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Unlocking green startup investments: How environmental policy pressures drive Venture Capital funding decisions

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ABSTRACT

The urgency of addressing climate change has spotlighted the role of green startups. Independent (IVCs), Corporate (CVCs), and Governmental (GVCs) Venture Capitalists are key players in financing these startups. This study examines how public environmental policies influence the investment decisions of different VCs toward green startups, addressing a gap in understanding the interplay between VCs' behavior and policy frameworks. Drawing on Real Option, Open Innovation, Agency, and New Institutional theories and leveraging a panel dataset of 6754 VCs investments in 13,015 startups (2010–2019) from Crunchbase, Compustat, and OECD Environmental Policy Stringency data, our findings reveal that GVCs and CVCs have a positive propensity to invest in green startups, while IVCs have a negative one. Moreover, incentives do not reduce IVCs' investments while encouraging CVCs' funding in green startups. Conversely, constraints mitigate the risk perceived by IVCs, fostering their propensity to invest in green startups while discouraging CVCs. We contribute to the literature on the influence of environmental policies on investments by introducing a theory-driven classification of environmental policies and demonstrating that policy effectiveness varies across VC types due to their different investment logic. These insights guide policymakers in designing tailored incentives and constraints to mobilize private capital toward green startups.

1. Introduction

The emphasis on environmental sustainability within international politics underscores the urgent need to direct investments toward green startups, whose technologies are characterized by a foundational commitment to environmental sustainability and promise to mitigate climate change (Darnall and Edwards Jr., 2006; Meyskens and Carsrud, 2013). Previous studies have demonstrated how Venture Capitalists (VCs), including Independent (IVCs), Corporate (CVCs), and Governmental Venture Capitalists (GVCs), are at the forefront of this investment wave, recognizing the pivotal role green startups play in tackling environmental issues and helping corporations adopt sustainability practices (Bendig et al., 2022; Cumming et al., 2016). Moreover, prior research has emphasized that public environmental policies are essential in motivating VCs to invest in the growth of green startups and development of their technologies (Bürer and Wüstenhagen, 2009; Tian et al., 2023).

This study seeks to contribute to the existing body of research investigating VCs' investment decisions toward green startups under the influence of environmental policies by exploring novel overlooked perspectives. First, while prior research extensively recognized green startups quest for funding to sustain their survival and growth (e.g., Ghosh and Nanda, 2010; Bergset, 2017), environmental policies' impact on VCs'investment behaviors has produced few and sometimes inconsistent findings (e.g., Da Rin et al., 2006; Dreyer and Schulz, 2023; Randjelovic et al., 2003), which need to be reconciled. Second, no studies have specifically adopted the CVCs' perspective, disregarding how these investors respond to public environmental measures. Finally, existing studies typically analyzed different VCs in isolation rather than together, calling for further understanding of how they collectively respond to environmental policy instruments. Addressing this threefold gap, we aim to systematically understand whether and how public environmental policies affect the decision of IVCs, CVCs, and GVCs to invest in green startups.

Private investments in environmental sustainability, particularly from IVCs and CVCs, remain significantly underrepresented compared to public funds, such as GVCs. As of 2022, private investments in environmental sustainability accounted for only 20% of the total (OECD,

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2024). This disparity highlights the need for more effective policies to mobilize private capital toward green startups. Investigating the influence of policies on the decisions of different VCs to invest in green startups is thus relevant to deepening the understanding of prominent strategies that could incentivize or force private investors, such as IVCs and CVCs, to commit resources to green startups. Moreover, shedding new light on the role of such policies when considering different VCs is essential for policymakers to ensure a balanced and sustainable flow of public and private investments for addressing global environmental challenges (Letta, 2024).

To reach our aim, we build upon Real Option (RO) theory (Folta and Miller, 2002; Santoro and McGill, 2005), the Open Innovation (OI) literature (Chesbrough, 2012; Weiblen and Chesbrough, 2015), and the Agency theory (Eisenhardt, 1989), arguing that different VCs undertake diverse investment decisions toward investing green startups. Particularly, we posit that IVCs have a negative propensity toward investing in green startups, while CVCs and GVCs have a positive one. Moreover, based on the New Institutional Theory (NIT) (Dimaggio and Powell, 1983), which emphasizes the role of regulatory frameworks and cultural systems in shaping investor behavior, we considered the most prominent OECD public environmental policies and classified them as government *incentives* or *constraints* (Lucas et al., 2022). Adopting such a perspective, we hypothesize that government incentives (i.e., interventions that offer rewards for sustainable investments) and government constraints (i.e., instruments that compel organizations to comply with environmental standards to avoid penalties or societal disapproval) policies positively moderate the IVCs and CVCs' propensity to nurture green startups.

To test our hypotheses, we built an ad-hoc dataset by gathering data from Crunchbase and Compustat on a sample of 3473 VCs representing the top investors of 13,015 startups founded between 2010 and 2019. Considering such a sample, we built a panel of 6754 IVCs, CVCs, and GVCs' investments during that time horizon in both green and non-green startups. Moreover, following previous scholars (Kruze et al., 2022), we leveraged the OECD Environmental Policy Stringency (EPS) database to collect data to measure the environmental incentives and constraints policies considered in this study. We further performed a difference-in-difference analysis using the Paris Agreement as an endogenous shock to check for endogeneity and robustness.

By providing insights on the distinct propensity of each VC type to invest in green startups and the specific influence that environmental policy incentives and constraints have on IVCs and CVCs, our study makes two key contributions. First, we introduce a new theory-driven classification of environmental policies, categorizing them as "incentives" or "constraints" based on NIT rather than purely economic criteria. Second, by simultaneously examining IVCs, CVCs, and GVCs within the same panel, an approach that has not been taken in previous research (Hegeman and Sørheim, 2021), we uncover nuanced differences in their willingness to fund green startups, thereby also shedding new light on the previously understudied behavior of CVCs (Lin, 2022). Particularly, our findings challenge and extend the existing literature on the impact of public environmental policies (Erdoğan et al., 2023; Hu et al., 2023; Tchorzewska et al., 2025) by illustrating that policy effectiveness is contingent upon the specific institutional pressures, strategic logic, and financial returns uncertainty of different investor types.

Finally, this research also offers critical implications for policymakers, investors, and green entrepreneurs. Policymakers should create tailored environmental policies that align with the specific motivations of different VC types, such as incentivizing corporate acquisitions of green startups. For investors, IVCs can leverage government incentives to reduce risks, while CVCs should balance compliance with strategic green initiatives through collaboration with parent companies. Green entrepreneurs should demonstrate regulatory compliance to attract IVCs and align their ventures with corporate objectives to engage CVCs.

2. Theoretical Background

2.1. Investment logics guiding different VCs' investment decisions

The VCs' landscape involves heterogeneous investors operating under distinct investment logic, each shaped by their unique goals and strategic priorities (e.g., Guo et al., 2015; Alvarez-Garrido and Dushnitsky, 2016). These divergent logics underscore the need for diverse theoretical approaches to analyze their investment decisions (Wadhwa and Basu, 2013). For instance, IVCs are limited-liability partnership companies that raise and manage funds from institutional and independent investors (Shuwaikh et al., 2023). They are exclusively focused on their investments and do not run other businesses or operations, so their investment decisions are driven by the goal of achieving financial returns and influenced by the uncertainty surrounding such investments (Guo et al., 2015; Alvarez-Garrido and Dushnitsky, 2016). Therefore, the Real Option (RO) theory, which provides insights into how investment decisions are made in uncertain environments to maintain or improve profitability (Folta and Miller, 2002), has been largely recognized as appropriate for assessing IVCs investment decisions. Particularly, according to the RO lens, we expect that if future returns are uncertain, IVCs will refrain from investing while waiting for the uncertainty of future returns to decrease. When returns become more certain since, for example, the startup has completed the development of its technology and its technology has reached the market, future returns become more certain, leading IVCs to invest.

However, while suitable for understanding the investment decisions of IVCs, the RO theory is not the most appropriate framework for capturing the investment logic of CVCs. CVCs are investment units of parent corporations that invest the parent's resources to meet strategic objectives (Dushnitsky and Lenox, 2006; Maula and Murray, 2017). Case studies on corporations like Intel and IBM illustrate how CVCs strategically invest in emerging startups to gain insights into cutting-edge technologies, explore new markets, and shape the innovation ecosystem to align with their broader strategic goals (Gutmann et al., 2023). Therefore, the Open Innovation (OI) literature provides a more fitting lens for analyzing CVC investment decisions. This framework, indeed, emphasizes the role of such investments as a mechanism for corporate learning and innovation, whereby firms leverage startups to complement their internal R&D and adapt to dynamic technological landscapes (Benson and Ziedonis, 2009). Unlike RO logic, which prioritizes deferring investments under uncertainty, the OI perspective underscores the proactive engagement of CVCs with startups, even under uncertain conditions, to secure access to valuable knowledge, capabilities, or market opportunities that may offer strategic benefits.

Finally, regarding GVCs, a well-suited theory for analyzing their investment logic is the Agency Theory (Eisenhardt, 1989) because it addresses principal-agent relationships such as those between government bodies (principals) and fund managers (agents). GVCs are governmental entities designed to invest in sectors deemed strategically important by the government with the dual objective of fostering innovation and achieving societal goals mandated by the government (Kaplan and Strömberg, 2004). Thus, under the Agency Theory lens, GVCs' investment decisions follow the government's directives since the propensity of GVCs to invest in startups is underpinned by the alignment of such investments with broader public policy objectives, suggesting that GVCs, as agents of the government, prioritize the principal's objectives over traditional risk-return calculations (Jensen and Meckling, 1979; Norton, 1996). Moreover, the New Institutional Theory (NIT) (Dimaggio and Powell, 1983) is well-suited to explain GVC investments in green startups. Under the NIT perspective, indeed, the concept of coercive isomorphism, which suggests investors are obliged to conform their behaviors to those of the Institutions, may explain how government-imposed funding conditions exert pressure on GVCs to conform to state-mandated environmental objectives (Brophy & Guthner, 1988).

2.2. Public environmental policies and VCs' investments in green startups

The OECD has identified 15 key environmental public policies to address critical environmental challenges and promote sustainability (Botta and Koźluk, 2014). These include emission taxes (ET) on CO2, NOx, SOx, and diesel emissions, which aim to internalize the environmental costs of pollution and incentivize the adoption of cleaner practices. Complementing these fiscal measures, some other mechanisms, such as trading schemes (TS), including CO2 emissions trading and renewable energy credit markets, encourage industries to invest in low-carbon technologies and renewable energy sources. To further regulate industrial emissions, Emission Limit Values (ELVs) establish strict caps on pollutants such as NOx, SOx, and particulate matter (PM), compelling industries to adopt environmentally friendly technologies to comply with these standards. Supporting these tools are policies that promote technological advancement, including public funding for research and development (RD) to spur innovation in pollution reduction and renewable energy. In tandem, targeted support (SUP) policies accelerate the deployment of renewable energy technologies, particularly solar and wind, through subsidies, grants, and financial incentives, ensuring a smoother transition to a sustainable energy system.

Prior literature has classified these policies along various dimensions as "carrots" and "sticks" (Tchorzewska et al., 2025), "command and control" (Lenox and Kaplan, 2016), "market-based" (Cheng et al., 2017; Botta and Koźluk, 2014) and "market-pull", "technology-push" (Hille et al., 2020), or "supply-push" and "demand-pull" (Norberg-Bohm, 2000). In this paper, we propose a novel classification informed by NIT (Dimaggio and Powell, 1983), distinguishing policies based on their roles as "incentives", which encourage voluntary compliance, or "constraints", which enforce mandatory limits. This perspective emphasizes the role of regulatory frameworks and cultural systems in shaping investors' behavior (Lucas et al., 2022). By categorizing environmental policies as incentives or constraints, we agree with the NIT's assertion that government regulations and norms can encourage or restrict organizations' behaviors and decisions. Particularly, we classified TS, RD, and SUP as government incentives because they serve as positive reinforcements, aligning economic benefits with desired behaviors and encouraging organizations to innovate and adapt in environmentally beneficial ways. Conversely, we classified ET and ELV as government constraints because they impose costs and legal limits on polluting activities, compelling companies to reduce emissions and forcing them to comply with these standards. It is to be specified that our new classification might recall the one provided by Tchorzewska et al., 2025, which associates subsidies to "carrots" and environmental taxes as "sticks". In such a sense, "carrot" might recall an incentive and "stick" a constraint. The authors, however, do not provide any definition for such classifications. Our classification differs substantially from the one by Tchorzewska et al., 2025. First, since our classification of "incentives" and "constraints" is theoretically grounded on NIT. Second, it includes a complete coverage of the most prominent policy instruments, rather than only subsidies and taxes. Moreover, the impact of such classified policies is studied by Tchorzewska et al., 2025 from an internal innovation perspective (i.e., R&D investments), while our study assesses their impact on the open innovation one (i.e., CVC investments).

Prior literature has studied the effect of constraining policies on specific investment and innovation behaviors (Ulucak and Kassouri, 2020). Specifically, constraints, which are Emission taxes (ET) and emission limit values (ELVs), are critical regulatory tools for internalizing environmental costs and driving compliance with environmental standards. According to Porter (Porter and van der Linde, 1995), well-designed measures, including taxes and limits, can stimulate innovation despite associated costs (Ulucak and Kassouri, 2020). Conversely, previous findings suggest that ET often elevates operational costs for parent corporations and crowds out long-term sustainable investments (Wang et al., 2022; Gray and Shadbegian, 2003).

The evidence on constraints is mixed. As concerns the ET, moderate levels can encourage independent venture capital (IVC) investments in green technologies by reducing uncertainties and prompting firms to comply with stricter standards (Bianchini and Croce, 2022; Criscuolo and Menon, 2015), yet stringent ET levels can impose financial burdens that deter innovation and reduce long-term sustainable commitments (Cojoianu et al., 2020). Similarly, ELVs yield inconclusive findings. While some research identifies no influence on IVC and a non-linear impact on green venture capital (GVC) (Bianchini and Croce, 2022), other evidence suggests that stringent ELVs can indeed stimulate IVC investments (Cojoianu et al., 2020).

These contradictions underscore another gap: the effects of ELVs on CVC remain unknown. While research has extensively examined their role in fostering innovation, their impact on CVC still needs to be studied. This leaves a critical gap in understanding how such constraints influence strategic green investment behavior beyond corporations' internal boundaries and into their open innovation (OI) initiatives.

Incentivizing policies, such as targeted support policies (SUP), trading schemes (TS), and public R&D funding (RD), are intended to reduce financial and operational risks for eco-innovation. Although these policies have been shown to enhance the development of clean technologies (Norberg-Bohm, 2000; van den Bergh, 2013; Tchorzewska et al., 2025), their outcomes for VC investments also present mixed evidence.

In particular, there is mixed evidence on R&D and TS within the incentives. R&D funding appears to ease access to green opportunities for IVC (Cojoianu et al., 2020; Bianchini and Croce, 2022) while constraining GVC (Bianchini and Croce, 2022), and trading schemes foster GVC investments (Bürer and Wüstenhagen, 2009) but negatively affect IVC (Cojoianu et al., 2020; Bianchini and Croce, 2022), with support mechanisms like feeding tariffs leaving IVC and GVC largely unaffected (Bianchini and Croce, 2022).

Moreover, despite these findings, understanding the influence of these incentives on CVC remains limited, generating another gap in the literature. Such policies may create unintended outcomes such as rent-seeking behavior leading to crowding out effects (Bleda and Krupnik, 2024). Rent-seeking occurs when firms choose not to increase their R&D efforts but concentrate on systematically securing public support through dedicated funding applications or lobbying activities, such as R&D funds and subsidies. This focus on obtaining financial resources can lead to crowding-out effects, where public support displaces firms' R&D resources and efforts, as companies substitute their initially planned R&D investments with the acquired funding instead of pursuing innovative projects they might otherwise undertake. This shift diverts resources away from innovation and toward activities aimed at obtaining public funds. Therefore, examining the policy impact on the investment behavior of IVCs, GVCs, and particularly CVCs is necessary.

Addressing these gaps will allow us to reconcile conflicting evidence for IVC and GVC and integrate knowledge about CVCs. This will clarify how incentives and constraints collectively shape corporations' strategic green investment behavior, thereby advancing our comprehensive understanding of corporate innovation pathways.

3. Research design and method

3.1. Hypotheses development

3.1.1. IVCs' investment in green startups

IVCs might associate a high level of uncertainty with investments in green startups (Bergset, 2017). Because of the newness of the green startup market, longer development times are expected for the development or patenting of a green startup's technology compared to other startups in more mature industries, making it more challenging to commercialize and profit from them (Wustenhagen and Teppo, 2006). Under these circumstances, IVC may be concerned about the possibility that allocating resources to green startups could undermine the financial returns of these investments (Folta and Miller, 2002). Moreover, IVCs may refrain from investing in green startups if their technologies have not yet proven successful in the markets (Cumming et al., 2016). Market-risk still makes a return on investments in green technologies highly volatile, undermining the IVC's investment profitability (Chakrabarti and Sen, 2021). Thus, we reason IVCs may avoid committing resources while waiting for the uncertainty surrounding a green startup to decrease. For example, through the registration of patents or the testing of their prototypes, green startups can ensure the feasibility of their products, reducing the technological uncertainty of IVCs and gaining profits from funding them (Audretsch et al., 2012; Zhang et al., 2019). As such, we argue that IVCs are less likely to commit resources to green startups while waiting for more information, reducing the uncertainty surrounding the financial profitability of such investments.

H1a. *IVCs have a negative propensity to invest in green startups.*

Considering the role of government incentives, they may lower the financial uncertainty surrounding green startup investments. Indeed, the incentives bestowed to the startups, such as RD, provide additional financial flows to develop the startups' technologies. Such flows boost the probability of the startups' survival and successful technology launch and, therefore, the likelihood of a favorable exit for the backed new venture (Conti, 2018). Also, incentives like TS enable the receiving green startup to sell green certificates to external companies, thus providing an additional source of revenue to the startup (Bretschger and Soretz, 2022). Finally, SUP ensures higher prices for green products or services, making the green startup more marketable and profitable (Giraudo et al., 2019). In sum, all these incentives allow the reduction of the market and profitability risk for green startups, improving the likelihood of positive exits through acquisitions or IPOs (Yang et al., 2022). Hence, reducing the uncertainty surrounding green startups' investments, according to the RO theory, government incentives lessen the value of postponing investment options by inducing IVCs to invest in green startups (Criscuolo and Menon, 2015).

H1b. *Government incentives positively moderate the negative propensity of IVC to invest in green startups.*

Moreover, government constraints can lower the financial uncertainty surrounding green startup investments. These measures force established companies to adopt cleaner technologies to comply with environmental standards and reduce financial liabilities associated with emissions. Green startups, often at the forefront of innovation in sustainable solutions, thus become attractive acquisition targets for incumbents seeking to integrate advanced technologies into their operations or diversify their portfolios to meet regulatory requirements (Hegeman and Sørheim, 2021). By fostering demand for innovative, sustainable technologies, these policies indirectly boost green startups' market value and strategic relevance, increasing their appeal to acquirers (Basse-Mama et al., 2013). This heightened acquisition potential translates into more lucrative exit opportunities for VC investors. Thus, by anticipating this, IVCs perceive a reduced investment risk, seeing acquisitions as a profitable exit for their venture investments. In sum, Government-imposed constraints, such as emission limit values and emission taxes, can significantly enhance the likelihood of green startups' acquisition, thus reducing IVC's uncertainty perception and increasing their investment propensity in green startups. Hence, IVCs might choose to exercise their option to expand in the green-startup market instead of waiting for more favorable scenarios.

H1c. *Government constraints positively moderate the negative propensity of IVCs to invest in green startups.*

3.1.2. CVCs' investment in green startups

Investing in green startups may represent a strategic opportunity for CVCs aiming at accessing technologies addressing environmental sustainability issues and exploiting them to develop new environmentally sustainable patents, processes, and products to improve their green performance (Bendig et al., 2022). For instance, CVCs may invest in green startups to decrease their environmental impact or integrate sustainable services in their offer to intercept new customer niches (Bendig et al., 2022; Hegeman and Sørheim, 2021). Indeed, investing in a startup through CVCs allows corporations to open up their boundaries to access ready-to-use external technologies more efficiently than through in-house development (Van de Vrande et al., 2011). Startups often focus on innovative, cutting-edge solutions and can adapt to market demands more quickly than established corporations, leveraging their agility and specialized expertise (Weiblen and Chesbrough, 2015). By investing in these startups, corporations can bypass the lengthy and costly process of internal R&D, explore a wider array of green technologies, and more rapidly integrate them into their operations, gaining a competitive edge in sustainability and meeting the green standards expected by stakeholders (Gutmann et al., 2023). With these opportunities ahead, we reason that CVCs may invest in green startups to achieve strategic environmental objectives.

H2a. *CVCs have a positive propensity to invest in green startups.*

Government incentives can significantly enhance the likelihood of CVCs investing in green startups by reinforcing their strategic motivations. These incentives align with the parent corporations' goals to innovate and gain a competitive edge in the green technology market. For instance, subsidies or grants for RD provide parent companies with cost-free funding to develop innovative sustainability projects and refine their technology development, thus increasing the chances of successful scaling and commercialization (Marino et al., 2016). Additionally, policies such as SUP improve the profitability of green technologies, making investments in green startups more attractive by ensuring a favorable market environment (Jenner et al., 2013). Similarly, TS creates financial opportunities for parent corporations by allowing them to sell surplus emission allowances generated by the invested green startups. These earnings can then be reinvested in developing and integrating green technologies, strengthening the parent corporation's operations (Hoffmann, 2007). By offering these tangible benefits, government incentives reduce the financial risks associated with green innovation and amplify corporations' interest in investing in green startups as part of their open innovation strategies.

Moreover, according to NIT, government incentives play a role in CVC investments toward green startups by facilitating normative isomorphism (Greenwood and Suddaby, 2006). According to normative isomorphism, organizations from the same industry approach problems in much the same way. An underlying concept of normative isomorphism is that rules of conformity don't have to be explicitly articulated in laws and regulations, they can be implicit (Dimaggio and Powell, 1983). Thus, although there are no rules stating that certain investments in green startups are mandatory for CVCs, corporate investment branches may still prefer to invest in green startups because the government policy framework, consisting of incentives, indicates a normative pressure toward green innovation. Furthermore, corporates are also sensitive to normative institutional pressures because they frequently interact with government institutions due to their social importance or because their large customer base exposes them to a significant social and environmental responsibility (Campbell, 2007). Thus, the recent pressure the institutional environment has put on environmental issues could accelerate the interest of corporates in leveraging OI objectives by nurturing green startups.

Thus, we reason that environmental policy incentives increase the willingness of CVCs to invest in green startups.

H2b. *Government incentives positively moderate the positive propensity of CVC to invest in green startups.*

Government constraints can also enhance the likelihood of CVCs investing in green startups because, through such investments, corporations can comply with stringent environmental standards. Accessing technology from a green startup allows CVCs to address the ELV requirements they should abide by (Van de Vrande et al., 2011). For example, ET imposes financial costs on companies based on their levels of pollutant emissions, incentivizing them to reduce their emissions to minimize tax liabilities. By investing in green startups focused on emission reduction technologies, CVCs enable their parent companies to adopt advanced solutions that lower their emissions and thus reduce their tax burden (Porter and van der Linde, 1995). Moreover, acquiring ready-to-use technology rather than developing it in-house allows CVCs to address the ELV requirements with which they should comply more promptly. Similarly, ELV sets maximum allowable emission levels for specific pollutants, requiring companies to stay within these limits to avoid penalties. By investing in new ventures that develop cutting-edge technologies that reduce emissions, CVCs ensure their parent companies can comply with these regulatory limits, avoiding costly fines and enhancing operational efficiency. Adopting these technologies not only ensures regulatory compliance but also improves the corporation's public image and contributes to the parent corporation's long-term sustainability and competitive advantage, making such investments strategically valuable (Hegeman and Sørheim, 2021).

Furthermore, government constraints imposed by environmental policies lead to coercive mechanisms of NIT (Dimaggio and Powell, 1983). Indeed, regulatory pressures compel CVCs to enhance and refine the parent company's environmental operations and technologies to meet new standards. To achieve corporate greening, CVCs invest in green startups with innovative environmental technologies rather than develop them in-house (Hegeman and Sørheim, 2021). Investing in green startups allows CVCs to integrate advanced solutions into the parent company's operations promptly and more rapidly than developing them in-house, aiding timely compliance with environmental regulations and enhancing sustainability credentials. For instance, when invested by CVCs, startups specializing in renewable energy can reduce the parent company's carbon footprint, while those in waste management can improve their recycling efforts (Porter and van der Linde, 1995). These investments facilitate rapid knowledge transfer, further refining the parent company's environmental performance and ensuring timely compliance with stringent standards. Thus, environmental constraints make the OI objective more urgent for corporations that must promptly adopt technologies that allow them to match the regulatory requirements. Such an urgency pushes OI acquisitions of green technological startups.

Therefore, we suggest that environmental policy constraints increase the willingness of CVCs to invest in green startups.

H2c. *Government constraints positively moderate the positive propensity of CVC to invest in green startups.*

3.1.3. GVCs' investment in green startups

Because public policies are increasingly oriented toward environmental sustainability (Letta, 2024; Boyle et al., 2021), GVCs might interpret such policies as a directive to fund solutions that enable environmental compliance across the industry. Such alignment between the GVCs and the governments could be achieved by investing in green startups. They, indeed, provide innovative technologies while conveying societal and environmental objectives through their green processes (Bergset and Fichter, 2015). Through investments in green startups, GVCs address the governments' objectives by prioritizing them over their financial goals. For example, in 2021, the UK government implemented a mandate for its Green Investment Group, a GVC fund, to prioritize investments in green startup sectors to accelerate the transition to a low-carbon economy by ensuring that GVC funds were allocated to projects that promoted renewable energy and other green technologies. The directive required that a significant portion of the GVC's investment portfolio be dedicated to green ventures, aligning with the government's environmental objectives. As a result, GVC-backed companies in the UK are increasingly focused on deploying innovative green technologies that fulfill the government's mandate (Owen, 2023).

Moreover, since GVCs are directly financed by the governments, and such funds are often bestowed to the GVCs with specific conditions or requirements from the governments, GVC's investment decisions might be affected by governments' coercive pressure (Brophy & Guthner, 1988; Bruton & Ahlstrom, 2003; Isaksson et al., 2004). Governments can exert such coercive pressure through conditions that might include investing in particular geographic areas, focusing on certain technologies, or meeting specific social and economic objectives. Thus, we can expect that the pressure exerted on GVCs leads to coercive isomorphism (i.e., conforming to powerful actors exerting coercive pressure, such as governments, to appear legitimate to them) (Dimaggio and Powell, 1983). Since GVCs operate under coercive pressures from the government, where investments in green startups are seen as part of fulfilling mandated governmental ecological objectives, they might conform to their investment directives to respond to their pressures and to secure investment funds from them. For instance, in 2002, the Australian government initiated the Pre-seed Fund program, a public-private partnership to foster investment in nascent high-tech entrepreneurial firms. The mandate required that the GVC funds prioritize early-stage, high-tech companies, especially those in the same state as the fund managers. Thus, the GVCs had to adopt investment criteria recommended by governments to secure funding from them (Cumming and Johan, 2009). Therefore, since they are driven by aligning objectives with the government and mandated to support environmental sustainability through coercive pressure, we reason that GVCs are willing to invest in green startups.

H3. *GVCs have a positive propensity to invest in green startups.*

An overall framework of the hypotheses and their theoretical development is represented in Fig. 1.

3.2. Research design and method

3.2.1. Data and sample

We built an ad hoc dataset by gathering data from three sources. We used the Crunchbase database, which contains comprehensive coverage of information about VCs' investments and is frequently used by scholars investigating the VC market (e.g., de Lange and Valliere, 2020). Leveraging Crunchbase, we first selected all startups for which top investors' names were available, founded between 2010 and 2019. We chose this decade because of the centrality of the Paris Agreement in 2015, which unprecedentedly bound 195 countries worldwide to reduce greenhouse gas emissions and represents a milestone in the international alignment toward environmental conservation. Moreover, by choosing such a time window, we also avoided the financial crisis of 2007–2009, which unpredictably impacted the VC market (Conti et al., 2019). Similarly, we chose 2019 to prevent considering the Covid-19 period. Thus, we collected all the top VC investors who have invested in such startups. We obtained a strongly balanced panel of 3473 IVCs, CVCs, and GVCs' unique investors, who made 16,761 total investments in 12,711 unique startups between 2010 and 2019. The top VCs represent the unit of analysis of the investigation. The panel contains the number of cumulated investments and the funding amounts each investor invested in green and non-green startups. Particularly, the classification of green startups has been made according to endogenous keyword selection through AI, starting from the Crunchbase startup industry classification under the "Sustainability" category. Since the wide variety of sustainable industries comprised this category, we further restricted the selection using ChatGPT 4.0, which processed the prompt ten times to validate the choice of the industries. Two academics who are experts in the sustainability field supervised the iterative process and selected 60 industries within those identified by ChatGPT. While ChatGPT provided an automated preliminary analysis across many categories, the experts were instrumental in curating a refined set of green industries that directly aligned with environmental objectives. Finally, the experts assessed the coherence of the selected industries with the EU Sustainable

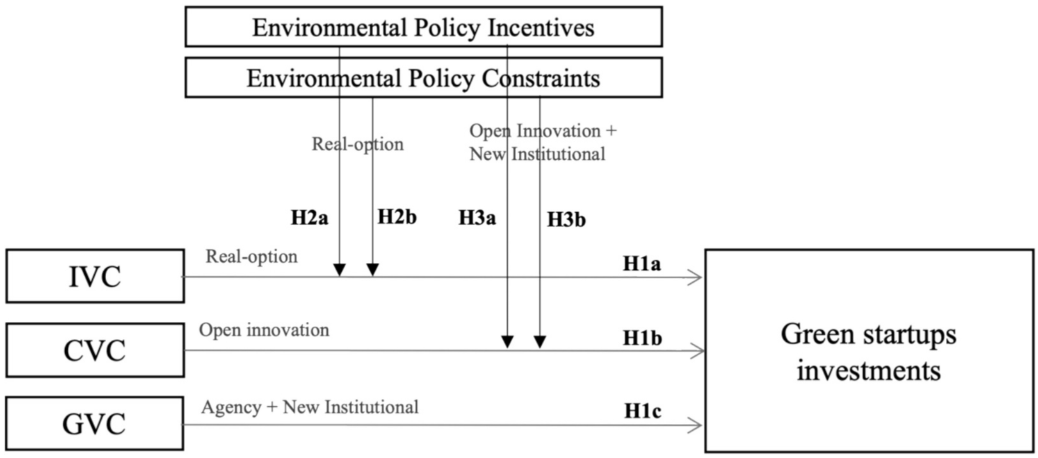

Fig. 1. Framework of hypotheses.

Finance Taxonomy guidelines, which outline six categories of sustainability specifying the pertaining NACE codes to classify green economic activities (European Commission, 2023). According to this check, the sectors align with the NACE industries classified as sustainable, with 95 % fit. Appendix A includes the list of the selected green industries.

Furthermore, economic and financial data of CVC's parent corporations were drawn for the Compustat database.

Finally, we used the OECD Environmental Policy Stringency Index Database, which contains information about environmental policies yearly and country by country for both these 27 OECD members and the five non-OECD members: Brazil, China, India, Indonesia, and South Africa. We used this policy database to measure the moderating role of government incentives and constraints.

3.2.2. Measures

The dependent variable of this study is $\%Num\_green\_investments_{i,t}$, which measures the percentage of the number of investments in green startups to the total number of investments made by each VC in the year *t*.

The independent variables are three dummy variables that distinguish the VCs type into *IVC*, *CVC*, and *GVC* according to the Crunchbase classification (Bianchini and Croce, 2022). *IVC, CVC,* and *GVC* assume a value of 1 if the investor pertains to that category and 0 otherwise.

To measure the moderating role of environmental policies, we created two moderating variables, $incentives_{c,t-1}$, and $constraints_{c,t-1}$. To build such moderators, we considered the 13 policy instruments embedded in the OECD classification (Table 1). Each policy instrument has been measured as a continuous, ordinal variable ranging from 0 to 6 on a yearly and country basis. Then, we normalize the values of each of the 13 policy instruments and aggregate them in 5 policy groups (Table 1), considering the mean values of its contained policy instruments. In particular, "TS" contains CO2 Trading Schemes and Renewable Energy Certificates, "RD" is a unique-policy instrument group, "SUP" contains Support Solar and Support Wind, "ET" contains CO2 tax, NOx tax, SOx tax, diesel tax, and finally "ELV" contains ELV NOx, ELV SOx, ELV PM, and ELV Sulphur. Thus, we obtained five policy variable groups, measured at the year before the deal, i.e. *t-1*, and country *c*. This approach, also used by other authors in the same field, helps to prevent potential endogeneity issues by accounting for the delayed response of investors to changes in public environmental policies, given that a several-month duration characterizes VCs' investment decision process (Kaplan and Stromberg, 2001; Bianchini and Croce, 2022). Then, we classified TS, RD, and Support as incentives. Oppositely, we classified ET and ELV as constraints. Thus, the variables $incentives_{c,t-1}$ and $constraints_{c,t-1}$ were built as the average of the 3 and 2 policy group variables, respectively, in year *t-1* and considering the VC headquarter country *c*.

Control variables included in the model were grouped into VC-related variables, macroeconomic variables, and policy variables, and they have been lagged by one year. By lagging the VC-related variables, we intended to capture the previous experience of the VCs; while lagging the policy variables, we account for the time needed for investors to become aware of the updates of changes in policies (Kaplan and Stromberg, 2001).

VC-related variables include the age of the VC at the year of investment ($VC\_age_{i,t}$), the logarithm of the cumulated number of deals made by the VC *i*-th at the year before the deal, *t*-1, $ln\_Num\_investments_{i,t-1}$. This variable captures VCs' investment experience (Hopp and Lukas, 2014). Then, we also included the percentage of cumulated investments made by each investor *i*-th until the year before the deal, *t*-1, in specific industries (Gompers et al., 2005; Ewens et al., 2018), over the total number of investments made by each investor *i*-th until the same year, *t*-1. Given our dataset's high number of industries, we selected a subset of such industries through a Pareto analysis. In particular, we first computed the total number of invested startups for each industry in our database, and we then selected the industries that have received 80 % of the investments in our database. Thus, the industry experience variables that have been considered are: $Hardware_{i,t-1}$, $Manufacturing_{i,t-1}$, $Mobile_{i,t-1}$, $Healthcare_{i,t-1}$, $FinancialServices_{i,t-1}$, $MediaandEntertainment_{i,t-1}$, $InformationTechnology_{i,t-1}$, $CommerceandShopping_{i,t-1}$, $InternetServices_{i,t-1}$, $ScienceandEngineering_{i,t-1}$, $DataandAnalytics_{i,t-1}$, $Software_{i,t-1}$, $Other_{i,t-1}$.

Since the policy instruments have been specifically tailored to OECD countries, we included a dummy variable named *OECD* to control whether a VC's headquarters is in one of the 27 OECD member countries or not. Moreover, among the countries where VCs are headquartered, we chose those whose resident investors performed 60 % of the total VC

Table 1
Incentives and constraints variables construction.

Variables	Policy groups	Policy instruments
		CO2 Trading Scheme
	TS	Renewable Energy Certificates
	RD	R&D Subsidies
	SUP	Support Solar
Incentives		Support Wind
		CO2 tax
		NOx tax
		SOx tax
	ET	Diesel tax
		ELV NOx
	ELV	ELV SOx
		ELV PM
Constraints		ELV sulphur

investments in our dataset. These are the USA, China, UK, Germany, and Japan, and we created five dummy variables (i.e., *Usa*, *China*, *Uk*, *Germany*, and *Japan*).

We included the variation in the percentage of the world GDP (purchase price adjusted) per capita from year t-1 to year t as a macroeconomic variable, *Δ_gdp%* (Tao et al., 2022).

4. Analysis and results

4.1. Main analysis results

Table 2 in Appendix B presents the descriptive statistics for all variables.

Table 3 shows the pairwise correlation matrix (i.e., the pairwise correlation values among all variables). This table revealed a high correlation between the OECD and incentives variables, so the *OECD* variable has been removed. Additionally, we calculated the Variance Inflation Factor (VIF) (Stevens, 2002)to check for multicollinearity. Since the VIF is below the critical threshold of 10, the explanatory variables can be included simultaneously in our models (Gujarati, 2021).

Considering the continuous nature of the dependent variable *% Num_green_investments*$_{i,t}$, we adopted an OLS regression model. We used a random effect estimation model to account for unobserved heterogeneity (i.e., individual-specific effects not captured by the observed variables). Similar models have been applied to panel data studying the impact of policies on investments (Bianchini and Croce, 2022). The random effect model assumes that these unobserved individual effects are random and uncorrelated with the explanatory variables, allowing us to control for them without losing degrees of freedom. The results of the OLS estimation are reported in Table 4.

Our baseline model (Model 1) includes only control variables. The lagged cumulative investments *ln_Num_investments*$_{i,t-1}$ are positive and highly significant ($\beta = 0.0537$, $p < 0.001$), underscoring how prior experience fosters subsequent sustainable allocations, a finding consistent with real options (RO) logic, where investors leverage learned capabilities and market familiarity to reduce uncertainty (Gompers et al., 2016).

By contrast, world GDP variation is negative and insignificant ($\beta = -0.0760$, $p > 0.1$), suggesting limited responsiveness to macroeconomic conditions and reinforcing the Kuznet curve and the dilemma countries face while promoting their GDP at the cost of green innovation (Tao et al., 2022). The GDP variation accounts for macroeconomic factors like interest rates, inflation, and policy uncertainty, which shape VC investment in green technologies. IVCs are indirectly influenced by GDP fluctuations, with economic downturns leading to increased risk aversion and safer investment choices (Ning et al., 2015). Lower GDP can also result in higher interest rates, further discouraging IVC investment (Bellavitis et al., 2023). However, negative interest rates associated with lower GDP may boost VC activity in high-risk sectors like green innovation (Bellavitis et al., 2023). GVCs, being dependent on government revenues, are directly impacted by GDP changes. A decline in GDP reduces funding for GVC initiatives, while economic growth increases government support for green innovation (Tykvová, 2018). Similarly, CVCs are affected by corporate profitability. During downturns, reduced corporate revenues can lower CVC investments, especially in green sectors, while GDP growth boosts corporate profits and investment flexibility (Schertler and Tykvová, 2011). Overall, the negative and non-significant relationship between GDP variation and green investment can be better understood by considering the response of each VC type. GVCs and CVCs are positively influenced by economic expansion, while IVCs are negatively affected.

Among the country-level controls, the *Usa* ($\beta = -0.0600$, $p < 0.001$) and *China* ($\beta = -0.0935$, $p < 0.001$) show significantly negative effects in Model 1, indicating that firms in these countries invest less in sustainability. Therefore, our results suggest that both firms in the OECD member country, like the USA, and non-OECD countries like China are discouraged from investing in sustainability initiatives. This investment pattern supports prior studies suggesting that countries' propension to invest in green startups correlates with the green market maturity levels measured by the Global Green Economy Index (GGEI). Particularly, countries with lower GGEI scores like China (0.528) and mid-level markets like the USA (0.567) exhibited negative policy intervention effects (Romano et al., 2017; Sarkodie et al., 2023).

Lagged industry investments highlight persistent sectoral legacies. Most industries display negative associations with sustainable deal proportions, such as Software ($\beta = -0.0225$, $p < 0.001$) and Healthcare ($\beta = -0.0474$, $p < 0.001$). At the same time, Mobile stands out as

Table 3
Pairwise correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)
(1) *%Num _green_ investments*	1.00																												
(2) *ID*	-0.01	1.00																											
(3) *year*	0.03*	0.00	1.00																										
(4) *IVC*	-0.09*	-0.02*	-0.00	1.00																									
(5) *CVC*	0.03*	0.00	0.02*	-0.72*	1.00																								
(6) *GVC*	0.10*	0.03*	-0.02*	-0.67*	-0.04*	1.00																							
(7) *ln_Num_investments*$_{i,t-1}$	0.17*	-0.01	0.09*	-0.08*	0.01*	0.10*	1.00																						
(8) *VC_age*$_{i,t}$	-0.02*	0.03*	0.05*	-0.10*	0.00	0.14*	-0.08*	1.00																					
(9) *InternetServices*$_{i,t-1}$	-0.11*	0.01	-0.08*	0.02*	0.02	-0.05*	-0.00	0.03*	1.00																				
(10) *Hardware*$_{i,t-1}$	0.03*	0.02	0.03*	-0.03*	0.01	0.03*	-0.01	-0.02*	-0.05*	1.00																			
(11) *ScienceandEngineering*$_{i,t-1}$	0.03*	0.03*	0.06*	-0.04*	0.00	0.06*	-0.00	0.02*	-0.15*	0.12*	1.00																		
(12) *Manufacturing*$_{i,t-1}$	0.11*	0.01	-0.00	-0.00	-0.00	0.01*	0.00	-0.02*	-0.13*	0.18*	0.16*	1.00																	
(13) *DataandAnalytics*$_{i,t-1}$	-0.03*	0.01	0.03*	-0.03*	0.01	0.03*	0.00	-0.00	0.08*	0.04*	0.19*	-0.07*	1.00																
(14) *Mobile*$_{i,t-1}$	-0.01	-0.03*	0.00	0.01*	-0.00	-0.00	0.04*	-0.01*	-0.01*	-0.01*	-0.01*	-0.01*	0.01*	1.00															
(15) *Software*$_{i, t-1}$	-0.12*	0.02	0.02	-0.02*	0.02*	0.01*	0.02*	0.03*	0.13*	0.21*	0.01*	-0.11*	0.26*	0.00	1.00														
(16) *HealthCare*$_{i,t-1}$	-0.12*	-0.02*	0.02*	-0.03*	-0.02*	0.07*	-0.01*	0.00*	-0.17*	-0.09*	0.33*	-0.01*	-0.08*	-0.01*	-0.20*	1.00													
(17) *FinancialServices*$_{i,t-1}$	-0.07*	-0.02*	0.03*	0.03*	-0.01*	-0.03*	-0.02*	-0.00*	-0.03*	-0.10*	-0.10*	-0.08*	-0.01*	-0.01*	0.03*	-0.12*	1.00												
(18) *MediaandEntertainment*$_{i,t-1}$	-0.11*	-0.02*	-0.08*	-0.01*	0.02*	-0.02*	-0.02*	0.02*	0.25*	-0.05*	-0.14*	-0.10*	-0.03*	-0.00*	0.01*	-0.17*	-0.09*	1.00											
(19) *InformationTechnology*$_{i,t-1}$	-0.08*	0.01	0.01	0.01*	-0.05*	0.03*	-0.00*	-0.01*	0.11*	0.08*	-0.06*	-0.10*	0.18*	0.00	0.27*	-0.12*	-0.01*	-0.07*	1.00										
(20) *CommerceandShopping*$_{i,t-1}$	-0.06*	0.02	-0.03*	0.05*	-0.02*	-0.05*	0.02*	0.00	0.12*	-0.08*	-0.15*	-0.09*	-0.02*	0.01*	-0.07*	-0.12*	0.01*	-0.02*	-0.11*	1.00									
(21) *Incentives*$_{c,t-1}$	0.05*	-0.04*	0.03*	-0.03*	0.02*	0.02*	-0.01*	0.01*	-0.02*	-0.04*	0.03*	-0.00*	0.01*	-0.02*	0.03*	0.06*	-0.01*	-0.00*	-0.02*	-0.01*	1.00								
(22) *Constraints*$_{c,t-1}$	0.05*	0.03*	0.32*	0.02*	0.00	-0.02*	0.07*	0.03*	-0.06*	0.04*	0.03*	0.06*	-0.02*	0.01*	-0.05*	-0.01*	-0.02*	-0.05*	-0.05*	-0.01*	0.38*	1.00							
(23) *OECD*$_{i}$	0.06*	-0.08*	-0.06*	-0.08*	0.04*	0.08*	-0.03*	0.03*	0.03*	-0.06*	0.05*	-0.03*	0.04*	-0.03*	0.08*	0.07*	-0.03*	0.02*	-0.01*	0.01*	0.64*	0.10*	1.00						
(24) *USA*$_{i}$	-0.06*	-0.04*	-0.04*	-0.01*	-0.00	0.02*	-0.07*	0.02*	0.01*	-0.04*	0.05*	-0.06*	0.05*	-0.01*	0.08*	0.11*	0.00*	0.04*	0.03*	-0.06*	0.13*	-0.41*	0.44*	1.00					
(25) *China*$_{i}$	-0.07*	0.10*	0.07*	0.09*	-0.04*	-0.09*	0.03*	-0.01*	-0.05*	0.09*	-0.02*	0.05*	-0.03*	0.04*	-0.09*	-0.05*	0.02*	-0.01*	0.01*	-0.03*	-0.47*	0.21*	-0.84*	-0.37*	1.00				
(26) *UK*$_{i}$	0.04*	-0.02*	-0.01*	-0.02*	0.02*	0.02*	0.01*	-0.04*	-0.03*	-0.00*	0.03*	-0.01*	0.02*	-0.01*	-0.01*	-0.00*	0.04*	-0.01*	-0.01*	0.00*	0.41*	0.16*	0.17*	-0.22*	-0.14*	1.00			
(27) *Germany*$_{i}$	0.03*	-0.03*	-0.05*	-0.02*	0.04*	-0.01*	0.02*	0.03*	0.01*	-0.02*	-0.05*	-0.02*	-0.00*	-0.00*	-0.04*	-0.01*	-0.03*	-0.02*	-0.01*	0.08*	0.09*	0.01*	0.14*	-0.17*	-0.12*	-0.07*	1.00		
(28) *Japan*$_{i}$	-0.00	0.01	0.04*	-0.01*	0.04*	-0.02*	-0.00	0.00*	-0.00*	-0.00*	-0.03*	0.01*	-0.01*	-0.00*	0.04*	-0.01*	-0.02*	0.06*	-0.01*	-0.01*	0.25*	0.12*	0.10*	-0.13*	-0.09*	-0.05*	-0.04*	1.00	
(29) *Δ_gdp%*	0.01	0.00	-0.03*	-0.00	0.00	0.00*	-0.00	-0.00	-0.01*	0.01*	0.01*	0.01*	0.01*	0.00	0.00*	0.01*	0.00*	0.00*	0.01*	-0.00*	-0.02*	0.02*	-0.01*	-0.01*	0.02*	-0.01*	0.00*	0.00	1.00

*$p < 0.05$.

Table 4
results Phase 1.

	%Num_green_investments$_{1,t}$					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
ln_Num_investments$_{i,t-1}$	0.0537***	0.0537***	0.0545***	0.0537***	0.0539***	0.0538***
	(0.00220)	(0.00220)	(0.00221)	(0.00220)	(0.00220)	(0.00220)
InternetServices$_{i,t-1}$	−0.0117*	−0.0116*	−0.0119*	−0.0117*	−0.0116*	−0.0115*
	(0.00506)	(0.00506)	(0.00506)	(0.00506)	(0.00506)	(0.00506)
Hardware$_{i,t-1}$	−0.0474***	−0.0474***	−0.0482***	−0.0474***	−0.0477***	−0.0476***
	(0.00555)	(0.00554)	(0.00554)	(0.00555)	(0.00554)	(0.00554)
ScienceandEngineering$_{i,t-1}$	−0.0210**	−0.0209**	−0.0214**	−0.0210**	−0.0213**	−0.0208**
	(0.00654)	(0.00654)	(0.00653)	(0.00654)	(0.00653)	(0.00654)
Manufacturing$_{i,t-1}$	−0.0138*	−0.0135*	−0.0144*	−0.0137*	−0.0145*	−0.0135*
	(0.00585)	(0.00585)	(0.00585)	(0.00585)	(0.00584)	(0.00585)
DataandAnalytics$_{i,t-1}$	−0.0192**	−0.0193***	−0.0193***	−0.0192**	−0.0189**	−0.0193***
	(0.00585)	(0.00585)	(0.00584)	(0.00585)	(0.00584)	(0.00584)
Mobile$_{i,t-1}$	0.0147*	0.0146*	0.0152*	0.0147*	0.0148*	0.0146*
	(0.00628)	(0.00628)	(0.00628)	(0.00628)	(0.00628)	(0.00628)
Software$_{i,\ t-1}$	0.00775	0.00779	0.00748	0.00775	0.00749	0.00785
	(0.00759)	(0.00759)	(0.00758)	(0.00759)	(0.00758)	(0.00759)
HealthCare$_{i,t-1}$	−0.826	−0.826	−0.840	−0.826	−0.833	−0.827
	(0.688)	(0.688)	(0.687)	(0.688)	(0.687)	(0.688)
FinancialServices$_{i,t-1}$	−0.0152*	−0.0153*	−0.0154*	−0.0152*	−0.0151*	−0.0153*
	(0.00663)	(0.00663)	(0.00663)	(0.00663)	(0.00662)	(0.00663)
MediaandEntertainment$_{i,t-1}$	−0.0414***	−0.0414***	−0.0418***	−0.0414***	−0.0412***	−0.0414***
	(0.00552)	(0.00552)	(0.00552)	(0.00552)	(0.00551)	(0.00552)
InformationTechnology$_{i,t-1}$	−0.0129*	−0.0128*	−0.0131*	−0.0128*	−0.0134*	−0.0130*
	(0.00537)	(0.00537)	(0.00537)	(0.00537)	(0.00537)	(0.00537)
CommerceandShopping$_{i,t-1}$	−0.0225***	−0.0225***	−0.0228***	−0.0225***	−0.0224***	−0.0224***
	(0.00436)	(0.00436)	(0.00435)	(0.00436)	(0.00435)	(0.00436)
Incentives$_{c,t-1}$	−0.0186	−0.0187	0.0108	−0.0186	−0.0203	−0.0191
	(0.0187)	(0.0187)	(0.0591)	(0.0187)	(0.0192)	(0.0187)
Constraints$_{c,t-1}$	0.0418**	0.0426**	−0.0219	0.0418**	0.0128	0.0437**
	(0.0159)	(0.0159)	(0.0195)	(0.0159)	(0.0781)	(0.0159)
USA$_i$	−0.0600***	−0.0589***	−0.0597***	−0.0599***	−0.0604***	−0.0583***
	(0.0126)	(0.0126)	(0.0126)	(0.0126)	(0.0126)	(0.0126)
China$_i$	−0.0935***	−0.0886***	−0.0898***	−0.0932***	−0.0934***	−0.0869***
	(0.0143)	(0.0143)	(0.0143)	(0.0143)	(0.0143)	(0.0143)
UK$_i$	−0.00944	−0.00865	−0.00864	−0.00934	−0.00903	−0.00868
	(0.0207)	(0.0206)	(0.0206)	(0.0207)	(0.0207)	(0.0206)
Germany$_i$	−0.0245	−0.0265	−0.0268	−0.0255	−0.0253	−0.0201
	(0.0254)	(0.0253)	(0.0253)	(0.0254)	(0.0254)	(0.0253)
Japan$_i$	−0.0519+	−0.0522+	−0.0516+	−0.0527*	−0.0506+	−0.0459+
	(0.0267)	(0.0267)	(0.0267)	(0.0268)	(0.0268)	(0.0267)
Δ_gdp%	−0.0760	−0.0772	−0.0626	−0.0757	−0.0618	−0.0812
	(0.293)	(0.293)	(0.293)	(0.293)	(0.293)	(0.293)
VC_age$_{i,t}$	−0.0000755	−0.000139	−0.000138	−0.0000751	−0.0000756	−0.000201
	(0.000153)	(0.000154)	(0.000154)	(0.000153)	(0.000153)	(0.000155)
IVC		−0.0658***	−0.185***			
		(0.0185)	(0.0390)			
IVC x Incentives$_{c,t-1}$			−0.190***			
			(0.0535)			
IVC x Constraints$_{c,t-1}$			0.0564***			
			(0.0162)			
CVC				0.0157	0.238***	
				(0.0239)	(0.0543)	
CVC x Incentives$_{c,t-1}$					0.0530***	
					(0.0160)	
CVC x Constraints$_{c,t-1}$					−0.386***	
					(0.0793)	
GVC						0.127***
						(0.0278)
_cons	0.148***	0.208***	0.321***	0.147***	0.142***	0.143***
	(0.0137)	(0.0217)	(0.0387)	(0.0137)	(0.0138)	(0.0137)
N	13,744	13,744	13,744	13,744	13,744	13,744

Standard errors in parentheses.
OLS regression results using the percentage of VC's yearly green investments. The baseline model (1), the direct relationship with IVC (2)s, CVCs (4), and GVCs (6) as independent variables, and the moderation of incentives and constraints on IVCs (3) and CVC (5).

+ $p < 0.10$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

positive (β = 0.0147, $p < 0.05$), supporting the notion that the success of these policies depends on industry-specific conditions and timing (**Van den Bergh, 2013**; **Faber and Frenken, 2009**; Norberg-Bohm, 2000).

Focusing on the policy variables, incentives are not associated with changes in green investments, while constraints emerge as increasing sustainable investment proportions (β = 0.0418, $p < 0.01$). This initial pattern suggests that incentives alone might not suffice to nudge investors toward green ventures, aligning with the theoretical expectation that voluntary instruments often lack the coercive strength required to alter established routines or reduce perceived uncertainty (Criscuolo and Menon, 2015; Dimaggio and Powell, 1983). Conversely, constraints appear more effective in compelling firms to integrate sustainable criteria, consistent with NIT's coercive mechanisms, where mandatory policies can catalyze shifts in strategic investment behavior.

When we introduce investor types, the results provide more nuanced insights. IVCs (Model 2) show a significant negative effect ($\beta = -0.0658$, $p < 0.001$), confirming H1a and supporting the idea that, from a RO perspective, IVCs remain reluctant to invest in uncertain green technologies (Bergset, 2017; Wustenhagen and Teppo, 2006). The moderation term between IVCs and incentives (Model 3) is negative and significant, suggesting that incentives fail to reduce the high uncertainty perceived by IVCs. Thus, H1b has been rejected. In contrast, the highly significant and positive interaction between IVCs and Constraints (Model 3) supports our prediction that constraints reduce the uncertainty surrounding green startup investments, thus supporting H1c.

Turning to CVCs, we find no significant direct association with green investments in Model 4 ($\beta = 0.0157$, $p = 0.512$), while the relationship turns out to be significant and positive in Model 5 ($\beta = 0.238$, $p < 0.001$) after introducing the interaction effect with policies, supporting H2a. This might reflect the propensity of CVCs to invest in green startups for acquiring technologies able to reduce their environmental impact or integrate sustainable services to increase their reputation and meet customer needs (Hegeman and Sørheim, 2021). Moreover, incentives positively moderate the propensity of CVCs to invest in green startups (Model 5, $\beta = 0.0530$, $p \leq 0.001$). This indicates that normative isomorphism from policy creates an interest in CVCs to invest in green startups as part of their open innovation strategies, to gain a competitive edge in the green technology market, or because their customers expose them to social and environmental responsibility. Thus, H2b is accepted. The interaction between CVCs and Constraints is negative and significant (Model 5 $\beta = -0.386$, $p \leq 0.001$), meaning that the coercive pressure of environmental policy pushes CVCs to refrain from green investing. This might be due, for example, to the fact that they prefer to develop green technology that allows them to meet the emission targets in-house or because the cost of non-compliance is not high enough to motivate green investments out of their strategic focus. Thus, H2c is rejected. This counterintuitive finding confirms previous research (Mahmood et al., 2022) supporting the regressor approach for CVCs, which means that environmental taxes negatively impact the economy. The introduction of ecotaxes makes production more costly, resulting in price hikes and abating consumerism while hindering sectoral investment. This result also aligns with previous research, which stated that constraining measures are ineffective due to their rigidity and low participants' enthusiasm (Lenox and Kaplan, 2016). From an NIT perspective, this result also implies that while CVCs are aware of normative pressures for sustainability, such pressure alone may not trigger immediate shifts in their OI strategies.

Finally, the introduction of GVCs (Model 8) confirms H3, showing a positive and significant effect ($\beta = 0.127$, $p < 0.001$). As predicted, GVCs, aligned with governmental mandates and guided by coercive institutional pressures, consistently invest in green startups (Bergset and Fichter, 2015; Cumming and Johan, 2009). This aligns with NIT's coercive isomorphism, as GVCs effectively enact the government's sustainability agenda, channeling public funds into ventures that fulfill green objectives.

4.2. Robustness and endogeneity check

Additional difference-in-difference (DID) analysis was performed to support the results further and address potential endogeneity. To do so, the panel dataset was further divided into two subsets, each containing all data about IVCs or CVCs.

Endogeneity in our model could be due to the omitted variables bias. To perform the DID analysis, we chose the ratification of the Paris Agreement as the shock date (Capasso et al., 2020). To assess the shock, we followed Atanasov and Black (2016) by verifying its strength, exogeneity, as-if randomization assignment, covariate balance, and only-through condition. The strength of the Paris Agreement is verified because it significantly changes the trend of incentives and constraints averages; it is exogenous because VCs have no decisional power on its ratification, but it is developed by the country's high representatives, such as Ministries. Since the Paris Agreement was ratified on December 12th 2015, we consider 2010–2015 as before shock and 2016–2019 as after shock years. As such, we build a did_t time-variant variable that assumes the value of 0 for the years between 2010 and 2015 and 1 for the years between 2016 and 2019. The as-in randomization is ensured through the construction of a treatment variable $treat_i$, a binary variable assuming randomly the value of 1 for half of the VCs composing the treatment group and 0 for the remaining half representing the control group. As expected, the *treat* variable does not achieve statistical significance in any of the IVC and CVC subsets models, indicating that our randomization is reliable and does not introduce systematic differences between the treated and control groups. Furthermore, we have verified the covariates balance. Moreover, the only-through condition is ensured because the did_t variable does not directly influence the dependent variables $\%Num\_green\_investments_{i,t}$, as its effect operates solely through the policy variables acting as moderators (i.e., $Incentives_{c,t\text{-}1}$ and $Constraints_{c,t\text{-}1}$). The *did* coefficient, however, captures the post-shock period and provides insights into the overall increasing green investment trend after 2015 (Owen, 2023). In sum, introducing the did_i variable using the ratification of the Paris Agreement as an exogenous shock helps absorb potential endogeneity from omitted variables. By comparing pre-shock (2010–2015) and post-shock (2016–2019) periods, we ensure that unobserved factors impacting investor behavior and sustainability outcomes are more effectively controlled.

Finally, to check the robustness of our results for CVCs further, we control for variables related to the parent companies of CVCs (Ryu et al., 2024). Specifically, we add *ln_revenues*, the logarithm of the parent company's yearly revenues, to account for the dimension of the parent corporation and *parent_ esg_adoption.* This time-variant dummy variable has a value of 0 for the year before the adoption of the ESG report and 1 from the adoption onward.

We perform the regression analysis for both CVCs and IVCs using $\%Num\_green\_investments_{i,t}$, (i.e., the percentage of yearly sustainable investments). In addition, as a robustness check, we used an alternative dependent variable, $\%Funds\_green\_investments_{i,t}$, which measures the percentage of funds (in US dollars) invested in green startups to the total amount financed in the year *t* by each VC.

Before performing the analysis, we checked for high correlation and multicollinearity through the VIF. No high correlation of multicollinearity was present. Regardless, we dropped the variable *Mobile* in the CVC estimations because no observations were present.

Consistent with the main results, *Incentives* shows limited effectiveness for IVCs under the DID specification and maintains a negative sign. In Table 5, incentives negatively influence the percentage of green investments (e.g., the triple interaction involving incentives (Did_i x $Treat_i$ x $Incentives_{c,t\text{-}1}$). Although it is not significant when using deal counts as a dependent variable (Model 2: $\beta = -0.0394$, $p > 0.1$), it becomes significant with a negative coefficient when considering the funds-based outcome measure (Model 5: $\beta = -0.0565$, $p < -0.05$). These results reaffirm our earlier conclusion that incentives do not reliably encourage IVCs toward green investments, thereby rejecting H1b.

In contrast, *Constraints* demonstrates to be a positive driver for IVCs. Under the DID framework, constraints show positive and highly significant coefficients (e.g., Model 3: $\beta = 0.621$, $p < 0.001$ for deal counts, and Model 6: $\beta = 0.116^*$, $p < 0.001$ for funds), suggesting that policy restrictions effectively foster sustainable investment behaviors even after addressing endogeneity, especially concerning the number of

Table 5
results Phase 2 - analysis of IVCs.

	%Num_green_investments$_{i,t}$			%Funds_green_investments$_{i,t}$		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
ln_Num_investments$_{i,t-1}$	0.0506***	0.0507***	0.0510***	0.0972***	0.0954***	0.0960***
	(0.00243)	(0.00238)	(0.00244)	(0.00397)	(0.00390)	(0.00397)
InternetServices$_{i,t-1}$	−0.0126*	−0.0127*	−0.0127*	−0.0113	−0.0112	−0.0113
	(0.00508)	(0.00507)	(0.00508)	(0.00900)	(0.00900)	(0.00900)
HealthCare$_{i,t-1}$	−0.0432***	−0.0431***	−0.0432***	−0.0744***	−0.0743***	−0.0742***
	(0.00571)	(0.00570)	(0.00570)	(0.00999)	(0.00999)	(0.00999)
FinancialServices$_{i,t-1}$	−0.0235***	−0.0236***	−0.0235***	−0.0271*	−0.0275*	−0.0272*
	(0.00657)	(0.00657)	(0.00657)	(0.0117)	(0.0117)	(0.0117)
CommerceandShopping$_{i,t-1}$	−0.0123*	−0.0120*	−0.0121*	−0.0305**	−0.0300**	−0.0300**
	(0.00586)	(0.00586)	(0.00586)	(0.0101)	(0.0101)	(0.0101)
Hardware$_{i,t-1}$	−0.0280***	−0.0281***	−0.0280***	−0.0172+	−0.0178+	−0.0175+
	(0.00577)	(0.00577)	(0.00577)	(0.0101)	(0.0101)	(0.0101)
ScienceandEngineering$_{i,t-1}$	0.0123+	0.0125+	0.0123+	0.0195+	0.0192+	0.0194+
	(0.00644)	(0.00644)	(0.00644)	(0.0114)	(0.0114)	(0.0114)
Manufacturing$_{i,t-1}$	0.0142+	0.0138+	0.0140+	0.0199	0.0195	0.0192
	(0.00770)	(0.00770)	(0.00770)	(0.0138)	(0.0138)	(0.0138)
Mobile$_{i,t-1}$	−0.708	−0.728	−0.732	−1.412	−1.426	−1.441
	(0.671)	(0.671)	(0.671)	(0.949)	(0.949)	(0.949)
DataandAnalytics$_{i,t-1}$	−0.0211**	−0.0212**	−0.0211**	−0.0290*	−0.0290*	−0.0291*
	(0.00667)	(0.00666)	(0.00666)	(0.0119)	(0.0119)	(0.0119)
MediaandEntertainment$_{i,t-1}$	−0.0419***	−0.0418***	−0.0418***	−0.0795***	−0.0792***	−0.0794***
	(0.00560)	(0.00560)	(0.00560)	(0.00995)	(0.00995)	(0.00995)
InformationTechnology$_{i,t-1}$	−0.0239***	−0.0239***	−0.0240***	−0.0499***	−0.0499***	−0.0499***
	(0.00527)	(0.00527)	(0.00527)	(0.00938)	(0.00937)	(0.00937)
Software$_{i,t-1}$	−0.0217***	−0.0217***	−0.0218***	−0.0351***	−0.0351***	−0.0351***
	(0.00443)	(0.00443)	(0.00443)	(0.00767)	(0.00767)	(0.00768)
Incentives$_{c,t-1}$	−0.0262	−0.0394+	−0.0271	−0.0647*	−0.0565	−0.0619+
	(0.0193)	(0.0228)	(0.0193)	(0.0322)	(0.0364)	(0.0322)
Constraints$_{c,t-1}$	0.0750***	0.0795***	0.0750***	0.147***	0.128***	0.152***
	(0.0175)	(0.0179)	(0.0196)	(0.0296)	(0.0303)	(0.0321)
USA$_i$	−0.0531***	−0.0523***	−0.0534***	−0.0238	−0.0259	−0.0246
	(0.0131)	(0.0131)	(0.0131)	(0.0162)	(0.0162)	(0.0162)
China$_i$	−0.0815***	−0.0827***	−0.0817***	−0.0530**	−0.0512**	−0.0527**
	(0.0146)	(0.0146)	(0.0146)	(0.0186)	(0.0187)	(0.0186)
UK$_i$	0.00127	0.00288	0.00171	−0.00438	−0.00534	−0.00424
	(0.0214)	(0.0214)	(0.0214)	(0.0270)	(0.0270)	(0.0270)
Germany$_i$	−0.0364	−0.0361	−0.0374	0.0188	0.0184	0.0187
	(0.0269)	(0.0269)	(0.0269)	(0.0312)	(0.0312)	(0.0313)
Japan$_i$	−0.0447	−0.0427	−0.0434	−0.0136	−0.0151	−0.0129
	(0.0280)	(0.0280)	(0.0280)	(0.0341)	(0.0342)	(0.0342)
Δ_gdp%	−0.0232	−0.0297	0.0274	−0.553	−0.788	−0.711
	(0.319)	(0.309)	(0.318)	(0.549)	(0.532)	(0.546)
VC_age$_{i,t}$	−0.000105	−0.000100	−0.0000912	−0.000368+	−0.000404+	−0.000382+
	(0.000166)	(0.000166)	(0.000166)	(0.000218)	(0.000218)	(0.000218)
Treat$_i$	0.00593			−0.0130		
	(0.0102)			(0.0127)		
Did$_t$	−0.00421			−0.00326		
	(0.00266)			(0.00454)		
Treat$_i$ x Incentives$_{c,t-1}$		−0.0135			−0.0642+	
		(0.0221)			(0.0354)	
Did$_i$ x Incentives$_{c,t-1}$		−0.0436+			−0.0296	
		(0.0245)			(0.0390)	
Did$_i$ x Treat$_i$ x Incentives$_{c,t-1}$		−0.0377			−0.0724+	
		(0.0238)			(0.0382)	
Treat$_i$ x Constraints$_{c,t-1}$			0.0780***			0.121***
			(0.0195)			(0.0320)
Did$_i$ x Constraints$_{c,t-1}$			0.0722***			0.160***
			(0.0179)			(0.0292)
Did$_i$ x Treat$_i$ x Constraints$_{c,t-1}$			0.0621***			0.116***
			(0.0180)			(0.0293)
_cons	0.121***	0.121***	0.122***	0.0582*	0.0624**	0.0577**
	(0.0155)	(0.0148)	(0.0146)	(0.0227)	(0.0221)	(0.0218)
N	12,730	12,730	12,730	8708	8708	8708

Standard errors in parentheses.
DID analysis using the percentage of IVC's yearly green investments (1–3) and the percentage of the funds invested in green (4–6), using IVC as independent variable..
The baseline model (1 and 4) and the interaction of incentives (2 and 5) and constraints (3 and 6).

$^{+}$ $p < 0.10$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 6
results Phase 2 - analysis of CVCs.

	$\%Num\_green\_investments_{i,t}$			$\%Funds\_green\_investments_{i,t}$		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
$ln\_Num\_investments_{i,t-1}$	0.0482***	0.0454***	0.0487***	0.0922***	0.0906***	0.0920***
	(0.0135)	(0.0136)	(0.0135)	(0.0122)	(0.0125)	(0.0122)
$InternetServices_{i,t-1}$	−0.0412	−0.0433	−0.0420	0.0165	0.0152	0.0165
	(0.0347)	(0.0352)	(0.0348)	(0.0342)	(0.0342)	(0.0342)
$HealthCare_{i,t-1}$	−0.0473	−0.0549	−0.0500	−0.0123	−0.0181	−0.0116
	(0.0455)	(0.0458)	(0.0455)	(0.0497)	(0.0503)	(0.0498)
$FinancialServices_{i,t-1}$	−0.00120	−0.00270	−0.000643	−0.0296	−0.0300	−0.0317
	(0.0448)	(0.0449)	(0.0448)	(0.0470)	(0.0474)	(0.0472)
$CommerceandShopping_{i,t-1}$	−0.0316	−0.0238	−0.0279	−0.0286	−0.0265	−0.0313
	(0.0446)	(0.0452)	(0.0449)	(0.0436)	(0.0444)	(0.0441)
$Hardware_{i,t-1}$	−0.0261	−0.0198	−0.0271	−0.0582	−0.0525	−0.0545
	(0.0415)	(0.0417)	(0.0416)	(0.0485)	(0.0493)	(0.0490)
$ScienceandEngineering_{i,t-1}$	0.00477	0.00762	0.00570	−0.0206	−0.0189	−0.0214
	(0.0407)	(0.0409)	(0.0408)	(0.0425)	(0.0427)	(0.0427)
$Manufacturing_{i,t-1}$	−0.119+	−0.121+	−0.122+	0.0116	0.00734	0.00969
	(0.0638)	(0.0645)	(0.0638)	(0.0587)	(0.0596)	(0.0590)
$DataandAnalytics_{i,t-1}$	0.0326	0.0288	0.0279	−0.00737	−0.00895	−0.00789
	(0.0469)	(0.0471)	(0.0469)	(0.0574)	(0.0576)	(0.0575)
$MediaandEntertainment_{i,t-1}$	−0.0135	−0.0124	−0.0112	−0.0697	−0.0676	−0.0649
	(0.0370)	(0.0371)	(0.0369)	(0.0449)	(0.0455)	(0.0457)
$InformationTechnology_{i,t-1}$	0.0517	0.0563	0.0516	−0.0703	−0.0624	−0.0698
	(0.0505)	(0.0510)	(0.0505)	(0.0448)	(0.0464)	(0.0451)
$Software_{i,t-1}$	−0.0541+	−0.0541+	−0.0542+	−0.0616*	−0.0615*	−0.0616*
	(0.0295)	(0.0295)	(0.0294)	(0.0287)	(0.0286)	(0.0287)
$Incentives_{c,t-1}$	−0.154	−0.223	−0.160	−0.0863	−0.116	−0.0878
	(0.126)	(0.167)	(0.125)	(0.132)	(0.173)	(0.134)
$Constraints_{c,t-1}$	−0.342*	−0.277+	−0.371*	−0.254+	−0.235	−0.300+
	(0.140)	(0.161)	(0.165)	(0.132)	(0.167)	(0.155)
USA_i	0.00452	0.0109	0.00966	−0.0337	−0.0154	−0.0279
	(0.0836)	(0.0829)	(0.0832)	(0.0892)	(0.0866)	(0.0873)
$China_i$	−0.173	−0.179	−0.174	−0.0678	−0.0664	−0.0647
	(0.125)	(0.125)	(0.125)	(0.102)	(0.102)	(0.103)
UK_i	0.258+	0.265+	0.262+	−0.0614	−0.0563	−0.0641
	(0.154)	(0.155)	(0.156)	(0.144)	(0.143)	(0.145)
$Germany_i$	0.129	0.135	0.128	−0.0473	−0.0273	−0.0385
	(0.145)	(0.144)	(0.146)	(0.244)	(0.241)	(0.245)
$Japan_i$	−0.0912	−0.0737	−0.0802	0.0413	0.0554	0.0470
	(0.127)	(0.128)	(0.127)	(0.125)	(0.125)	(0.126)
$\Delta\_gdp\%$	1.880	1.844	1.981	−1.865	−1.863	−1.996
	(2.194)	(2.134)	(2.196)	(2.111)	(2.061)	(2.109)
$VC\_age_{i,t}$	−0.00190*	−0.00188*	−0.00191*	−0.000346	−0.000332	−0.000364
	(0.000882)	(0.000882)	(0.000889)	(0.00101)	(0.00100)	(0.00102)
$ln\_revenues_{i,t}$	0.0340**	0.0344**	0.0346**	−0.000135	0.00117	−0.000236
	(0.0113)	(0.0113)	(0.0114)	(0.0114)	(0.0113)	(0.0115)
$parent\_esg\_adoption_{i,t}$	−0.0356	−0.0358	−0.0351	−0.0117	−0.0128	−0.0140
	(0.0389)	(0.0387)	(0.0389)	(0.0389)	(0.0387)	(0.0393)
Did_i	−0.0224			−0.0134		
	(0.0194)			(0.0193)		
$Treat_i$	0.0661			−0.00356		
	(0.0703)			(0.0735)		
$Treat_i$ x $Incentives_{c,t-1}$		−0.0965			−0.0496	
		(0.135)			(0.146)	
Did_i x $Incentives_{c,t-1}$		−0.324+			−0.161	
		(0.172)			(0.180)	
Did_i x $Treat_i$ x $Incentives_{c,t-1}$		−0.139			−0.107	
		(0.143)			(0.155)	
$Treat_i$ x $Constraints_{c,t-1}$			−0.220			−0.256
			(0.167)			(0.168)
Did_i x $Constraints_{c,t-1}$			−0.417**			−0.304*
			(0.139)			(0.129)
Did_i x $Treat_i$ x $Constraints_{c,t-1}$			−0.256			−0.290+
			(0.158)			(0.161)
_cons	−0.435	−0.444	−0.445	0.265	0.217	0.279
	(0.302)	(0.299)	(0.301)	(0.306)	(0.304)	(0.303)
N	311	311	311	203	203	203

Standard errors in parentheses.
DID analysis using the percentage of CVC's yearly green investments (1–3) and the percentage of the funds invested in green (4–6), using CVC as independent variable.. The baseline model (1 and 4) and the interaction of incentives (2 and 5) and constraints (3 and 6).

+ $p < 0.10$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

deals. This rise supports the theoretical notion that shifts in the institutional environment, such as the Paris Agreement, can reinforce the salience of environmental objectives, reducing uncertainty and enabling investors to perceive greener markets as less risky and more profitable (Dimaggio and Powell, 1983; Porter and van der Linde, 1995). This result confirms the main analysis (Table 4), indicating that constraints strengthen the propensity of IVCs to invest in green startups, thus supporting H1c. The persistent influence of constraints in a more rigorous quasi-experimental setting underscores their role as credible signals that stimulate RO considerations by IVCs that now see green ventures as more likely to yield profitable exits under regulatory pressure (Basse-Mama et al., 2013; Hegeman and Sørheim, 2021).

Finally, it is worth noting that, as shown in Table 5, Science and Engineering stands out as significant and positive ($\beta = 0.0123$, $p < 0.1$) as well as Manufacturing ($\beta = 0.0123$, $p < 0.1$), while all other industries are significant and negative. This supports the notion that IVCs are more inclined to direct green investments toward technologically intensive industries within cleantech. This trend aligns with the idea that sectors like cleantech, that leverage advancements in materials science and energy to enhance environmental performance, tend to be more attractive as IVC green investments as compared to other technological domains like software and ICT, depending on industry-specific conditions (Dhayal et al., 2023; **Van den Bergh,** 2013**).**

The analyses on CVCs are presented in Table 6. In Model 1, our analysis reveals no significant relationship between parent company ESG adoption (*parent_esg_adoption*$_{i,t}$) and CVC green investments, suggesting that parent companies' ESG adoption does not directly drive CVC green investments. This finding aligns with previous literature indicating that ESG ratings might influence VC investment decisions in context-dependent ways rather than through a "one size fits all" approach (Amel-Zadeh and Serafeim, 2017). While CVCs generally aim to enhance their parent corporations' overall environmental performance and ESG ratings through green startup investments (Bendig et al., 2022), the impact of ESG metrics on VC investment propensity varies significantly based on corporate strategy, geographic location, and industry-specific factors.

For CVCs, Manufacturing ($\beta = -0.119$, $p < 0.1$) and Software ($\beta = -0.0541$, $p < 0.1$) stand out as significant and negative, while all other industries are non-significant.

In line with the main results (Table 4), the interaction ($Did_i \times Treat_i \times Incentives_{c,t-1}$) is significant and positive. Thus, after introducing a variable that absorbs potential endogeneity, H2b is further accepted. Moreover, the relationship with constraints is coherent with the results shown in the main analysis by the negative sign of the triple interaction in Model 3 ($Did_i \times Treat_i \times Constraints_{c,t-1}$) and the negative sign and significant interaction in Model 6. Overall, the DID analysis confirms the main findings.

5. Conclusions

5.1. Contribution to the literature

The discussion around the effectiveness of public environmental policies is gaining traction among scholars investigating the investment decisions of VCs in the green sector. Our study contributes to such discussion by offering several insights into the mechanisms of environmental policy influence on VCs' green investment decisions.

A key contribution of our study is to propose a novel classification of environmental policies as "incentives" or "constraints" that do not rely on purely economic or administrative distinctions. Existing classifications often focus on whether policies are market-based or non-market-based (Botta and Koźluk, 2014), and previous studies all emphasize that the success of these policies depends on their integration and adaptation to industry-specific conditions and timing (Van den Bergh, 2013; Faber and Frenken, 2009; Norberg-Bohm, 2000). In contrast, our approach is grounded in NIT, framing policy tools as mechanisms that impose varying degrees of normative or coercive pressure. This conceptual shift from economy-based to theory-based categorization helps illuminate why specific policies resonate differently with investor types. By adopting this theory-oriented viewpoint, we better capture the institutional and strategic dimensions shaping VCs' responses to environmental policies, thereby contributing a more versatile and explanatory framework for understanding policy effectiveness in advancing sustainable innovation.

The contribution of this paper to the literature is threefold. First, it contributes to the literature about the propensity of different VC types to invest in green startups. While previous research has focused on the impact of environmental policies on IVCs or GVCs (Bianchini and Croce, 2022; Cojoianu et al., 2020; Cumming and Johan, 2009), our study is among the first to test how such measures influence the behavior of CVCs systematically. Specifically, our results demonstrate how environmental policy constraints increase pollution control and compliance costs for companies, leading to a crowding-out effect by reducing investments in productive activities, innovative projects, and effective organizational management to meet the environmental requirements (Gray and Shadbegian, 2003). Additionally, incentive policies align the corporations' OI strategic objectives, so fostering their funding toward green technologies aimed at addressing sustainable goals (Mrkajik et al., 2017; Lin, 2022).

Second, we complement the knowledge about the reaction of such VC types within their peculiarity to environmental policies and reveal how the effectiveness of such interventions hinges on the investor's distinct investment objectives. This integrated perspective enables a richer theoretical understanding of how different institutional pressures intersect with distinct investment logic rooted in RO theory and OI literature. Our findings show that for risk-averse investors (such as IVCs) whose decision-making aligns closely with RO logic (Folta and Miller, 2002), constraining policies that exert coercive pressure effectively reduce uncertainty, clarify market conditions, and thus prompt them to invest more confidently in green startups. In contrast, voluntary, incentivizing measures fail to generate the same confidence boost, underscoring that not all policy measures equally mitigate perceived risk for such financially driven, uncertainty-sensitive investors. On the other hand, for strategic, innovation-seeking investors (like CVCs) who pursue strategic objectives rather than purely financial returns (Weiblen and Chesbrough, 2015; Wadhwa and Basu, 2013; Gutmann et al., 2023), institutional pressures produce opposite responses. Coercive constraints dampen their propensity to invest in green startups, presumably by imposing compliance pressures channeling corporate attention inward rather than toward external ventures. On the other hand, incentives boost CVCs' propensity to fund green startups, suggesting that such market signals align their OI goals with environmental priorities.

In sum, these insights show how mandatory policies such as government constraints can successfully reduce uncertainty for investors who are more focused on financial gains while refraining from other OI-driven investors. Our study clarifies how institutional pressures must be strategically tailored by contrasting the effective "uncertainty reduction" role of constraints for IVCs with their counterproductive effect on CVCs. In doing so, we offer a more robust theoretical lens to prior literature about environmental policy influence on VCs' investments (Bianchini and Croce, 2022; Bürer and Wüstenhagen, 2009; Cojoianu et al., 2020). Conversely, incentivizing policies boost the mobilization of green finance for innovation-seeking investors and hinder the green funding propensity of investors exclusively focused on maximizing their financial gains. This demonstrates that investor heterogeneity and their underlying investment logic fundamentally shape environmental policies' capacity to mobilize funding toward green startups.

5.2. Implications for policymakers and practitioners

Our study shows that CVC investors are more interested in internalizing incentives and constraints because of their immediate compliance pressure, so they do not perceive such policies as pushing their open innovation objectives and leveraging their isomorphism needs. Thus, for policymakers, the study underscores the importance of tailored environmental policies reflecting different VC types' distinct motivations.

Policymakers need to address the crowding-out effect from CVCs. In asset-intensive sectors such as manufacturing, CVCs may prioritize internal compliance measures, such as investing heavily in energy-efficient machinery or upgrading production lines to meet stricter emission standards. These internal efforts often consume significant financial resources, leaving less capital available for supporting external green strategic innovations. This shift away from external investments in startups working on green technologies can undermine broader corporate long-term green strategy through OI and compromise the desired effect of constraining policies. To create a balanced and effective policy framework addressing such challenges, CVC face governments could complement existing constraints with specific incentives that help them meet the emission requirement. On the constraint side, companies with higher emissions could face a more gradual increase in taxes, allowing them more time to adjust without facing severe financial strain. This would ensure that companies still work toward reducing emissions but without the immediate financial burden of steep tax hikes. On the incentive side, the government could offer exemptions or lower tax rates for emissions resulting from specific green technologies, such as renewable energy adoption or energy-efficient production processes. This would ease the financial pressure of compliance and enable CVCs to allocate more capital toward strategic green innovations, complementing their internal efforts. Moreover, policymakers could provide tax breaks or adjusted ELVs specifically for CVCs that invest in startups focused on greening technologies. This approach ensures that CVCs are both encouraged to support external innovations and can balance the costs of meeting regulatory requirements with their investments in green solutions. From the incentives side, to avoid CVCs' rent-seeking behavior, incentives in the form of R&D could be bestowed only under the promise to invest them specifically in green startups. This would ensure that funds are directed toward fostering green innovation rather than being used for other, non-environmentally related purposes. To further align incentives with CVCs' needs, policymakers could also design targeted incentives that appeal directly to corporate objectives. For example, policies could offer innovation grants for green startup collaborations, contributing to the corporation's broader sustainability strategy. Finally, regulatory frameworks could reward corporations for demonstrating measurable progress in external green investments, encouraging CVCs to integrate them into compliance priorities.

Moreover, to increase the effectiveness of incentives for IVCs, policies that incentivize green startup acquisitions by corporates could decrease the financial risk perceived by them; for example, new policies that could favor Open Innovation and Acquisition objectives for corporations provide VCs with more likely successful exits.

Our study also has some important implications for professional investors. The findings suggest strategically leveraging government incentives to mitigate financial risks for VC investors. IVCs should align their investments with incentives to capitalize on reduced uncertainties while increasing the odds of successful market placement by, for example, targeting startups that are in the wind or energy sector, so are subject to the price and quantity support, or investing in CO2 offsetting companies, in a way to capitalize on the Trading Schemes, ultimately increasing the odds of financial performance of their startups and decreasing the investment risk. VCs, instead, need to manage normative and coercive pressures effectively (Greenwood and Suddaby, 2006; Dimaggio and Powell, 1983). Managers of CVCs should collaborate with the parent corporation's managers to develop strategies that balance internal compliance requirements with opportunities for technological integration and strategic positioning in the green market to enhance their ability to respond to regulatory demands and market trends (Porter and van der Linde, 1995).

Our study also has implications for green entrepreneurs, particularly in navigating the complex landscape of constraining and incentivizing environmental policies. For entrepreneurs targeting risk-averse investors like IVCs, who respond positively to coercive policies that reduce uncertainty, it is crucial to position their ventures as compliant with regulatory standards and capable of thriving within clarified market conditions. This alignment can attract IVC investments by leveraging the stabilizing effects of such policies. On the other hand, green entrepreneurs seeking funding from CVCs face a different challenge. Since CVCs are less responsive to external incentives and negatively affected by coercive policies that shift their focus inward, green entrepreneurs cannot frame their ventures in ways that align with the corporation's internal strategic objectives. This alignment can attract CVC investments by counterbalancing the crowding-out effects of policy constraints or enhancing the impact of policy incentives.

5.3. Limitations and further research avenues

This study presents limitations that offer future research opportunities.

This study disregards exploring policy spillovers across regions. Previous research investigating the impact of policy spillovers suggests how the effects on VC investments vary with institutional proximity (Li and Weng, 2023). Particularly, VCs in neighboring regions with strong ties with the policy-issuing country benefit more from the effects of policy spillovers. For example, environmental constraints applied in one region create a spillover effect in VC investments through global value chains in neighboring regions (Herman and Xiang, 2019, 2022). These constraints limit neighboring regions' VC investments in green startups as subsidiaries prioritize compliance, while other VCs benefit from reduced uncertainty, making regulatory-aligned startups more attractive. Other studies also highlight how incentivizing policies like R&D subsidies might push some VCs, such as CVCs, to transmit green technology across regions by integrating investments in green startups into global strategies (Dechezleprêtre and Glachant, 2014; Li et al., 2024). Therefore, future research could analyze the influence of policy incentives and constraints on different VCs by considering the effect of policy spillovers beyond the domestic policy issued in the headquarter region of the VCs.

Moreover, by considering the countries of VCs' headquarters and overlooking the headquarters country of the startup, our research approach may introduce bias, particularly when the investment activity spans regions with distinct environmental policies, such as Europe and the US, overlooking the role of policy spillover influence across countries. Addressing this limitation through further primary data-based research exploring the specific influence of environmental policies on VCs' green investment across countries will enhance the understanding of policy influence on international mobilizing VC investments in green startups.

The study also presents a limitation in its reliance on AI-assisted green industries classification and expert validation. While the methodology used has been further validated by cross-referencing the green industries with those identified by the EU taxonomy for sustainable activities, future studies can provide a more structured method by, for example, leveraging supervised machine learning or thematic coding to further enhance rigor.

In addition, our study accounts for the influence of VCs' previous investment experience in different sectors on their green investments. However, it disregards how the influence of public environmental policies shapes VC behavior through an interaction with the emergence of green technology. Further studies might explore how the influence of public environmental policies might be contingent upon the advent of such transformative technologies (e.g., hydrogen energy, carbon capture).

Another potential limitation of this study lies in its overlooking of the temporal shifts in policy effectiveness. While some authors highlight how environmental policy can produce smaller short-term than long-term effects (Li and Weng, 2023), others observed that the impact of interventions like FIT may diminish over time (Romano et al., 2017). Future studies could address this question and incorporate a temporal analysis to better understand how policy impacts evolve over time.

Furthermore, our study focused solely on static OECD-selected policies. Future research could explore how the pressures created by policy incentives and constraints interact with uncertainty. For example, investigating the effects of policy uncertainty, as noted by Bretschger and Soretz (2022), could shed light on why such policies fail to generate the desired pressure to drive IVC and CVC investments in green startups. Clarifying how policy uncertainty influences these pressures could help design more effective environmental policies to align with investor priorities. For instance, qualitative research could offer deeper insights into VCs' decision-making processes, which are beyond the scope of econometric analysis. For example, conjoint experiments might explore how VC investors perceive investment opportunities under uncertain constraining and incentivizing institutional pressures to provide nuanced insights into how these pressures influence their investment decision-making.

Finally, a limitation of this study is the assumption of clear distinctions among IVCs, CVCs, and GVCs. In practice, these categories may overlap, with some investors adopting hybrid models that combine characteristics of multiple types. This overlap could influence the results, as the behaviors and motivations of such investors may not fully align with those of traditional IVCs, CVCs, or GVCs. Future research could explore these hybrid models to provide a more nuanced understanding of how overlapping characteristics impact investment decisions in green startups.

CRediT authorship contribution statement

Eleonora Rizzitello: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Mariangela Piazza:** Writing – original draft, Investigation, Conceptualization. **Giovanni Perrone:** Writing – original draft, Validation, Supervision, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

AI-assisted technology has not been involved in this work except for using essential tools to check grammar and spelling and the methodological assistance described in section 4.2.

Declaration of competing interest

We hereby declare that that there is no financial or personal interest or belief that could affect our objectivity.

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Appendix A. – green startups industries

Advanced Materials, AgTech, Air Transportation, Aquaculture, Battery, Biofuel, Biomass Energy, Building Maintenance, Car Sharing, Clean Energy, CleanTech, Collaborative Consumption, Consumer, Lending, Cycling, Electric Vehicle, Electrical Distribution, Energy, Space, Travel, Transportation, Energy Efficiency, Energy Management, Energy Storage, Environmental Consulting, Environmental Engineering, Farming, Fleet Management, Forestry, Fuel Cell, Green Building, Green Consumer Goods, GreenTech, Hydroponics, Innovation Management, Marine Technology, Natural Resources, Nuclear, Organic, Organic Food, Pollution Control, Power Grid, Public Transportation, Railroad, Recycling, Renewable Energy, Ride Sharing, Sensor, Sharing Economy, Smart Building, Smart Cities, Smart Home, Solar, Sustainability, Timber, Waste Management, Water, Water Purification, Water Transportation, Wind Energy, Wood Processing.

Appendix B. – descriptive statistics

Table 2
- Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
IVC	34,730	0.9190901	0.2727006	0.0	1.0
CVC	34,730	0.0463576	0.2102614	0.0	1.0
GVC	34,730	0.0345523	0.1826455	0.0	1.0
ID	34,730	1737.0	1002.583	1.0	3473.0
year	34,730	2014.5	2.872323	2010.0	2019.0
$VC\_age_{i,t}$	34,500	16.25481	31.14834	0.0	204.0
OECD	34,680	0.6822376	0.4656133	0	1
USA_i	34,680	0.3088235	0.4620148	0.0	1.0
$China_i$	34,680	0.1903114	0.3925525	0.0	1.0
UK_i	34,680	0.0657439	0.2478375	0.0	1.0
$Germany_i$	34,680	0.0389273	0.1934246	0.0	1.0
$Japan_i$	34,680	0.0357555	0.1856826	0.0	1.0
$ln\_revenues_{i,t}$	929	24.17811	3.186343	11.21183	33.12725
$parent\_esg\_adoption_{i,t}$	1330	0.7120301	0.4529873	0.0	1.0
Δ_gdp%	34,730	0.0198577	0.0050105	0.0145151	0.0326548
$ln\_Num\_investments_{i,t-1}$	34,730	0.4826183	0.6814194	0.0	6.977281
%Num _green_ investments	15,355	0.1368916	0.2938083	0.0	1.0
%Fund _green_ investments	10,577	0.1338278	0.3270017	0.0	1.0
$InternetServices_{i,t-1}$	34,730	0.0961089	0.2556715	0.0	1.0
$Hardware_{i,t-1}$	34,730	0.0618307	0.20896	0.0	1.0

(continued on next page)

Table 2 (*continued*)

Variable	Obs	Mean	Std. Dev.	Min	Max
$ScienceandEngineering_{i,t-1}$	34,730	0.0594681	0.2097473	0.0	1.0
$Manufacturing_{i,t-1}$	34,730	0.0314766	0.1530341	0.0	1.0
$DataandAnalytics_{i,t-1}$	34,730	0.0527541	0.1915791	0.0	1.0
$Mobile_{i,t-1}$	34,730	1.58e-05	0.0013178	0.0	125
$Software_{i, t-1}$	34,730	0.1658927	0.3316733	0.0	1.0
$HealthCare_{i,t-1}$	34,730	0.0675463	0.2237414	0.0	1.0
$FinancialServices_{i,t-1}$	34,730	0.0442342	0.181027	0.0	1.0
$MediaandEntertainment_{i,t-1}$	34,730	0.068832	0.219345	0.0	1.0
$InformationTechnology_{i,t-1}$	34,730	0.0796851	0.2343786	0.0	1.0
$CommerceandShopping_{i,t-1}$	34,730	0.0629047	0.2093168	0.0	1.0
$Incentives_{c,t-1}$	31,040	0.338687	0.1365142	0.0	0.6666667
$Constraints_{c,t-1}$	31,040	0.4856616	0.1483352	0.0	0.9125

Data availability

Data will be made available on request.
VC green investments 2010-2019 (Original data) (Mendeley Data)

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