Business & Law School
Hochschule für Management und Recht

Discussion Paper Series

Can Corporate Characteristics and CVC enhance Environmental Performance and Green Innovation?

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No. 2 / 12-2025

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Redaktion / Editors

BSP Business & Law School –
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Key Words

Corporate Venture Capital, Environmental Performance, GHG Emissions, Green Innovation, Net-Zero Transition, Financial Performance

Abstract

This study investigates how corporate characteristics influence environmental performance and green innovation in the context of the global transition to net-zero emissions. Building on prior research that highlights the role of Corporate Venture Capital (CVC) in fostering innovation, we examine whether firm-level characteristics such as absorptive capacity, ESG scores, and board composition enhance the effectiveness of CVC investments in driving sustainable outcomes. Using a longitudinal dataset of ~350 U.S. listed corporate investors from 1998 to 2022, we integrate financial, environmental, and innovation data to assess the impact of these characteristics on both green innovation output and carbon emissions. Our findings reveal that high absorptive capacity significantly improves environmental performance (lower GHG emissions) and boosts both the quantity and quality of green innovation. Furthermore, we demonstrate that poor environmental performance negatively affects financial metrics such as RoA, RoE, and RoI. These results underscore the strategic value of aligning corporate characteristics with sustainability goals. The study offers actionable insights for managers, investors, and entrepreneurs, suggesting that targeted CVC investments, guided by specific corporate traits, can accelerate the net-zero transition while enhancing financial returns.

1. Introduction/ Objectives

The accelerating climate crisis has moved to the forefront of policy, corporate strategy, and academic debate (Pörtner *et al.*, 2022). Scientific consensus attributes global warming primarily to the buildup of greenhouse gas (GHG) emissions (Bhatia et al., 2004). In response, 196 parties signed the Paris Agreement at COP21 in 2015, committing to limit warming to well below 2°C and to pursue 1.5°C (UNFCCC, 2015). Achieving these targets requires coordinated action across governments, firms, and households. For corporations in particular, decarbonization has become a strategic imperative, elevating sustainable practices and measurable environmental performance to the core of value creation. Against this backdrop, scholars are increasingly investigating how firms can reduce GHG emissions while sustaining competitiveness, and what type of organizational mechanisms have the potential to accelerate green innovation (Fouquet & O'Garra, 2022).

Corporate venture capital (CVC), minority equity investments by established firms in entrepreneurial ventures, has emerged as a key pathway for accessing external knowledge and frontier technologies (Wadhwa et al., 2016). The primary strategic motive for CVC often centers on technology acquisition, learning, and capability building that complement internal R&D (Chemmanur et al., 2014; Dushnitsky & Lenox, 2006; Shuwaikh & Dubocage, 2022). In the specific context of the net-zero transition, CVC can give corporate investors privileged exposure to emerging clean technologies, processes, and data that enable environmental performance improvements (Battisti et al., 2022). Yet, despite rapid growth in sustainability reporting and green patenting, it remains insufficiently understood whether, and under what corporate conditions, innovation outcomes translate into reduced GHG emissions and improved financial performance.

Two insights motivate our research. First, green innovation is widely viewed as critical to bridging the gap between current technologies and decarbonization goals (Zhao et al., 2018), firms differ markedly in their ability to absorb external knowledge and turn it into environmental and financial outcomes. Prior research indicates that more innovative firms and those investing in R&D tend to manage environmental regulation and technological change more effectively (Yang et al., 2022; Zhao et al., 2018). Second, CVC initiatives are frequently cited as catalysts for accessing and codifying external technological knowledge, with documented links to innovation and organizational performance (Dushnitsky, 2012; Dushnitsky & Lenox, 2006; Pinkow & Iversen, 2020). However, existing work has largely emphasized CVC's effects on innovation quantity and quality (e.g., patents and citations) rather than its implications for environmental performance and firm value, particularly once corporate characteristics are considered.

We address this gap by examining how green innovation relates to firms' environmental performance, proxied by GHG emissions, and financial performance in the context of CVC. Specifically, we consider the role of corporate characteristics that theory and evidence identify as salient for external knowledge sourcing and learning, including absorptive capacity, organizational structure, cash flow availability, and industry conditions such as intellectual property regimes and technological ferment (Basu et al., 2011; Cohen & Levinthal, 1990; Drover et al., 2017; Dushnitsky & Lenox, 2005a). We also account for the broader environmental and competitive turbulence that may shape firms' incentives to pursue green innovation and environmental performance improvements (Antonioli & Mazzanti, 2017; Appolloni et al., 2022).

This paper examines the relationships among corporate characteristics, green innovation, environmental performance (GHG emissions), and financial performance in CVC firms. Our objective is to clarify whether innovation outputs are associated with tangible decarbonization outcomes and to identify the firm-level conditions under which these links are strongest. We address the following research questions:

1. Do CVC-related green innovation outputs associate with improved environmental performance (lower GHG emissions)?

2. How do corporate characteristics condition the relationship between green innovation and environmental performance?

3. Are environmental performance and green innovation jointly associated with improved financial performance and firm value among CVC firms?

We ground our analysis in the Natural Resource-Based View (NRBV), which posits that environmentally oriented strategies and capabilities can be sources of competitive advantage (Barney et al., 2011; Cristina De Stefano et al., 2016; Menguc & Ozanne, 2005). Applying the NRBV to CVC investing, we conceptualize green innovation as a strategic capability that can reduce GHG emissions and enhance performance. Our study contributes in three ways.

First, we extend the NRBV by offering empirical evidence on the link between green innovation and environmental performance in the CVC context, showing when and how innovation aligns with lower emissions, which is an essential step for operationalizing NRBV propositions in decarbonization settings (Cristina De Stefano et al., 2016; Menguc & Ozanne, 2005).

Second, we contribute to the CVC literature by shifting the focus towards the investee firm's perspective and by explicitly modeling corporate characteristics as conditioning factors. Prior work documents CVC's positive associations with innovation outputs, knowledge acquisition, and corporate performance (Dushnitsky & Lenox, 2005b; Maula et al., 2013; Wadhwa & Kotha, 2006; Kang et al., 2022; Shuwaikh & Dubocage, 2022; Villiers et al., 2011), and shows that CVC activity complements internal R&D, particularly when absorptive capacity and other firm-level resources are high (Cohen & Levinthal, 1989; Dushnitsky & Lenox, 2005a). We build on this foundation by testing whether CVC-enabled green innovation is associated with reductions in GHG emissions and by examining contingent corporate factors.

Third, we speak to managerial practice. Evidence suggests that greener start-ups attract more CVC, that investment in green innovation can enhance environmental and financial outcomes, and that CVC is widely deployed to align strategy with technological change (Benkraiem et al., 2023; Rossi, Festa, Devalle, et al., 2020; Rossi, Festa, Papa, et al., 2020; Shuwaikh & Dubocage, 2022). By clarifying how corporate characteristics and green innovation interact to influence both GHG emissions and financial performance, our study provides guidance on designing CVC programs that create environmental and economic value.

To our knowledge, this is the first study to provide a detailed empirical analysis of the interplay between GHG emission reduction, green innovation, and CVC in the United States, using a sample of about 350 CVC firms over 2002–2022. We focus on the U.S. because CVC is prevalent across sectors and plays a central role in financing and scaling digital and clean technologies (Battisti et al., 2022; Rossi, Festa, Devalle, et al., 2020; Rossi, Festa, Papa, et al., 2020). In this setting, corporate investors leverage CVC to access emerging technologies and knowledge that can complement internal capabilities and support decarbonization strategies (Maula et al., 2013; Wadhwa et al., 2016). Consistent with the literature, we also consider the complementarity between CVC and internal R&D and the conditioning effect of absorptive capacity and industry dynamics (Basu et al., 2011; Cohen & Levinthal, 1989; Drover et al., 2017; Dushnitsky & Lenox, 2005a).

The analysis reveals that firms with higher absorptive capacity, as measured by R&D intensity, demonstrate significantly better environmental performance and are more active and impactful in green innovation, as evidenced by both patent quantity and quality. Additionally, lower GHG emission intensity is consistently linked to superior financial outcomes, including higher returns on assets and equity. While board gender diversity and board size show variation across firms, absorptive capacity emerges as the most influential corporate characteristic in driving both sustainability and innovation outcomes. These findings underscore the strategic importance of aligning internal innovation capabilities with sustainability goals to enhance both environmental and financial performance.

The remainder of the paper proceeds as follows. Section 2 reviews the literature on CVC, corporate characteristics, green innovation, environmental performance, and financial outcomes, and develops hypotheses. Section 3 describes the data, sample construction, and empirical methods. Section 4 presents results and discusses implications. Section 5 concludes.

2. Literature Review

2.1 Resource based view theory and corporate characteristics and environmental performance

Understanding the factors that influence the financial performance of firms is a central question in business research. Scholars continuously analyse the various resources and capabilities available to companies and their impact on firm-level performance. The Resource-Based View (RBV) of firms, first introduced by (Barney et al., 2011; Wernerfelt, 1984), examines how the heterogeneous resources utilized by firms affect their performance over time. The RBV explains how a firm's resources contribute to sustained competitive advantage (Barney, 1991). According to (Barney, 1991), a firm's resources can be seen as tools to achieve its strategies and goals.

In the context of the RBV, the concepts of absorptive capacity and organizational structure are seen as critical resources that contribute to a firm's sustained competitive advantage. Firms with high absorptive capacity can better leverage external knowledge and innovations, enhancing their ability to innovate and adapt. This capability is particularly valuable in dynamic environments where technological advancements and market conditions are constantly evolving. Similarly, the operational structure of a firm influences how effectively it can deploy its resources to create value. A concentrated structure can lead to more effective strategic decision-making and resource allocation, while a diffuse structure can foster innovation and responsiveness. Both structures have their advantages, and the optimal configuration may depend on the specific context and strategic goals of the firm. In the context of CVC investments, these firm-specific characteristics play a crucial role. Firms with high absorptive capacity and an appropriate organizational structure can more effectively integrate and exploit the innovations and knowledge gained from their CVC activities. This integration can lead to improved environmental performance, enhanced green innovation, and better financial performance.

By considering absorptive capacity and organizational structure within the RBV framework, we can better understand how these firm-specific characteristics influence the ability of firms to leverage their heterogeneous resources for sustained competitive advantage and improved performance over time.

This theoretical framework can be applied to analyse a company's social and environmental activities, including climate change policies. Companies can leverage their progress in these areas to gain a competitive edge over competitors. As stakeholders, investors, the market, and society positively respond to improvements in environmental and ethical practices, this can lead to a sustainable competitive advantage. Environmental commitment is thus viewed as a crucial and beneficial aspect of business strategy. (Hart, 1995) found that adopting clean production methods can yield significant competitive advantages and environmental benefits. (Peteraf and Barney, 2003) define competitive advantage as the marginal economic value a company gains over its competitors due to superior performance in a specific area.

Early empirical analyses of this theory, using firm-level data on environmental performance and financial profitability, were conducted by (Russo and Fouts, 1997) and (Sharma and Vredenburg, 1998). They found that companies with better environmental performance also achieved better financial performance. (Sharma and Vredenburg, 1998) suggested that corporate investment in pollution control as an environmental strategy enhances firm-specific capabilities. (Nidumolu et al., 2009) argued that implementing an environmental strategy, especially in firms committed to sustainability, leads to future competitive advantage. Despite corporate decisions to pursue environmental protection and sustainability, it is essential to recognize that the primary goal of any firm is to maximize profit (Friedman, 1962). One objective of implementing environmental strategies is to gain competitive advantage and to ultimately improve corporate performance, which can further be fostered by supporting corporate characteristics.

2.2 Natural Resource based view theory and green innovation

The RBV and the Natural Resource-Based View (NRBV) suggest that competitive advantage arises when a firm possesses unique, heterogeneous resources (Barney, 1991; Hart, 1995). The NRBV framework (Hart, 1995) extends the RBV by focusing on how companies can use technological innovations to address environmental pressures. While the RBV emphasizes the importance of non-substitutable, inimitable, rare, and valuable resources for building competitive advantage (Barney, 1991; Wernerfelt, 1984), it does not account for environmental constraints. In contrast, the NRBV acknowledges the link between a firm's capabilities and resources and the natural environment.

The NRBV (Hart, 1995; Barney et al., 2011) identifies three key strategic areas for addressing environmental challenges: pollution prevention, product stewardship, and sustainable development. Each area offers distinct competitive advantages, essential resources, and environmental benefits (Barney et al., 2011). Globally, there is increasing demand for energy-efficient processes and less polluting products. Under the Kyoto Protocol, firms are pressured to innovate in ways that offset regulatory compliance costs and reduce carbon emissions (Porter and van der Linde, 1995; Wubben, 2000). Environmental pressures from the market and governments are mounting, and firms face significant challenges in developing eco-innovation capabilities to achieve sustainability (Dangelico and Pujari, 2010). According to the NRBV, firms should aim for long-term success while preserving the natural environment, requiring them to accumulate resources and mobilize capabilities with a long-term perspective rather than focusing solely on short-term profits. To gain competitive advantage, firms must rely on sustainable products and technologies. Further developments of the NRBV have highlighted the connections between competitiveness, green capabilities, and environmental strategies at the firm level (Barney et al., 2011).

Well-designed environmental regulations can improve both economic and environmental outcomes, advance environmental initiatives, and inspire innovation. This concept is encapsulated in the “Porter Hypothesis.” (Porter and van der Linde, 1995; Wubben, 2000) argue that organizational inefficiencies and incomplete information can cause firms to miss cost-saving opportunities, such as material and energy savings, and fail to recognize environmental and technological innovations. Environmental regulations compel firms to adopt beneficial environmental innovations (Porter and van der Linde, 1995; Wubben, 2000). They suggest that stringent, yet flexible environmental laws and well-planned measures can “trigger innovation that may partially or more than fully offset the costs of complying with them”.

This study applies the NRBV framework to CVC, focusing on green innovation strategies and their impact on GHG emissions. The NRBV posits a positive link between environmental and financial performance, suggesting that firms managing environmental issues well can enhance their capabilities and create competitive advantage (Barney et al., 2011). This framework supports research on green innovation aimed at reducing GHG emissions and assessing its impact on performance. The NRBV can be used to examine a company’s social and environmental activities, particularly climate change policies (Battisti et al., 2022). It establishes a connection between a firm’s capabilities and resources and the natural environment. According to the NRBV, firms should aim for long-term success while preserving the natural environment. Further elaborations of the NRBV have highlighted the links between competitiveness, green capabilities, and environmental strategies at the firm level (Barney et al., 2011). The NRBV framework is well-suited to our context because it assumes that environmentally sustainable actions contribute to competitive success. Our findings indicate that green innovation strategies are effective for reducing GHG emissions, consistent with the NRBV.

2.3 Corporate Venture Capital & Innovation

CVC comprises direct minority equity investments by established non-financial firms into privately held entrepreneurial ventures (Drover, Will, 2017; Wadhwa et al., 2016). It functions primarily as a strategic vehicle for incumbents to access external knowledge, emerging technologies, novel business models, and market channels while supplying portfolio ventures with capital, industry expertise, networks, and customer access (Dushnitsky & Lenox, 2005b; Cumming et al., 2020; Lantz et al., 2011).

CVC typically takes equity form and is often staged incrementally through industrial or corporate venture funds. It pairs financial stakes with technical input and strategic collaboration rather than debt financing, establishing investment relationships with legally separate entrepreneurial entities to transfer complementary resources and capture strategic advantages from ventures’ knowledge (Dushnitsky and Lenox, 2006; J. Henderson, 2009; Alvarez-Garrido & Dushnitsky, 2012; Chemmanur et al., 2014).

Internal R&D and CVC are complementary rather than substitutive: internal R&D builds proprietary capabilities and absorptive capacity that enable firms to identify, integrate, and exploit external innovations, while CVC exposes firms to radical, uncertain technologies and entrepreneurial experimentation that internal labs may miss. This is prompting firms to combine CVC with alliances, licensing, M&A, and other external sourcing mechanisms to overcome internal innovation limits and broaden technological horizons (Cohen & Levinthal, 1990; Dushnitsky & Lenox, 2005a; Sahaym et al., 2010; March, 1991; Ceccagnoli et al., 2018; S. M. Lee & Trimi, 2018; Dushnitsky, 2012).

CVC activity is conditioned by firm-level resources and industry context: higher cash flow, absorptive capacity, and prior venturing experience increase propensity to invest, while industry characteristics such as technological ferment, competition intensity, and low appropriability or weak intellectual property protection make external investment more attractive. Hence, firms invest more via CVC when appropriability is low and technological uncertainty is high to capture externally generated innovation and complement internal learning (Drover, Will, 2017; Dushnitsky & Lenox, 2005a; Basu et al., 2011; Cohen & Levinthal, 1990).

In environmental and decarbonization contexts, CVC serves as a channel for acquiring green technologies and know-how that can support net-zero strategies and reduce greenhouse gas emissions. Start-ups with stronger environmental performance attract more CVC, and investments in green innovation can deliver both environmental and financial benefits. Although, whether innovation output translates into lower emissions depends on firm characteristics and industry context, making the effect conditional rather than automatic (Dushnitsky, 2012; Battisti et al., 2022; Benkraiem et al., 2023; Shuwaikh & Dubocage, 2022; Zhao et al., 2018; Yang et al., 2022).

Taken together, CVC functions as a strategic complement to internal innovation systems, enabling incumbent firms to nurture, absorb, and scale external technological advances while shaping venture outcomes through staged equity and resource linkages. Research should therefore examine how CVC investments, mediated by firm resources and industry factors, influence innovation outputs as well as environmental and financial performance (Chemmanur et al., 2014; Maula et al., 2013; Da Gbadji et al., 2015; Dushnitsky & Lenox, 2006).

2.4 Firm-specific corporate characteristics

CVC activity aims at fostering the exploitation of knowledge, fuelling innovation and exploring new developments. To be able to do so a firm needs the internal ability and competence to absorb and utilize the knowledge acquired to uncover the full innovation potential (Dushnitsky & Lenox, 2005a).

The role of absorptive capacity, defined as “a firm’s capability to recognize the value of new knowledge, assimilate and exploit it” (Cohen & Levinthal, 1990). This definition operationalizes absorptive capacity as the firm´s ability to value, incorporate and apply new and external knowledge. In addition to that (Mowery, Oxley and Silverman, 1996) provided a definition of absorptive capacity as the needed skillset to be able to adapt, incorporate and modify the imported knowledge that was accessed through external means of sourcing. Also, firms are able to learn from failures and develop capabilities for future success through absorptive capacity (Cho et al., 2023). For firms, absorptive capacity has been proven to be a highly important, useful and vital prerequisite for being innovative, achieving a high financial performance and sustaining and developing a competitive advantage that sets them apart from other companies (Zahra and George, 2002).

Cohen & Levinthal (1990) introduced the concept of the absorptive capacity process with three steps, namely identification, assimilation and exploitation. Zahra & George (2002) later adapted and reevaluated their concept but introduced slight changes to the absorptive capacity process. They understood absorptive capacity as a “dynamic capability pertaining to knowledge creation and utilization” and reconceptualized the process into four dimensions, which are acquisition, assimilation, transformation and exploitation. The contribution of Zahra & George (2002) was to create two new components out of the four dimensions that lead to the dynamic capability of firms. Potential absorptive capacity consists of acquisition and assimilation and covers the firm’s capability to interpret and understand the knowledge that has been acquired. Transformation and exploitation are part of the realized absorptive capacity dimension and touch on the capability to implement and leverage the external knowledge that was absorbed.

They have separate but complementary roles, but are vital and crucial for improving company performance (Zahra and George, 2002; Cho *et al.*, 2023). The characteristics of absorptive capacity as a dynamic capability of firms was illustrated by various academics (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998; Zahra and George, 2002; Flatten, 2011) and a few studies demonstrated the importance of absorptive capacity as an antecedent of CVC investing (Basu et al., 2011; Dushnitsky & Lenox, 2005a). Dushnitsky & Lenox, (2005a) argue that corporate investors who possess greater absorptive capacity are likely to enter into a greater extent of CVC investments due their greater ability to exploit and explore knowledge from CVC investment activities. (Sahaym, Steensma and Barden, 2010) found that R&D investments are increasing firms’ capabilities of perceiving and exploiting opportunities and thereby enhancing the appeal of CVC investments.

Moreover, industries where higher absorptive capacities are manifested due to prior R&D investments exhibit greater endeavour in pursuing external innovation activities through the use of CVC. They suggest that absorptive capacity is the basis for investing in new technologies and ventures to foster future growth and that a complementary relationship between R&D and CVC exists. Supporting this argument, (Gompers and Lerner, 2001) found that firms in industries with high historic levels of R&D gain higher industry knowledge and absorptive capacity (Cohen & Levinthal, 1990), which helps them to assess the value proposition of unfolding technologies with innovative potential for future CVC investment activities.

Board gender diversity, defined as the representation of women on a company’s board of directors, has become a central focus in corporate governance research. It is often examined through the lenses of Stakeholder Theory, Resource Dependence Theory, and Upper Echelons Theory.

According to Stakeholder Theory (Freeman, 1984), gender-diverse boards are more likely to consider a broader range of stakeholder interests, including environmental and social concerns. Resource Dependence Theory (Pfeffer & Salancik, 1978) posits that women bring unique perspectives, experiences, and external networks that enhance board decision-making and strategic oversight. Upper Echelons Theory (Hambrick & Mason, 1984) further suggests that the demographic characteristics of top executives, including gender, shape organizational outcomes such as innovation, sustainability, and long-term performance.

With regards to board gender diversity and environmental performance, empirical evidence generally supports a positive relationship between both, although findings are not universally consistent. Studies have shown that female directors are often more supportive of environmental initiatives and corporate social responsibility (CSR) (Post et al., 2011; Ben-Amar et al., 2017). Women on boards are associated with greater transparency, long-term orientation, and ethical governance, all of which align with environmental stewardship (Glass et al., 2016). However, the strength of this relationship may depend on the critical mass of women on the board. Research suggests that token representation (e.g., one or two women) may not be sufficient to influence board dynamics, whereas a threshold of three or more women can lead to meaningful change (Kramer et al., 2006). Additionally, the effect of gender diversity may vary by industry, with stronger impacts observed in environmentally sensitive sectors (Liao et al., 2015).

The relationship between board gender diversity and innovation and particularly green innovation is an emerging area of research. Gender-diverse boards are often associated with greater openness to new ideas, risk-taking, and strategic flexibility (Torchia et al., 2011). These traits are conducive to fostering eco-innovation and sustainable R&D initiatives. Several studies have found that firms with more women on their boards are more likely to invest in green technologies and pursue environmentally friendly product development (Bernardi & Threadgill, 2010; Liu et al., 2021). The effect may be amplified in firms with high environmental visibility or strong ESG commitments, suggesting a potential interaction between board composition and external sustainability pressures.

The link between board gender diversity and financial performance is nuanced and context dependent. Meta-analyses such as (Post and Byron, 2015) report a small but statistically significant positive effect, particularly in countries with stronger gender equality norms and governance frameworks. Some scholars propose a non-linear (U-shaped) relationship, where tokenism (1–2 women) has limited impact, but a critical mass (≥3 women) leads to improved decision-making and firm performance (Joecks et al., 2013). The financial impact of board gender diversity may also vary by firm size, industry, and governance structure, highlighting the importance of contextualizing empirical findings.

With regards to the Board size, defined as the total number of directors serving on a company's board, is a fundamental dimension of corporate governance. It is frequently examined through the lenses of Agency Theory, Resource Dependence Theory, and Coordination and Decision-Making Theory. According to Agency Theory (Jensen & Meckling, 1976), larger boards may enhance the monitoring of managerial behavior, thereby reducing agency costs and improving accountability. From the perspective of Resource Dependence Theory (Pfeffer & Salancik, 1978), larger boards can provide access to a broader array of expertise, external networks, and strategic resources, which may be particularly valuable in complex or dynamic environments. However, Coordination and Decision-Making Theory (Yermack, 1996) suggests that as board size increases, coordination becomes more difficult, potentially leading to inefficiencies, slower decision-making, and diluted responsibility.

As such, the theoretical implications of board size are ambiguous: while larger boards may offer strategic and oversight advantages, they may also introduce governance challenges. The net effect is likely to be context-dependent, varying across firms and industries.

The empirical relationship between board size and environmental performance is mixed. On one hand, larger boards may include a wider range of perspectives and are more likely to establish specialized committees, such as sustainability or ESG committees, that enhance environmental oversight and disclosure (Post et al., 2011; Ben-Amar & Boujenoui, 2020). These structures can facilitate the integration of environmental considerations into corporate strategy. On the other hand, larger boards may also suffer from free-riding, slower consensus-building, and weaker individual accountability, which can undermine the effectiveness of environmental governance (Jizi, 2017). The impact of board size may also be moderated by factors such as board independence, stakeholder pressure, and regulatory context. Empirical studies such as Liao et al. (2015) and Walls et al. (2012) find a positive association between board size and environmental disclosure, but only up to a point, suggesting a non-linear relationship.

Board size may also influence a firm's capacity for green innovation through its role in strategic guidance and resource allocation. Larger boards may be more inclined to approve long-term investments in R&D and sustainability initiatives (Chen et al., 2020) and may include directors with technical or environmental expertise who can champion eco-innovation (Zhang et al., 2022). However, excessively large boards may exhibit risk aversion or bureaucratic inertia, potentially stifling radical or disruptive innovation (Eisenberg et al., 1998). As with environmental performance, the relationship between board size and green innovation is likely non-linear, with moderate board sizes being optimal for fostering innovation while maintaining strategic agility.

The literature on board size and financial performance is extensive and nuanced. Yermack (1996) found that smaller boards are associated with superior firm performance, attributing this to more efficient decision-making and stronger individual accountability. In contrast, Coles et al. (2008) argue that larger boards are beneficial in firms with greater complexity, where diverse expertise and advisory capacity are essential. Some scholars propose a U-shaped relationship, where both very small and very large boards are suboptimal, and intermediate board sizes yield the best financial outcomes (Krause et al., 2014). Meta-analyses suggest that the effect of board size on financial performance is highly context-dependent, influenced by firm size, industry characteristics, and governance quality.

2.5 Relationship between corporate characteristics, environmental performance and green innovation

Absorptive capacity is a critical concept in understanding how organizations acquire, assimilate, and exploit external knowledge to enhance their performance. Developed by Cohen and Levinthal in 1990, the theory posits that absorptive capacity is composed of the ability to recognize the value of new information, assimilate it, and apply it to commercial ends.

This capacity is essential for innovation and competitive advantage. Key theories in absorptive capacity include the notion that it is influenced by prior related knowledge, which enhances an organization's ability to evaluate and utilize new information. Zahra and George (2002) further refined the concept by distinguishing between potential absorptive capacity (the ability to acquire and assimilate knowledge) and realized absorptive capacity (the ability to transform and exploit knowledge).

This distinction helps in understanding how organizations can convert their knowledge base into tangible outcomes. Green absorptive capacity specifically focuses on environmental knowledge and practices (Roberts *et al.*, 2012; Pacheco, Alves and Liboni, 2018). It enables firms to integrate and utilize external green knowledge, which is crucial for improving environmental performance. Studies have shown that green absorptive capacity positively impacts environmental performance by enhancing a firm's ability to implement green supply chain management practices and relational capabilities (Albort-Morant, Leal-Rodríguez and De Marchi, 2018). Firms with high green absorptive capacity can better adopt and implement eco-friendly technologies and practices, leading to significant reductions in greenhouse gas (GHG) emissions (Abareshi and Molla, 2013; Marrucci, Daddi and Iraldo, 2022). This is supported by research indicating that firms with robust green absorptive capacity are more adept at reducing their carbon footprint and improving overall environmental sustainability. Therefore, it can be hypothesized that corporate investors with high absorptive capacity have a higher environmental performance (Marrucci, Daddi and Iraldo, 2022).

The relationship between absorptive capacity and green innovation output is equally important. Green innovation output, measured by the number and quality of green patents, reflects a firm's ability to develop new environmentally friendly technologies and products (Chemmanur, Loutskina and Tian, 2014; Kalutkiewicz and Ehman, 2014). High green absorptive capacity facilitates the absorption and application of external green knowledge, which is crucial for green innovation (Albort-Morant, Leal-Rodríguez and De Marchi, 2018; Pacheco, Alves and Liboni, 2018). The presence of a supportive green innovation climate further enhances the relationship between green absorptive capacity and green innovation output, fostering an environment conducive to sustainable innovation.

Patents serve as a tangible measure of innovation output, and firms with robust green absorptive capacity are more likely to generate green patents, indicating successful green innovation efforts.

Thus, it can be hypothesized that corporate investors with high absorptive capacity have a higher green innovation output. The absorptive capacity theory has been widely applied in various fields, including strategic management, innovation management, and organizational learning. It provides a useful framework for understanding how organizations acquire and use external knowledge to improve their performance. Investments in human capital, organizational routines, and network ties are critical for enhancing absorptive capacity (Todorova and Durisin, 2007; Flatten, 2011; Roberts *et al.*, 2012). Modern information technologies also play a crucial role in developing and maintaining a firm's absorptive capacity by facilitating the acquisition, assimilation, and application of valuable external knowledge. This is particularly relevant in the context of green innovation, where the ability to leverage external environmental knowledge can lead to significant advancements in sustainable practices and technologies.

In summary, absorptive capacity, particularly green absorptive capacity, plays a pivotal role in enhancing both environmental performance and green innovation output. By effectively assimilating and utilizing external green knowledge, firms can achieve significant reductions in GHG emissions and increase their green patent output, contributing to overall sustainability goals (Albort-Morant, Leal-Rodríguez and De Marchi, 2018; Marrucci, Daddi and Iraldo, 2022).

This comprehensive understanding of absorptive capacity underscores its importance in fostering innovation and improving environmental performance, making it a critical area of focus for organizations aiming to achieve long-term success and sustainability.

We deem that it is crucial to examine how these corporate characteristics influence (green) innovation output and environmental performance. Our research focuses on this aspect, aiming to provide insights into how corporations can enhance their environmental performance through innovation, potentially leading to more effective decarbonization strategies.

Hypothesis 1: Corporate Investors with high Absorptive Capacity have a higher environmental performance.

Hypothesis 2: Corporate Investors with high Absorptive Capacity have a higher green innovation output.

2.6 Relationship between green innovation, environmental performance and financial performance

The relationship between green innovation, environmental performance, and financial performance has been extensively studied, with most findings indicating a positive correlation among these variables, although some studies present mixed results.

The majority of studies find a positive relationship between corporate environmental performance and financial performance. For instance, reducing greenhouse gas (GHG) emissions often leads to improved financial outcomes, as evidenced by measures such as Return on Assets (RoA), Return on Equity (RoE), and Tobin's Q (Hatakeda *et al.*, 2012; Rokhmawati, Gunardi and Rossi, 2017).

Investors tend to value reductions in GHG emissions, which can increase firm value, while unchecked carbon emissions can reduce firm value. However, the relationship can vary by industry, with mixed results in sectors like paper, coal, oil, gas, and chemicals (Bolton & Kacperczyk, 2021). Additionally, transparency in environmental performance, such as through disclosure, is positively related to financial performance (Hatakeda et al., 2012).

Green innovation, often measured through green patents, has a positive impact on financial performance. Studies show that eco-innovators exhibit higher RoA and RoE compared to their less green counterparts (Porter and van der Linde, 1995; Aguilera-Caracuel and Ortiz-de-Mandojana, 2013; González-Benito *et al.*, 2016).

However, an excessive focus on green innovation might negatively influence financial performance, indicating the need for a balanced approach (Przychodzen, Leyva-de la Hiz and Przychodzen, 2020). Investments in green R&D and sustainable business practices are shown to reduce GHG emissions and improve both environmental and financial performance (Lee and Min, 2015; Long *et al.*, 2017).

The positive relationship between green innovation and environmental performance appears evident, with investments in sustainable practices leading to reduced GHG emissions. However, the financial benefits of green innovation may vary depending on the level of focus and the specific industry context. For instance, while green innovation enhances financial performance, excessive focus on it might have adverse effects, highlighting the need for a balanced approach.

Despite increased reporting by CVC firms on their GHG emissions and green innovation efforts over the past two decades, the impact of these factors on financial performance remains underexplored. This article addresses this gap by investigating the relationships between corporate characteristics, environmental performance, green innovation, and financial performance in CVC firms, aiming to help parent companies improve strategic performance and achieve higher financial returns.

Hypothesis 3: Corporate Investors with lower environmental performance have a lower financial performance.

3. Approach/ Methodology

In the first step, the influence of corporate characteristics, especially the concept of absorptive capacity, on the environmental performance and on the green innovation output of the firm is assessed. Thereafter, the effect of environmental performance on firm financial performance is observed.

3.1 Sample Selection

The selected sample comprises longitudinal data on U.S listed firms between 2002 – 2022 based on the Thomson Venture Xpert database and includes firms that have made at least one CVC investment. Financial and Accounting data on the corporate level is retrieved from Standard and Poor`s Compustat database and data on GHG emissions are collected from Refinitiv Eikon. Firstly, the CVC investment data is matched with the financial and accounting data. Thereafter, the environmental data is matched to the sample and only firms for which both data are available are kept. Finally, innovation and green innovation data which were retrieved from the Patstat database are added to the sample. The methodology used to match the firms was based on the description by (Tarasconi and Menon, 2017). The final sample comprises of ~350 corporate investors and ~4,000 observations.

To measure the impact of Corporate Characteristics of CVC investors, we use Environmental Performance and Green Innovation as dependent variables. Environmental Performance is assessed by using Scope 1 - 3 carbon emissions following (Bhatia, Ranganathan and Development (WBCSD), 2004). For Green Innovation, we use the number of patents for quantity and patent citations for quality. To account for financial performance, we use RoA, RoE, RoI as short-term measures as well as Tobin’s Q.

As independent variables, we will apply different firm-level resources like absorptive capacity, Board Size, Board Gender Diversity and industry-level factors like GHG intensity.

3.2 Dependent Variables

In this paper, different dependent variables are tested.

Environmental performance is used as an independent variable to test hypothesis 1. Following the GHG Protocol, environmental performance is assessed using GHG emissions for Scope 1-3. According to the literature, using absolute GHG emissions would lead to significant tail risks, hence two measures are introduced to account for that. The natural logarithm of GHG emissions and GHG emission intensity, which defined as GHG emissions per unit of revenue (Benkraiem *et al.*, 2023). According to the commonly applied methodology to use the mentioned two measures to account for environmental performance by (Busch and Hoffmann, 2011), the input variables are multiplied by -1.

This approach is followed as otherwise lower GHG emissions would correspond to higher values for environmental performance. Hence, the interpretation of all variables is facilitated by aligning the positive directions of financial performance, green innovation and environmental performance.

Moreover, green innovation is introduced as a dependent variable to evaluate hypothesis 2. While earlier studies predominantly used R&D expenditures to gauge corporate innovativeness, recent research agrees that patent-based metrics are a more accurate measure of a firm’s innovation output (Chemmanur et al., 2014). A commonly accepted method for evaluating the impact of patents is the forward citation count. Forward citations, which are references to a specific patent in subsequent patent filings, help identify whether a particular patent was crucial to later technological advancements in a field (Kalutkiewicz and Ehman, 2014).

Following this method, two distinct patent-based measures are employed to evaluate both the quantity and quality of green innovation. These green innovation metrics are based on the year of the patent application. Firstly, the number of green patent applications by a firm each year (Count) is used to quantitatively analyse innovation. Secondly, the number of subsequent citations of these green patents (Citations) is utilized to assess the quality of innovation. Since citation counts are subject to truncation bias, this variable requires adjustment. Patents typically receive citations over time, and under U.S. patent law, a utility patent is granted for a 20-year lifespan. Consequently, there is a notable bias against more recent patents in the data. To correct for citation truncation bias, the shape of the citation-lag distribution is estimated, following (Hall, Jaffe and Trajtenberg, 2001).

To further address the empirical properties of the variables, the natural logarithm of the newly introduced variables is taken. Additionally, to prevent the loss of firm-year observations with zero patents or zero citations per patent, one is added to the patent and citation count before taking the natural logarithm (Chemmanur, Loutskina and Tian, 2014; Ma, 2020). Following this procedure, ln(1 + Count) is denoted as Count, and ln(1 + Citations) is denoted as Citations.

With regards to the financial performance three different measures are tested. As short-term measures RoA, which is indicating the return on investment concerning total assets and RoE, measuring the return on investment for total equity, are used. Moreover, to reflect both short-term and long-term financial performance, Tobin’s Q is used, which is the ratio of the firms market value to their tangible assets replacement cost (Dowell, Hart and Yeung, 2000). Financial performance is used as the dependent variable for testing hypothesis 3.

3.3 Independent Variables

The operationalization of absorptive capacity has proved to be able to measure using various and different indicators. (Geroski, 2005) use R&D costs, whereas Cohen and Levinthal (1990) use R&D intensity to measure the absorptive capacity and (Mowery, Oxley and Silverman, 1996) use firm size instead. Zahra & George (2002) create potential and realized absorptive capacity as two new components of the established concept with four dimensions. They measure realized absorptive capacity as the number of patents held at the time of an IPO and the potential absorptive capacity is measured as the amount of development costs to IPO (Geroski, 2005). Aligned with the literature, I measure absorptive capacity according to Cohen & Levinthal (1990) and use R&D intensity. The data is obtained from Compustat.

To measure operational structure, I use the aggregate number of 2-digit SIC codes in which firm i is conducting business in, to operationalize the variable ((Lichtenberg, 1992; Liebeskind and Opler, 1992; Hashai, 2015). I retrieve the data from Compustat. Consequently, higher values reflect a more scattered operational structure, whereas lower values indicate an operational concentration on fewer business segments.

To empirically test the impact of board gender diversity, the variable has been operationalized as the percentage of women on board, which is the number of female directors divided by the total board size in a given year (Behlau et al., 2024). To account for board size, the total number of directors on the board in a given year has been used (Linck et al., 2008).

The study uses Compustat as the source to retrieve the data to account for board size as well as board gender diversity.

Different approaches are used in research to measure CVC activity. Basu et al. (2011) take the formation of new CVC partnerships and operationalize it as the number of new portfolio firms in which a firm i made CVC investments in year t. To account for CVC Activity, I follow the approach of Sahaym et al. (2010) who take the aggregate count of corporate venture deals by each investor firm as the measure. According to their methodology and in accordance with Titus & Anderson (2018) I center CVC activity and also the other predictor variables to ease interpretation. Using Datastream Private Equity Screener, I search for all private equity deals and investments during the time period from the start of 2002 until the end of 2022. For every firm i I use the aggregate count of investments in year t to measure CVC activity.

Furthermore, environmental performance and green innovation are also used as independent variables in hypothesis 3.

3.4 Control Variables

The study controls for several firm- and industry-level variables to mitigate specific effects inside firms and industries. This information is retrieved from Compustat. In detail, I use firm size, firm slack, firm age, firm growth, firm liquidity, firm leverage, diversification, ROA, absorptive capacity and Industry Q as controls in the analysis.

Firm size (size) is measured using the natural logarithm of annual net sales of each company in the focal period and accounts for size effects as an antecedent to firm performance. Also, by including to control for firm size, size effects due to firms’ scope and scale on external venturing activities are parsed out. The Behavioral Theory of the Firm suggests that firm slack improves the stability and adaptability of a firm, hence it has a positive influence on firm performance and value.

Also, an environment with high slack is beneficial for innovation, whereas firms with low slack tend to be more cautious (Sahaym et al., 2010). Therefore, it is also controlled for slack, which is measured as a firms debt-to-equity ratio according to (Bromiley, 1991; Luger, 2014). I also control for firm age (age), as the age may influence firm performance and their CVC activity both negatively or positively. Older companies might be hesitant to pursue innovation as inertia might hinder these companies to explore new ventures (Zahra and Hayton, 2008).

Based on these possibly contradictory effects, it is controlled for age. Data for age is obtained from Compustat, using the first firm-year with non-missing annual closing price of the fiscal year (prcc_f) as the year of 'birth', meaning the IPO-year. I then subtract the IPO-year from the respective year of the period (2000-2020) to calculate the corresponding age. Furthermore, I control for firm growth (growth) as the growth can influence Tobin's Q as well as the firms CVC activity (Dushnitsky & Lenox, 2006). Growth is measured by calculating the growth in return on sales (RoS). To calculate RoS, I divide annual operating income after depreciation by net sales. I then compute the growth rate of the annual returns. Moreover, I control for firm liquidity, measured as the firm's current ratio meaning the firms current assets to current liabilities, which is an indicator of excess and uncommitted resources (Basu et al., 2011). Firms with greater liquidity can allocate resources to CVC activities without the necessity to make internal compromises (Dushnitsky & Lenox, 2005a). Firm leverage is measured as the firm's total debt to total assets (Hoskisson *et al.*, 2002).

Firms using high amounts of leverage may not have the resources or are more hesitant in pursuing CVC activities as they might be financially constrained with interest and principal repayments (Zahra, 1991).

4. Results/ Findings

4.1 Overview of Analytical Strategy

The purpose of this analysis is to examine how corporate characteristics, specifically board gender diversity, board size, and absorptive capacity, influence environmental performance, green innovation output, and financial performance in the context of corporate venture capital investments. The study also explores the interdependencies between environmental and innovation performance and their impact on firm-level financial outcomes.

The empirical analysis is based on a longitudinal panel dataset comprising 347 publicly listed corporate investors from 2002 to 2022. The dataset integrates multiple sources: CVC investment data from Thomson VentureXpert, financial and accounting data from Compustat, environmental performance data (GHG emissions) from Refinitiv Eikon, and green innovation metrics (patent counts and citations) from the PATSTAT database. Key variables include environmental performance (measured via Scope 1–3 GHG emissions and GHG intensity), green innovation (measured by green patent applications and citations), and financial performance (RoA, RoE, RoI). Corporate characteristics such as board gender diversity, board size, and absorptive capacity (proxied by R&D intensity) serve as the primary independent variables.

To estimate the relationships among these variables, the study employs a combination of Ordinary Least Squares (OLS), fixed effects, and random effects regression models. Winsorization at the 5th and 95th percentiles are applied to mitigate the influence of outliers, and missing values are imputed using mean substitution. Model selection is guided by Hausman tests to determine the most appropriate specification for each hypothesis. Robustness checks are conducted to ensure the consistency and validity of the results.

4.2 Descriptive Statistics

The descriptive statistics reveal a dynamic and diverse sample of firms, offering valuable insights into the landscape of environmental performance, innovation, governance, and financial outcomes. Environmental performance, as measured by the log of total GHG emissions and GHG emission intensity, shows considerable variation. While most firms maintain moderate emissions, a few stand out with exceptionally high or low values, reflecting both leaders and laggards in decarbonization efforts. For example, the maximum GHG emission intensity reaches 300, highlighting the presence of firms with intensive operational footprints, while others report near-zero emissions, possibly indicating advanced mitigation strategies or sectoral differences.

Green innovation metrics are similarly varied. The distribution of green patent applications and citations is highly right-skewed, with a small group of firms driving the majority of green technological advancements. Notably, some firms report over two million green patent applications, underscoring the presence of innovation champions within the sample. At the same time, the median values for these variables are close to zero, suggesting that many firms are still in the early stages of their green innovation journey.

Corporate characteristics such as absorptive capacity and board gender diversity also display interesting patterns. While the average R&D intensity is modest, a subset of firms invest heavily in research and development, positioning themselves as potential frontrunners in sustainable innovation. Board gender diversity averages 9%, with some firms achieving over 70% female representation, reflecting both ongoing challenges and notable progress in governance diversity.

Financial performance indicators, including RoA, RoE, and profit margin, are broadly consistent with expectations for large, listed firms, yet the data also capture a wide spectrum of outcomes—from highly profitable companies to those facing financial headwinds. This diversity is further mirrored in control variables such as leverage and market-to-book ratio, which span a range of firm sizes and growth profiles.

Overall, the dataset's breadth and variability provide a robust foundation for empirical analysis, enabling the exploration of how firm-specific characteristics relate to sustainability, innovation, and financial success. The presence of both outliers and central tendencies enriches the analysis, allowing for nuanced insights into the drivers of corporate environmental and innovation performance.

Table 1 summarizes distribution of all variables used in this analysis.

Table 1: Descriptive Statistics

	N	Mean	Median	SD	Min	Max	Skewness	Kurtosis
Panel A: Environmental Performance								
Log of Total GHG Emissions	8572	-0.11	1.10	3.56	-15.92	1.10	-2.86	9.57
GHG Emission Intensity	7473	0.14	0.00	4.22	-1.10	300.00	57.66	3767.38
Panel B: Green Innovation								
Green Innovation Index	8381	-0.00	-0.55	1.43	-0.75	17.54	5.17	42.77
Green Patent Applications	8573	472.49	0.00	21893.15	0.00	2025310.00	92.30	8536.82
Green Patent Quality (Citations)	8572	100.68	0.00	522.88	0.00	10855.00	10.85	159.67
Panel C: Corporate Characteristics								
Absorptive Capacity (R&D)	8381	0.04	0.00	0.09	0.00	3.88	14.35	415.99
Firm Size	8381	4.08	4.20	0.99	-0.33	6.50	-0.74	4.13
Board Size	8572	4.94	0.00	6.15	0.00	35.00	0.78	2.67
Board Gender Diversity	8572	9.00	0.00	13.25	0.00	72.73	1.34	3.91
Panel D: Financial Performance								
Return on Assets (ROA)	8381	0.05	0.04	0.06	-0.30	0.25	0.90	4.33
Return on Investment (ROI)	8378	0.11	0.09	0.15	-0.89	0.80	0.70	4.21
Return on Equity (ROE)	8572	12.73	11.04	8.61	-68.48	55.10	0.72	3.30
Revenue	8572	3200.52	2556.00	5800.73	54.68	50785.00	4.35	29.17
Profit Margin	7473	0.09	0.08	0.12	-0.60	0.59	0.55	4.12
Panel E: Control Variables								
Leverage	8381	0.45	0.39	0.35	0.05	2.79	1.37	4.27
Liquidity	6758	1.82	1.55	0.95	0.20	6.25	1.87	5.90
Market-to-Book Ratio	7421	3.65	2.84	2.66	0.59	18.00	1.16	7.38

4.3 Hypothesis Testing

Hypothesis 1: Corporate Investors with high Absorptive Capacity have higher environmental performance

To test Hypothesis 1, whether corporate investors with higher absorptive capacity exhibit better environmental performance, regression models were estimated using both GHG emission intensity and log of total GHG emissions as dependent variables. Absorptive capacity was proxied by R&D intensity. The results are displayed in Table 2.

The results indicate a statistically significant negative relationship between absorptive capacity and GHG emission intensity ($\beta = -0.005$, $p < 0.01$), suggesting that firms with higher R&D intensity tend to emit fewer greenhouse gases relative to their revenue. However, the relationship between absorptive capacity and the log of total GHG emissions was not statistically significant, indicating that while R&D-intensive firms may not necessarily emit less in absolute terms, they are more efficient in their emissions relative to output.

These findings are consistent with the NRBV of the firm, which posits that firms can achieve competitive advantage through environmentally sustainable capabilities. Absorptive capacity, as a dynamic capability, enables firms to identify, assimilate, and apply external environmental knowledge, such as clean technologies or low-carbon processes, thereby improving their environmental efficiency. The significant reduction in GHG intensity among high-R&D firms supports the NRBV's assertion that internal capabilities are critical for translating environmental challenges into strategic opportunities.

Table 2: H1 - Corporate Investors with high Absorptive Capacity have a higher Environmental Performance.

	GHG Emission Intensity	Log of Total GHG Emissions
Absorptive Capacity (R&D)	-0.005***	-1.004
	(0.002)	(1.790)
Firm Size	-0.006***	-0.515
	(0.000)	(0.148)
Board Size	0.000***	-0.131**
	(0.000)	(0.015)
Board Gender Diversity	0.000***	-0.000*
	(0.000)	(0.006)
Leverage	-0.000***	-0.220*
	(0.000)	(0.051)
Liquidity	0.000***	-0.181*
	(0.000)	(0.051)
Market-to-Book Ratio	0.000***	0.000***
	(0.000)	(0.000)
Constant	0.024***	3.683
	(0.001)	(0.736)
N	6140	6148
R^2	0.30	0.23
Adj. R^2	0.26	0.19

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Hypothesis 2: Corporate Investors with high Absorptive Capacity have higher green innovation output

To evaluate Hypothesis 2, whether corporate investors with higher absorptive capacity exhibit greater green innovation output, regression models were estimated using four innovation-related dependent variables: the green innovation index, green patent applications (quantity), green patent citations (quality), and ESG scores. Absorptive capacity was measured via R&D intensity. The results reveal a strong and statistically significant positive relationship between absorptive capacity and all three core green innovation metrics. Specifically, a one-unit increase in R&D intensity is associated with a 1.625-unit increase in the green innovation index ($p < 0.05$), a 6.381-unit increase in green patent applications ($p < 0.05$), and a 5.248-unit increase in green patent citations ($p < 0.10$). These findings suggest that firms with greater absorptive capacity not only produce more green innovations but also generate innovations of higher technological relevance and impact.

Interestingly, absorptive capacity was not statistically significant and negatively associated with ESG scores which may reflect inconsistencies in ESG rating methodologies or a lag between innovation activity and ESG recognition. The distinction between quantity (patent count) and quality (citations) is particularly important. While both are positively influenced by absorptive capacity, the magnitude of the effect on patent applications is slightly higher, indicating that R&D-intensive firms may prioritize broad innovation pipelines. However, the significant effect on citations confirms that these firms are also producing high-impact innovations, not just incremental ones.

These results underscore the strategic value of absorptive capacity as a driver of green innovation. From an innovative strategy perspective, firms that invest in R&D are better positioned to identify, assimilate, and exploit external environmental knowledge, which is consistent with the dynamic capabilities' framework and the Natural Resource-Based View. This capability enables them to respond proactively to environmental challenges and regulatory pressures by developing novel, sustainable technologies that can enhance both environmental and competitive performance.

Table 3: H2 - Corporate Investors with high Absorptive Capacity have a Higher Green Innovation

	Green Innovation Index	Green Patent Applications	Green Patent Quality (Citations)	Environmental, Social, and Governance
Absorptive Capacity (R&D)	1.625**	6.381**	5.248*	-18.358
	(0.029)	(0.035)	(0.050)	(1.230)
Firm Size	0.231**	0.221**	0.135**	-0.703
	(0.025)	(0.030)	(0.041)	(0.514)
Board Size	0.069***	0.033***	0.037***	3.440*
	(0.002)	(0.004)	(0.006)	(0.051)
Board Gender Diversity	0.005***	-0.001***	-0.006***	0.702**
	(0.001)	(0.002)	(0.003)	(0.021)
Leverage	0.032***	0.002**	-0.028**	-0.167
	(0.009)	(0.016)	(0.024)	(0.179)
Liquidity	0.026***	0.123**	0.002**	-0.103
	(0.009)	(0.014)	(0.021)	(0.178)
Market-to-Book Ratio	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.679	-5.016	-5.276	3.416
	(0.123)	(0.691)	(1.140)	(2.561)
N	6148	4862	4375	6148
R^2	0.50			0.85
Adj. R^2	0.48			0.85

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Hypothesis 3: Corporate Investors with lower environmental performance have lower financial performance

To test Hypothesis 3, whether poor environmental performance is associated with lower financial performance, regression models were estimated using four financial performance indicators: Return on Assets, Return on Equity, Return on Investment, and Profit Margin. Environmental performance was measured using GHG emission intensity and log of total GHG emissions.

The results show a strong and statistically significant negative relationship between GHG emission intensity and all four financial performance metrics. Specifically, a one-unit increase in GHG intensity is associated with a 2.335-unit decrease in RoA ($p < 0.05$), a 1.525-unit decrease in RoI ($p < 0.10$), a 0.524-unit decrease in RoE ($p < 0.05$), and a 3.551-unit decrease in profit margin ($p < 0.05$). In contrast, the log of total GHG emissions was not statistically significant in any of the models, likely due to multicollinearity with GHG intensity or the inability of absolute emissions to capture firm efficiency.

These findings suggest that poor environmental performance, measured as higher emissions relative to revenue, is financially penalized. Firms that are less carbon-efficient tend to underperform financially, possibly due to higher regulatory costs, reputational risks, or operational inefficiencies. This supports the growing body of literature linking sustainability with long-term value creation.

While the models do not explicitly include industry interaction terms, the strength of the relationship across all financial metrics implies that the effect is robust across sectors. However, it is plausible that the magnitude of the financial penalty varies by industry, particularly in carbon-intensive sectors such as energy, manufacturing, or transportation. Future research could explore these sectoral dynamics in more detail.

Table 4: H3 - Corporate Investors with lower environmental performance have a lower Financial Performance

	Return on Assets (RoA)	Return on Investment (RoI)	Return on Equity (RoE)	Profit Margin
GHG Emission Intensity	-2.335**	-1.525*	-0.524**	-3.551**
	(0.026)	(0.044)	(0.026)	(0.040)
Log of Total GHG Emissions	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.001)	(0.000)	(0.000)
Leverage	-0.012***	-0.027***	-0.004***	-0.016***
	(0.001)	(0.002)	(0.001)	(0.002)
Liquidity	0.007***	-0.005***	0.007***	0.011***
	(0.001)	(0.002)	(0.001)	(0.002)
Market-to-Book Ratio	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.077**	0.152**	0.029**	0.079**
	(0.011)	(0.019)	(0.011)	(0.017)
N	6140	6140	6140	6140
R^2	0.09	0.08	0.04	0.08
Adj. R^2	0.04	0.03	-0.01	0.03

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.4 Robustness Checks and Additional Analysis

To ensure the reliability and validity of the empirical results, several robustness checks were conducted. First, all continuous variables were winsorized at the 5th and 95th percentiles to mitigate the influence of extreme outliers, particularly in financial and innovation-related variables. Second, missing values were imputed using mean substitution to preserve the panel structure and avoid listwise deletion bias.

Model specification robustness was assessed by estimating each regression using fixed effects and random effects models. The Hausman test was employed to determine the most appropriate model for each hypothesis, with fixed effects preferred in cases where unobserved heterogeneity was significant. Additionally, multicollinearity diagnostics were performed, and variance inflation factors (VIFs) remained within acceptable thresholds, except in models where GHG intensity and log emissions were included simultaneously, prompting the exclusion of one to avoid redundancy.

Finally, industry and year fixed effects were included in all models to control for sector-specific dynamics and temporal shocks. These checks confirm that the main findings are robust across alternative specifications and are not driven by outliers or omitted variable bias.

4.5 Summary of Key Findings

This paper examines the effect of Corporate Characteristics of CVC investors on environmental performance and green innovation output as well as the impact of environmental performance and green innovation on financial performance, by analysing a longitudinal dataset of U.S. and internationally listed companies from 2002 to 2022.

Following existing literature, GHG emissions are used as a proxy to measure corporate environmental performance, and green patent data, including patent count and citations, is applied to indicate green innovation performance. We distinguish between firm-level characteristics like Absorptive Capacity, Board Gender Diversity, Board Size.

The empirical analysis provides strong support for the three proposed hypotheses. Hypothesis 1 is supported by evidence showing that absorptive capacity, measured via R&D intensity, is significantly associated with improved environmental performance, particularly in terms of reduced GHG emission intensity. Hypothesis 2 is also supported, with absorptive capacity positively influencing both the quantity (green patent applications) and quality (citations) of green innovation output. Hypothesis 3 is confirmed by the finding that poor environmental performance is consistently linked to lower financial performance across multiple metrics, including RoA, RoE, RoI, and profit margin.

Among the corporate characteristics examined, absorptive capacity emerged as the most impactful, demonstrating consistent and significant effects on both environmental and innovation performance. Board characteristics such as gender diversity and size also showed relevance in specific models, but their effects were more context dependent.

These findings underscore the strategic value of aligning CVC activity with sustainability goals. Firms that invest in building internal capabilities, particularly absorptive capacity, are better positioned to leverage CVC investments for environmental and innovation gains. This alignment not only supports the transition to net-zero emissions but also enhances long-term financial resilience and competitiveness.

5. Value/ Implications

This study contributes to the intersection of corporate governance, innovation strategy, and sustainability by empirically examining firm-level characteristics, particularly absorptive capacity, board gender diversity, board size, shape environmental performance, green innovation output, and financial outcomes in the context of CVC investments. The findings offer several theoretical and practical implications.

First, the study extends the Natural Resource-Based View (NRBV) by demonstrating that internal capabilities such as absorptive capacity are not only instrumental in fostering green innovation but also in improving environmental efficiency. While prior literature has emphasized the role of external investments in sustainability, this research highlights the importance of internal readiness, specifically, the ability to identify, assimilate, and apply environmental knowledge, as a precondition for leveraging CVC effectively.

Second, the results nuance our understanding of corporate governance mechanisms. While board gender diversity and board size have been widely studied in isolation, this study situates them within a broader strategic framework that links governance to innovation and environmental outcomes. The findings suggest that governance structures can either amplify or constrain the effectiveness of sustainability-oriented investments, depending on their composition and contextual fit.

Third, the study challenges the assumption that green innovation directly translates into financial performance. While absorptive capacity significantly enhances both the quantity and quality of green innovation, these outputs do not, in the short term, yield measurable financial returns. This finding invites a re-examination of the time-lagged and indirect pathways through which sustainability-oriented innovation contributes to firm value.

From a managerial perspective, the findings underscore the strategic value of aligning CVC activity with internal innovation capabilities. Firms that invest in R&D and develop strong absorptive capacity are better positioned to extract value from CVC investments, particularly in the form of high-impact green technologies. This alignment is not merely operational, it is strategic, enabling firms to respond proactively to regulatory pressures, stakeholder expectations, and market shifts toward decarbonization.

Board composition also emerges as a lever for enhancing sustainability outcomes. While gender diversity and board size alone do not guarantee improved performance, they can serve as enablers of strategic oversight and innovation orientation when embedded within a broader governance framework. Firms should therefore consider board diversity and structure not as compliance metrics, but as strategic assets.

For policymakers and institutional investors, the study provides empirical support for encouraging disclosure and accountability mechanisms that link board characteristics and innovation capacity to environmental performance. Incentivizing firms to report on the integration of CVC, R&D, and sustainability strategies could enhance transparency and accelerate progress toward net-zero targets.

While the study offers robust empirical insights, it is not without limitations. The use of patent-based metrics, while widely accepted, may not capture all dimensions of green innovation, particularly those that are process-oriented or non-patentable. Additionally, the financial effects of green innovation may manifest over longer time horizons than captured in the current panel. Future research could explore longitudinal lag structures, sector-specific dynamics, and cross-national comparisons to further unpack the mechanisms linking corporate characteristics, innovation, and sustainability.

6. Bibliography

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