dependent variable is a count of yearly eco-patent application of a corporation. The variable is bound to zero and does solely entail integer values. Since the dependent variable is count and not normally distributed, a Poisson regression is assumed to be most appropriate (Wadhwa et al., 2016). Nevertheless, the dependent variable exhibits a significant overdispersion, which is tested through the likelihood-ratio test. In particular, Table 9 in Appendix D shows the significant likelihood-ratio test result, implying that the dependent variable is overdispersed (Z. Yang, Hardin, Addy, & Vuong, 2007). As the Poisson model assumes equal mean and variances of the depended variable, a negative binomial regression is applied for the empirical analysis. According to Hausman et al. (1984), it is a generalization of the Poisson model and allows for overdispersion through including an individual unobserved effect in the conditional mean. Among prior research that has dealt with overdispersed patent data, it is common to apply the negative binomial regression model (Dushnitsky & Lenox, 2005b; Lee et al., 2015; Wadhwa et al., 2016).

The nature of the gathered data allows for unobserved heterogeneity. First, it might stem from unmeasured differences in firm characteristics that have an impact on the corporation's eco-innovation performance. Second, as outlined in the control variable section, unobserved heterogeneity might also be the consequence of unmeasured systematic time effects (Wadhwa

et al., 2016). Two negative binomial regressions were run with fixed and random effects to control for unobserved heterogeneity. To verify whether it is appropriate to use the random effect model, assuming that the error term does not correlate with regressors of firm and year, a Hausman specification test was employed (Hausman et al., 1984). The result of the Hausman test in Table 8 is not significant, indicating that a random-effects model is appropriate to use (Appendix D). Since a random-effects model does not account for time-invariant variables, this study includes industry as well as year dummies in each regression. The use of dummies allows to capture the influence of aggregate time-series trends as well as to control for industry differences.

Hence, this study adopts a negative binomial regression with industry, year fixed, and firm random effects. Additionally, independent variables are adjusted with a one-year time lag. The expected count of eco-patent applications can be specified as

$$E[\text{ecopatents} | X_{it}] = \lambda_{it} = \exp(\beta X_{i,t-1} + \varepsilon_{it} + v_i)$$

where β represents the coefficient and $X_{i,t-1}$ embodies time-variant firm attributes. Furthermore, v_i and ε_{it} are expressing independent random variables.

4. Analyses and results

The following chapter elaborates on the results of the empirical analyses. In Section 4.1, the univariate analysis provides the descriptive statistics of the variables in this sample. Section 4.2 entails the bivariate analysis that examines the correlations between the variables in this study. In Section 4.3, the negative binomial regression is employed to test the influence of several factors on the dependent variable. Furthermore, the results of the performed regression are discussed and compared to the proposed hypotheses.

4.1 Univariate analysis – Descriptive statistics

Table 1 presents the descriptive statistics (mean, standard deviation, minimum and maximum values) of the dependent as well as independent variables. Additionally, Table 1 entails a short description of each variable. The dependent variable *EcoPatents* shows, as indicated earlier, overdispersion since the mean is clearly smaller than the standard deviation and thus also the variance of the sample ($M = 121.65$, $SD = 328.77$). Further, a corporation's yearly patent applications range from 0 to 2565. The variable seems to be heavily skewed since a few firms have a very high patenting activity compared to many other corporations that show a rather low patenting activity. The variable of interest, *CVCDeals*, displays an average of 6.12, meaning that CVC investors have, on average, pursued around six CVC investments in a year. The maximum value of *CVCDeals* reaches up to 66 investments in a year. With regard to the moderating variable, *InvestStage*, a .57 average can be observed. This result shows that, on average, CVC investors in this sample have a slight tendency to invest in later stages. In addition, the average of *TechProximity* is 1.36, with a range from 0 to 4. Hence, it seems that CVC investors in this sample tend to invest in ventures that have a rather unrelated knowledge base. Concerning the control variables, the average of firms' total yearly *Revenue* is \$52.39 billion and ranges from \$1.66 billion to \$470.17 billion. The corporations in this sample spend, on average, \$2.96 billion on *R&D*. Firms' R&D expenditures range from a minimum value of \$2.75 million to a maximum of \$22.62 billion. *ROA*, measuring a firm's financial performance, has an average score of 9.2% and ranges from -23.9% to 49% in the given time period. Lastly, the *EScore*, representing firms' environmental focus, ranges from 0 to 2, with an average of 1.31, indicating that the firms in this sample tend to have a rather strong environmental focus.

Table 1: Descriptive statistics

Variable	Description	Mean	SD	Min	Max
EcoPatents	Count of new patents (classification in Table 6) applied for by a firm each year t	121.651	328.771	0	2565
CVCDeals	Count of CVC investments by a firm each year $t-1$	6.119	9.182	0	66
EScore	Environmental score of a firm each year $t-1$	1.308	.615	0	2
Revenue	Total revenue of firm (\$bn) $t-1$	52.385	67.088	1.657	470.171
ROA	Return on assets of firm (%) $t-1$.092	.076	-.239	.49
R&D	Total R&D expenditures of firm (\$bn) $t-1$	2.959	3.447	.003	22.62
InvestStage	Average investment stage of firms CVC investments $t-1$.568	.342	0	1
TechProximity	Average technological proximity between CVC investor and venture $t-1$	1.355	1.322	0	4

4.2 Bivariate analysis – Correlation matrix

To assess the relationship between the variables as well as to rule out potential multicollinearity issues, a correlation matrix is constructed (Table 2). Concerning multicollinearity, the rule of thumb states that the independent variables should not exhibit a correlation that is higher than 0.8 (Franke, 2010). At first glance, one can observe that all correlations range between -0.224 and 0.498. As these correlations are below the threshold of 0.8, it is assumed that multicollinearity should not be an issue in this study. Concerning the central independent variable, *CVCDeals*, a significant positive correlation with *EcoPatents* is detected. This observation is in line with the relationship predicted in Hypothesis 1. The moderating variable *InvestStage* positively, but also weakly, correlates with *EcoPatents* at a significant level ($p < .01$). *TechProximity* does not correlate significantly with *EcoPatents*. Many of the control variables in this study, such as *Revenue*, *R&D expenditures*, and *EScore*, are significantly related to the dependent variable in expected directions. *ROA* is the only independent variable that does not show a significant correlation with the dependent variable. Although the correlations between the independent variables do not display any unexpected directions, they provide relevant information about the relationships between the variables. The relationship

between *EScore* and Revenue suggests that larger firms tend to focus more on environmental sustainability than smaller firms. Furthermore, *EScore* has a significant relationship with *CVCD Deals* and *R&D expenditures*, proposing that firms that have a stronger environmental focus more on knowledge creation and acquisition. Moreover, a significant positive correlation between *CVCD Deals* and *R&D expenditures* can be observed. The relatively strong correlation between both variables indicates that firms with higher *R&D expenditures* are more likely to pursue *CVCD Deals* and vice versa.

These correlations indicate that it is indeed relevant to control for these variables, as it allows a more precise estimation of the predictor coefficient. Nevertheless, it is important to note that these correlations do not imply any causation and require further investigation.

Table 2: Correlations among the variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) EcoPatents	1.000							
(2) CVCD Deals	0.256***	1.000						
(3) InvestStage	0.121***	-0.027	1.000					
(4) TechProximity	-0.033	0.151***	-0.244***	1.000				
(5) Revenue	0.229***	0.062	0.044	-0.116***	1.000			
(6) R&D expend.	0.282***	0.498***	-0.075*	0.390***	0.193***	1.000		
(7) EScore	0.112***	0.157***	0.066	-0.027	0.271***	0.155***	1.000	
(8) ROA	0.013	0.099**	-0.024	0.102**	-0.074*	0.173***	0.010	1.000

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.3 Multivariate analysis – Negative binomial regression model

As elaborated in the research design section, a negative binomial regression model has been applied. Table 3 reports seven different models that analyze the effect of various variables on the dependent variable *EcoPatents*. Model 1 is the basic model that only includes the control variables *ROA*, *Revenue*, *R&D expenditures*, and *EScore*. In Model 2, the variable of interest, the number of *CVCD Deals* is introduced to test Hypothesis 1. To examine Hypothesis 2, Model 3 and 4 are introduced. Model 3 only includes the main effect of the moderating variable *InvestStage*. As it is expected that the variable *InvestStage* and *CVCD Deals* interact with each other, it is probably not meaningful when *InvestStage* is only included as a single causal variable. Therefore, Model 4 incorporates the main effect as well as the interaction effect

between *CVCD Deals* and *InvestStage*. Hypothesis 3 is tested through the use of the Model 5 to Model 7, as the sample had to be split into three subsamples. The underlying idea of the sample split is discussed in a later part of this section.

All seven models are based on the same dataset, ensuring an accurate comparison of the results. Due to the suggestion of the Hausman test, all models assume firm random-effects. Moreover, each of the models includes year and industry dummy variables. The dummy variables are introduced in every model to detect any unobserved systematic differences. Nevertheless, this study refrains from interpreting the significance of the dummy variable coefficients as they are often perceived as ambiguous (Brown, 1968). For simplicity reasons, the coefficients of the dummy variables are not presented in Table 3. Additionally, the robustness of the models was tested through the use of the Wald χ^2 . In all models, a significant Wald χ^2 ($p < .01$) could be observed, showing that the added variables improve the fit of the model.

The results of Model 1 demonstrate that three out of four control variables are significant. In particular, *Revenue* ($\beta = 0.002$, $p < .1$), *R&D expenditures* ($\beta = 0.057$, $p < .01$) and *EScore* ($\beta = 0.145$, $p < .05$) are positively as well as significantly related to the subsequent year's eco-patent applications. These results are in line with the expected directions based on past literature. However, ROA does not seem to have a significant effect on the dependent variable ($\beta = 0.120$, $p > .1$). Hence, Model 1 indicates that a firm's financial performance is not a relevant predictor of a firm's eco-innovation performance. Only for the subsample "high proximity", a significant effect of ROA is detected.

Hypothesis 1 predicts a positive relationship between CVC investments and the firm's eco-innovation performance, measured in eco-patent applications. The results in Model 2 indicate that CVC investments are positive and significantly related to the firm's eco-innovation performance ($\beta = 0.008$, $p < .1$). Accordingly, **Hypothesis 1 is supported**, assuming a 10% significance level. This result implies that more CVC investments enable corporations to acquire valuable external knowledge that can be used to generate eco-innovation. The actual effect on eco-innovation can be analyzed by using the incident rate ratios (IRR) displayed in Table 12 in Appendix D. In order to report the actual effect of CVC investments, the full Model 4 is used as it demonstrates the best model fit (Wald $\chi^2 = 513.89$, $p < .01$). The IRR predicts the percentage increase in a firm's eco-patent applications with a one-unit increase in the independent variable (Moore & Bergner, 2016; UCLA Statistical Consulting Group, 2019). Hence, a one-unit increase in CVC investments leads to a 2.07% increase in eco-patent applications. CVC investments seem to have a small but significant impact on a firm's eco-innovation performance. The relatively small effect on eco-patent applications may be due to

various other factors, depicted in Figure 5 in Appendix A, that may also influence a firm's eco-innovation performance.

Hypothesis 2 suggests that the investment stage moderates the effect of CVC investments on a firm's eco-innovation performance. More precisely, it predicted that the lower the investment stage, the stronger the impact on a firm's eco-innovation performance. Evidence of moderation is found in Model 4 since the interaction term is negative, as predicted, and significant ($\beta = -0.026, p < .05$). As expected, Model 3 shows that the variable investment stage is not meaningful and significant when examined without the interaction effect with CVC investments. The increase in the Wald χ^2 from Model 3 to Model 4 shows that the inclusion of the interaction term has further improved the model fit. Hence, this study claims **support for Hypothesis 2** that CVC investments have a stronger positive impact on a corporation's eco-innovation performance when investing in early-stages compared to later-stages.

Hypothesis 3 predicts an inverted U-shaped moderation effect of technological proximity on the relationship between CVC investments and the firm's eco-innovation performance. In order to examine the inverted U-shaped relationship, it was deliberately decided against the traditional approach of applying an interaction term. The interaction term would have required an additional squared interaction term increasing both the complexity of the model and the chance of multicollinearity issues. Furthermore, the use of a categorical SIC code for technological proximity is not considered appropriate for the analysis with an interaction term (Aguinis, 2003). Consequently, this study decided to use three different subsamples to analyze the effect. The approach to investigate an inverted U-shaped moderation effect with subsamples was used similarly by other researchers such as Keil et al. (2008) and Yang et al. (2013). The subsamples are divided as follows:

- (0) Low technological proximity = Average overlap of SIC codes is below 1
- (1) Moderate technological proximity = Average overlap of SIC codes is between 1 and 2
- (2) High technological proximity = Average overlap of SIC is larger than 2

The variable CVC Investments, as well as the control variables, are included in all three subsamples to best demonstrate the moderation effect on the relationship between CVC investments and eco-innovation performance.

Table 3: Random negative binomial regression - Using seven different models

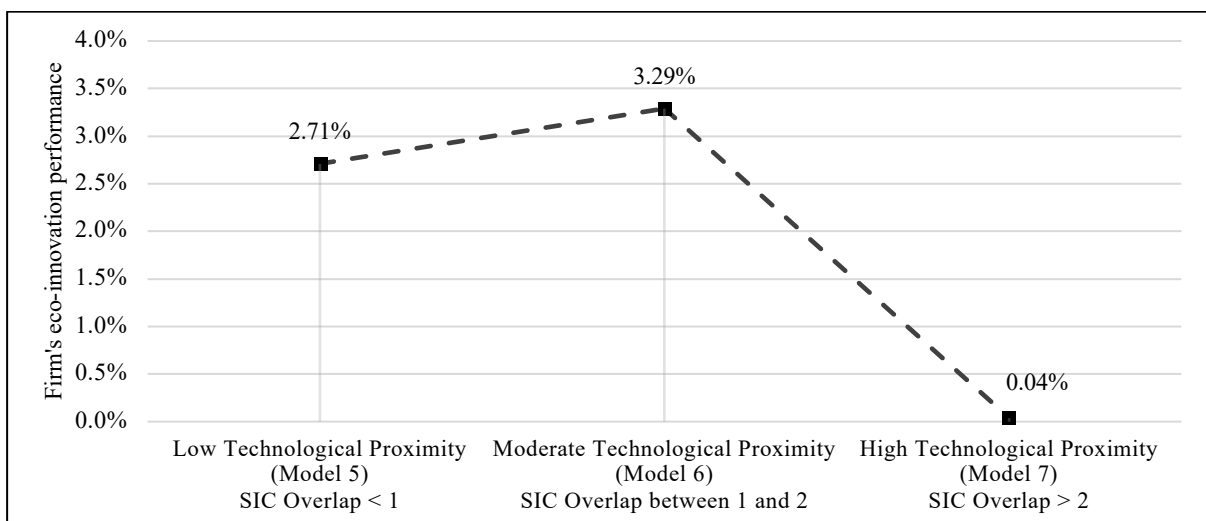
	Control Variables	Variable of Interest	InvestStage	InvestStage Interaction Term	Low Proximity	Moderate Proximity	High Proximity
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
Constant	2.020*** (0.480)	1.910*** (0.479)	2.369*** (0.515)	2.344*** (0.509)	2.627*** (0.611)	2.059*** (0.401)	1.702 (1.288)
Revenue	0.002* (0.001)	0.002* (0.001)	0.002** (0.001)	0.002* (0.001)	0.002 (0.002)	0.004 (0.002)	0.002 (0.002)
R&D	0.057*** (0.014)	0.049*** (0.015)	0.004*** (0.002)	0.044*** (0.016)	0.080*** (0.029)	0.028 (0.032)	0.073** (0.037)
EScore	0.145** (0.067)	0.131* (0.067)	0.071 (0.069)	0.075 (0.068)	-0.014 (0.097)	-0.017 (0.134)	0.123 (0.132)
ROA	0.120 (0.556)	0.024 (0.557)	-0.144 (0.575)	-0.050 (0.576)	-0.351 (0.951)	0.595 (1.492)	1.992** (0.873)
CVCDeals		0.008* (0.004)	0.005 (0.004)	0.020** (0.008)	0.027** (0.011)	0.032*** (0.009)	0.005 (0.007)
InvestStage			0.072 (0.080)	0.157* (0.090)			
CVCDeals X InvestStage				-0.026** (0.013)			
Observations	534	534	472	472	211	113	210
Firms	71	71	70	70	51	49	50
Log Likelihood	-2215.973	-2214.423	-1992.389	-1990.453	-897.595	-565.342	-795.235
Wald χ^2	465.897***	477.005***	510.993***	513.885***	306.671***	130.301***	158.657***
Firm Effects	Random	Random	Random	Random	Random	Random	Random
Industry Dummies	Included	Included	Included	Included	Included	Included	Included
Year Dummies	Included	Included	Included	Included	Included	Included	Included

Standard errors are in parenthesis

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Hypothesis 3 predicts a significantly more positive impact on firms' eco-innovation performance for CVC investments with moderate technological proximity in comparison to low or high technological proximity to the venture. Model 6 in Table 3 shows that CVC investments have a significant positive effect on firms' eco-innovation performance in the moderate technological proximity subsample ($\beta = 0.032$, $p < .01$). Surprisingly, low technological proximity does seem to be also a relevant moderating variable since CVC investment is significant at the 5% level ($\beta = 0.027$, $p < .05$). In particular, Figure 4 illustrates the IRR coefficients of Model 5 to 7. A closer look at the results reveals a stronger interaction effect in the moderate proximity subsample compared to the high and low proximity subsample. In particular, Model 6, the moderate technological proximity subsample, presents a 3.29% increase in a firm's eco-innovation performance for CVC investments in moderately proximal ventures. Similarly, Model 5, the low technological proximity subsample, shows a slightly smaller gain of 2.71% when pursuing CVC investments in ventures that have a very dissimilar technological knowledge base compared to the corporation. In contrast, CVC investments into ventures that are very similar to a firm's existing technological knowledge base seem to be not very effective, represented by a gain of 0.04% in the firm's eco-innovation performance (Model 7). Overall, this analysis can only **partially support** the predicted inverted U-shaped moderation effect of **Hypothesis 3**.

Figure 4: Moderating effect of technological proximity on the central relationship²



²More detailed overview of IRR coefficients for each subsample can be found in Table 13

5. Discussion and conclusion

The final chapter of this study comprises the central findings of the investigation and compares them with the proposed hypothesis. Section 5.1 discusses how this study contributes to academic literature in the area of corporate entrepreneurship, eco-innovation, and real options. Subsequently, Section 5.2 elaborates on the managerial implications that are derived from the results of this study. In Section 5.3, limitations and future research suggestions are presented. Finally, Section 5.4 entails the conclusion that wraps up the findings and provides key takeaways from this research.

5.1 Theoretical implications

This study sets out to investigate how corporations are able to improve their eco-innovation performance in order to tackle environment-related challenges. Firms are not only forced to transform and improve their products and processes to protect the planet from further destruction but also because of changing customer needs, new regulations as well as new societal expectations. Hence, it is very relevant for managers to understand how they are able to promote environmentally friendly innovations and what they need to consider.

One of the vehicles that enables firms to incorporate environmental issues into their strategies while also achieving a competitive advantage is eco-innovation (Chen et al., 2006). However, researchers have also shown that eco-innovations often require knowledge and skills distant from a firm's internal knowledge base (De Marchi & Grandinetti, 2013). Consequently, it is assumed that internal R&D activities are not sufficient to tackle environmental issues. Thus, by focusing on CVC investments, this paper investigates a rather unexplored instrument to promote a firm's eco-innovation performance. CVC investment is considered to be a valuable mechanism to explore external knowledge, discover opportunities, and learn from ventures to develop novel solutions (Dushnitsky & Lenox, 2005b). By now, many corporations have adopted CVC investments to complement their R&D capabilities and screen the environment for new technologies (CBInsights, 2019b; Chesbrough, 2002).

The exploration of the relationship between CVC investments and firms' eco-innovation performance has particularly contributed to the existing corporate entrepreneurship, eco-innovation, and real options literature.

This study advances the corporate entrepreneurship literature as it provides insights into how the company is able to source relevant external knowledge that can lead to the development of eco-innovation. In addition, it reveals moderating factors that facilitate knowledge sourcing through CVC investments. Consistent with Hypothesis 1, the results of the empirical analysis suggest that CVC investments are positively related to a corporation's eco-innovation performance. One of the factors that moderate the above-stated relationship is the venture's investment stage a firm is investing in. Consistent with Hypothesis 2, this study found that early-stage investments have a stronger positive impact on the corporation's eco-innovation performance compared to later-stage investments. Furthermore, the study revealed a moderation effect of technological proximity between venture and incumbent. Hypothesis 3, proposing that the linkage between CVC investments and the firm's eco-innovation performance is stronger with moderate technological proximity, is only partially supported. Although it has the most pronounced effect, low technological proximity between corporation and venture seems to have a similar positive impact on the main relationship. Overall this study supports two out of three hypotheses while one is only partially supported.

To the best of the author's knowledge, the central relationship between CVC investments and eco-innovation has not been studied before. Nevertheless, prior research has investigated in similar directions by focusing on the effect of CVC investments on regular innovation and knowledge creation (Dushnitsky & Lenox, 2005b; Wadhwa & Kotha, 2006). Authors such as Dushnitsky and Lenox (2005b) found a positive relationship between CVC investments and organizational learning, showing the effective knowledge transfer between venture and corporation. Echoing prior findings, this study emphasizes the benefits of CVC investments with regard to external knowledge sourcing as well as knowledge creation of the incumbent.

In the eco-innovation literature, CVC investment has yet been ignored even though several studies have found that eco-innovation often requires a higher degree of external knowledge. The need for other knowledge sources is driven by eco-innovations' intrinsic complexity requiring a variety of specialist knowledge that is often spread across different organizations (Belin et al., 2011; De Marchi & Grandinetti, 2013). Based on the study's findings, CVC investments are considered a relevant instrument to source knowledge about environmentally friendly technologies. Furthermore, CVC investors seem to learn from the acquired knowledge and are able to generate new knowledge to capitalize on further eco-innovations. Ventures appear to provide an innovate setting in which environmentally friendly technologies can flourish. However, internal knowledge generation, such as R&D, does have a similarly

significant effect on a firm's eco-innovation performance. This is also in line with De Marchi and Grandinetti (2013), as they suggest that internal R&D is also critical for the development of eco-innovation. For this reason, CVC investments, as well as internal R&D, should be seen as complements rather than substitutes. While CVC investment could act as a vehicle to extend the range of ideas and identify potential new, environmentally friendly technologies, R&D may be used to pursue these opportunities and create new knowledge.

Besides CVC investments and the firm's internal R&D, this study has identified firm size as well as a firm's environmental focus as antecedents of corporation's eco-innovation performance. This study confirms prior research on eco-innovation that has found larger firms to be more likely to eco-innovate (Horbach, 2008; Qi et al., 2010). This effect is probably due to the availability of more human capital and financial resources to invest in knowledge sourcing as well as knowledge generation. Furthermore, a corporation's commitment to environmental sustainability activities seems to increase the firm's propensity to eco-innovate. Moreover, this study contributes to the real options literature since the analysis has shown that CVC investments are particularly effective in early-stage ventures. These early-stage ventures often exhibit a high level of uncertainty as the technology is still in an immature stage. For this reason, some prior researchers have argued that knowledge transfer is more effective when the venture is in a later stage. They suggested that a venture's deep and mature knowledge base would be a richer source of knowledge that facilitates organizational learning (Wadhwa et al., 2016). However, this study found the opposite and traces the result back to the real-option theory underlying CVC investments as well as the uncertainty inherent in eco-innovation. The real-options nature of CVC investment is especially valuable for early-stage investments as it allows firms to make small-scale, and low commitment investments into ventures that can be reassessed over time. Hence, corporations can mitigate their risk when exploiting ventures' uncertain and unexplored technologies. In fact, for most large firms, eco-innovations represent a technological frontier that has not been explored yet (De Marchi & Grandinetti, 2013). These early-stage investments seem to enable firms to source valuable and radically new knowledge that triggers their eco-innovation development. Potentially, a firm's early-stage CVC investments could be even more effective and less risky when the firm would diversify their CVC investments into various ventures. Diversification could increase the likelihood of sourcing external knowledge that is particularly relevant for the development of eco-innovations. However, this assumption would need to be investigated by future research.

Further, this study extends past studies by examining how the central relationship between CVC investments and eco-innovation is contingent upon technological proximity between venture and incumbent. Prior research has argued that the venture and the firm need to differ to some extent in order to share valuable information. In case the venture shows too many similarities, the corporation would not be able to learn and create value from the investment (Y. Yang, Narayanan, & De Carolis, 2014). Moreover, corporations, as well as ventures, may cannibalize their products (Hellmann, 2002). In contrast, low technological proximity between venture and firm is considered rather risky as it may preclude sufficient mutual understanding.

Unexpectedly, it was found that both moderately and low technological proximity positively affect the relationship between CVC investments and the corporation's eco-innovation performance. One potential reason explaining why low technological proximity does also improve the corporation's eco-innovation performance can be based on the findings of Benson and Ziedonis (2009). They argue that investments in unrelated ventures are particularly valuable when exploring emerging technologies and getting a window on novel technological areas. The development of environmentally friendly technologies, products, and services is considered a form of organizational exploration since it is a novel process for most corporations (Lin, 2016). Explorative learning enables firms to break away from their present knowledge path and shift to an altered technological trajectory (Lavie, Stettner, & Tushman, 2010; Lin, 2016). A venture that has a very similar technological expertise to the corporation does not provide proper learning opportunities that allow breaking away from a firm's existing knowledge path. Most companies that want to develop eco-innovations seek external ideas from sources that differ substantially from their current business model or technical capabilities (Calza, Parmentola, & Tutore, 2017). Therefore, one can assume that radical eco-innovation can be most effectively sourced through an explorative strategy enabling firms to transform into a more sustainable company (Martínez-Pérez, García-Villaverde, & Elche, 2015).

The results of this study are underlined by robustness through various control and model specifications. The usage of a one-year time lag between the independent variables and the dependent variable allows mitigating the possibility of reverse causation (Leszczensky & Wolbring, 2019). Furthermore, the sector, as well as year dummies, are included to capture potential fixed industry effects and unobserved year fixed effects. By controlling for R&D expenditures, revenue, ROA, and firm's environmental sustainability focus, a more precise interpretation of the central linkage between CVC investments and eco-innovation performance is ensured.

As outlined above, this study contributes to various literature streams by providing insights into the novel relationship between CVC investments and eco-innovation. Besides the analysis of the central linkage, it gives a detailed view of factors that facilitate a corporation's eco-innovation performance when investing with CVC.

5.2 Practical implications

Built upon the theoretical insights, this study also provides some practical implications for managers. As an increasing number of corporations aim to become more environmentally friendly, managers seek to find appropriate tools to do so. This study not only suggests a mechanism to improve a corporation's eco-innovation performance but also provides insights that could help managers when facing investment target decisions.

First, the study's findings show managers that CVC investments may be used to facilitate a corporation's eco-innovation performance. Ventures seem to provide a rich environment for environmentally friendly technologies that are of interest to corporations. Hence, the interaction with ventures leads to a knowledge inflow that can be combined with firms their internal knowledge stock to create novel eco-friendly solutions. Additionally, managers should not neglect internal knowledge generation through R&D as this seems to be also critical for the development of eco-innovation. CVC investments could be used to seek entire new ideas and opportunities from ventures, while internal R&D may further exploit the acquired external knowledge. Complementary usage of both tools would help corporations to transform environmentally friendly.

Second, to effectively source external knowledge through CVC, managers need to be aware of CVC investment configurations that promote the knowledge flow from ventures. This study suggests that managers should preferably place small bets on early-stage ventures. Early-stage ventures seem to provide greater opportunities to acquire knowledge about environmentally friendly technologies. Managers have the ability to reassess the investment over time and decide whether they should pursue follow-up investments or even exit the venture. These early-stage investments are especially relevant for managers that want to diversify their investments further or have a rather small CVC budget.

Third, managers should follow an explorative strategy when pursuing CVC investments by focusing on ventures that have some or no technical similarities to the corporation. By investing in companies that have a somewhat or even entirely different knowledge base, managers enable their employees breaking away from their existent way of thinking.

If decision-makers carefully manage their CVC programs with the understanding of the underlying moderation factors, knowledge sourcing from ventures could be more successful. Managers are advised to incorporate these implications into their next investment-decisions to promote eco-innovation development and be at the forefront of sustainable change.

5.3 Limitations and future research

This study is subject to certain limitations that require future research. Before diving into the limitations, it is important to note that the results and interpretations are based on this particular data sample. Although this study has included several robustness tests, pursued a diligent data cleaning procedure, and controlled for certain effects, one can never be sure that these interpretations are valid for the whole population.

First, although patents are widely acknowledged as a proxy for innovation performance, they also have several limitations. Count of patents does not observe direct knowledge flow from venture to corporate. In order to examine direct knowledge flow, cross-citations between patents of both parties would have been required. However, for most ventures in this investigation, this data was not available. Furthermore, although firms are developing innovative products and capture innovative benefits from their investments, they do not necessarily patent their ideas. Hence, this measure is not able to capture all knowledge created in a firm. Based on the concerns mentioned above, it is suggested that future research should use another eco-innovation proxy that validates the results of this investigation.

Second, concerning the SIC based measure for corporates technological proximity, this study has already made adjustments to account for corporate's variety of business sectors through the inclusion of primary and secondary SIC codes. Nevertheless, the measure in this study ignores the fact that ventures could potentially be categorized in more than one industry. Additionally, since technological proximity is based on the SIC industry code, this measure is sensitive to the assumption that the firm's technological knowledge depends on the firm's industry of operation. Future research should adjust for ventures' cross-sector activities as well as attempt to use a proxy that directly observes corporations' and ventures' knowledge base.

Third, CVC investors might have a particular investment objective that particularly targets ventures with environmentally friendly technologies. Although this study has tried to identify the focus of corporates' CVC programs manually, it was not feasible to determine a measure that is relevant for all CVC programs. Hence, this study has used corporates' environmental score to control for their investment objective. However, future research should try to extract a

relevant investment objective measure to provide even more insights into the relationship between CVC investment and eco-innovation.

Fourth, future research should also consider the magnitude of the CVC investments instead of only using the count of investments. This measure could provide future research with additional insights about the quality of the venture that could have a positive impact on corporate's eco-innovation performance.

As this study found that CVC investments can trigger corporations' eco-innovation performance, it sets a foundation for future research to build upon. In particular, future research should attempt to investigate whether improved eco-innovation performance does also have an impact on corporations' performance or even their environmental-friendly behavior. Furthermore, future research should try to capture the differences between the influences of CVC investments on different types of eco-innovation, such as process eco-innovation and organizational eco-innovation.

5.4 Conclusion

The more eco-innovations are advocated as a potential solution for the climate crisis and as an enabler of corporations' competitiveness, the more it is important to understand how firms can adopt and promote them. Prior research has focused mainly on the role of external drivers such as regulations as well as internal motivators such as managerial environmental concerns spurring the development of eco-innovation. This study attempted to fill this gap by examining an instrument that enables firms to source external knowledge that is crucial for the development of environmentally friendly products and processes. In particular, the main contribution of this study lies in underlining the effect of CVC investments on the development of corporations' eco-innovations applying the organizational learning theory. The results of this study suggest that CVC investments enable corporations to source relevant external knowledge from ventures that promotes their eco-innovation development. In terms of a firm's internal innovation resources, the presence of a strong R&D department contributes to the development of eco-innovation. Hence, external knowledge sourcing, as well as internal knowledge, generation should work complementary rather than substituting each other. Due to the complexity and uncertainty inherent in eco-innovation, it is suggested that CVC investments should rather flow into early-stage ventures so that corporations have the ability to exploit their uncertainties and reassess the investment over time. Further, the development of eco-innovation requires knowledge that is rather different from a corporation's knowledge base. Hence, this

study shows that corporate's eco-innovation performance benefits the most when CVC investments target ventures that exhibit a moderate or even low technological proximity to the incumbent. The findings of this study contribute to the understanding of different CVC specifications and how they spur corporate's eco-innovation performance. Managers might incorporate these insights into their environmental strategies to contribute to a cleaner world.

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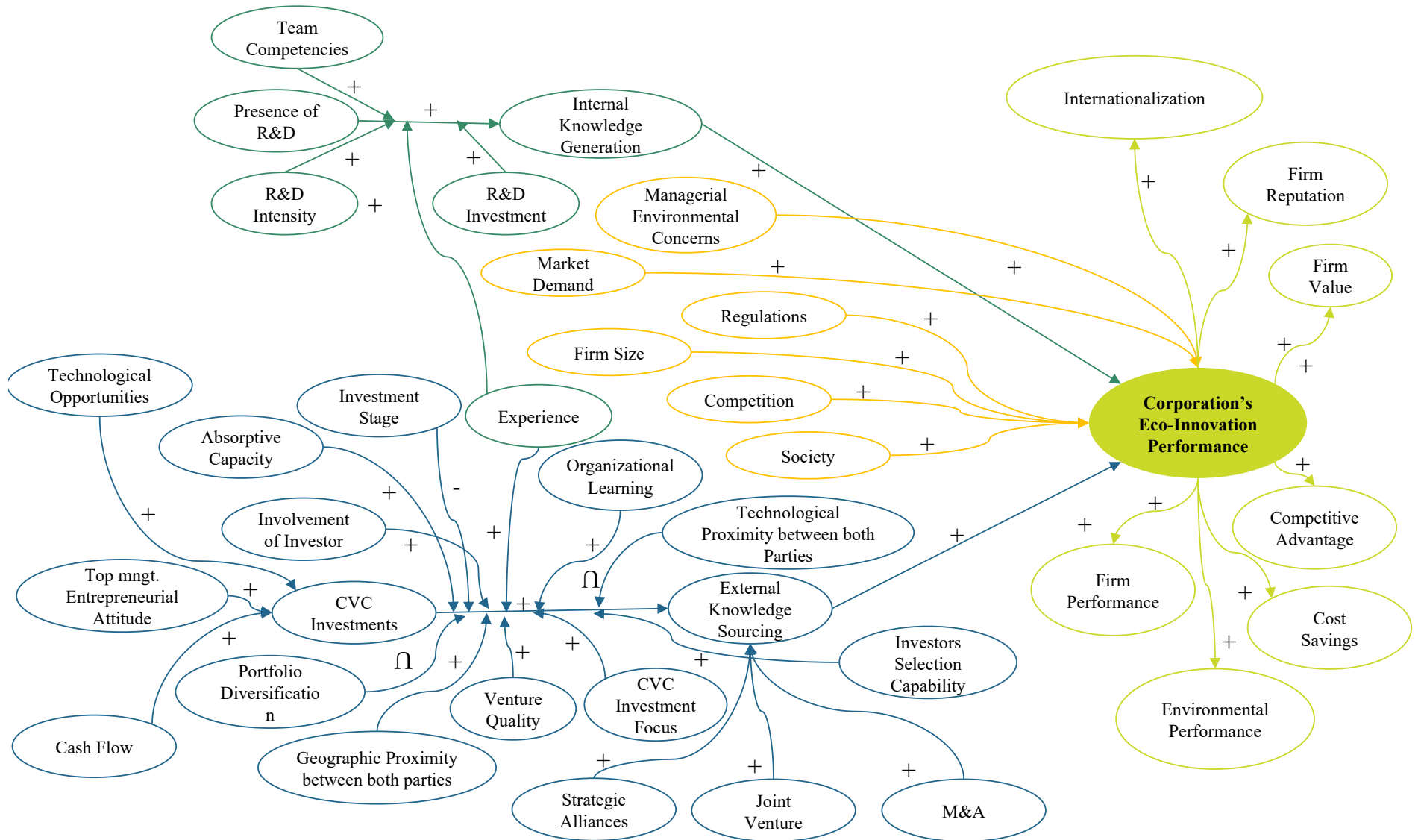
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Appendix
Appendix A: General overview
Figure 5: Conceptual scheme



Appendix B: Literature review**Table 4: Effects of CVC investments**

Author (s)	Year	Context	Criterion	Main Findings
Dushnitsky & Lenox	2006	171 public firms with CVC investments between 1990-1999	CVC investments in millions of dollars	<ul style="list-style-type: none"> - Firm performance measured in tobins q (+) - Underlying objectives of CVC program moderate relationship - Strategic objective (+)
Wadhwa & Kotha	2006	36 public telecommunication equipment manufacturers (>1 CVC investment) between 1989-1999	Number of CVC unique investments	<ul style="list-style-type: none"> - Knowledge creation (inverted U-shaped) - Moderating effect of corporate investor involvement (+)
Chesbrough & Tucci	2002	270 public companies that initiated a CVC program between 1973-1990	CVC Program existence (dummy)	<ul style="list-style-type: none"> - Association between internal R&D and external CVC investment (+)
Dushnitsky & Lenox	2005	250 U.S. public firms that engaged in some level of CVC investing during 1975-1995	CVC investments in millions of dollars	<ul style="list-style-type: none"> - Firm innovation performance (+) - Moderated by firm's absorptive capacity (+) - Moderated by strength of intellectual property protection of sector (+)
Benson & Ziedonis	2009	34 prominent CVC investors in the IT sector during 1987-2003	CVC intensity	<ul style="list-style-type: none"> - Venture acquisition performance (+)

Keil, Maula, Schildt & Zahra	2008	110 largest public U.S. companies in four ICT industries during the period 1993-2000	Count of each CVC external business development activity	<ul style="list-style-type: none"> - Firm innovation performance (+) - Moderating effect of technological relatedness (inverted U-shape)
Lee, Kim & Jang	2015	29 large firms with CVC investments in ICT industries during 1995-2005	Number of unique CVC investments	<ul style="list-style-type: none"> - Knowledge transfer (Inverted U-shaped relationship) - Moderating effect of social relation between corporate and venture (+) - Moderating effect of corporates knowledge diversity (+)
Schildt, Maula & Keil	2005	110 largest public U.S. companies in four ICT industries during the period 1992-2000	Dummy of firm's CVC activity	<ul style="list-style-type: none"> - Firm's explorative learning (+) - Moderating effect of technological similarity on explorative learning (-)

Table 5: Determinants of firm's eco-innovation performance

Author (s)	Year	Context	Criterion	Main Findings
Ghisetti, Marzucchi & Montrosor	2013	Manufacturing firms in 11 countries during 2006-2008	Count of environmental innovation (community innovation survey)	<ul style="list-style-type: none"> - External knowledge sourcing (+) - Breadth of knowledge sources (+) - Depth of interaction with external knowledge provider (+)
De Marchi	2012	6047 Spanish manufacturing companies in year 2007	PITEC survey– dummy filtering high / medium firm's environmental importance	<ul style="list-style-type: none"> - Cooperation with external partners (+) - Cooperation with suppliers, KIBS and universities more relevant than for other innovators (+)
Laurens, Bas, Lhuillery & Schoen	2017	Companies with sustained inventive activities during 2003-2005	Eco-patent applications (Y02E)	<ul style="list-style-type: none"> - Firm's knowledge capital in clean and not-clean technologies (+) - External-related knowledge (+)
Horbach	2008	4846 firms in the manufacturing and service sector in 2001	Mannheim innovation panel survey - Dummy variable filtering firms realized eco-innovation	<ul style="list-style-type: none"> - Knowledge capital generated by R&D (+) - Expected future demand (+) - Environmental regulations, environmental management tolls and organizational changes (+)
De Marchi & Grandinetti	2013	6334 Italian manufacturing firms during 2006-2008	Proxy for environmental innovation based on community innovation survey	<ul style="list-style-type: none"> - Green innovators fuel innovation through Interorganizational relationship more intensively than other innovations - External sources of information (+)

Appendix C: Methodology and research design

Table 6: CPC classification

CPC Classification	Description of each CPC Classification
Y02A	Technologies for adaptation to climate change
Y02B	Climate change mitigation technologies related to buildings, e.g. housing, house appliances or related end-user applications
Y02C	Capture, storage, sequestration or disposal of greenhouse gases
Y02D	Climate change mitigation technologies in information and communication technologies, i.e. information and communication technologies aiming at the reduction of their own energy use
Y02E	Reduction of greenhouse gas emissions, related to energy generation, transmission or distribution
Y02P	Climate change mitigation technologies in the production or processing of goods
Y02T	Climate change mitigation technologies related to transportation
Y02W	Climate change mitigation technologies related to wastewater treatment or waste management
Y04S	Systems integrating technologies related to power network operation, communication or information technologies for improving the electrical power generation, transmission, distribution, management or usage, i.e. smart grids

‘Adapted from Sustainable Technologies,’ by European Patent Office, 2018

Table 7: Overview of the variables

Theoretical Variables		STATA Terminology	Operationalization
Dependent variable	Eco-innovation performance	EcoPatents	<i>Count of yearly patent applications with the CPC classification of Y02 and Y04S (Eco-Patents)</i>
Central independent variable	CVC investments	CVCDeals	<i>Count of yearly CVC deals</i>
Moderating Variables	Techological proximity	TechProximity	<i>Average yearly overlap with ventures industry SIC. Overlap is computed as follows: 0 - If no overlap between venture's SIC code and firm's SIC codes exist 1 - If the first digit of the venture's SIC code and one of the firm's SIC codes overlap 2 - If the first two digits of the venture's SIC code and one of the firm's SIC codes overlap 3 - If the first three digits of the venture's SIC code and one of the firm's SIC codes overlap 4 - If the venture's SIC code and one of the firm's SIC codes completely overlap</i>
	Investment stage	InvestStage	<i>Average yearly investment stage a corporation has invested in. Investment stages are coded as follows: 0 - Early-stage investments: Seed stage and early stage 1 - Later-stage investments: Expansion stage and later stage</i>
Control Variables	Firm size	Revenue	<i>Corporation's yearly revenue</i>
	Firm's financial performance	ROA	<i>Corporation's yearly return on assets (ROA)</i>
	Firm's environmental focus	EScore	<i>Thomson Reuters environmental score. EScore is coded as follows: 0 - If the firm is rated lower than C+ 1 - If the firm is rated between C+ and A- 2 - If the firm is rated higher than A-</i>
	R&D expenditures	R&D	<i>Corporation's yearly spending on Research and Development</i>

Table 8: Results of the Hausman test

	---- Coefficients ----		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fixed	(B) random		
Revenue	.001358	.0019774	-.0006193	.0005651
R&D	.0461921	.043831	.0023612	.
EScore	.0517079	.074586	-.0228781	.0109057
ROA	-.1120819	-.0495276	-.0625543	.1950848
CVCDeals	.042379	.0466986	-.0043196	.
InvestStage	.1791784	.1569396	.0222388	.0134005
CVCDeals X InvestStage	-.0248745	-.0262546	.0013801	.
Industry				
SIC2	-.7891905	-.789376	.0001855	.1963018
SIC3	.0079646	-.0689805	.0769451	.1988924
SIC4	-1.714664	-1.703804	-.0108607	.2048911
SIC5	2.978264	.9928119	1.985452	2.590338
SIC6	-.2152629	-.7847054	.5694424	.3052125
SIC7	.3667859	-.2709029	.6376888	1.107326
Year				
2011	-.0468138	-.0455961	-.0012177	.0144798
2012	-.0408983	-.029338	-.0115603	.0323698
2013	-.2743678	-.298415	.0240472	.0158682
2014	-.4268607	-.4460982	.0192375	.
2015	-.5984915	-.6059471	.0074556	.0178361
2016	-1.108919	-1.11143	.0025107	.0210478
2017	-2.296831	-2.316995	.0201635	.0215573

b = consistent under Ho and Ha; obtained from xtnbreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtnbreg

Test: Ho: difference in coefficients not systematic

$$\begin{aligned} \text{chi2}(20) &= (b-B)' [(V_b-V_B)^{-1}] (b-B) \\ &= 5.61 \\ \text{Prob}>\text{chi2} &= 0.9993 \end{aligned}$$

Table 9: Results of the likelihood-ratio test overdispersion

```

Random-effects negative binomial regression      Number of obs      =          624
Group variable: id                             Number of groups   =           78

Random effects u_i ~ Beta                      Obs per group:
                                                min =              8
                                                avg =              8.0
                                                max =              8

Wald chi2(1) = 5.90
Log likelihood = -2781.8736                    Prob > chi2       = 0.0151
    
```

```

-----+-----
EcoPatents |      Coef.   Std. Err.      z    P>|z|    [95% Conf. Interval]
-----+-----
    CVCD deals |   .0118828   .004892    2.43  0.015    .0022946   .0214709
      _cons |   .3133943   .0751635    4.17  0.000    .1660764   .4607121
-----+-----
      /ln_r |  -.5708158   .1403833           .845962  -.2956695
      /ln_s |   1.285118   .2138666           .8659468  1.704288
-----+-----
           r |   .5650643   .0793256           .4291443   .7440333
           s |   3.615093   .7731475           2.377256   5.497472
-----+-----
    
```

```

LR test vs. pooled: chibar2(01) = 801.59          Prob >= chibar2 = 0.000
    
```

Appendix D: Results

Table 10: Negative binomial regression Stata output - Model 2

```

Random-effects negative binomial regression      Number of obs   =       534
Group variable: id                             Number of groups =        71

Random effects u_i ~ Beta                      Obs per group:
                                                min =           2
                                                avg =           7.5
                                                max =           8

Log likelihood = -2214.4229                    Wald chi2(18)   =       477.01
                                                Prob > chi2     =        0.0000
    
```

EcoPatents	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Revenue	.0017991	.0009293	1.94	0.053	-.0000224	.0036205
R&D	.0490136	.0152793	3.21	0.001	.0190668	.0789605
EScore	.131135	.0673877	1.95	0.052	-.0009424	.2632124
ROA	.0242989	.5572674	0.04	0.965	-1.067925	1.116523
CVCD Deals	.0075473	.0041604	1.81	0.070	-.0006068	.0157015
Industry						
SIC2	-.4471134	.4779739	-0.94	0.350	-1.383925	.4896984
SIC3	-.1073626	.4782423	-0.22	0.822	-1.0447	.8299751
SIC4	-1.473159	.4725845	-3.12	0.002	-2.399407	-.5469101
SIC5	.9677589	.7185166	1.35	0.178	-.4405077	2.376026
SIC6	-.5800224	.5724681	-1.01	0.311	-1.702039	.5419945
SIC7	.0192947	.8991508	0.02	0.983	-1.743008	1.781598
Year						
2011	.0031121	.0715374	0.04	0.965	-.1370985	.1433228
2012	.0832525	.0715957	1.16	0.245	-.0570725	.2235775
2013	-.17582	.0767367	-2.29	0.022	-.3262211	-.0254189
2014	-.3903592	.0819237	-4.76	0.000	-.5509267	-.2297917
2015	-.4734304	.0832443	-5.69	0.000	-.6365863	-.3102745
2016	-1.002982	.0960287	-10.44	0.000	-1.191195	-.8147691
2017	-2.1729	.1351957	-16.07	0.000	-2.437879	-1.907921
_cons	1.910423	.4785219	3.99	0.000	.9725376	2.848309
/ln_r	-.3040592	.1520273			-.6020273	-.0060912
/ln_s	.7604228	.2026982			.3631416	1.157704
r	.7378172	.1121684			.5477002	.9939274
s	2.13918	.433608			1.437839	3.182617

LR test vs. pooled: chibar2(01) = 929.62 Prob >= chibar2 = 0.000

Table 11: Negative binomial regression Stata output - Model 4

```

Random-effects negative binomial regression      Number of obs      =      472
Group variable: id                            Number of groups   =       70

Random effects u_i ~ Beta                     Obs per group:
                                                min =              2
                                                avg =              6.7
                                                max =              8

Wald chi2(20) = 513.89
Prob > chi2   = 0.0000

Log likelihood = -1990.4528
    
```

EcoPatents	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Revenue	.0019774	.0010431	1.90	0.058	-.0000671	.0040218
R&D	.043831	.015644	2.80	0.005	.0131693	.0744926
EScore	.074586	.0676511	1.10	0.270	-.0580077	.2071797
ROA	-.0495276	.5761201	-0.09	0.931	-1.178702	1.079647
CVCD Deals	.020444	.0084196	2.43	0.015	.0039419	.0369462
InvestStage	.1569396	.090335	1.74	0.082	-.0201138	.333993
c.CVCD Deals#						
c.InvestStage	-.0262546	.0133937	-1.96	0.050	-.0525057	-3.46e-06
Industry						
SIC2	-.789376	.5056798	-1.56	0.119	-1.78049	.2017382
SIC3	-.0689805	.5057157	-0.14	0.892	-1.060165	.9222042
SIC4	-1.703804	.504586	-3.38	0.001	-2.692774	-.7148334
SIC5	.9928119	.78604	1.26	0.207	-.5477981	2.533422
SIC6	-.7847054	.6065099	-1.29	0.196	-1.973443	.4040322
SIC7	-.2709029	.9029935	-0.30	0.764	-2.040738	1.498932
Year						
2011	-.0455961	.0702029	-0.65	0.516	-.1831913	.0919991
2012	-.029338	.0687597	-0.43	0.670	-.1641046	.1054286
2013	-.298415	.0762908	-3.91	0.000	-.4479421	-.1488878
2014	-.4460982	.077402	-5.76	0.000	-.5978033	-.2943931
2015	-.6059471	.0841558	-7.20	0.000	-.7708895	-.4410048
2016	-1.11143	.0938318	-11.84	0.000	-1.295337	-.9275228
2017	-2.316995	.1353486	-17.12	0.000	-2.582273	-2.051716
_cons	2.343924	.5093998	4.60	0.000	1.345518	3.342329
/ln_r	-.2604066	.1540182			-.5622767	.0414635
/ln_s	.7328332	.2041451			.3327161	1.13295
r	.7707381	.1187077			.5699101	1.042335
s	2.080968	.4248195			1.394751	3.104803

LR test vs. pooled: chibar2(01) = 848.68 Prob >= chibar2 = 0.000

Table 12: IRR - Negative binomial regression Stata output - Model 4

```

Random-effects negative binomial regression      Number of obs      =      472
Group variable: id                             Number of groups   =      70

Random effects u_i ~ Beta                      Obs per group:
                                                min =              2
                                                avg =              6.7
                                                max =              8

Log likelihood = -1990.4528                    Wald chi2(20)      =      513.89
                                                Prob > chi2        =      0.0000
    
```

EcoPatents	IRR	Std. Err.	z	P> z	[95% Conf. Interval]	
Revenue	1.001979	.0010452	1.90	0.058	.9999329	1.00403
R&D	1.044806	.0163449	2.80	0.005	1.013256	1.077337
EScore	1.077438	.0728899	1.10	0.270	.9436427	1.230204
ROA	.9516789	.5482813	-0.09	0.931	.3076778	2.94364
CVCDeals	1.020654	.0085935	2.43	0.015	1.00395	1.037637
InvestStage	1.169925	.1056852	1.74	0.082	.9800871	1.396533
c.CVCDeals#						
c.InvestStage	.9740871	.0130466	-1.96	0.050	.9488489	.9999965
Industry						
SIC2	.4541281	.2296434	-1.56	0.119	.1685555	1.223528
SIC3	.9333449	.4720072	-0.14	0.892	.3463986	2.514827
SIC4	.18199	.0918296	-3.38	0.001	.0676929	.4892736
SIC5	2.698813	2.121375	1.26	0.207	.5782216	12.59654
SIC6	.4562541	.2767226	-1.29	0.196	.1389775	1.497852
SIC7	.7626906	.6887046	-0.30	0.764	.1299328	4.476904
Year						
2011	.9554278	.0670738	-0.65	0.516	.8326089	1.096364
2012	.9710882	.0667718	-0.43	0.670	.8486533	1.111187
2013	.7419934	.0566072	-3.91	0.000	.6389417	.8616657
2014	.6401209	.0495466	-5.76	0.000	.5500186	.7449836
2015	.5455575	.0459118	-7.20	0.000	.4626014	.6433896
2016	.3290881	.0308789	-11.84	0.000	.2738056	.3955323
2017	.0985694	.0133412	-17.12	0.000	.075602	.1285141
_cons	10.42205	5.30899	4.60	0.000	3.840177	28.28492
/ln_r	-.2604066	.1540182			-.5622767	.0414635
/ln_s	.7328332	.2041451			.3327161	1.13295
r	.7707381	.1187077			.5699101	1.042335
s	2.080968	.4248195			1.394751	3.104803

LR test vs. pooled: chibar2(01) = 848.68 Prob >= chibar2 = 0.000

Table 13: IRR - Technological proximity subsamples

	Low Proximity	Moderate Proximity	High Proximity
	Model (5)	Model (6)	Model (7)
Constant	0.631* (2.28)	1.176** (3.58)	0.531 (1.93)
Revenue	1.002 (1.09)	1.004 (1.57)	1.002 (0.95)
R&D	1.008** (2.75)	1.003 (0.87)	1.007* (1.98)
EScore	0.986 (-0.15)	0.983 (-0.13)	1.131 (0.93)
ROA	0.704 (-0.37)	1.813 (0.40)	7.333* (2.28)
CVCDeals	1.027* (2.49)	1.033*** (3.43)	1.005 (0.70)
Observations	211	113	210
Firms	51	49	50
Log Likelihood	-897.595	-565.342	-795.235
Wald χ^2	306.671***	130.301***	158.657***
Firm Effects	Random	Random	Random
Industry Dummies	Included	Included	Included
Year Dummies	Included	Included	Included

Standard errors are in parenthesis

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Appendix E: Declaration of Originality MSc Thesis

By signing this statement, I hereby acknowledge the submitted MSc Thesis titled:

The Effect of Corporate Venture Capital Investments on the Investor's Eco-Innovation Performance

to be produced independently by me, without external help.

Wherever I paraphrase or cite literally, a reference to the original source (journal, book, report, internet, etc.) is provided.

By signing this statement, I explicitly declare that I am aware of the fraud sanctions as stated in the Education and Examination Regulations (EERs) of SBE, Maastricht University.

Place: Aachen, Germany

Date: 04.01.2020

First and last name: Marko Keulers

Study programme: M.Sc. International Business – Strategy and Innovation

ID Number: I6094901

Signature: