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Do venture capital investments contribute to the achievement of the sustainable development goals?

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Abstract

Achieving the goals of the 2030 agenda for sustainable development requires substantial investment and depends on the ability to attract private capital to complement public resources. Venture Capital (VC) investments have traditionally focused on sectors such as technology, healthcare, and clean energy, which align closely with the enhancement of sustainable development, and VC investors can accelerate progress toward sustainability by providing expertise and mentorship to startups working on sustainable solutions. This study aims to contribute to the literature on the intersection between finance and sustainability by investigating whether higher VC investments are associated with a higher level of achievement of the Sustainable Development Goals (SDGs). Using a panel data fixed effect model on a sample covering more than 100 countries, we find that a higher level of VC activity is associated with stronger SDGs' performances, with this effect being primarily driven by economic factors. We document heterogeneous effects related to the round of investments as well as the organizational form of VC investors and the industry and country of the VC-backed companies.

KEYWORDS
investments, sustainability, Sustainable Development Goals, sustainable finance, venture capital

1 | INTRODUCTION

The Sustainable Development Goals (SDGs), as outlined in the United Nations' 2030 agenda for sustainable development, provide a global framework for addressing social, economic, and environmental challenges. The SDGs encompass 17 goals, covering a wide range of areas including poverty eradication, gender equality, climate action, and sustainable economic growth. Achieving these goals necessitates collaborative efforts from various stakeholders, including governments, civil society, and the private sector.

Research supports the notion that businesses have a significant role to play in advancing the SDGs (Mio et al., 2020; Sullivan et al., 2018). Scholars emphasize that businesses can align their reporting practices with the SDGs by disclosing sustainability-related information and addressing specific goals in their reports (Calabrese et al., 2021). Such efforts contribute to sustainability and demonstrate a higher commitment to sustainable frameworks (Rosati & Faria, 2019). Businesses are urged to adopt a holistic approach to sustainability by integrating the SDGs into their strategies and practices (Scheyvens et al., 2016). Businesses can foster the SDGs through sustainable entrepreneurship and impact investing, aligning their

Abbreviations: CVC, Corporate Venture Capital; ESG, Environmental, Social, and Governance; FDIs, Foreign Direct Investments; GHG, Green House Gas; IVC, Independent Venture Capital; PPP, Private-Public Partnership; SDG, Sustainable Development Goal; VC, Venture Capital.

activities and investments with the goals, for instance, by focusing on innovation and technological advancements (Yin, 2019), responsible consumption and production by adopting sustainable practices and reducing waste (Silva & Figueiredo, 2020), or actively reducing greenhouse gas (GHG) emissions and investing in renewable energy sources (Scheyvens et al., 2016).

Within this framework, finance plays a critical role in achieving the SDGs by providing the necessary capital for sustainable development projects and initiatives (Ziolo et al., 2021). There is a recognized gap in the financial resources required to achieve the SDGs (Barua, 2020; Gambetta et al., 2021; Griffiths, 2018; Lucci, 2015). Previous research has explored various aspects of the relationship between finance and the SDGs. Studies have examined the interplay between public and private financing to bridge the financial gaps associated with the SDGs (Schmidt-Traub & Sachs, 2015). The role of the banking sector in sustaining renewable energy growth has been investigated, highlighting the positive impact of adopting renewable energy on corporate profitability and loan repayment capability (Choudhury et al., 2023). Other innovative financial instruments leveraging blockchain technology are found to be positive contributors to environmental SDGs (Parmentola et al., 2022), especially via the supply chain (Calandra et al., 2023; Govindan, 2022; Sislian & Jaegler, 2022). Moreover, several institutional investors are increasingly interested in how businesses integrate their corporate social responsibility objectives with the SDGs (García-Sánchez et al., 2022). Furthermore, research has explored the role of Foreign Direct Investments (FDIs) in sustainable development, noting the potential for FDI to contribute to SDG targets (Aust et al., 2020). However, there is a research gap regarding the specific influence of Venture Capital (VC) investments on the achievement of the SDGs. This study aimed to address this gap by examining whether VC activity is associated with higher levels of sustainable development across economic, environmental, and social dimensions.

In fact, VC is potentially a valuable tool for financially supporting innovative and younger companies that contribute to various areas of the SDGs. VC investors have the potential to impact the economy, environment, and society (Bocken, 2015). By focusing on the growth of VC-backed companies in terms of revenue, employment, and profitability, VC investors directly contribute to economic growth at a macro level (Bellucci et al., 2021; Samila & Sorenson, 2011). Furthermore, through the selection of innovative firms, VC investors facilitate the diffusion of new technologies, generating positive spillovers in the economic systems they operate in (Bertoni & Tykvová, 2015; Kortum & Lerner, 2001) as well as in green sectors (Mrkajic et al., 2019). Venture Capitalists possess organizational capacity, allowing them to swiftly adjust their behavior in response to external shocks, reallocating resources to projects that become more relevant and profitable (Bellucci et al., 2023a). This adaptability enables VC investors to drive and even anticipate significant trends, such as social and environmental sustainability (Croce et al., 2021; Popescu et al., 2021; Randjelovic et al., 2003). Moreover, recent literature has documented the positive relationship between VC investments and sustainability, including the role of VC in green investments (Bürer & Wüstenhagen, 2009; Dong et al., 2021), the development of sustainable technological innovations (Bellucci et al., 2023b; Gaddy et al., 2017; Migendt et al., 2017), and the potential contributions policymakers can make to enhance sustainability (Criscuolo & Menon, 2015; Polzin & Sanders, 2020; Wu et al., 2020).

In the current study, we tackle this topic by examining the role of VC in the achievement of SDGs at the worldwide level. We first construct an original dataset obtained by matching information on SDGs for 132 countries and 7 years (2015–2021) with information on VC diffusion (e.g., invested volumes and number of transactions) in the same sample. Using the panel structure of the database, we conduct econometric analyses to investigate the relationship between VC activity and the achievement of SDGs and how this relationship varies among the 17 underlying goals and across different groups of countries and sectors.

Our baseline results highlight a positive association between the level of VC-invested amounts and the SDG Index Score, which measures how close countries are to achieving all of the SDGs. These findings underscore the potential of VC investments to foster sustainable development across countries. Moreover, we find that this positive relationship is mainly driven by the economic pillar of sustainable development, as VCs promote growth by investing in startups, and this growth in turn primarily affects the economic development of those countries by creating jobs and generating wealth. We obtain similar results when we aggregate the 17 individual indicators according to different classifications based on the ESG and the Doughnut Economics narratives. When we explore the most granular level of analysis, that is, the 17 goals underlying the SDG Index, we find that VC activity is never detrimental to the achievement of the individual goals. Instead, VC investments are correlated with a limited number of goals, primarily in the economic and governance areas.

To gain insights into the mechanisms underlying the positive relationship between VC activity and SDG attainment, we explore several heterogeneous effects at the level of VC-backed companies, VC investors, and VC transactions. Recognizing the crucial role of the VC-backed company's industry, we investigate the differential contribution of VC investments across selected sectors based on their *ex ante* interaction with the SDGs (positive, neutral, or negative) or their average polluting attitude. Additionally, we explore the relationship between VC investments and the SDGs based on the organizational characteristics of VC investors (i.e., independent [IVCs] vs. corporate VCs [CVCs]) and the round of investment (i.e., early vs. late stages). Finally, we examine the role of countries' economic development in driving SDG and VC activity evolution. Our findings indicate that VC activity is associated with higher levels of the SDG Index, particularly for deals completed by IVCs, in less-polluting industries, and for startups based in countries with more advanced economies.

These findings offer valuable insights for policymakers, highlighting the necessity to support existing positive relationships between VC and SDGs while incentivizing establishment in areas where it is lacking, particularly in developing countries. Additionally, policymakers might address the limited effect of VC on environmental sustainability by reducing investment risk in green startups and fostering

collaborations between VC investors and other stakeholders to maximize SDG impact.

Overall, this study contributes to the debate on whether and to what extent financial players can contribute toward achieving more sustainable development by supporting companies in their early stages. Our empirical evidence contributes to the ongoing dialogue on the role of VC investments in sustainable development, providing guidance for policymakers, investors, and stakeholders committed to creating a more sustainable future.

The rest of the study is structured as follows. Section 2 presents the institutional setting by documenting the role of the private sector and the financial sector in the achievement of the SDGs. Section 3 describes the dataset and empirical strategy. Section 4 presents the main results, while Section 5 explores underlying channels and mechanisms by investigating heterogeneous effects. Section 6 offers robustness tests. Finally, Section 7 concludes and provides some policy implications.

2 | INSTITUTIONAL SETTING AND RESEARCH HYPOTHESIS

2.1 | SDGs and the role of the private sector

The SDGs were adopted by the United Nations in 2015 as a comprehensive action plan to tackle social, economic, and environmental challenges, with 193 member countries committing to achieve these goals by 2030 (Gupta & Vegelin, 2016; UN, 2015). The agenda contains 17 SDGs (see Table 1), encompassing 169 targets and over 200 indicators, aiming to eradicate poverty and hunger, reduce inequalities, promote peace and justice, and ensure environmental sustainability (UN, 2015, p. 4). Although distinct, each goal should be considered according to an integrated approach (van Zanten & van Tulder, 2021a); that is, progress on one objective should support or balance progress on another. The SDGs can be divided into different broader intertwined areas (Jayasooria, 2016): people (SDGs 1–5), prosperity (SDGs 6–12), planet (SDGs 13–15), peace (SDG 16), and partnership (SDG 17). Additionally, SDGs can be grouped into three key pillars: economy, society, and environment, with good governance as an overarching structure (Murphy et al., 2021).

The SDGs build on the concept of sustainable development first introduced in the Brundtland report (WCED, 1987) and extend the action of the Millennium Development Goals by adopting a holistic and integrated approach where the importance of addressing inequality, environmental sustainability, and economic growth simultaneously is emphasized (Ruhil, 2015). Given its multifaceted nature, implementing the SDGs is complex and requires global, national, and local efforts, along with effective governance and monitoring mechanisms (Caiado et al., 2018). Together with public authorities and policymakers, the private sector is recognized as crucial—especially larger firms—in achieving the SDGs (UN, 2015).

Research supports the significant role businesses can play in advancing the SDGs (Mio et al., 2020; Sullivan et al., 2018), even during crises (García-Sánchez & García-Sánchez, 2020). Aligning

TABLE 1 Sustainable development goals.

Pillar	#	SDG	Short description
Social	1	No poverty	Eradicate extreme poverty for all people everywhere by 2030
	2	Zero hunger	Create a world free of hunger by 2030
	3	Good health and well-being	Ensure healthy lives and promote well-being at all ages
	4	Quality education	Provide quality education for all to create a peaceful and prosperous world
	5	Gender equality	Promote laws, policies, budgets, and institutions to advance gender equality
	6	Clean water and sanitation	Reach universal access to drinking water, sanitation and hygiene by 2030
Economic	7	Affordable and clean energy	Ensure access to clean and affordable energy
	8	Decent work and economic growth	Promote inclusive and sustainable economic growth, employment and decent work for all
	9	Industry, innovation and infrastructure	Build resilient infrastructure, promote sustainable industrialization and foster innovation
	10	Reduced inequalities	Reduce inequalities and ensure no one is left behind
	11	Sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient and sustainable
	12	Responsible consumption and production	Ensure sustainable consumption and production patterns
Environmental	13	Climate action	Take urgent action to combat climate change and its impacts
	14	Life below water	Conserve and sustainably use the oceans, seas and marine resources
	15	Life on land	Sustainably manage forests, combat desertification, land degradation, and biodiversity loss
Governance	16	Peace, justice and strong institutions	Promote just, peaceful and inclusive societies
	17	Partnership for the Goals	Revitalize the global partnership for sustainable development

Source: Author's elaborations from UN-SDGs website (https://www.un.org/sustainabledevelopment/education/).

corporate reporting with the SDGs is emphasized as a tool to contribute to sustainability (Calabrese et al., 2021), with early adopters of ESG reporting found to be often more committed to sustainability (Rosati & Faria, 2019). Companies are encouraged to integrate the SDGs into their strategies (Scheyvens et al., 2016), foster sustainable entrepreneurship, and invest in impact-driven activities (Yin, 2019). This is supported by the concept that companies can act as drivers of innovation and technological advancements, for instance, by contributing to SDG 9 on industry, innovation, and infrastructure and to SDG 11 on the development of sustainable cities and communities. The concept of responsible consumption and production (SDG 12) is another area where businesses can make a significant impact. By adopting sustainable production practices, promoting responsible consumption, and reducing waste, firms can contribute to SDG 12. This is emphasized by the research of Silva and Figueiredo (2020), who provide guidance for small- and medium-sized enterprises on integrating sustainability into their operations, especially when dealing with their supply chain. The contribution of proper management of the firm's supply chain to the pursuit of sustainability goals is also widely studied (Agrawal et al., 2022) and suggests that cooperation and integration among the different chain players also generate sustainability benefits (Kayikci et al., 2022; Nayal et al., 2022; Wong et al., 2018).

The role of businesses in fostering SDGs 13 and 14 on climate action is also crucial. By actively addressing climate change and reducing GHG emissions, companies contribute to these goals. The research supports this, highlighting the importance of companies setting emission reduction targets, implementing energy-efficient practices, and investing in renewable energy sources to mitigate climate change impacts. This aligns with the study by Scheyvens et al. (2016), who stress the need for companies to go beyond "business as usual" and adopt transformative and innovative practices to address climate change. Finally, partnerships and collaborations (SDG 17) are vital for achieving the SDGs, leveraging the strengths of the public and private sectors (Kolk & Lenfant, 2018).

However, while companies can play a crucial role in fostering the achievement of the SDGs, potential critiques and limitations are also associated with their contributions (Ensign, 2022; Sachs, 2012; Spangenberg, 2017). Critiques include greenwashing, when companies may superficially commit to sustainability without substantial change (Lashitew, 2021; Silva, 2021), and the challenge of balancing profit with sustainability objectives (Haldar, 2019). Effective multistakeholder collaboration is essential, as businesses alone cannot address all sustainability challenges (Kolk & Lenfant, 2018). Tailored approaches are required for smaller enterprises to enhance their contributions to the SDGs (Kolk et al., 2017; Smith et al., 2022).

Overall, while companies have the potential to foster the SDGs, they may face several limitations. To ensure genuine progress, companies should demonstrate transparency in their sustainability reporting, navigate the challenges of balancing profit and sustainability, recognize the need for multistakeholder collaboration, and consider the specific needs and capabilities of different types of businesses. By addressing these limitations, companies can enhance their contributions to the SDGs and drive meaningful change toward a sustainable future.

2.2 | Finance for sustainability and the SDGs

Finance plays a crucial role in achieving the SDGs by providing the necessary capital to fund sustainable development projects and initiatives (Ziolo et al., 2021). First, finance is required to invest in projects that align with the SDGs, such as renewable energy infrastructure, sustainable agriculture, clean water and sanitation systems, affordable housing, and social enterprises. In this respect, some studies highlight a gap in the financial resources required to achieve the SDGs (Barua, 2020; Gambetta et al., 2021; Griffiths, 2018; Lucci, 2015).

While a few studies have focused on the granular quantification of financial needs by goal (e.g., Kedir et al., 2017; Schwerhoff & Sy, 2017) or geographical area (e.g., Lee, 2020; Li et al., 2023), a growing body of literature is examining whether and to what extent different sources of public and private funding could provide a significant contribution to the achievement of the SDGs. Along these lines, Schmidt-Traub and Sachs (2015) examine the interplay between public and private financing to close SDG-related financial gaps. Choudhury et al. (2023) investigated whether the banking sector can sustain the growth in renewable energy supply, a relevant indicator underlying the SDGs, finding that the adoption of renewable energy improves corporate profitability and consequently loan repayment capability. Parmentola et al. (2022) explored the role of blockchain technologies as a potential driver of the achievement of the SDGs and documented a positive contribution. Research in the contiguous field shows that the channel through which blockchain technologies positively affect SDGs is companies' supply chains (Calandra et al., 2023; Govindan, 2022; Sislian & Jaegler, 2022). Aust et al. (2020) looked at the contribution that FDIs can provide to the achievement of the SDGs in Africa, documenting their positive support. Zaman (2023) estimates new future needs for financial flows to fund all the SDGs (e.g., public expenditure, PPPs, and FDIs) following the COVID-19 shock. García-Sánchez et al. (2022) investigated the role of institutional investors on the level of companies' transparency on SDG-related issues, finding that the positive contribution is driven by foreign investors and pension funds rather than government and financial institutions, which do not show any material impact on the SDG-related information systems. Overall, several studies investigated the relationship between finance and SDGs from different perspectives (Ziolo et al., 2021), following a micro (Gambetta et al., 2021) or macro approach (Kharas et al., 2014).

Potentially, VC is also a substantially valuable tool for financially supporting younger and innovative companies with investment initiatives that have an impact on various areas of the SDGs. In fact, VC investors can, in principle, contribute to each of the key areas of sustainable development: the economy, environment, and society. Venture Capitalists mainly aim at making VC-backed companies grow in terms of revenues, employment, and profitability (Bellucci et al., 2021). In doing so, VC activity not only has a direct impact on the VC-backed companies but also contributes indirectly to the economic growth and development of the areas in which these companies operate, for example, through the creation of new

jobs and the generation of wealth (Samila & Sorenson, 2011). In addition, through the selection of the most innovative firms, VC investors are often agents of the diffusion of new technologies, thus generating relevant positive spillovers in the economic systems in which they operate (Bertoni & Tykvová, 2015; Kortum & Lerner, 2001).

Concurrently, thanks to their organizational capacity, VC investors are able to immediately adjust their behavior to unexpected external shocks by abruptly reallocating their resources to projects that have become more relevant and profitable (Bellucci et al., 2023a). This allows them to drive—and in some cases, even anticipate—the most relevant "mega-trends," such as social (see, e.g., Croce et al. (2021) and Popescu et al. (2021)) and environmental sustainability (see, for instance, Bocken (2015), Croce and Bianchini (2022), and Randjelovic et al. (2003)). With concern for this last aspect, recent VC literature has focused on several strands of research (Dhayal et al., 2023), from the role of VC in green investments (e.g., Bürer & Wüstenhagen, 2009; Cappellari & Gucciardi, 2024; Dong et al., 2021) to the development of sustainable technological innovations, also known as "Cleantech" (e.g., Gaddy et al., 2017; Migendt et al., 2017), to the possible contributions that policymakers can make toward further enhancing sustainability (e.g., Criscuolo & Menon, 2015; Polzin & Sanders, 2020; Wu et al., 2020).

In addition to investments in the social and environmental domains that maintain financial returns as their primary objective, impact investors, that is, investors who have a dual objective in terms of social and environmental returns and financial returns, are gaining attention (Agrawal & Hockerts, 2021; Paetzold et al., 2022). A recent strand of analysis focusing on impact investing in the VC market indicates that investors in impact VC funds accept a reduction in financial returns to gain nonpecuniary utility from social or environmental impact investments (Barber et al., 2021), potentially generating a trade-off between the contribution such investments can make to the SDGs in the economic, environmental, and social domains.

2.3 | Research question and hypothesis

To the best of our knowledge, no studies have yet directly examined the relationship between VC investments and the SDGs. This study seeks to fill this gap, aiming to look at the concept of sustainability holistically (Ranjbari et al., 2021) while providing evidence on each of the 17 dimensions within the economic, environmental, social, and governance themes. Hence, we want to answer the question of whether VC investments are positively associated with the achievement of the overall SDGs and how this relationship varies among the different underlying dimensions.

Based on this literature gap, we propose the following hypothesis to be tested:

> **H.** All else being equal, VC activity is positively associated with a greater enhancement of the SDGs.

In addition to this main hypothesis, we also investigate the heterogeneity of the main findings based on the different characteristics on the VC and SDG sides. On the one hand, we aim to test whether results change based on the characteristics of the VC-backed companies (e.g., industry), VC investments (e.g., in terms of round), and VC investors (e.g., in terms of organizational form). This is motivated by the fact that the VC activity might have distinct goals and objectives based on the stage of investment (e.g., Randjelovic et al., 2003; Tian, 2011), whether it is done by an IVC or a CVC (e.g., Ma, 2020), and other relevant characteristics. On the other hand, we aim to see whether the contribution, if any, is limited to the economic component of the SDGs, as the relationship between VC and economic growth has been extensively shown, or if it applies also to the environmental, social, and governance aspects.

3 | DATA AND EMPIRICAL APPROACH

3.1 | Data source and sample construction

To investigate the relationship between the SDGs and VC investments, we built an original dataset matching information on VC investments, SDGs, and a set of socio-economic indicators from 2015 to 2021 at the worldwide level.

We first collect from Zephyr, a Bureau van Dijk database, all VC deals taking place during this period in the available 132 countries at the worldwide level. Together with details on the deal (e.g., date, round, invested amounts, and description of the underlying financed project or investment), Zephyr includes information on VC-backed companies and VC investors (e.g., denomination, industry, country of origin, and incorporation date).[1]

Regarding the SDGs, we retrieved data from the "Online database for the Sustainable Development Report 2022" (Sachs et al., 2022). This publicly available database includes information, for the same sample period and at the country-year level, about both the overall SDG Index Score and each of the 17 underlying SDGs. Specifically, the SDG Index Score is an indicator that ranges from 0 to 100, where a score of 100 indicates that all the SDGs have been achieved and can be used to proxy the level of achievement of sustainable development (by country and year). In turn, the SDG Index Score is obtained as the

[1]BvD Zephyr has been adopted as a reliable database on equity investments, and particularly on VC, in various studies in the fields of finance, entrepreneurship, and innovation (e.g., Bellucci et al., 2023a; Berger & Hottenrott, 2021; Bertoni et al., 2015; Schertler & Tykvová, 2011). Figure A1 in the Appendix illustrates Zephyr's volume of VC investments. These figures exhibit trends and magnitudes similar to those of other common providers such as Pitchbook (https://kpmg.com/xx/en/home/campaigns/2022/01/q4-venture-pulse-report-global.html), CB Insights (https://www.cbinsights.com/research/report/venture-trends-2021/), Refinitiv Eikon (https://www.wipo.int/global_innovation_index/en/gii-insights-blog/2022/venture-capital.html), and Capital IQ (https://www.spglobal.com/marketintelligence/en/news-insights/blog/the-private-equity-and-venture-capital-deal-landscape-q3-2023). Zephyr data are also considered representative for companies outside the US or Europe (Tykvová, 2018) and has been used in empirical analyses with an international scope (e.g., Beuselinck et al., 2009; Michaely & Roberts, 2012).

TABLE 2 Summary statistics.

Variables	Mean	Standard deviation	Min	Max
SDG index score	68.200	9.778	38.449	86.477
SDG 1	77.578	31.016	0.000	100.000
SDG 2	60.675	10.164	22.713	83.051
SDG 3	72.032	19.951	18.872	97.250
SDG 4	78.764	22.333	0.001	99.926
SDG 5	62.422	16.124	6.970	91.850
SDG 6	69.410	14.426	34.039	95.058
SDG 7	66.984	16.992	6.224	99.555
SDG 8	69.176	10.326	45.194	89.918
SDG 9	47.285	27.523	0.014	99.092
SDG 10	63.839	26.052	0.000	100.000
SDG 11	72.951	17.246	13.826	99.058
SDG 12	82.451	13.699	46.705	98.694
SDG 13	78.673	21.094	0.643	99.921
SDG 14	64.103	9.521	30.789	85.453
SDG 15	65.817	13.751	27.410	97.885
SDG 16	68.033	13.971	33.139	95.755
SDG 17	59.208	12.279	28.941	96.698
VC Volumes (ln)	6.331	5.210	0.000	12.907
VC transactions (ln)	1.532	1.478	0.000	4.007
FDI inflows (ln)	19.334	6.946	0.000	26.960
GDP growth rate	2.348	4.955	−33.493	41.745
Population (ln)	16.475	1.590	12.561	21.091
GovExp	16.179	5.253	2.360	36.217
Free index	61.425	28.785	2.000	100.000
Financial development	0.381	0.234	0.039	0.980
Bank credit over GDP	3.839	0.872	0.005	5.499

Note: Data for VC Volumes, Transactions and SDG scores are aggregated at the country-year level and are available for all the 132 countries and 7 years (2015–2021). Data for VC investments are 10% trimmed to account for outliers. The sample decreases up to 120 countries when we consider control variables which include some missing values in the same sample period.

simple arithmetic mean of 17 underlying subindicators, each accounting for a different sustainability dimension (the 17 SDGs). Again, the higher the value of each indicator, the closer the country is to attaining the related SDG, by year and country.

Finally, we complement the database by including a set of socio-economic variables retrieved from public sources such as the World Bank (i.e., GDP growth, population, public government expenditure, FDI inflows, and credit to the private sector as a percentage of GDP), the IMF (Financial Development Index), and the Freedom House (Freedom Index from Freedom House, 2023) to account for country-specific characteristics that might affect the relationship between VC investments and the SDGs.

We arrange all this information in a panel setting with time-series and cross-sectional dimensions, where the temporal units are the 7 years between 2015 and 2021 and the cross-sectional units are 132 countries around the world. For each country and year, the database includes information on the level of VC investments, the sustainable development—aggregate and specific—goals, and a set of country-level socio-economic indicators. Summary statistics for the full sample are reported in Table 2.[2]

[2]Further summary statistics based on different subsamples are reported in Table A1, where Panel A shows the statistics by continent (Africa, Americas, Asia-Pacific, and Europe) and Panel B by two categories of income: "advanced economies" and "emerging and developing economies" based on IMF classification (for reference, see https://www.imf.org/en/Publications/WEO/weo-database/2023/April/groups-and-aggregates). We observe some heterogeneity in the statistics across country groups, motivating the inclusion of country-fixed effects and economic variables in our empirical strategy. The total number of observed countries decreases to 120 when all the control variables are included in the model specification due to some missing values in the sources. We also report in Table A2 the correlation matrix for the variables included in our dataset, which highlights low levels of pairwise correlation based on standard thresholds (see, for instance, Schober et al., 2018), with values lower than 0.5 in over 80% of the occurrences and consistently below 0.7.

3.2 | Methodology

To investigate whether VC investments are associated with greater levels of SDG attainment worldwide, we follow two approaches.

First, we explore the relationship by estimating the following panel data fixed effect model specification:

$$SDG_{it} = \alpha + \beta\, VC_{it} + \gamma\, X_{it} + \phi_i + Trend + \epsilon_{it} \quad (1)$$

where *i* indicates countries and *t* refers to the years of the sample.[3] *SDG*, the dependent variable, is a continuous indicator ranging from 0 to 100. The higher its value, the closer the country is to attaining all the SDGs in a specific year, with a score of 100 indicating that all SDGs have been achieved. *VC* is the main regressor in our model and accounts for the presence of VC investments in a specific country and year. In most of the estimations we adopt as the main regressor, *VC Volumes*, built as a continuous variable measuring the (natural logarithm of 1 plus) VC-invested volumes, since we expect that the amount of investments, rather than the number of deals, could be related to the SDGs. Nevertheless, in the alternative specifications presented in the robustness section, we instead use the (natural logarithm of 1 plus) VC transactions as the main regressors to proxy for the presence of VC activity in a country and year. Under the hypothesis—to be tested—that VC investments are positively related to the achievement of the SDGs, we should expect a positive and statistically significant β associated with *VC*.

X is a vector of time-varying control variables at the country level. In particular, we included the GDP real growth rate (*GDPgr*) to account for the different levels of economic growth by country; the natural logarithm of the population (*Pop*) and the population density (*Density*) to consider potential differences of countries' communities in terms of social needs and environmental impact; the final consumption government expenditure as a fraction of GDP (*GovExp*) to take into account different public finance efforts of each country; the level of freedom and civil rights in each country, proxied by the Freedom Aggregate Score (*FRINDEX*) from Freedom House—an indicator ranging from 0 (least free) to 100 (most free)—to capture heterogeneous levels of social rights by country; the *FDIs*—constructed as the (natural logarithm of) FDI inflows—to capture the effects on the SDGs of alternative financial flows aimed at financing long-term investments[4]; and the level of financial development (*FinDev*)—an indicator ranging from 0 to 100 to score the level of a country's financial development—and the Domestic Credit to Private Sector by Banks as a percentage of GDP (*Credit*) to account for the diverse levels in the development and presence of financial and banking systems by country.

The inclusion of all these indicators in the estimations should support the control of specific characteristics of countries that might influence the achievement of SDGs other than VC investments. Nevertheless, other unobservable characteristics could still influence this relationship. Hence, to account for unobserved heterogeneity across countries, we include a set of country-fixed effects, ϕ_i. Analogously, we add a yearly trend to control for the overall direction in time of the relationship between VC activity and the SDGs. In some alternative specifications, we substitute time trends with year-fixed effects, ϕ_t, to control for shocks common to all countries in each year *t*. Finally, ϵ_{it} is the error term, clustered at the country level.

While this empirical strategy provides evidence on the concurrent association of VC activity and the SDGs, we also test a modified version of the baseline model in Equation (1) that includes the 1-year-lagged independent variables to provide some insights on the contribution of VC to SDG achievement. This approach also allows us to reduce the probability that our estimations could suffer from endogeneity and reverse causality issues. Hence, we estimate the following model:

$$SDG_{it} = \alpha + \beta\, VC_{it-1} + \gamma\, X_{it-1} + \phi_i + Trend + \epsilon_{it}. \quad (2)$$

The same control variables, fixed effects, and possible alternative specifications of the main model for Equation (1) also apply for Equation (2). We will also follow alternative empirical strategies to deal with potential endogeneity in the section dedicated to robustness tests.[5]

4 | RESULTS AND DISCUSSION

4.1 | Baseline results

The estimation results are presented in Table 3. In Column (1), we estimate that an increase in the level of VC-invested amounts is associated with a 0.029 increase in the SDG Index Score when country-fixed effects and year trends are included, and the estimate is significant at the 1% level. When we augment the specification of Column (1) by including the full set of control variables (Column 3), we still find a positive (0.025) and statistically significant coefficient. Notably, the estimated coefficients of the time trends are positive and statistically significant in both cases, providing evidence of the overall increasing positive evolution of the SDG levels in our sample period.

When we include year-fixed effects instead of time trends (Column 2), we find that the sign and magnitude (0.020) of the effect are consistent with the previous estimations. The same applies to the

[3]Unless otherwise specified, all the variables are aggregated by the country of the VC-backed company. Data on VC investments are 10%-trimmed to account for outliers.

[4]FDIs, capital flows that originate from foreign countries to finance local investment, are instruments capable of creating a stable link between economies (OECD, 2018) that bring economic, employment, and technological benefits to the receiving country (see, for instance, Iamsiraroj and Ulubaşoğlu (2015); Malikane and Chitambara (2017); Zhang (2014)). Although the literature documents mixed results, especially about the impact on environmental sustainability (e.g., Abdouli and Hammami (2018); Sarkodie and Strezov (2019)) of this instrument, Aust et al. (2020) recently showed that FDI positively influences the achievement of the SDGs in a sample of African countries.

[5]In the remainder of the study, for the sake of synthesis, we will refer to the models described in Equations (1) and (2) as "concurrent" and "lagged" models or analyses, respectively.

TABLE 3 Baseline findings (concurrent models).

	SDG index score			
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
VC Volumes	0.029***	0.020**	0.025***	0.017**
	(0.010)	(0.009)	(0.009)	(0.008)
GDPgr			−0.005	0.004
			(0.004)	(0.005)
Pop			−5.545**	−4.156*
			(2.446)	(2.479)
Density			9.629***	8.099***
			(2.478)	(2.469)
GovExp			−0.011	0.034
			(0.029)	(0.025)
FRINDEX			0.012	0.009
			(0.015)	(0.015)
FDIs			0.010**	0.012**
			(0.005)	(0.005)
FinDev			3.834**	3.251**
			(1.467)	(1.450)
Credit			−0.280	−0.133
			(0.408)	(0.380)
Year trend	0.285***		0.265***	
	(0.019)		(0.025)	
Observations	924	924	840	840
Adjusted *R*-squared	0.542	0.594	0.598	0.649
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes
Year trends	Yes	No	Yes	No

Note: The analysis covers 7 years from 2015 to 2021 and 132 countries (120 for the models including control variables due to missing values). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. Control variables are described in Section 3. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.
***Statistical significance at the 1% level.
**Statistical significance at the 5% level.
*Statistical significance at the 10% level.

model, including time trends and control variables (Column 4), with an estimated positive and statistically significant coefficient of 0.017.

Regarding the control variables, we find a positive and significant correlation between SDG levels and population density, consistent with the premise that high density may boost social connections, physical health, accessibility, and public transportation and services for the urban population (Salem, 2023). This result should be read in combination with the negatively estimated relationship between the SDGs and the level of population, aligning with previous studies that suggest the need for a decline in the world population to achieve the SDGs (see, e.g., Abel et al., 2016; Dasgupta et al., 2023). Moreover, the SDG Index is positively correlated with the financial development indicator, supporting the idea that financial development may contribute to sustainable development, especially by means of financing more efficient and advanced technologies (Adams & Klobodu, 2018; Dhahri et al., 2024; Renzhi & Baek, 2020) and with FDIs, in line with previous findings (Aust et al., 2020). Finally, we find a limited role played by the other economic factors (GDP growth rate), institutional factors (Free Index), and private (Domestic Credit to Private Sector by Banks as a percentage of GDP) and public (government expenditure) finance factors when controlling for all other variables.[6] Overall, we find that countries with a higher level of VC-invested amount tend to show a higher level of SDGs' achievement when including both fixed effects, time trends, and a full set of control variables.[7]

The results of the analysis on the relationship between VC and the SDGs, which includes the lagged independent variables, are presented in Table 4, where the column progression mirrors that of Table 3. Both models with the time trend (Columns 1 and 3) and models with time-fixed effects (Columns 2 and 4) document a positive relationship between lagged VC investments and the SDG Index. In terms of magnitude, the effect varies between 0.014 and 0.020, which is essentially consistent with the range of coefficients identified in the concurrent analysis.

Regarding the two model specifications that include control variables (Columns 3 and 4), we highlight that the regressors with a statistically significant estimated coefficient are the same—and with the same sign—as in the concurrent model, except for GDP growth, which has a positive and significant coefficient in the version including lagged regressors, while it is insignificant in the concurrent model. Overall, our empirical strategy suggests a positive correlation between VC activity and SDGs in both contexts, providing evidence to support the study hypothesis.

4.2 | Four (economic, social, environmental, and governance) dimensions

While sustainable development can be measured by a single indicator, it is a complex and multifaceted concept that accounts for several relevant dimensions. In the case of the SDGs, the economic, social, environmental, and governance drivers can be thought of as pillars of the overall sustainable development concept, with good governance

[6]The inclusion of several control variables in empirical models can raise concerns regarding multicollinearity and, consequently, potential biases in estimations. While this potential issue has been reconsidered in recent studies (see, e.g., Kalnins & Praitis Hill, 2023), we have attempted to cope with it by examining (i) the correlation matrix of the variables included in our dataset, which does not show significant levels of correlations (see Table A2); (ii) the adjusted R2 values of our estimations, which fall within an acceptable range (never exceeding 0.65); and (iii) a VIF analysis (results available upon request) suggesting that the estimated coefficients for our main variable of interest (VC) remain stable in magnitude and statistically significant as control variables are excluded up to the case in which the average VIF is lower than the standard thresholds of 10 and 5. All these findings suggest that the presence of multicollinearity in our models should not be a major concern.
[7]For the sake of robustness, we replicate the baseline model using robust standard errors instead of errors clustered at the country level. The results, reported in Table A3, highlight qualitatively consistent findings. We also obtain consistent baseline results (available upon request) when we do not exclude VC investments outliers from the sample.

TABLE 4 Baseline findings (lagged models).

	SDG index score			
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
VC Volumes $_{t-1}$	0.020**	0.016**	0.014*	0.016**
	(0.008)	(0.007)	(0.007)	(0.007)
$GDPgr_{t-1}$			0.032***	0.013*
			(0.008)	(0.008)
Pop $_{t-1}$			−5.554***	−5.220***
			(2.007)	(1.933)
Density $_{t-1}$			8.050***	7.823***
			(2.107)	(1.981)
GovExp $_{t-1}$			−0.005	0.029
			(0.026)	(0.026)
FRINDEX $_{t-1}$			0.010	0.008
			(0.015)	(0.015)
FDIs $_{t-1}$			0.013***	0.014***
			(0.004)	(0.004)
FinDev $_{t-1}$			3.414**	2.628*
			(1.381)	(1.380)
Credit $_{t-1}$			−0.211	−0.180
			(0.399)	(0.405)
Year trend	0.254***		0.284***	
	(0.020)		(0.031)	
Observations	792	792	720	720
Adjusted *R*-squared	0.456	0.535	0.547	0.595
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes
Year trends	Yes	No	Yes	No

Note: The analysis covers 7 years from 2015 to 2021 and 132 countries (120 for the models including control variables due to missing values). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. Control variables are described in Section 3. All regressors are taken as one-year-lagged indicators. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.
***Statistical significance at the 1% level.
**Statistical significance at the 5% level.
*Statistical significance at the 10% level.

acting as the underpinning structure (Murphy et al., 2021). To decompose the analysis on the influence of VC on these four dimensions, we replicate Equation (1), substituting the dependent variable, *SDG*, with indicators for the economic (*ECO*), social (*SOC*), environmental (*ENV*), and governance (*GOV*) pillars in four different estimations, respectively.[8]

[8]Specifically, based on the United Nations classification, *SOC* accounts for social-related ESG (1–6); *ECO* accounts for economic-related SDGs (7–12); *ENV* accounts for environmental-related SDGs (13–15); and *GOV* accounts for governance-related SDGs (16–17).

The results in Table 5 demonstrate that the coefficients related to economic development are positive and statistically significant for VC-invested volumes, both looking at the concurrent (Panel A) and lagged (Panel B) versions of the model. In line with Samila and Sorenson (2011), we can conclude that, overall, by supporting the growth of startups, VC activity promotes economic growth and that this growth, in turn, mainly affects economic development. By contrast, VC investments appear to play a more limited role in spurring social or environmental values. Moreover, the coefficients related to the governance area are found to be positive and statistically significant in both versions of the model. This result is consistent with the fact that the two indicators composing the *GOV* pillar are related to strong institutions, finance, and technology, which are factors fundamentally associated with the role of VC investments.[9]

4.3 | Single SDGs and some alternative aggregations

Despite allowing us to disaggregate the concept of sustainable development into four main dimensions, the results obtained at the pillar level are still aggregations of more granular goals on which the global community and single countries are working to achieve higher levels of sustainability. Hence, the assessment of the relationship with VC investments could also be conducted at the level of the 17 SDGs, which compose the SDG Index Score.[10] In addition to providing further indications about the disaggregated correlation of VC with different aspects of sustainability, this analysis also allows for testing for possible negative effects on subsets of the SDGs, resulting in a potential misalignment with the overall positive relationship.

The results—reported in Figure 1—indicate that only a minority of the 17 SDGs appear to be individually significantly correlated with VC investments. Specifically, we document a positive and significant relationship between VC-invested amounts and goals related to the social pillar (i.e., Goal 2, Goal 3, and Goal 4, with Goal 2 both in the concurrent and lagged models), the economic pillar (i.e., Goal 8 and Goal 11 in the concurrent model), and the governance pillar (i.e., Goal 16 in the lagged model and Goal 17 in the concurrent model).

All the other estimated coefficients are not statistically significant at the 10% level.

The results obtained at the individual goal level indicate that VC investments are only correlated with a limited number of underlying goals, primarily in the economic and governance areas, in line with our previous findings. Concurrently, none of the individual SDGs appears to be detrimental to the achievement of the SDGs. Moreover, although the social (*SOC*) dimension as an aggregate does not appear to be significantly related to VC, some of its underlying dimensions

[9]For official documents and statements related to the topics linked to SDGs 16 and 17, please refer to the UN SDGs websites: institutions (https://sdgs.un.org/topics/institutional-frameworks-and-international-cooperation-sustainable-development), finance (https://sdgs.un.org/topics/finance), and technology (https://sdgs.un.org/topics/technology), respectively.
[10]The overall SDG Index Score is calculated as the simple arithmetic average of the 17 SDGs.

TABLE 5 Effects on the four dimensions of sustainability.

Panel A—Concurrent model				
Dependent variable	**SOC (1)**	**ECO (2)**	**ENV (3)**	**GOV (4)**
VC Volumes	0.027	0.025*	0.011	0.041**
	(0.017)	(0.014)	(0.014)	(0.016)
Observations	840	840	840	840
Adjusted *R*-squared	0.315	0.487	0.082	0.282
Controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year trends	Yes	Yes	Yes	Yes
Panel B—Lagged model				
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
VC Volumes $_{t-1}$	0.017	0.038**	0.003	0.033*
	(0.014)	(0.015)	(0.009)	(0.017)
Observations	720	720	720	720
Adjusted *R*-squared	0.265	0.409	0.081	0.304
Controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year trends	Yes	Yes	Yes	Yes

Note: The analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). *SOC* accounts for social-related ESG (1–6); *ECO* accounts for economic-related SDGs (7–12); *ENV* accounts for environmental-related SDGs (13–15), and *GOV* accounts for governance-related SDGs (16–17). *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. *Controls* is a vector of control variables described in Section 3. The regressors included in the estimations displayed in Panel B are taken as one-year-lagged indicators. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.

***Statistical significance at the 1% level.

**Statistical significance at the 5% level.

*Statistical significance at the 10% level.

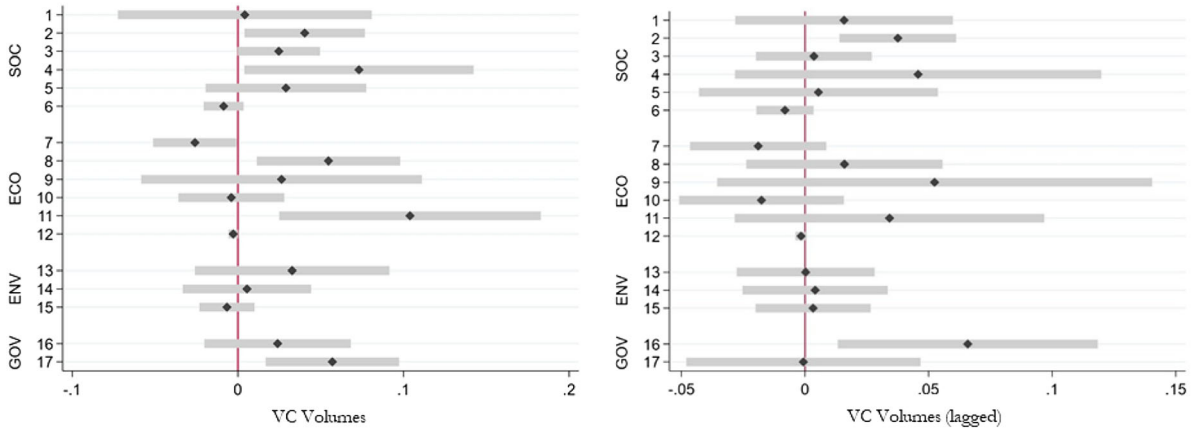

FIGURE 1 Effects on the 17 sustainable development goals. Note: the analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). Results for the concurrent and lagged models are displayed in the left and right panels, respectively. *SOC* accounts for social-related ESG (1–6); *ECO* accounts for economic-related SDGs (7–12); *ENV* accounts for environmental-related SDGs (13–15), and *GOV* accounts for governance-related SDGs (16–17). *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. All the control variables are included in the estimations and standard errors are clustered at the country level. The figure indicates coefficient estimates with a diamond and their 10% confidence intervals with a bar.

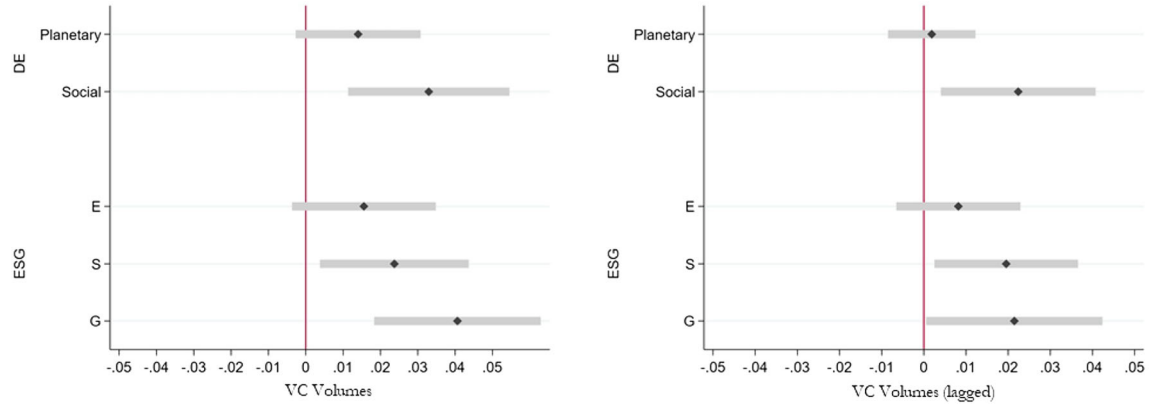

FIGURE 2 Effects on categories of SDGs according to the doughnut economics (DE) and the ESG frameworks. Note: the analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). Results for the concurrent and lagged models are displayed in the left and right panels, respectively. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. All the control variables and fixed effects are included in the estimations, and standard errors are clustered at the country level. The figure indicates coefficient estimates with a diamond and their 10% confidence intervals with a bar.

(especially Goal 2) are still positively correlated with the level of VC investment. This suggests the presence of diverse factors that may influence the relationship between VC and the SDGs.

We also replicate the exercise of aggregating the SDGs into thematic groups using two well-known categorizations adopted in literature and among policymakers. On one side, we have categorized the 17 SDGs into the 3 pillars of the ESG narrative: the environmental pillar is associated with 7 SDGs (6, 7, 9, 11, 12, 13, 14, and 15), the social pillar with 11 SDGs (1, 2, 3, 4, 5, 6, 8, 9, 10, 12, and 16), and the governance pillar with 8 SDGs (5, 8, 9, 11, 12, 13, 16, and 17).[11] Afterward, we follow the Doughnut Economics approach, an economic model coined by Raworth (2017) that identifies the "safe and just space for humanity," balancing human and social needs within the ecological planetary boundaries and combining economic, social, and environmental issues in the same framework, similarly to the SDGs. Specifically, we categorize the SDGs into social (SDG 6, 7, 11, 12, 13, 14, and 15) and planetary (SDG 1, 2, 3, 4, 5, 8, 9, 10, 16, and 17) boundaries based on each goal's characteristics.

Figure 2 plots the estimated coefficients for VC-invested amounts with respect to the ESG and Doughnut Economics frameworks in the concurrent (left panel) and lagged (right panel) approaches. We find that VC activity appears to be primarily associated with increasing levels of the SDGs attributable to the social and governance pillars of the ESG framework, with the environmental pillar coefficient being still positive, although slightly not significant. Moreover, we document increasing levels of the SDGs attributable to social boundaries based on the Doughnut Economics framework, with the contribution to mitigate activities leading to the overcoming of planetary boundaries being less relevant.

These results are consistent with our previous findings obtained when grouping SDGs based on the UN classification (as per Table 5 and Figure 1) while, at the same time, being related to the corporate and social responsibility (for ESG) and ecological/environmental economics (for Doughnut Economics) scholarly and policy narratives.

5 | HETEROGENEOUS EFFECTS AND MECHANISMS

In this section, we investigate the heterogeneous effects and potential mechanisms behind the relationship between VC and SDG attainment.[12] Specifically, we first examine the different roles of industries and sectors of VC-backed companies, and we then move our attention to the characteristics of VC investors, particularly comparing corporate and independent VCs, and investment, that is, early versus late stages.[13] Finally, we investigate how the level of countries' economic conditions might affect the relationship between VC activity and SDG achievement.

[11]Since some SDGs cannot be uniquely attributed to a single ESG pillar, a few of them are included in two categories—such as Goal 6 ("clean water and sanitation for all") for both E and S—or in three categories—such as Goal 9 ("industry, innovation and infrastructure"). Nevertheless, similar results apply when we limit the analysis to only those SDGs that are uniquely attributable to the ESG pillars.

[12]For the sake of synthesis, all these analyses are performed on the lagged version of the model based on Equation (2), as similar findings were obtained for both concurrent and lagged versions in the baseline estimations. Comparable results, available upon request, are also found for the concurrent models based on Equation (1).

[13]Summary statistics for VC-invested volumes and number of transactions by each of these categories are reported in Table A1 Panels C ("by industry") and D ("by investor type and round of investment"). These statistics indicate some heterogeneity in VC activity, especially when comparing more polluting vs. less-polluting industries and CVCs vs. IVCs, while the differences between SDG-related vs. non-SDG-related industries and early- vs. late-stage investments appear more limited. These differences may in part motivate a potentially different level of significance for some subsets of VC investments due to their relatively lower frequency in the overall VC activity.

5.1 | Industry of VC-backed companies

We have seen so far that VC investments are positively related to the achievement of the SDGs, although with a stronger focus on the economic and governance components and with different outcomes according to single goals. However, each VC investment and project might have substantially different interactions with the SDGs. The relevance of SDG practice is typically heterogeneous across industries, which might have different interactions with economic, social, and environmental issues (García-Meca & Martínez-Ferrero, 2021). Hence, the industry of VC-backed companies could be one relevant mechanism to explain the overall effect shown by the baseline model.

We test this channel by looking at the differential contribution of VC investments to some selected "SDG-related" industries. Indeed, previous studies have shown that some industries interact more with the SDGs than others (Schönherr et al., 2017), while the evidence on the possible impact of industries' activities on the SDGs in the literature is mixed (Lisowski et al., 2023). The absence of clear evidence on which sectors are SDG-related—and on the sign of their interaction—makes it less straightforward to ascertain whether VC transactions completed on target firms operating in these sectors contribute more than others to SDGs. Nevertheless, after analyzing several studies investigating the relationship between industry and the SDGs, van Zanten and van Tulder (2021b) constructed a representation that associates each NACE macro-sector (European Commission, 2008) with a positive, negative, or neutral interaction with the SDGs. Specifically, their analysis shows that there are six sectors with a predominantly positive interaction, 11 with a predominantly negative interaction, and the remaining four with no or mixed interaction.[14] Thus, we split our sample into two: firms operating in NACE sectors that show a positive interaction with SDGs (SDG-related industries, based on van Zanten and van Tulder (2021b)) and all other sectors. Afterward, we re-estimate our baseline model, limiting the analysis to VC completed in companies operating in SDG-related versus non-SDG-related industries.[15]

Table 6 reports the results of these estimations, displaying the results for SDG-related industries in column (1) and for non-SDG-related sectors in column (2). The estimated coefficients for *VC Volumes* in both estimations are positive, statistically significant, and close in magnitude (0.017 and 0.018). These results document that the positive relationship of VC investments with the SDGs does not appear to be differential based on the *ex ante* positive interaction of the industry with the SDGs. These findings could align with the notion that VC investors prioritize factors such as market potential, technological innovation, and profitability over the existing alignment of an industry with the SDGs when making investment decisions. Therefore, the positive association of VC investments with the SDGs may be more influenced by the strategies and initiatives implemented by the VC-backed companies after the investment than by the initial state of the industry's alignment with the SDGs.

As a further test related to the industries of the financed startups, we examine the presence of potential heterogeneous effects across sectors based on their polluting attitudes. Specifically, we identify the most polluting sectors based on GHG emissions in 2014 (the year prior to the start of our sample to reduce the risk of endogeneity) at the worldwide level and by macro sector, using data provided by Our World in Data—Climate Watch (2023). According to this source, 84% of the total global carbon dioxide emissions are associated with the activities of four NACE macro sectors: "Manufacturing", "Electricity, Gas, Steam, and Air Conditioning Supply," "Construction," and "Transporting and Storage." Thus, we identify VC deals completed in startups operating in "polluting industries" and re-estimate our baseline regression twice: once for VC investments completed in polluting industries and once for all others. The results, presented in Table 6, Columns (3) and (4), highlight that the primary contribution in the relationship between VC and the SDGs is not driven by the most polluting sectors. This result appears to be consistent with our previous findings, suggesting that the increase in SDGs associated with VC investments is concentrated on factors other than environmental ones.

5.2 | Type of investor

We investigate possible heterogeneous effects associated with the type of investor by distinguishing between IVCs and CVCs. While all VC investors are increasingly interested in investing in sustainable projects (Bento et al., 2019), this strategy could follow different paths when separately looking at IVCs and CVCs, given that these two categories of investors only partially share the same investment goals (Ma, 2020), thus potentially motivating differences in their contribution toward the achievement of the SDGs. Specifically, CVCs may show a greater inclination to invest in complementary technologies developed by startups (Da Rin et al., 2013; Dushnitsky & Lenox, 2006; Maula et al., 2013). This allows CVC-backed startups to more directly access resources and knowledge to enhance their sustainability performance (Battisti et al., 2022). At the same time, previous evidence suggests that CVCs do not appear to be more attracted than IVCs to sustainable investments (Gompers et al., 2021) or "signals" such as green patenting (Bellucci et al., 2023b). On the other side, while IVCs are typically more interested in maximizing the value of their portfolio ventures in view of an exit strategy (Gompers & Lerner, 2001), they are also interested in financing sustainable investments and green projects (Mrkajic et al., 2019). Hence, to test the prevailing effects, we estimate our model twice: once for VC investments completed by CVCs and once for those completed by IVCs.

The results in Columns (5) and (6) of Table 6 indicate that the positive relationship between VC activity and SDG achievement is driven by IVCs. Specifically, the estimated coefficient between VC

[14]The interaction between NACE macro sectors and SDGs on van Zanten and van Tulder (2021b) is reported in Table A4.

[15]Given that in our empirical setting, VC investments are collapsed at the country-year level, the total number of observations for this model will be equal to those of the baseline model. The same applies to all other heterogeneous analyses, with the exception of the one related to countries' attributes (advanced vs. developing economies), presented in Section 5.4.

TABLE 6 Heterogeneous effects.

	SDG index score									
	SDG-related industries		Polluting industries		Investor type		Round of investment		Level of income	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VC Volumes $_{t-1}$	0.017***	0.018**	0.007	0.017**	0.004	0.019***	0.033***	0.014**	0.022**	0.009
	(0.007)	(0.009)	(0.008)	(0.007)	(0.009)	(0.007)	(0.008)	(0.007)	(0.010)	(0.008)
Observations	720	720	720	720	720	720	720	720	204	516
Adjusted R-squared	0.597	0.596	0.593	0.597	0.592	0.596	0.604	0.597	0.673	0.612
SDG-related industries	Yes	No	-	-	-	-	-	-	-	-
Most polluting industries	-	-	Yes	No	-	-	-	-	-	-
Investor type	-	-	-	-	CVC	IVC	-	-	-	-
Round of investment	-	-	-	-	-	-	Early	Late	-	-
Level of income	-	-	-	-	-	-	-	-	Advanced	Developing
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. *SDG-related industries* are labeled with "Yes" for VC-backed companies operating in a subset of NACE2 macro-sectors identified by van Zanten and van Tulder (2021b) as SDG-related, and with "No" for all the other sectors. *Most polluting industries* is labeled with "Yes" for VC-backed companies operating in most polluting sectors based on 2014 GHG Emissions, and with "No" for all the other sectors. *Investor Type* is labeled with "CVC" if the investment is completed by a corporate VC, and with "IVC" if it is completed by an independent VC. *Round of Investment* is labeled with "Early" for early-stage VC investments, and "Late" for late-stage VC investments. *Level of Income* is labeled with "Advanced" and "Developing" based on IMF classification. *Controls* is a vector of control variables described in Section 3. All regressors are taken as one-year-lagged indicators. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.

***Statistical significance at the 1% level.

**Statistical significance at the 5% level.

*Statistical significance at the 10% level.

investments and the SDG Index Score is positive and statistically significant only for IVCs, whereas CVCs appear to show a different investment focus. These findings are consistent with previous studies that indicate that CVCs appear to respond less than IVCs to sustainable signals (Gompers et al., 2021; Bellucci et al., 2023a) and could be motivated by higher constraints that might lead them to focus primarily on startups that are closely aligned with parent companies' businesses and not necessarily with sustainability trends.

5.3 | Round of investment

We investigate heterogeneous effects related to the round of VC investments, comparing early and late stages of financing. Early-stage VC investors are more likely to seize the latest and newest opportunities and trends—such as those linked to sustainability—even at the cost of increased risk (Tian, 2011). By contrast, VC investors may instead prefer investing in early-stage less risky investments in more mature sectors or fields (Randjelovic et al., 2003). Conversely, VCs on average reserve for late-stage investments in larger amounts, which are more compatible with the development and dissemination of high-capital-intensive technologies related to improving (environmental) sustainability (Mrkajic et al., 2019). Concurrently, late-stage investments sometimes occur at an investment stage that requires a focus on commercializing existing products with a view to performance and profitability rather than investments pursuing further innovations (Park & Tzabbar, 2016).

To investigate the effects of investments at different rounds, we separately consider the seed stage and the first two investment rounds as early-stage VC investments, while late-stage includes all rounds from the third to the eighth. We then estimate our model based on the sample of early- and late-stage VC investments. Results—reported in Columns 7 and 8 of Table 6—indicate that the two estimated coefficients of VC investments are both positive and statistically significant, documenting that the relationship with the achievement of the SDGs is both driven by early- and late-stage investments.

5.4 | Countries' economic conditions

The economic conditions of countries can influence both the overall achievement of the SDGs and the increase of VC activity. The first point stems from the fact that six indicators among the 17 SDGs have an economic nature. This implies that an increase in income can

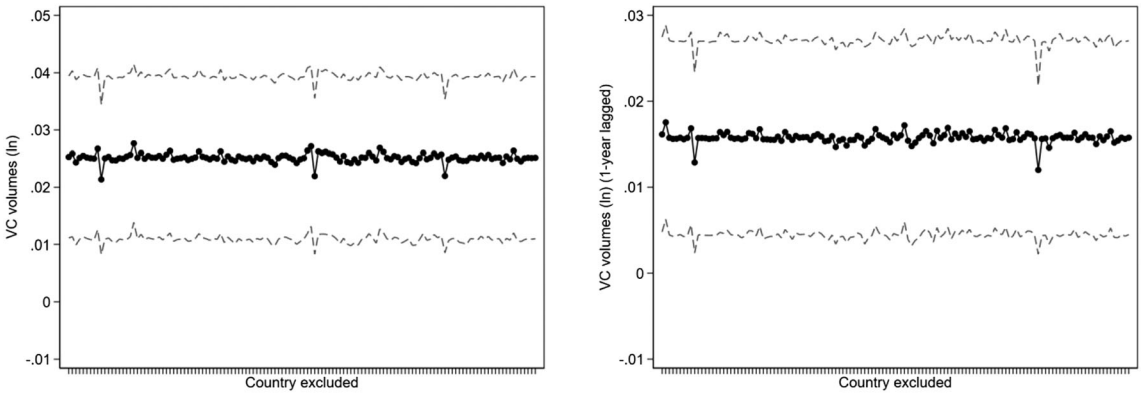

FIGURE 3 Country outliers. Note: the analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). The figure indicates coefficient estimates and their 10% confidence intervals for 120 estimations dropping one country at a time. Results for the concurrent and lagged models are displayed in the left and right panels, respectively. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. All the control variables and the whole set of fixed effects are included in the estimations, and standard errors are clustered at the country level.

directly lead to an improvement in these indicators. Regarding the second aspect, while the VC market is predominantly active in economically advanced countries such as the US, the UK, and some other European countries, with an increasing role for China (e.g., Bellucci et al., 2021), there is wide evidence in the literature that the level of income and GDP are significant factors in the diffusion of VC activity, both among advanced (e.g., Jeng & Wells, 2000) and emerging (e.g., Salehizadeh, 2005) economies. Hence, since more advanced economies generally exhibit higher average levels of SDGs (in our sample, advanced economies have an average SDG score of 78.6, while developing economies have 64.4), this implies that making a significant increase in the latter is not guaranteed. Concurrently, previous studies have found that the rise of VC investments in the sustainable spectrum (e.g., green or "Cleantech" VC) was positively correlated with economic output or GDP (e.g., Cumming et al., 2016).

Given this consideration, we explore the role of economic conditions in originating countries, splitting our sample between advanced and developing economies based on the categorization proposed by the IMF.[16] Afterward, we estimate our baseline lagged model again separately for both categories of countries. The results of this analysis—reported in Table 6 (Columns 9 and 10)—highlight that VC activity is positively related to the achievement of SDGs, especially in countries with advanced economies, where the majority of VC investments are generally concentrated. These findings indicate an incremental role of VC activity in the achievement of the SDGs for countries where the VC market is more active and the level of sustainable development is higher. In line with previous findings on polluting sectors, these results suggest that VC investments are not anticipating more sustainable trends in less developed countries and sustainable sectors, while they are further focusing on already developed and more sustainable activities.

[16]We present the trends in VC-invested amounts and the SDG Index, categorized by income levels according to the IMF classification, in Figures A1 and A2 of the Appendix. These figures highlight differences in levels while demonstrating consistent patterns in trends across both categories and in relation to the overall sample.

6 | ROBUSTNESS TESTS

We conduct a battery of tests to check the robustness of our baseline findings. Specifically, we first test the sensitivity of our main estimations to the presence of outliers across countries and single SDGs. Second, we investigate whether and to what extent the COVID-19 pandemic and its unexpected shock impacting both sustainability and financial activity have affected the relationship between VC and the SDGs. Afterward, we test the robustness of our findings using different empirical approaches. In particular, we employ alternative proxies for the dependent variable, that is, the number of VC transactions rather than invested amounts, and consider other specifications of the lagged model, accounting for potential endogeneity and reverse causality.

6.1 | Country outliers

We investigate whether our baseline findings are sensitive to the exclusion of a single country. Accordingly, we estimate Equations (1) and (2) by dropping one country at a time. The estimated coefficients and their 90% confidence intervals, shown in Figure 3, indicate that the results are aligned with those obtained in our baseline model. Specifically, the estimated coefficients suggesting the relationship between VC investments and the SDGs for the concurrent (Panel A) and lagged (Panel B) models are consistently positive and statistically significant. Hence, we can conclude that our main findings are not driven by any particular country.

6.2 | Divergence of single SDGs

The findings of Section 4 indicate that while VC investments are positively correlated with the overall level of sustainable development, the effects are not uniform across individual SDGs. We now aim to ascertain whether the exclusion of a single SDG affects the overall results by estimating Equation (1) 17 times. Each estimation includes, as the dependent variable, a new version of the SDG Index Score calculated as the average of 16 goals, thus excluding one goal at a time from the original 17. The same estimation approach is then applied to the version of the model based on Equation (2). Figure 4 presents the estimated coefficients and their 90% confidence intervals, suggesting that our findings for both versions of the model are robust as they are not influenced by any specific SDG. Overall, these results provide further evidence of the robustness of our baseline findings.

6.3 | Impact of the COVID-19 pandemic

The recent COVID-19 pandemic had a profound and unexpected impact on the global economy. For instance, lockdown measures implemented to mitigate the transmission of the virus have subjected individuals and businesses to a rapid and severe economic downturn (e.g., Gopinath, 2020; Vidya & Prabheesh, 2020), influencing the behaviors of equity investors in the process (e.g., Gompers et al., 2021; Gompers et al., 2022). Concurrently, the pandemic also introduced relevant challenges to the achievement of sustainable development (Mukarram, 2020), despite the fact that the estimated impact of the pandemic on the SDGs is still not fully clear (especially for developing countries) and highlights mixed evidence with different goals that can be positively or negatively affected (Wang & Huang, 2021). In particular, the pandemic-related lockdowns have prompted significant shifts in energy consumption patterns, resulting in a notable reduction in global CO_2 emissions (Aktar et al., 2021) while increasing social inequality (Wildman, 2021) and reducing economic growth (IMF, 2020). Therefore, considering the effects of the pandemic on VC investment and the SDGs, it is crucial to assess whether our baseline findings remain unaffected by this impactful disruption.

To take into account this phenomenon and test the robustness of our baseline findings in the presence of the pandemic, we conducted two separate tests. First, we replicate the baseline estimations, including the additional control variable, *Covid*, a binary indicator that is equal to 1 for the years affected by the pandemic (i.e., 2020 and 2021) and 0 otherwise. Results, displayed in Table 7 Columns (1) and (2), reveal that (i) the *Covid* indicator is negatively related to *SDG*, suggesting that the diffusion of the pandemic could have had a negative impact on sustainable development, and (ii) the coefficients associated with the VC activity are positive and statistically significant in each of the concurrent and lagged specifications, thus providing further evidence of the robustness of our baseline findings.

Second, we retrieved data on COVID-19 cases per million inhabitants (source: Our World in Data), calculated the median value at the worldwide level, and built a binary indicator, *CovidHigh*, which is equal to 1 for countries above the global median and 0 otherwise. We then estimate our baseline models, including the new indicator in the specification. Results shown in Table 7 Columns (3) and (4) indicate that the estimated coefficients for VC-invested volumes are again positive and significant and that the *CovidHigh* indicator is negatively related to SDGs, thus providing further evidence of the robustness of our baseline findings even in the areas that have been more severely affected by the health and economic crisis.

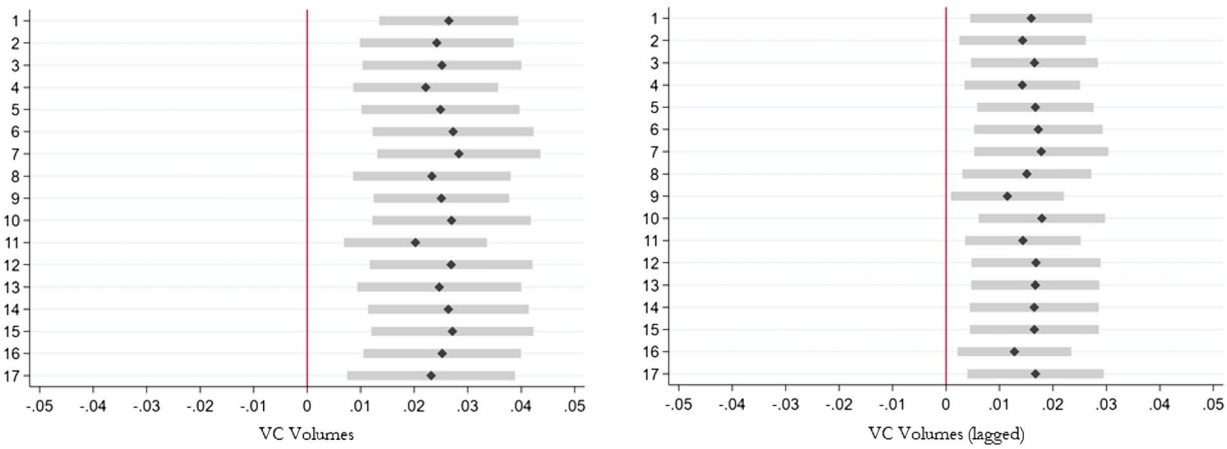

FIGURE 4 Divergence of sustainable development goals. Note: the analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). Results for the concurrent and lagged models are displayed in the left and right panels, respectively. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. All the control variables and fixed effects are included in the estimations, and standard errors are clustered at the country level. The figure indicates coefficient estimates with a diamond and their 10% confidence intervals with a bar.

TABLE 7 Robustness tests—The role of the COVID-19 pandemic.

	SDG index score			
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
VC Volumes	0.021**		0.025***	
	(0.008)		(0.009)	
VC Volumes $_{t-1}$		0.013**		0.014*
		(0.007)		(0.008)
Covid	−0.633***	−0.354***		
	(0.070)	(0.074)		
CovidHigh			−9.116**	−10.094**
			(4.561)	(4.226)
Observations	840	720	840	720
Adjusted *R*-squared	0.636	0.559	0.603	0.553
Controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year trend	Yes	Yes	Yes	Yes

Note: The analysis covers 7 years from 2015 to 2021 and 132 countries (120 for the models including control variables due to missing values). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. *Covid*, a binary indicator that is equal to 1 for the years affected by the pandemic (i.e., 2020 and 2021) and 0 otherwise. *CovidHigh*, is a binary indicator that is equal to 1 for countries above the global median of COVID-19 cases per million inhabitants and 0 otherwise. *Controls* is a vector of control variables described in Section 3. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.
***Statistical significance at the 1% level.
**Statistical significance at the 5% level.
*Statistical significance at the 10% level.

6.4 | Different proxies for VC activity (number of VC transactions)

The role of VCs in contributing to the achievement of the SDGs should be primarily attributed to the amount of invested resources that VC investors can allocate to projects aimed at improving the sustainability of the countries where the funded startups are located. For the sake of robustness, we shift our focus to the number of transactions, which can be considered another proxy for the level of VC activity by country.

We replicate the estimations of Equations (1) and (2), using the (natural logarithm of 1 plus the) number of VC deals as the main independent variable instead of the VC-invested amounts. In Table 8, we present the results of these estimations, following the same empirical strategy as our baseline estimations. In particular, we estimate both versions of the models with concurrent and lagged regressors, once with year trends and once with year-fixed effects, always including all the control variables (as per Tables 3 and 4, Columns (3) and (4)). In all these cases, we observe a positive relationship between SDGs and VC transactions, with estimated coefficients ranging between 0.119 and 0.161 for the concurrent model and between 0.070 and 0.086 for the lagged model, and all estimates being statistically significant. These findings further support the notion that VC activity is positively related to the achievement of sustainable development.

6.5 | Other model specifications dealing with endogeneity

In one of the baseline estimations, we introduced lagged independent variables to investigate how VC activity may contribute to SDG achievement. We now test the robustness of those results by employing two alternative specifications based on the growth rate of either the dependent variable (*SDG Index*) or the main regressor of interest (*VC Volumes*). Specifically, we estimate one model using the (levels of) SDG Index as the dependent variable, as in the baseline, while including the year-on-year growth rate of VC-invested volumes. Additionally, we estimate a second model using the year-on-year growth rate of the SDG Index as the dependent variable, with all other regressors remaining consistent with the baseline. Each of the two models is then estimated, including, alternatively, a time trend or time-fixed effects.

The results for these four estimations are reported in Table 9, where Columns (1) and (2) focus on the first model (*VC Volumes growth rate*) and Columns (3) and (4) on the second one (*SDG Index*

TABLE 8 Robustness tests—Number of VC transactions.

	SDG index score			
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
VC transactions	0.161***	0.119**		
	(0.053)	(0.053)		
VC transactions $_{t-1}$			0.070*	0.086**
			(0.044)	(0.042)
Year	0.274**		0.289***	
	(0.026)		(0.031)	
Observations	840	840	720	720
Adjusted *R*-squared	0.601	0.651	0.547	0.595
Controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year trend	Yes	No	Yes	No
Year fixed effects	No	Yes	No	Yes

Note: The analysis covers 7 years from 2015 to 2021 and 132 countries (120 for the models including control variables due to missing values). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *VC Transactions* is a continuous variable built as the natural logarithm of the (1 plus the) number of VC transactions in a specific country and year. *Controls* is a vector of control variables described in Section 3. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.
***Statistical significance at the 1% level.
**Statistical significance at the 5% level.
*Statistical significance at the 10% level.

TABLE 9 Robustness tests—VC and SDG index growth rates.

	SDG index score		SDG index score growth rate	
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
VC Volumes growth rate	0.097**	0.063*		
	(0.042)	(0.036)		
VC Volumes			0.023**	0.018
			(0.011)	(0.011)
Observations	542	542	840	840
Adjusted *R*-squared	0.638	0.676	0.205	0.225
Controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year trend	Yes	No	Yes	No
Year fixed effects	No	Yes	No	Yes

Note: The analysis covers 7 years from 2015 to 2021 and 120 countries (control variables included). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *SDG Index Score growth rate* is the year-on-year growth rate of the SDG Index. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. *VC Volumes growth rate* is the year-on-year growth rate of the VC invested volumes. *Controls* is a vector of control variables described in Section 3. The table reports coefficient estimates followed by standard errors, clustered at country level, in parentheses.
***Statistical significance at the 1% level.
**Statistical significance at the 5% level.
*Statistical significance at the 10% level.

growth rate). We find that the estimated effect is consistently positive and statistically significant in three out of the four estimations. The exception is the model using the growth rate of the SDG Index as the dependent variable and including time-fixed effects (Column 4), whose coefficients are positive but marginally insignificant (*p*-value: .122). Overall, these results confirm our baseline findings and provide support for the hypothesis of a positive relationship between VC activity and SDG attainment.

7 | CONCLUSIONS AND POLICY IMPLICATIONS

The SDGs provide a global framework for addressing social, economic, and environmental challenges. Businesses have a crucial role to play in fostering the achievement of the SDGs. Academic research supports the idea that companies can contribute to the SDGs through various strategies, including aligning reporting practices, adopting sustainable entrepreneurship, promoting responsible consumption and production, addressing climate change, and engaging in partnerships and collaborations. Finance plays a crucial role in achieving the SDGs by providing capital for sustainable development projects. Research has examined the interplay between public and private financing as well as the contributions of different funding sources, such as FDIs.

In principle, VC investments have the potential to support the achievement of the SDGs. Indeed, VC investors can drive economic growth, facilitate the diffusion of new technologies, and adjust their resources to address relevant sustainability challenges. However, there is a gap in the direct examination of VC investments in the SDGs, presenting an opportunity for further research to explore the influence of VC on sustainability across economic, environmental, and social dimensions. This study attempts to fill this gap by investigating whether higher levels of VC activity are associated with greater achievement of the SDGs in a sample of 132 countries observed between 2015 and 2021, leveraging a unique dataset that includes information on VC (investments, investors, and backed companies), the SDGs and their pillars, and other economic, demographic, and institutional indicators at the country level.

Our analysis confirms a positive relationship between VC investment volumes and the achievement of the SDGs. When decomposing the SDGs into their main pillars, we find that VC investments are positively related to more sustainable development through a limited number of drivers while never having negative effects on the achievement of the SDGs. In particular, the economic and governance pillars are the primary dimensions of sustainability associated with higher VC investments, but positive correlations are also observed in some underlying dimensions of the environmental and social pillars.

To investigate potential channels driving these results, we explore five additional factors that may influence the relationship between VC investments and SDGs. These factors include the industry of VC-backed companies, the organizational type of investors, the round of VC investment, and the economic conditions of the countries where the VC-backed companies are located. We find that VC investments are associated with higher levels of the SDG Index, particularly for transactions completed by Independent VCs, in less-polluting industries, and for startups based in countries with more advanced economies.

Our findings are robust to a battery of tests confirming that, despite observed heterogeneity, the baseline results are not dependent on the specific behavior of individual indicators and countries, the presence of the COVID-19 pandemic, the use of a different proxy for VC activity, or other specifications of the baseline model dealing with endogeneity.

These findings come with some limitations. Despite the use of models that include the time lags (or the growth rate) of VC activity to assess the relationship between VC and SDGs, which reduce the risk of endogeneity and reverse causality, the current empirical setting does not allow for definitive conclusions about a potential causal link between the two variables. To highlight a causal relationship, for example, it would be necessary to exploit an exogenous shock that could be placed in a quasi-natural experimental setting. At the same time, while our study focuses on analyzing the mechanisms driving the relationship between VC and SDGs mainly based on startup characteristics (e.g., its sector) or VC characteristics (e.g., its type), less emphasis has been placed on the nature of the deal (with the exception of the investment round). Specifically, to highlight a potential reallocation effect from unsustainable to sustainable VC investments, it would be necessary to explore more closely the technologies owned by the VC-backed startups (e.g., green vs. brown patents), the specific sustainability attributes of startups' activities (e.g., through ESG ratings or keywords in the company's business description available on the website or from specialized data providers that can proxy their level of sustainability), or the potential duality of the VC investments' goal (e.g., in the case of impact investing). The identification of the exogenous shock, along with subsequent causal analysis and the integration of the dataset to consider other green or sustainable attributes of startups, is left for future research.

Overall, this study contributes to the literature on the intersection between external equity financing and sustainable development, providing valuable evidence for policymakers. New policies could follow a twofold approach: one, by continuing to support contexts where the relationship between VC and SDG is already positive, and two, by incentivizing those where it has not yet been established. In particular, since the positive relationship between VC and SDGs is more pronounced in advanced economies and given that VC is less prevalent in developing countries, strategies should be developed to further encourage the diffusion of VC even in these areas. For example, this could entail fostering an environment conducive to entrepreneurship and innovation, for instance by establishing collaborative frameworks to facilitate the interaction between startups and VCs, promoting technology transfer, and improving financial literacy and entrepreneurship. This aspect is particularly relevant for IVC entities, as corporations operating as CVCs do not appear to adhere to the same sustainability investment logic.

Concurrently, policymakers should recognize that while private investments in the form of VC appear to correlate with overall improved sustainability levels, such investments have limited impact on environmental sustainability, as higher levels of VC investments are not associated with higher SDG levels in the most polluting sectors. This underscores the necessity for structuring policies aimed at significantly reducing the uncertainty and risk associated with investing in green startups (Corrocher & Solito, 2017; Mazzucato & Semieniuk, 2018) while supporting the idea that both public and private investments are necessary for achieving the goals outlined in agenda 2030. Finally, to maximize the impact of VC investments on SDGs, policymakers can facilitate collaborations and partnerships between VC investors, industry players, academia, and government agencies. These collaborations can leverage diverse expertise,

resources, and networks to identify and support innovative solutions that address sustainability challenges.

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APPENDIX A

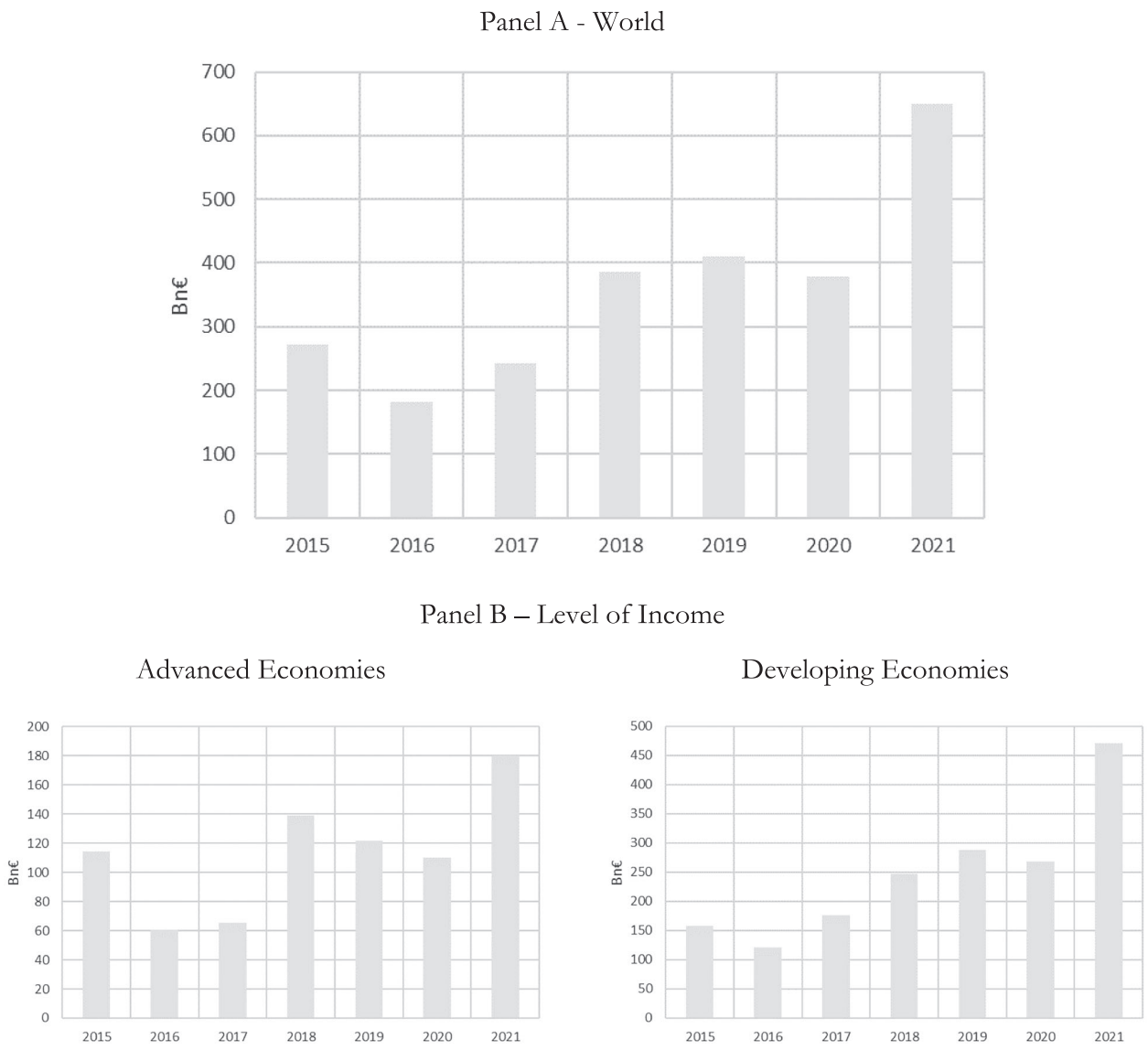

FIGURE A1 Evolution of global VC financing (2015–2021). Note: the figure shows VC Volumes (in bn€) for the whole sample (a) and by level of income (b) from 2015 to 2021.

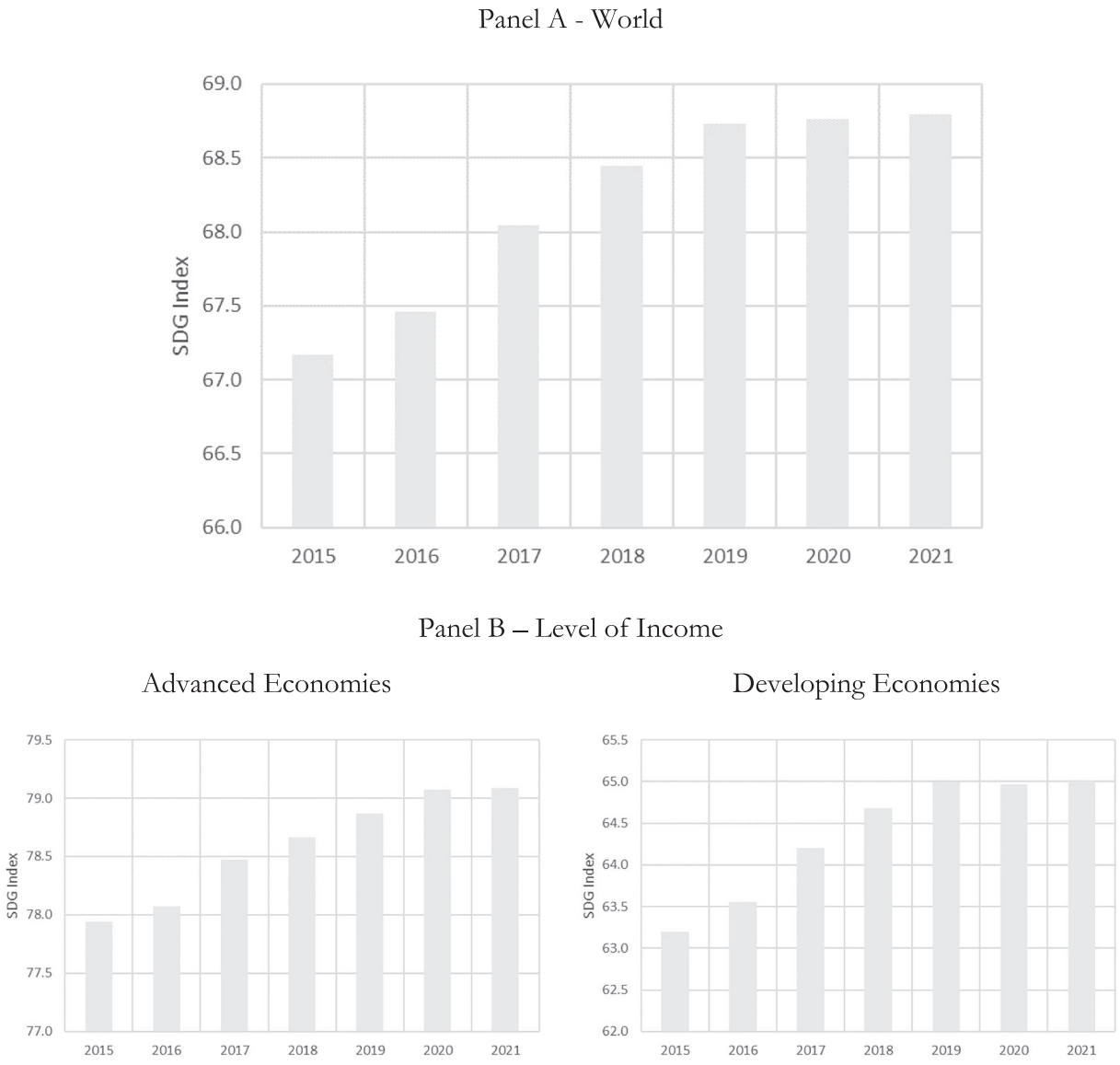

FIGURE A2 Evolution of sustainable development goal (SDG) index (2015–2021). Note: the figure shows SDG index evolution for the whole sample (a) and by level of income (b) from 2015 to 2021.

TABLE A1 Summary statistics by continent and level of income.

Panel A—By continent					
Continent	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
Africa	SDG index score	56.679	7.100	38.449	71.510
	SDG 1	36.271	29.578	0.000	98.710
	SDG 2	54.852	9.865	22.713	67.395
	SDG 3	46.053	14.941	18.872	79.567
	SDG 4	50.902	21.077	0.001	95.838
	SDG 5	53.846	15.421	17.960	88.393
	SDG 6	54.279	8.349	36.345	71.759
	SDG 7	48.647	17.309	6.224	76.324
	SDG 8	61.076	6.552	45.194	73.350
	SDG 9	21.823	14.536	0.014	67.297
	SDG 10	48.150	24.390	0.000	97.015
	SDG 11	55.738	15.229	13.826	92.601
	SDG 12	94.515	4.586	74.809	98.694
	SDG 13	95.918	4.744	77.018	99.921
	SDG 14	65.926	8.106	45.739	81.355
	SDG 15	66.317	11.741	27.410	89.553
	SDG 16	56.057	10.436	39.675	76.346
	SDG 17	53.165	10.874	33.333	78.175
	VC Volumes (ln)	3.643	4.517	0.000	12.907
	VC transactions (ln)	0.741	1.016	0.000	3.932
	FDI inflows (ln)	18.638	5.401	0.000	24.444
	GDP growth rate	2.905	4.777	−20.599	15.050
	Population (ln)	16.789	1.144	14.046	19.169
	GovExp	14.639	6.450	4.403	36.217
	Free index	45.636	22.790	2.000	90.000
	Financial development	0.180	0.133	0.039	0.593
	Bank credit over GDP	3.028	0.971	0.005	4.854
Americas	SDG index score	69.080	5.761	51.617	77.790
	SDG 1	86.668	16.851	14.601	99.932
	SDG 2	59.294	9.800	38.678	74.474
	SDG 3	77.546	10.757	39.290	93.466
	SDG 4	87.588	9.084	59.712	99.353
	SDG 5	68.015	9.198	38.966	81.701
	SDG 6	74.793	9.271	52.216	90.373
	SDG 7	78.073	12.504	45.751	98.195
	SDG 8	69.008	6.909	50.938	82.486
	SDG 9	40.987	19.984	6.164	94.544
	SDG 10	36.609	17.009	12.817	85.894
	SDG 11	78.290	13.020	31.717	93.672
	SDG 12	83.565	8.877	61.201	95.578
	SDG 13	83.665	16.986	27.617	98.740
	SDG 14	66.267	9.311	46.690	84.216
	SDG 15	58.516	7.084	44.480	75.568
	SDG 16	62.391	11.820	33.139	87.436
	SDG 17	63.080	11.463	34.641	81.494

(Continues)

TABLE A1 (Continued)

Panel A—By continent					
Continent	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
	VC Volumes (ln)	4.912	5.301	0.000	12.907
	VC transactions (ln)	1.219	1.509	0.000	4.007
	FDI inflows (ln)	20.307	5.781	0.000	26.960
	GDP growth rate	1.075	5.055	−17.945	15.336
	Population (ln)	16.305	1.769	12.561	19.623
	GovExp	14.508	3.199	7.303	22.652
	Free index	74.266	18.604	14.000	99.000
	Financial development	0.368	0.212	0.089	0.926
	Bank credit over GDP	3.825	0.625	2.234	5.381
Asia-Pacific	SDG index score	67.988	6.178	51.280	79.560
	SDG 1	87.443	17.198	28.733	100.000
	SDG 2	60.394	11.076	31.187	83.051
	SDG 3	75.854	13.658	42.846	95.547
	SDG 4	83.393	15.484	41.577	99.656
	SDG 5	55.266	15.873	6.970	89.782
	SDG 6	66.620	12.227	34.039	94.109
	SDG 7	67.573	10.272	34.453	91.744
	SDG 8	67.466	10.350	48.725	87.753
	SDG 9	49.445	25.206	6.410	99.092
	SDG 10	70.569	16.910	31.541	100.000
	SDG 11	71.835	14.634	30.844	94.815
	SDG 12	83.711	12.659	52.498	97.788
	SDG 13	72.975	25.699	0.643	98.699
	SDG 14	60.724	10.167	30.789	80.824
	SDG 15	56.689	9.494	30.148	78.572
	SDG 16	69.448	10.835	39.931	91.755
	SDG 17	56.386	11.274	28.941	75.946
	VC Volumes (ln)	6.902	5.268	0.000	12.907
	VC transactions (ln)	1.636	1.500	0.000	4.007
	FDI inflows (ln)	19.672	7.225	0.000	26.534
	GDP growth rate	2.598	5.694	−33.493	41.745
	Population (ln)	16.860	1.783	13.028	21.091
	GovExp	15.067	5.042	2.360	30.003
	Free index	45.571	27.232	3.000	99.000
	Financial development	0.424	0.210	0.098	0.933
	Bank credit over GDP	4.129	0.754	1.893	5.499
Europe	SDG index score	78.171	3.724	69.749	86.477
	SDG 1	98.885	2.025	86.658	99.964
	SDG 2	66.978	4.773	56.613	76.156
	SDG 3	87.999	7.057	66.702	97.250
	SDG 4	93.613	9.008	54.874	99.926
	SDG 5	74.094	10.999	39.455	91.850
	SDG 6	82.571	7.896	62.827	95.058
	SDG 7	76.140	9.493	51.325	99.555
	SDG 8	78.258	7.382	53.656	89.918

TABLE A1 (Continued)

Panel A—By continent					
Continent	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
	SDG 9	71.522	19.811	23.029	97.516
	SDG 10	87.110	11.936	47.751	100.000
	SDG 11	86.274	7.676	63.511	99.058
	SDG 12	69.736	11.667	46.705	88.594
	SDG 13	66.177	15.060	18.712	91.594
	SDG 14	64.661	9.240	42.988	85.453
	SDG 15	79.086	11.237	54.233	97.885
	SDG 16	80.615	8.877	51.349	95.755
	SDG 17	65.195	11.466	46.184	96.698
	VC Volumes (ln)	8.985	4.147	0.000	12.907
	VC transactions (ln)	2.317	1.365	0.000	4.007
	FDI inflows (ln)	19.028	8.326	0.000	26.531
	GDP growth rate	2.351	4.051	−11.325	24.370
	Population (ln)	15.901	1.425	12.708	18.799
	GovExp	19.498	3.505	11.265	27.860
	Free index	84.154	19.744	11.000	100.000
	Financial development	0.513	0.223	0.153	0.980
	Bank credit over GDP	4.214	0.510	3.184	5.144
Panel B—By level of income					
Cluster of income	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
Advanced economies	SDG index score	78.597	3.376	71.092	86.477
	SDG 1	99.345	0.547	96.722	99.974
	SDG 2	67.948	5.555	57.816	83.051
	SDG 3	92.042	3.607	80.202	97.250
	SDG 4	96.733	3.325	76.810	99.926
	SDG 5	76.973	8.517	57.365	91.850
	SDG 6	84.011	8.028	62.827	95.058
	SDG 7	77.518	9.326	51.325	99.555
	SDG 8	80.538	6.109	55.843	89.918
	SDG 9	82.973	12.011	51.691	99.092
	SDG 10	84.779	12.109	51.985	100.000
	SDG 11	88.827	5.641	69.770	99.058
	SDG 12	63.995	8.071	46.705	80.131
	SDG 13	57.407	15.157	9.764	85.362
	SDG 14	61.792	11.072	30.789	85.202
	SDG 15	74.331	14.889	30.148	97.885
	SDG 16	83.962	6.362	71.082	95.755
	SDG 17	62.976	11.945	37.896	96.698
	VC Volumes (ln)	10.534	3.418	0.000	12.907
	VC transactions (ln)	2.798	1.291	0.000	4.007
	FDI inflows (ln)	19.472	8.762	0.000	26.960
	GDP growth rate	2.345	3.856	−11.325	24.370
	Population (ln)	16.010	1.600	12.708	19.623
	GovExp	19.688	3.840	9.973	27.860
	Free index	92.176	8.830	48.000	100.000

(Continues)

TABLE A1 (Continued)

Panel B—By level of income					
Cluster of income	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
	Financial development	0.641	0.204	0.197	0.980
	Bank credit over GDP	4.544	0.461	3.362	5.499
Emerging and developing economies	SDG index score	64.370	8.493	38.449	80.628
	SDG 1	69.559	32.827	0.000	100.000
	SDG 2	57.995	10.167	22.713	81.968
	SDG 3	64.660	18.384	18.872	88.078
	SDG 4	72.144	22.710	0.001	99.508
	SDG 5	57.061	14.912	6.970	88.393
	SDG 6	64.031	12.392	34.039	90.373
	SDG 7	63.103	17.529	6.224	98.195
	SDG 8	64.990	8.190	45.194	83.862
	SDG 9	34.137	18.464	0.014	83.749
	SDG 10	56.124	25.571	0.000	100.000
	SDG 11	67.101	16.377	13.826	93.672
	SDG 12	89.251	7.808	63.657	98.694
	SDG 13	86.508	17.215	0.643	99.921
	SDG 14	64.954	8.739	45.739	85.453
	SDG 15	62.680	11.866	27.410	93.659
	SDG 16	62.164	11.146	33.139	83.426
	SDG 17	57.821	12.116	28.941	81.545
	VC Volumes (ln)	4.782	4.893	0.000	12.907
	VC transactions (ln)	1.066	1.252	0.000	4.007
	FDI inflows (ln)	19.283	6.150	0.000	26.534
	GDP growth rate	2.349	5.306	−33.493	41.745
	Population (ln)	16.647	1.553	12.561	21.091
	GovExp	14.814	5.096	2.360	36.217
	Free index	50.096	25.064	2.000	99.000
	Financial development	0.282	0.155	0.039	0.741
	Bank credit over GDP	3.576	0.842	0.005	5.214
Panel C—By industry					
Cluster of industry	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
SDG-related industries	VC Volumes (ln)	5.018	5.667	0.000	19.365
	VC transactions (ln)	1.147	1.602	0.000	8.948
Non-SDG-related industries	VC Volumes (ln)	5.750	5.467	0.000	19.774
	VC transactions (ln)	1.510	1.732	0.000	8.657
More polluting industries	VC Volumes (ln)	3.963	5.295	0.000	18.584
	VC transactions (ln)	0.829	1.345	0.000	7.654
Less polluting industries	VC Volumes (ln)	6.169	5.470	0.000	19.152
	VC transactions (ln)	1.566	1.738	0.000	8.833
Panel D—By investor type and round of investment					
Cluster of industry	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
CVC	VC Volumes (ln)	2.295	4.604	0.000	18.626
	VC transactions (ln)	0.388	0.897	0.000	5.263

TABLE A1 (Continued)

Panel D—By investor type and round of investment					
Cluster of industry	**Variables**	**Mean**	**Standard deviation**	**Min**	**Max**
IVC	VC Volumes (ln)	6.487	5.612	0.000	20.037
	VC transactions (ln)	1.710	1.853	0.000	9.478
Early stages	VC Volumes (ln)	5.064	5.446	0.000	19.495
	VC transactions (ln)	1.317	1.688	0.000	7.864
Latestages	VC Volumes (ln)	4.231	5.762	0.000	19.940
	VC transactions (ln)	0.846	1.406	0.000	8.580

Note: Data for VC Volumes, transactions and SDG scores are aggregated at the country-year level and are available for all the 132 countries and 7 years (2015–2021). Data for VC investments are 10% trimmed to account for outliers. The sample decreases up to 120 countries when we consider control variables which include some missing values in the same sample period.

TABLE A2 Table correlation matrix.

	SDG index score	VC Volumes	VC transactions	FDI inflows	GDP growth rate	Population	Density	GovExp	Free index	Financial development	Credit over GDP
SDG index score	1.000										
VC Volumes	0.537	1.000									
VC transactions	0.543	0.909	1.000								
FDI inflows	−0.002	0.029	0.014	1.000							
GDP growth rate	0.621	0.389	0.397	−0.007	1.000						
Population	0.453	0.169	0.190	−0.200	0.358	1.000					
Density	0.147	0.235	0.257	0.213	0.053	−0.165	1.000				
GovExp	−0.168	0.315	0.404	0.056	−0.291	−0.247	0.241	1.000			
Free index	0.002	0.059	0.062	0.076	−0.063	−0.287	0.083	0.010	1.000		
Financial development	0.690	0.671	0.636	−0.047	0.526	0.403	0.140	0.109	0.052	1.000	
Credit over GDP	0.698	0.500	0.494	0.012	0.423	0.405	0.148	−0.056	0.097	0.681	1.000

Note: Correlation matrix across main indicators included in our dataset.

TABLE A3 Baseline estimations with robust standard errors.

	SDG index score			
Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
Panel A—Concurrent model				
VC Volumes	0.020**	0.029***	0.017**	0.025***
	(0.008)	(0.008)	(0.007)	(0.008)
Observations	924	924	840	840
Adjusted R-squared	0.594	0.542	0.649	0.598
Controls	No	No	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No
Year trends	Yes	Yes	Yes	Yes
Panel B—Lagged model				
VC Volumes	0.016**	0.020**	0.016**	0.014*
	(0.008)	(0.009)	(0.007)	(0.008)
Observations	792	792	720	720
Adjusted *R*-squared	0.535	0.456	0.595	0.547
Controls	No	No	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	Yes	Yes
Year trends	Yes	Yes	Yes	Yes

Note: The analysis covers 7 years from 2015 to 2021 and 132 countries (120 for the models including control variables due to missing values). *SDG Index Score* is a continuous variable ranging from 0 to 100, where a score of 100 indicates that all SDGs have been achieved. *VC Volumes* is a continuous variable built as the natural logarithm of (1 plus) VC-invested volumes in a specific country and year. *Controls* is a vector of control variables described in Section 3. The table reports coefficient estimates followed by robust standard errors in parentheses.

***Statistical significance at the 1% level.

**Statistical significance at the 5% level.

*Statistical significance at the 10% level.

TABLE A4 Interaction between NACE macro-sectors and sustainable development goals.

NACE macro-sector		
Code	**Description**	**Interaction with SDGs**
A	Agriculture, forestry and fishing	Negative
B	Mining and quarrying	Negative
C	Manufacturing	Negative
D	Electricity, gas, steam and air conditioning supply	Negative
E	Water supply	Positive
F	Construction	Negative
G	Wholesale and retail trade	Negative
H	Transportation and storage	Negative
I	Accommodation and food service activities	Negative
J	Information and communication	Positive
K	Financial and insurance activities	Positive
L	Real estate activities	Negative
M	Professional, scientific and technical activities	Negative
N	Administrative and support service activities	Not assigned
O	Public administration and defence	Not covered
P	Education	Positive
Q	Human health and social work activities	Positive
R	Arts, entertainment and recreation	Positive
S	Other service activities	Not assigned
T	Activities of households as employers	Not covered

Note: Author's elaboration based on the study by van Zanten and van Tulder (2021b). The category "Positive" ("Negative") indicates that most of the articles reviewed attribute a positive (negative) interaction of the sector with the SDG. The category "Not assigned" ("Not covered") indicates that no specific interaction with the SDGs is found (documented) in the reviewed articles.