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Corporate Venture Capital and Climate Change Mitigation Technologies

Tijl van der Meché*

University of Münster, Schlossplatz 2, 48149 Münster, Germany.
E-mail: tijl.vandermeche@uni-muenster.de

Jens Leker

University of Münster, Schlossplatz 2, 48149 Münster, Germany.
E-mail: leker@uni-muenster.de
* Corresponding author

Abstract: Corporate venture capital (CVC) is increasingly used by incumbent firms to access external knowledge, yet its role in climate change mitigation technologies (CCMTs) remains underexplored. This study argues that CVC supports CCMT output by enabling incumbent firms to access and absorb knowledge and technologies generated by entrepreneurial ventures. In addition to that, the staged-nature of CVC activities simultaneously enables firms to pursue a "wait-and-see" strategy to gather valuable information on (technological) development before scaling their involvement step by step, thereby reducing uncertainty regarding the likelihood of successful innovation outcomes.

Based on a longitudinal panel of large incumbent firms, our preliminary results indicate a positive association between CVC and subsequent CCMT output. While these early findings are promising, the robustness of the empirical results is currently being further examined. This study contributes to CVC and green entrepreneurship research by highlighting CVC as an efficient and flexible mechanism for advancing CCMTs.

Keywords: corporate venture capital; cvc; venture capital; vc; climate change mitigation technologies; CCMTs; green innovation; eco-innovation; innovation uncertainty; uncertainty

1 Introduction

Environmental challenges have increased pressure on firms to reduce their environmental impact due to growing demands from consumers and stricter governmental regulations (IPCC, 2021; Kotler, 2011; Paparoidamis et al., 2019). These pressures require firms to improve environmental performance while maintaining productivity, creating a need for innovative solutions. In this context, the development of green innovation – defined as "new or modified processes, techniques, practices, systems and products to avoid or reduce environmental harms" (Beise and Rennings, 2005, p. 6) – is a highly effective approach to reducing environmental impact without compromising competitiveness (de Marchi, 2012; Porter and van der Linde, 1995).

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Climate change has emerged as one of the most pressing environmental challenges for firms. Mitigation efforts focus on reducing greenhouse gas (GHG) emissions from major sources such as fossil fuels, agriculture, and land-use change (IPCC, 2007). In this context, climate change mitigation technologies (CCMTs) – a specific subset of green innovations – directly target emission reductions and carbon efficiency, thereby representing critical levers for achieving net-zero pathways by the century's end (Probst et al., 2021). These technologies cover a broad range of innovation domains, such as alternative energy technologies, carbon capture and storage, information and communication technologies aimed at efficiency improvements, low-carbon production and manufacturing processes, advanced waste management solutions, low-carbon transportation technologies, and energy-efficient building technologies (IPCC, 2014; Probst et al., 2021). These technologies not only contribute to emission reductions, but also hold substantial economic and strategic potential, as they can enhance resource and energy efficiency (e.g., low-carbon production processes), reduce environmental and regulatory risks (e.g., carbon capture and storage), improve reputation and legitimacy, and create new (and long-term) market opportunities and revenue streams (e.g., low-carbon product design, alternative energy and low-carbon transportation technologies) (Hart, 1995; Hart and Dowell, 2011).

The growth in CCMT inventions has been significantly faster than in other technological fields. According to the European Patent Office, CCMTs account for nearly 6% of global invention activity today, compared to around 1.5% in 1990, suggesting that climate policies such as emission taxes or feed-in tariffs for renewable energy have played an important role in stimulating innovation in these technologies (EPO and UNEP, 2015).

Nevertheless, CCMTs (and in general green innovation) are characterized by high levels of uncertainty, such as technological success, market adoption and profitability, against the backdrop of substantial development costs due to the absence of widely accepted standards for technological solutions. In addition, these technologies are associated with significant irreversibility, as many mitigation technologies require significant asset-specific and long-term investments (de Marchi, 2012; Fuss et al., 2012; Ginbo et al., 2021). By investing equity in independent entrepreneurial firms, incumbent companies use corporate venture capital (CVC) as a key mechanism to acquire new knowledge and technologies, thereby enhancing (green) innovation performance (Bendig et al., 2022; Da Gbadji et al., 2015; Dushnitsky and Lenox, 2006), while managing uncertainty (Tong and Li, 2011).

This view can also be identified in the practice, as a growing number of corporate firms pursue and intensify CVC investments to develop CCMTs (Global Venturing, 2022). For instance, in 2024, the global water technology company Xylem expanded its CVC program to $50 million to invest in startups developing solutions to address water-related climate challenges. Through direct investments in emerging ventures and specialized venture capital funds, the company aims to foster disruptive climate change mitigation technologies in areas such as advanced water treatment and digital solutions for complex water systems (Spencer, 2024). However, there is a significant gap in research examining the impact of CVC investments on climate change mitigation technologies, which this study addresses. Drawing on a comprehensive set of theoretical perspectives, this study argues that corporate venture capital enables incumbent firms to access external knowledge and novel technologies from entrepreneurial ventures through structured governance mechanisms, such as board participation and close strategic interaction. Building on insights from organizational learning and search theory, which suggest that repeated engagement within related knowledge domains enhances firms' search efficiency, CVC further allows firms to deepen their understanding of emerging technological trajectories. At the same time, the staged nature of CVC investments embeds real-options logic, enabling firms to pursue a step-by-step "wait-and-see" strategy by incrementally adjusting their commitment under conditions of uncertainty. Through this sequential engagement, firms are able to gather valuable information about technological trajectories, market potential, and strategic fit over time, which, in turn, reduces uncertainty regarding the likelihood of innovation success. Taken together, these mechanisms suggest that CVC can serve as a flexible and efficient instrument for enhancing firms' CCMT output.

Utilizing a longitudinal cross-industry panel of S&P 500 firms, we provide preliminary empirical evidence suggesting that higher CVC intensity is positively associated with subsequent CCMT output. While these initial findings are consistent with our theoretical expectations, further robustness checks and additional model refinements are currently underway.

This study contributes to entrepreneurship in the environmental and climate-related domain by supporting and extending prior work on corporate venture capital and innovation performance by examining its role in the context of climate change mitigation technologies. In addition, the longitudinal and cross-industry design enables the analysis of time-lagged effects of CVC activities while simultaneously enhancing the generalizability of the observed relationship.

2 Theoretical background and hypotheses

Literature review

Literature has already examined the relationship between CVC and broad environmental constructs, such as Corporate Social Responsibility (Battisti et al., 2022) and environmental performance (Shuwaikh et al., 2025a; Shuwaikh et al., 2025b). In a related context, Hegeman and Sørheim (2021) investigate why incumbent firms invest in cleantech startups. Within the innovation performance literature, numerous studies have analyzed the impact of CVC on both incumbent and entrepreneurial firms' technological and innovation outcomes (Belderbos et al., 2018; Da Gbadji et al., 2015; Dushnitsky and Lenox, 2005; Wunder and Maula, 2026).

To a lesser extent, studies examined the relationship between CVC activities and green innovation constructs (Hegeman and Sørheim, 2021). For example, Shuwaikh et al. (2025a) analyze how dynamic ambidexterity in CVC influences an incumbent's green innovation (and environmental) performance, while Bendig et al. (2022) investigate the effect of investments in green startups on incumbents' green innovation output. In addition, Wunder and Maula (2026) examine whether startup green innovation increases the likelihood of receiving CVC investments from both green and non-green corporate investors.

At the same time, the literature on CCMTs has primarily focused on the consequences of these technologies. Prior studies have examined their effects on economic growth (Ferreira et al., 2020), carbon dioxide emissions (Xin et al., 2022), renewable energy development (Wang and Pang, 2025) and on unified (environmental and operational) performance (Wang, 2017). Furthermore, Probst et al. (2021) analyze global trends in the invention and diffusion of CCMTs, while Gisa et al. (2025) investigate the impact of green manufacturing orientation on the development of these technologies. Despite these contributions, research examining the impact of general CVC activities on incumbents' climate change mitigation technology output remains scarce, a gap this study aims to address.

Corporate venture capital and climate change mitigation technologies

Despite their strong environmental and economic potential, green innovations and particularly CCMTs represent a technological frontier characterized by limited firm experience and substantial technological and economic/market uncertainty. This uncertainty largely arises from the absence of widely accepted standards for technological solutions and for evaluating the environmental performance of products and production processes, unlike in the case of conventional innovations (de Marchi, 2012). Moreover, firms face additional uncertainty stemming from regulatory and policy frameworks, particularly regarding future climate policies and carbon pricing, which can substantially affect the profitability of such investments.

In addition, these uncertainties are often accompanied by a high degree of investment irreversibility, as many mitigation technologies, such as carbon capture and storage (CCS), renewable energy technologies, or production process innovations, require substantial asset-specific and long-term investments resulting in significant sunk costs that cannot easily be recovered once the investment has been made (Fuss et al., 2012; Ginbo et al., 2021). As a result, firms are encouraged to open up their innovation processes beyond internal R&D and engage in collaborations with specialized external R&D partners to minimize these outlined risks (de Marchi, 2012).

This challenge is particularly salient for incumbent firms, as they typically possess deep domain-specific knowledge and established organizational routines, procedures, and information filters that enable efficient incremental innovation within their core business environment, but may hinder their ability to recognize and respond to novel and specialized technological paradigms, such as CCMTs (Bendig et al., 2022; Henderson and Clark, 1990). Such innovations often require more flexible and continuously evolving organizational structures, rather than formalized and rigid ones. In contrast, young entrepreneurial firms, which are not yet constrained by such established structures, tend to exhibit greater organizational adaptability (Dushnitsky and Lenox, 2005; Henderson, 1993). While these differences suggest that incumbent firms may benefit from accessing knowledge from entrepreneurial ventures, they do not clarify which governance mechanisms are most suitable to facilitate such access under conditions of high uncertainty and irreversibility. Corporate venture capital activities are particularly valuable instruments for absorbing external knowledge and technologies, while simultaneously helping firms manage issues in the context of high technological and market uncertainty (Ruhnka and Young, 1991; Tong and Li, 2011), as well as irreversibility (Folta et al., 2006) in uncertain environments such as those characterized by climate change mitigation technologies.

Already during the due diligence phase, firms gain early insights into entrepreneurial innovations before making any financial commitment. In this phase, a background check takes place, in which the founders and key management team are examined, discussions with key customers take place, and a review of the product and technology is pursued,

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often through a combination of corporate R&D personnel that gauge a venture's technological feasibility and corporate executives that examine business and market risks (Dushnitsky and Lenox, 2005).

Once an investment has been made, investors can deepen their understanding of emerging technologies through governance involvement, such as holding board positions or board observer rights, or appointing dedicated liaison personnel, which serve as a communication interface between the investor and the investee by helping to understand the start-up's technology, identifying relevant knowledge, and transferring promising innovations into the corporation. In addition, incumbents often establish structured interaction mechanisms with portfolio ventures to facilitate knowledge transfer, such as regular meetings, monitoring of product development, technical exchanges, joint pilot projects, or collaborative development activities (Belderbos et al., 2018; Carlson and Safavi, 2024; Dushnitsky and Lenox, 2005; Lee et al., 2015).

After an initial investment and the corresponding knowledge-transfer process described earlier, the investing firm holds the possibility, but not the obligation, to make follow-up investments and increase its equity stake. This certain possibility to stage their investments creates several types of real options that allow the corporate venture to manage risk while gradually acquiring highly strategically relevant information, in contrast to market for technology transactions, such as R&D alliances, acquisitions, or licensing activities, which require higher upfront commitment (e.g., one-time investments) and provide less flexibility (Ceccagnoli et al., 2018; Folta et al., 2006; Tong and Li, 2011; van de Vrande et al., 2009). These real options can be implicit, but they may also be explicitly embedded in CVC contracts through option clauses, milestones, or performance indicators (Kaplan and Strömberg, 2003; Tong and Li, 2011).

Firstly, firms can utilize the option to grow or expand, allowing the firm to scale their involvement if the venture develops favorably. In addition to that, CVC investments also embed the option to defer. Following an initial investment, uncertainty may remain unresolved. In such situations, the investing firm is not forced to immediately decide whether to expand or terminate the investment. Instead, it can postpone further commitment/follow-up investments while gathering additional valuable information about the technological capabilities and feasibility, the potential market adoption and technological payoff, the strategic relevance, or changes in regulatory conditions such as CO_2 pricing (Ceccagnoli et al., 2018; Sahlman, 1990; Trigeorgis, 1996; Tong and Li, 2011). Lastly, firms also possess an option to abandon, which enables them to terminate or liquidate their investment if uncertainty resolves to their disadvantage, thereby limiting losses and reallocating resources to more promising opportunities (Kaplan and Strömberg, 2003; Tong and Li, 2011). In addition to that, even unsuccessful venture developments can generate valuable learning opportunities, either through still viable technologies, or valuable information and lessons-learned (Hoetker and Agarwal, 2007; McGrath, 1999).

In the CCMT context, these real options – especially this combination of staged follow-up investment commitments and the option to defer investment decisions, commonly referred to as a step-by-step "wait-and-see strategy" – are particularly well suited to addressing issues surrounding uncertainty and irreversibility in CCMTs. Such strategies allow firms to observe technological developments of CCMTs over time, learn from entrepreneurial ventures, regulation, and adequately anticipate the economic viability of the emerging climate technologies before committing (larger) follow-up investments, which reduces the risks associated with substantial uncertainty (Ceccagnoli et al., 2018; Tong and Li, 2011).

After the firm has decided to increase its equity stake by pursuing a follow-on investment, more frequent interactions with the entrepreneurial venture, enabled by (higher) follow-on investments, can enhance the corporate investor's innovative knowledge base, for instance through increased board participation or deeper technological collaboration (Belderbos et al., 2018; Dushnitsky and Lenox, 2005). Repeated and higher engagements with similar knowledge domains enable firms to develop deeper understanding of underlying technological concepts and improve their ability to identify, connect, and combine valuable knowledge elements. Moreover, as firms accumulate experience within relevant knowledge domains, the search process becomes more structured and predictable, as innovation requirements are better understood. Thereby, innovation development tasks can be translated into actionable sub-problems, while unnecessary steps can be eliminated, which enhances efficiency of innovation development (Katila and Ahuja, 2002).

Considering our argumentation above, CVC represents a flexible and effective mechanism through which firms can access external knowledge and experiment with novel climate technologies, while simultaneously reducing substantial uncertainty, which, in turn, increases the efficiency of CCMT output. Accordingly, we postulate:

Hypothesis 1: Higher corporate venture capital intensity is positively associated with corporate climate change mitigation technology output.

3 Methods

To operationalize the theoretical concepts and empirically test the hypotheses, a cross-industry panel of S&P 500 firms has been employed.

A panel-based regression approach with fixed effects has been applied to empirically examine the proposed relationships. The longitudinal structure of the data allows us to account for time-lagged relationships between CVC activities and subsequent CCMT outcomes.

To ensure robustness, standard data treatment procedures were applied, such as checks for multicollinearity and heteroskedasticity.

At the current stage, the empirical analysis should be interpreted as preliminary. Additional robustness checks and alternative model specifications are currently being conducted to further assess the stability of the findings.

To operationalize the empirical analysis, we next define the key variables used in the model. The dependent variable captures firms' output in climate change mitigation technologies. Conceptually, we especially focus on technological activities that contribute to reducing greenhouse gas emissions or improving climate-related efficiency across relevant domains. The measure is designed to reflect firm-level climate-related technological activity over time.

The independent variable captures the intensity of corporate venture capital engagement. We understand CVC intensity as the extent to which incumbent firms engage with entrepreneurial ventures through corporate investment activities.

Several control variables are included to account for alternative explanations. These controls reflect firm- and industry-level characteristics that may influence climate-related innovation, including internal R&D (Ayoub and Lhuillery, 2024), firm size (Bendig et al., 2023; Sheng and Ding, 2024), firm age (Bendig et al., 2023; Cheng et al., 2025), financial resources (de Villiers et al., 2011), profitability (Albitar et al., 2023; Al-Tuwaijri et al., 2004; de Villiers et al., 2011; Qureshi et al., 2022; Sheng and Ding, 2024), competitive environment (Duanmu et al., 2018), and climate-related firm exposure (Bendig et al., 2025). Together, these variables help distinguish the specific role of CVC engagement from broader organizational and industry-level factors.

4 Preliminary results

Our preliminary results provide initial support for the proposed relationship between corporate venture capital and climate change mitigation technologies. Across the main empirical specification, CVC intensity is positively associated with subsequent CCMT output.

At the same time, these findings should be interpreted with caution. The empirical analysis is still ongoing, and additional robustness checks are being conducted to assess the stability of the observed relationship across alternative specifications and modelling approaches. Therefore, we present the current findings as preliminary evidence rather than final causal estimates.

5 Discussion

Central findings

Our principal hypothesis of the underlying research is that corporate venture capital investments enhance the development of climate change mitigation technologies. We argue that CVC provides a flexible and efficient governance mechanism that enables firms to access external knowledge and novel technologies from entrepreneurial ventures through mechanisms such as board participation and structured interactions between both parties. In addition, by pursuing a “wait-and-see” strategy with staged investments, firms can significantly reduce (innovation) uncertainty, such as the risk of unsuccessful innovation outcomes. In addition to that, repeated engagement within similar knowledge domains enables firms to develop a deeper understanding of underlying technologies, structure their search processes more effectively, and translate innovation challenges into actionable sub-problems, thereby further enhancing the efficiency of innovation development.

Our preliminary empirical findings are consistent with this argument. They indicate a positive relationship between CVC intensity and subsequent CCMT output. However, the robustness of this relationship is currently being further examined, and the results should therefore be interpreted as early evidence rather than final empirical confirmation.

Theoretical contributions

The paper contributes to entrepreneurship research in environmental and climate-related contexts in several ways. First, it confirms prior studies that examine the impact of CVC investments on various innovation performance constructs of incumbent firms (e.g., Belderbos et al., 2018; Dushnitsky and Lenox, 2005; Shuwaikh et al., 2025a), while

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extending this line of research to the domain of climate change mitigation technologies. In doing so, the study addresses a critical research gap concerning the impact of CVC activities on CCMTs and simultaneously responds to the broader lack of research on the relationship between CVC and green innovation, as highlighted by Hegeman and Sørheim (2021).

Furthermore, our paper employs a longitudinal research design with an extended timeframe, enabling the analysis of time-delayed effects and the integration of external archival data to construct theoretically grounded control variables, while addressing the limitations of cross-sectional designs (Schäper et al., 2023). Moreover, this study includes a broad set of industries, providing more generalizable insights regarding the positive relationship between CVC and CCMTs. In addition, the inclusion of a broad range of industries is valuable, as climate-related research has strong cross-sectoral relevance, unlike other environmental dimensions, such as biodiversity (IPCC, 2022).

Practical implications

Our study delivers clear implications for corporate and startup managers, as well as policymakers. CVC can be viewed as an efficient strategy for gaining access to novel knowledge and technologies that may enhance firms' CCMT output. Such engagement not only has the potential to improve corporate climate performance but may also contribute to aspects, such as greater operational efficiency, market and reputation opportunities, firm valuation, and increased investor appeal (Hart, 1995; Matsumura et al., 2014; Porter and van der Linde, 1995). For startups, participating in CVC relationships likewise represents a rational choice, as it not only provides access to significant funding but also enables them to indirectly contribute to climate change mitigation (Bendig et al., 2022).

Startups may further strengthen these benefits by negotiating contractual arrangements that grant them a share in the value created from successful corporate innovations arising from the CVC process. Such milestone-aligned agreements can create a win–win situation: While startups gain additional financial upside, they are also more likely to intensify their commitment, provide greater support, and actively contribute to the collaboration, thereby simultaneously increasing the likelihood of successful corporate CCMT development.

Lastly, policymakers should support CVC investments with climate change mitigation aims with targeted incentives, such as tax credits. Nevertheless, "there is a pressing need to develop creative and impactful incentive schemes that go beyond tax reductions for investing firms" (Bendig et al., 2022, p. 9), such as outcome-based incentives, milestone-based grants, or risk sharing mechanisms.

Limitations and future research

This study has limitations that open up avenues for future research. First, the study focuses on S&P 500 firms and therefore primarily captures large corporations, excluding small- and medium-sized enterprises. In addition, the study solely examines CVC investments as a mode of external innovation. However, firms may deploy CVC as part of a broader strategy. Following an initial investment, corporate firms may pursue licensing agreements, acquisitions, or R&D alliances instead of a follow-up CVC investment (Ceccagnoli et al., 2018). Future studies may take this into account by providing a more holistic perspective on firms' external innovation strategies and the dynamic interplay between different governance modes.

Furthermore, although our argumentation suggests that CCMTs have the potential to enhance aspects of a firm's economic performance, this study does not empirically prove this relationship. As this relationship generally remains underexplored, future studies should examine it in greater detail. Lastly, the development of CCMTs may be significantly influenced by regulatory frameworks and policy uncertainty, which are not explicitly captured in this study. Therefore, future research could incorporate institutional and policy-related factors, particularly across different sectors.

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