Biodiversity Ventures

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Abstract

This registered report proposes to examine the effectiveness of venture capital (VC) financing for an emerging type of biodiversity organization. Unlike large public firms where biodiversity projects are side initiatives (e.g., Google's Wildlife Insights project), these startup ventures were founded with an exclusive focus on biodiversity. We plan to provide systematic descriptive evidence of these new biodiversity organizations for the first time. We then propose to examine how different tools can improve funding outcomes for biodiversity ventures, which face greater difficulty in securing VC financing due to the limited size and types of the investor base and the complexities of nature-related business models associated with monetizing natural resources. One tool of particular interest is social media, which has been shown in research to improve financing outcomes among startups whose founders lack connections to an established investor network. We explore this early evidence on biodiversity ventures and examine the role of social media in engaging with different investor types, thus serving as an alternative to in-person networking and reducing information asymmetry for biodiversity ventures. Our project employs multiple sources of alternative data including Twitter, LinkedIn, as well as private equity and venture capital investment data from Crunchbase and PitchBook. The proposed results will contribute not only to the burgeoning literature on biodiversity finance by studying an emerging type of biodiversity organization, but also to the more established literature on VC financing by focusing on nature-capital firms and offering new insights into their challenges with information and investor access.

1. Objectives of the study

Biodiversity loss is one of the most pressing environmental issues today, with significant implications for businesses in terms of their operations, reputation, and financial well-being. For example, pharmaceutical companies rely on Limulus amebocyte lysate (LAL), an extract from the blood of horseshoe crabs, which is crucial for detecting even minuscule levels of toxins. The diminishing population of horseshoe crabs presents a significant challenge, as no known natural alternative is as effective. Additionally, every company, regardless of size, industry, or location, helps drive biodiversity loss through vectors such as land and sea use changes, consumption of water and other biological resources, as well as pollution and the production of waste. Even service-oriented companies contribute indirectly through their supply chains and procurement practices. According to the Kunming-Montreal Global Biodiversity Framework (GBF) passed in December 2022:

> *"Biodiversity is fundamental to human well-being, a healthy planet, and economic prosperity for all people, including for living well in balance and in harmony with Mother Earth. We depend on it for food, medicine, energy, clean air and water, security from natural disasters as well as recreation and cultural inspiration, and it supports all systems of life on Earth."*[1]

Biodiversity issues are distinct from conventional climate issues for two reasons. First, the impact of biodiversity loss is irreversible (Karolyi and Tobin-de la Puente, 2023). Once the damage is done, it is permanent and irremediable. Second, compared to climate-linked startup firms, biodiversity ventures face more challenges in delivering financial returns to investors, making it more difficult to raise capital. [2] These factors highlight the need to address biodiversity issues separately from climate issues, particularly in terms of venture financing challenges.

[1] See: <https://www.unep.org/resources/kunming-montreal-global-biodiversity-framework>, or <https://www.cbd.int/gbf/introduction>.

[2] In the climate sector, generating revenue to service debt payments is relatively straightforward: a proposed green energy project produces power, generating cash flows to repay investors. However, the paradox of biodiversity finance lies in its goal of generating revenue by conserving a natural resource rather than transforming it, which is the typical method of monetizing natural resources. (Karolyi and Tobin-de la Puente (2023))

For this project, we propose to study a new type of biodiversity-linked organization that has received little scholarly attention. The conversation regarding biodiversity and corporate responsibility has largely focused on publicly listed and well-established companies (e.g., Google with its project Wildlife Insights). However, unlike these large public firms where biodiversity projects are side initiatives, we use Crunchbase to identify private ventures that are exclusively focused on biodiversity, which we call "biodiversity ventures." These start-ups and private organizations, though relatively small, are fully dedicated to biodiversity and could become significant forces in conservation, much as small start-ups grew into industry giants and ultimately became the leading force of the tech sector.

While these organizations have the potential to save biodiversity, they face additional hurdles in attracting investment compared to conventional start-ups. A 2021 study by the Paulson Institute, The Nature Conservancy, and Cornell's Atkinson Center for Sustainability estimated that the biodiversity financing gap is such that we would need to spend an additional $700 billion annually to reverse the decline in biodiversity by 2030. In terms of biodiversity ventures, i.e., the emerging entities we described above, there are extra funding challenges compared to climate ventures. For example, in 2022, nature tech companies (or biodiversity ventures) only received $1.56 billion in VC investments while climate tech companies received $41 billion.[3] There are reasons behind the financing gap for biodiversity ventures. For example, biodiversity ventures often lack the resources to organize road shows to attract potential investors. Besides resource constraints, their targeted investor base is limited as they engage with impact investors who prioritize environmental and social benefits, while most investors focus on financial returns. Last, mainstream financial media also tends to focus on large corporations, limiting coverage of early-stage ventures with environmental and social impact. Lack of promotion from traditional media makes biodiversity finance even more challenging because biodiversity is a relatively new concept, and many investors, including those involved in impact investing, may not fully grasp its importance and urgency. Given the three potential reasons above, it is crucial to help biodiversity ventures close this financing gap.

[3] This is according to the latest State of Nature Tech Report (2023) from Nature4Climate, Nature Tech Collective, and Serena.

Given the importance of these unexplored biodiversity ventures and their financing challenges, our proposal studies two main questions. First, based on Crunchbase data, we use textual analysis of startup profiles to identify biodiversity enterprises. We find approximately 200 biodiversity ventures that fall into three categories. The first category includes ventures aiming to mitigate biodiversity loss. For instance, Seagrass Technologies, an India-based startup, is developing technology to grow marine microalgae using non-potable water and non-arable land. The second category includes those promoting biodiversity and raising public awareness, such as the Internet of Elephants, a gaming company that creates engaging digital experiences to bring wildlife stories to people. The last is non-profit organizations raising funds to combat biodiversity loss. We provide systematic evidence on these firms, including descriptive statistics and their funding status, and demonstrate how underfinanced they are compared to climate and non-climate firms.

In the second part of this registered report, we propose to study solutions for the financing challenges these ventures face, focusing on how social media can help these biodiversity enterprises raise capital. Our examination is motivated by anecdotal evidence and an important recently published study on VC-financed startups. Anecdotally, in an interview with VC investor Anuraag Guptaa, he described his experience using Twitter for deal sourcing: "Using Twitter effectively for deal sourcing involves strategic engagement and content curation. Start by following key industry influencers, potential investment targets, venture capitalists, and other relevant stakeholders to stay informed about industry trends and emerging opportunities." Similarly, investor Andrew Saunders emphasized in a recent interview: "There are a multitude of effective tools one could implement to use Twitter for deal sourcing. In brief, proficiently leveraging Twitter to deal source can occur by following industry leaders, creating lists, and using strategic hashtags."[4] A recent study by Wang, Wu, and Hitt (2024) also supports the idea that social media can help. They point out that using Twitter can assist start-ups in securing venture financing and enhancing the visibility of women entrepreneurs and others who may lack social capital, addressing funding disparities faced by start-ups founded by these individuals.

We believe social media platforms such as Twitter can play a crucial role in helping private enterprises communicate with investors and secure essential funding for three reasons. First, from

[4] Consistent with the anecdotal evidence, Cao, Fang, and Lei (2021) provide systematic evidence on how corporations widely use Twitters for different business purposes.

a cost perspective, using Twitter is free, enabling new ventures in biodiversity to reach potential investors without the need for expensive roadshows. Additionally, many of these ventures already use Twitter to promote the concept of biodiversity and educate investors, further reducing the costs. Second, these ventures' targeted audience (social investors) are active on social media: biodiversity start-ups focus on social value and need to attract impact-investing investors. Although it is difficult to locate impact-investing investors through traditional channels, many demonstrate their interest in impact investing and showcase their portfolios on their Twitter profiles, making it more a straightforward platform for biodiversity ventures to effectively target and engage with them. Third, using Twitter allows these ventures to control the content and promotion, which is not possible for traditional media who do not normally care about these small organizations.

To execute this analysis as effectively as possible, experimental design matters. To explore whether active engagement on Twitter incrementally contributes to improved financing outcomes for biodiversity ventures, we will first investigate the extent to which Twitter engagement enhances the attraction of investors to biodiversity ventures compared to traditional new businesses, or *the extrinsic value of biodiversity ventures*. Next, to pin down their *intrinsic value*, we also intend to assess their relative effect when compared to climate new businesses involved in carbon capture and green energy generation. For the extrinsic value, we expect that utilizing Twitter can enhance the success of new biodiversity ventures in securing funding, increasing funding levels, and improving their chances of obtaining additional funding. However, despite anecdotal evidence suggesting social media may help, large data analysis may produce different outcomes. The voluntary and unaudited nature of Twitter disclosures lacks the same level of reputational capital as traditional financial media and brokers, potentially diminishing their influence on investor opinion. Thus, our working null hypothesis is that there is no difference in VC financing performance before and after the adoption of social media among biodiversity-linked and other ventures. We expect to reject this null in favor of a specified alternative that social media can alleviate funding disparities for biodiversity-linked firms who are able to use it effectively. For intrinsic value compared to climate firms, we remain more agnostic about the outcomes as we may find that the financing role of Twitter is more pronounced for biodiversity ventures or find no difference between the two types as both are driven by social value and are nontraditional start-ups. Our working null hypothesis in this analysis is that there is no difference in VC financing

performance before and after the adoption of social media among biodiversity-linked and climate-linked ventures. We are less confident that we will ultimately reject this null in favor of a specified alternative that social media can more effectively alleviate funding disparities for biodiversity-linked firms who are able to use it well.

To further investigate how social media helps biodiversity-linked venture financing, we seek to focus on three channels. First, we plan to assess the impact on *different investor types*, such as venture capital versus non-venture capital. As biodiversity new ventures attract both private and blended capital, including non-profit organizations and philanthropic investors, it is crucial to assess the varying impact of Twitter use on attracting investment from different sources. Second, we want to examine other tools to remedy funding disparities to circumvent the *challenge of in-person networking*. The role of social media is, after all, an alternative to in-person forms of interaction, particularly during constraints such as COVID-19. Third, we propose to investigate an *information asymmetry channel*, evaluating how social media impacts biodiversity ventures facing more information asymmetry, proxied by factors like distance between VCs and biodiversity ventures or limited connections among venture CEOs. To enhance our identification, we plan to employ two different natural experiments: one introduces an exogenous increase in Twitter activity (positive) while the other introduces a decrease in Twitter activity (negative). For the positive shock, we will leverage the exogenous shock of Twitter increasing its character limit from 140 to 280 in 2017. This expansion allows for richer content and promotion, facilitating more Twitter activity as suggested by *Forbes*. The negative shock relies on Elon Musk's acquisition and privatization of Twitter in 2022, which decreased Twitter usage by more than 20% on average. We take advantage of the positive (negative) shocks to Twitter activity and explore the empirical evidence on how Twitter promotion of biodiversity ventures positively (negatively) impacts fundraising. When both biodiversity and climate ventures experience a similar exogenous increase or decrease in Twitter activities, we plan to demonstrate how changes in Twitter activity among biodiversity ventures impact their funding outcomes compared to those of climate ventures, thereby enhancing identification strategies.

Related Literature and Potential Extensions

In sum, we plan to introduce a new type of biodiversity venture that has not been studied before and provide descriptive evidence on these firms. Biodiversity firms face unique financial challenges, and we show that social media can help mitigate these issues in different ways: engaging with different investor types, serving as an alternative to roadshows, and reducing information asymmetry. Overall, we offer implications for biodiversity ventures, presenting social media as a convenient financing method and an alternative to traditional roadshows. We are the first to combine biodiversity finance and social media alternative data analytics, demonstrating the benefits of using social media to attract funds for biodiversity ventures and offering insights for other initiatives in biodiversity finance. Echoing two important research calls (Karolyi and Tobin-de la Puente (2023) and Goldstein, Jiang, and Karolyi (2019), we hope to demonstrate how alternative data can be used to address biodiversity-related questions. We believe that future studies in biodiversity finance could benefit hugely from applying alternative data given that this emerging area lacks structured data. For the existing diversity finance studies, our new findings on emerging biodiversity ventures will contribute to the literature in different ways. Our work is closely related to Flammer, Giroux, and Heal (2023), and Junge, Feuer, and Sassen (2023) who study how private capital can help finance the conservation and restoration of biodiversity or at least limit biodiversity loss. In addition, Giglio et al. (2024) model the economic consequences of biodiversity loss in an ecologically founded framework, which provides theoretical foundations for empirical research in biodiversity financial economics. Our paper provides empirical support for reducing biodiversity loss and thereby mitigating its negative economic consequences. We also complement another group of recent working papers that study the pricing of biodiversity risks, such as Garel et al. (2024), Giglio et al. (2023), Coqueret and Giroux (2023), and Xiong (2023). Other notable papers focus on the relation between biodiversity loss and financing costs in the capital markets: Rizzi (2022) and Chen et al. (2023) investigate the relation between natural capital and municipal bond yields, respectively; Hoepner et al. (2023) study the influence of biodiversity, water, and pollution on the CDS term structure; and Soylemezgil and Uzmanoglu (2024) examine biodiversity risks and the borrowing costs of corporate bonds.

Our study could also contribute to the climate finance (ESG) literature and studies of entrepreneurial finance. Biodiversity finance is an emergent and crucial area of ESG and sustainable and climate finance (Edmans and Kacperczyk 2022; Starks 2023). Our work complements a stream of influential climate finance literature such as Bolton and Kacperczyk

(2021, 2023), Bolton, Eskildsen, and Kacperczyk (2024), Krueger, Sautner, and Starks (2020), and Ilhan et al. (2023). Our work also builds on other ESG finance and socially responsible investing (SRI) literature including Dimson, Karakaş, and Li (2015, 2018), Hoepner et al. (2023), and Horan et al. (2022). For studies of private equity and entrepreneurial finance, our study will identify a new challenge for entrepreneurial finance—biodiversity ventures—and provide implications for remedying these difficulties, thus adding to the series of emerging studies related to Lerner et al. (2018), Lerner and Leamon (2023), Lerner, Li, and Liu (2023), Maurin, Robinson, and Strömberg (2023), Kisseleva, Mjøs, and Robinson (2023a, 2023b), Chen and Ewens (2021), and Ewens and Farre-Mensa (2022).

There is potential for a broader research program following this first registered report proposal. Twitter's positive effects may extend beyond VC financing for biodiversity ventures. We believe that there are other key stakeholders to socially motivated enterprises like biodiversity-linked firms, so relevant outcomes can extend to areas like talent acquisition and identifying different customers or suppliers. Job candidates on platforms like Glassdoor often prioritize monetary benefits, making it difficult to recruit employees who are interested in biodiversity initiatives. Biodiversity venture customers and suppliers are also driven by social values, but it may be particularly difficult to locate them. Twitter can be a potential venue to target stakeholders interested in social values, including biodiversity. Thus, social media may help biodiversity ventures identify important stakeholders such as employees, customers, and suppliers, beyond just their prospective shareholders. We are convinced these are worthy follow-up questions for further research.

2. Methodologies and research design

How to identify biodiversity ventures

1. We use textual analysis of startup profiles to identify biodiversity enterprises in Crunchbase, using the biodiversity keywords from Giglio et al. (2023). After the initial identification, we then manually verify each venture by reviewing their individual corporate website.

2. The selection process results in 239 biodiversity ventures. In our draft, we identify three categories: (a) ventures focused on mitigating biodiversity loss (80), (b) ventures dedicated to promoting biodiversity and raising public awareness (112), and (c) non-profit organizations raising funds to combat biodiversity loss (47). If necessary, we can repeat the same exercise for PitchBook for cross-verification.

Description of variables used in the analysis

Key Variables of Interest

TwitterActivity	The measure of Twitter engagements by a venture's official account. This could be the raw number of tweets (excluding replies) posted. Alternatively, following Wang, Wu, and Hitt (2024), it could be the first principal component of the total number of tweets and the Twitter interactions (the total number of reposts, comments, and likes).[5]
HasTwitter	Following Wang, Wu, and Hitt (2024), it is a dummy variable indicating whether a venture has an official Twitter official account or not.
TotalFundingAmt	Total amount of funding received in US dollars [Crunchbase/PitchBook]
Avg funding per round	Avg amount of funding per round in US dollars [Crunchbase/PitchBook]

[5] Most of Twitter studies, e.g., Wang, Wu, and Hitt (2024) and Teoh (2018), do not use textual analysis of the tweets but count the number of postings. This is because tweets are typically very short and include pictures and hyperlinks to other webpages.

#Investor per round	Avg number of investors per round that invest in a venture [Crunchbase/PitchBook]
BVenture	A dummy variable indicating whether a venture is biodiversity-related or not. We consider two control groups (*BVenture*=0) of private ventures. The first group only consists of climate-related new business that only engages in either green energy generation or carbon capture. The second group consists of general private ventures, but we match them to biodiversity-related ventures on industry segment (e.g, 2-digit SIC code) and on the firm size (i.e., the number of employees).
Age	The number of years since the venture was founded [Crunchbase]
#Emp	Total number of employees in the venture [PitchBook]
CEOConnections	The number of CEO connections on LinkedIn
CEOGender	A dummy variable indicating the CEO's gender [PitchBook, LinkedIn]
PromotingBio	An indicator variable equal to one if a biodiversity venture primarily promotes biodiversity and raises public awareness.
NPO	An indicator variable equal to one if a biodiversity venture is a non-profit organization.
Industry	The industry segment in which the venture operates.
Country	The country where the venture operates.
LessConnectedCEO	A dummy variable that equals 1 if CEO connections is less than the sample median. Data on CEO connections are from LinkedIn.
NonVCFunder	A dummy variable indicating whether the investor is a non-VC investor or not. [PitchBook]
Covid	A dummy variable indicating the COVID-19 pandemic period (the calendar year of 2020 and 2021)
DistantFirmInvestor	A dummy variable that equals 1 if the average distance between the venture and the funding investors are greater than the sample median. The data on locations of ventures and investors is from PitchBook.

Planned figures

FIGURE 1

Biodiversity Ventures Across the World

This figure plots the distribution of biodiversity ventures across the world. It can have an overlay of distribution of investors and/or biodiversity risk. [***Note: the figure currently contains artificial data for illustrative purposes. ***]

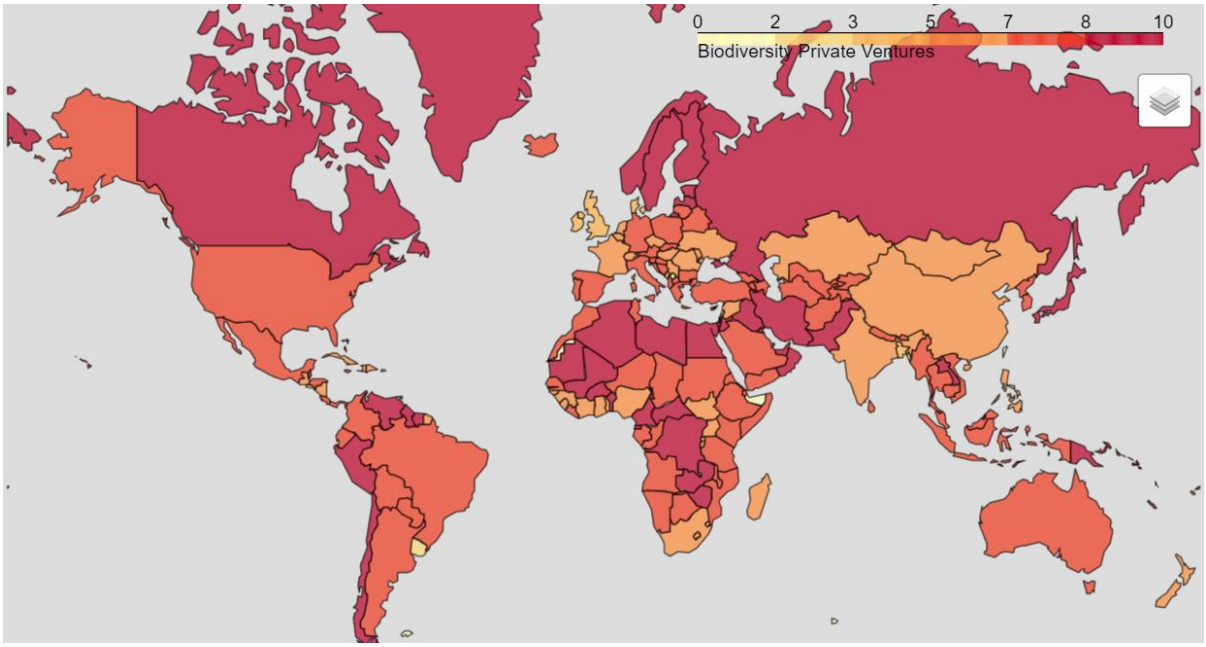


FIGURE 2

Biodiversity Ventures and Funding Over Time

This figure plots the number of biodiversity ventures and the total funding received over the years. [***Note: the figure currently contains artificial data for illustrative purposes. ***]

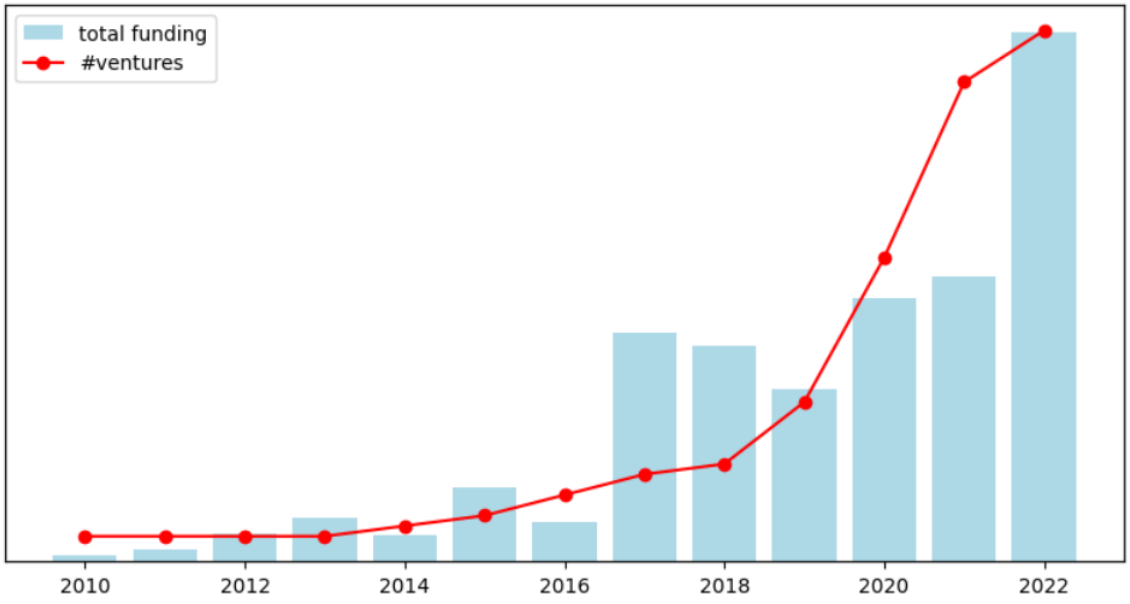
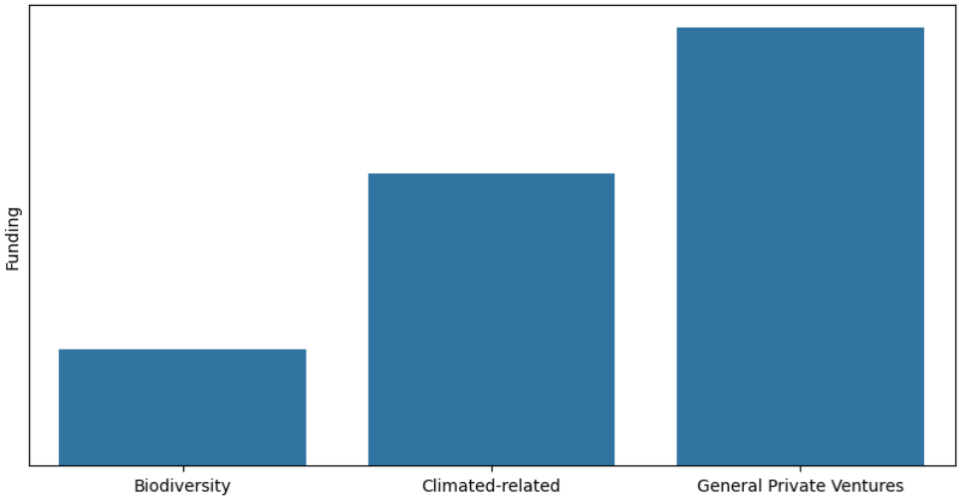


FIGURE 3

Biodiversity Ventures vs Other Ventures for Funding Outcomes

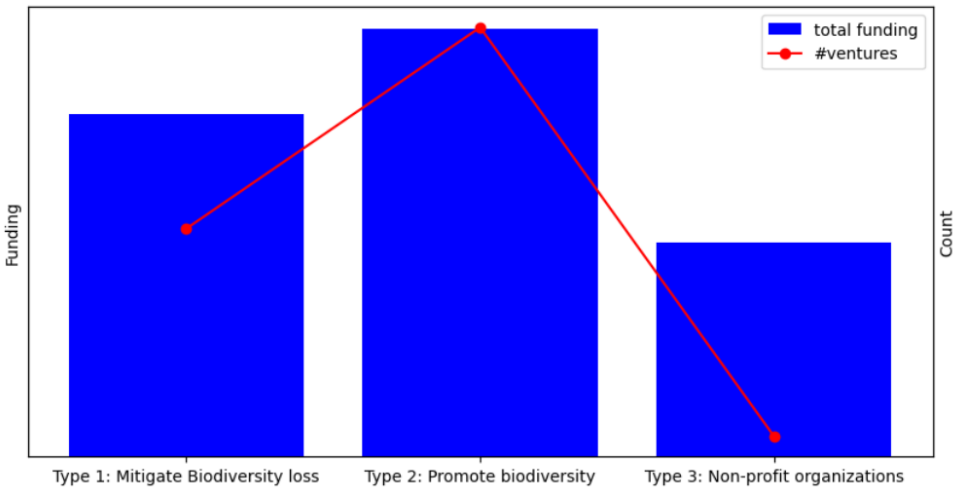
Panel (A)

Panel (A) will compare average funding received by a biodiversity ventures, climate-related private ventures, and other general private ventures. It is expected to highlight that biodiversity enterprises receive less funding relatively. [***Note: the figure currently contains artificial data for illustrative purposes. ***]



Panel (B)

Panel (B) will compare the funding received by different types of biodiversity ventures including those that promote biodiversity and raise public awareness, those that directly mitigate biodiversity loss, and non-profit organizations raising funds to combat biodiversity loss. [***Note: the figure currently contains artificial data for illustrative purposes. ***]



Planned tables

TABLE 1
Summary Statistics

This table will present the summary statistics of the numeric variables used in the empirical analysis.

Statistic	N	Mean	St. Dev.	Q1	Median	Q3
TwitterActivity	X	X	X	X	X	X
HasTwitter	X	X	X	X	X	X
FundingAmt	X	X	X	X	X	X
BVenture	X	X	X	X	X	X
Age	X	X	X	X	X	X
#Emp	X	X	X	X	X	X
CEOConnections	X	X	X	X	X	X
CEOGender	X	X	X	X	X	X
PromotingBio	X	X	X	X	X	X
NPO	X	X	X	X	X	X
LessConnectedCEO	X	X	X	X	X	X
NonVCFunder	X	X	X	X	X	X
Covid	X	X	X	X	X	X
DistantFirmInvestor	X	X	X	X	X	X

TABLE 2

Determinants of Twitter Activities

HasTwitter (TwitterActivitiy) = Venture Characteristics

This table studies the determinants of biodiversity-related venture's Twitter activities. The dependent variable in (1) and (2) is a dummy variable of *HasTwitter* and measures whether the private venture has an official Twitter account or not. The dependent variable in (3) and (4) is a continuous measure *TwitterActivitiy* of Twitter engagement. The determinants being considered include the age of firm (*Age*), the number of employees in the firm (*#Emp*), the CEO's social connections (*CEOConnections*), the CEO's gender (*CEOGender*), whether the venture promotes biodiversity and raise public awareness (*PromotingBio*), and whether the venture is a non-profit organization or not (*NPO*).

	(1) *HasTwitter*	*(2)* *HasTwitter*	*(3)* *TwitterActivity*	*(4)* *TwitterActivity*
Age	X	X	X	X
	(X)	(X)	(X)	(X)
#Emp	X	X	X	X
	(X)	(X)	(X)	(X)
CEOConnections	X	X	X	X
	(X)	(X)	(X)	(X)
CEOGender	X	X	X	X
	(X)	(X)	(X)	(X)
NPO	X	X	X	X
	(X)	(X)	(X)	(X)
PromotingBio	X	X	X	X
	(X)	(X)	(X)	(X)
Country FE	No	Yes	No	Yes

TABLE 3

The Effects of Twitter Activities on Financing

$$Financing\ Outcome_i = 1 + TwitterActivity_i \times BVenture_i + TwitterActivity_i + BVenture_i$$

Panel (A): Extrinsic Effects

This table studies the *extrinsic effects* of Twitter activities on the biodiversity venture's fundraising. For *extrinsic effects*, the control group consists of *general private ventures* matched to biodiversity ventures based on 2-digit SIC code and the number of employees. Data are aggregated over time for a private venture. For instance, *TwitterActivity* measures a private venture's total Twitter engagement up to date. Column (1) measures the total funding received by a venture to date. Column (2) measures financing outcomes by the average funding received per round, addressing the heterogeneity in the number of financing rounds and the funding amount within each round. Column (3) measures financing outcomes by the average number of investors involved in each round, capturing the outreach of a venture's Twitter activity.

	Financing Outcomes		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investors per round*
$TwitterActivity_i \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$TwitterActivity_i$	X	X	X
	(X)	(X)	(X)
$BVenture_i$	X	X	X
	(X)	(X)	(X)
HasTwitter	X	X	X
	(X)	(X)	(X)
Age	X	X	X
	(X)	(X)	(X)
#Emp	X	X	X
	(X)	(X)	(X)
CEOConnections	X	X	X
	(X)	(X)	(X)
CEOGender	X	X	X
	(X)	(X)	(X)
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

TABLE 3 – Cont.

Panel (B): Intrinsic Effects

This table studies the *intrinsic effects* of Twitter activities on the biodiversity venture's fundraising. For *intrinsic effects*, the control group consists of *climate-related private ventures* that work on green energy generation and carbon capture. Data are aggregated over time for a private venture. For instance, *TwitterActivity* measures a private venture's total Twitter engagement up to date. Column (1) measures the total funding received by a venture to date. Column (2) measures financing outcomes by the average funding received per round, addressing the heterogeneity in the number of financing rounds and the funding amount within each round. Column (3) measures financing outcomes by the average number of investors involved in each round, capturing the outreach of a venture's Twitter activity.

	Financing Outcomes		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investors per round*
$TwitterActivity_i \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$TwitterActivity_i$	X	X	X
	(X)	(X)	(X)
$BVenture_i$	X	X	X
	(X)	(X)	(X)
HasTwitter	X	X	X
	(X)	(X)	(X)
Age	X	X	X
	(X)	(X)	(X)
#Emp	X	X	X
	(X)	(X)	(X)
CEOConnections	X	X	X
	(X)	(X)	(X)
CEOGender	X	X	X
	(X)	(X)	(X)
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

TABLE 4

The Effects of Twitter Activities on Financing Across Different Horizons

Panel (A): Extrinsic Effects

$$Financing\ Outcome_{i,t} = 1 + TwitterActivity_{i,t-1} \times BVenture_i + TwitterActivity_{i,t-1} + BVenture_i$$

This table studies the *extrinsic effects* of Twitter activities on the biodiversity venture's fundraising. For *extrinsic effects*, the control group consists of *general private ventures* matched to biodiversity ventures based on 2-digit SIC code and the number of employees. Data are indexed by private venture *i* and time *t*. For instance, $TwitterActivity_{i,t-1}$ measures firm *i*'s Twitter engagement in *t-1* period. As we are not sure about the best measure of period, we will study three different horizons: short horizon (e.g., one month), medium horizon (e.g., one quarter), and long horizon (e.g., one year). Total funding amt measures the total funding received by a venture in period *t*; avg funding per round measures financing outcomes by the average funding received per round in period *t*, addressing the heterogeneity in the number of financing rounds and the funding amount within each round; #investor per round measures financing outcomes by the average number of investors involved in each round during period *t*, capturing the outreach of a venture's Twitter activity.

	Financing Outcomes								
	Short horizon			Medium horizon			Long horizon		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total funding amt	*Avg funding per round*	*#Investor per round*	*Total funding amt*	*Avg funding per round*	*#Investor per round*	*Total funding amt*	*Avg funding per round*	*#Investor per round*
$TwitterActivity_{i,t-1} \times BVenture_i$	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
$TwitterActivity_{i,t-1}$	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
$BVenture_i$	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
HasTwitter	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Age	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
#Emp	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
CEOConnections	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
CEOGender	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 4 – Cont.

Panel (B): Intrinsic Effects

$$Financing\ Outcome_{i,t} = 1 + TwitterActivity_{i,t-1} \times BVenture_i + TwitterActivity_{i,t-1} + BVenture_i$$

This table studies the *intrinsic effects* of Twitter activities on the biodiversity venture's fundraising. For *intrinsic effects*, the control group consists of *climate-related private ventures* that work on green energy generation and carbon capture. Other variables follow the same definitions as in Panel (A).

	Financing Outcomes								
	Short horizon			Medium horizon			Long horizon		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total funding amt	*Avg funding per round*	*#Investor per round*	*Total funding amt*	*Avg funding per round*	*#Investor per round*	*Total funding amt*	*Avg funding per round*	*#Investor per round*
$TwitterActivity_{i,t-1} \times BVenture_i$	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
$TwitterActivity_{i,t-1}$	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
$BVenture_i$	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
HasTwitter	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Age	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
#Emp	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
CEOConnections	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
CEOGender	X	X	X	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 5
Identification Using Positive Twitter Shock

$$Financing\ Outcome_{i,t} = PostCharLimit280_t \times BVenture_i + PostCharLimit280_t + BVenture_i + Controls$$

Panel (A): Baseline Results

This table leverages the increase of Twitter character limit from 140 to 280 as a positive Twitter shock to enhance our identification strategy. The increased character limit allows for longer text, enabling branded URLs, creative tweet structures, and complete sentences in posts. When both biodiversity and climate-related ventures experience a similar exogenous increase in Twitter activities, we aim to demonstrate how changes in Twitter activity for biodiversity ventures impact their funding outcomes (potentially in a stronger way) relative to those of climate ventures. The control group consists of climate-related ventures engaging in green energy generation and carbon capture because they are the most similar to biodiversity ventures in many aspects compared to general private ventures. The horizon will be selected based on the results in Table 4. $PostCharLimit280_t$ is an indicator variable equal to one if *t* is after the increase of character limit.

	Financing Outcome$_{i,t}$		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investor per round*
$PostCharLimit280_t \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$BVenture_i$	X	X	X
	(X)	(X)	(X)
$PostCharLimit280_t$	X	X	X
	(X)	(X)	(X)
Age	X	X	X
	(X)	(X)	(X)
#Emp	X	X	X
	(X)	(X)	(X)
CEOConnections	X	X	X
	(X)	(X)	(X)
CEOGender	X	X	X
	(X)	(X)	(X)
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

TABLE 5 – Cont.

Panel (B): Parallel Trend Analysis

This table will examine the parallel trend assumption underlying Panel (A). $CharLimit280_{t-2}$ ($CharLimit280_{t-1}$) is an indicator variable equal to one if *t* is two (one) periods ahead of the increase of Twitter character limit from 140 to 280. If the coefficients of $CharLimit280_{t-2} \times BVenture$ and $CharLimit280_{t-1} \times BVenture_i$ are not significantly different from zeros, it will support the parallel trend assumption. Other variables are defined similarly as in Panel (A).

	Financing Outcome$_{i,t}$		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investor per round*
$CharLimit280_{t-2} \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$CharLimit280_{t-1} \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$PostCharLimit280_t \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$BVenture_i$	X	X	X
	(X)	(X)	(X)
HasTwitter	X	X	X
	(X)	(X)	(X)
Age	X	X	X
	(X)	(X)	(X)
#Emp	X	X	X
	(X)	(X)	(X)
CEOConnections	X	X	X
	(X)	(X)	(X)
CEOGender	X	X	X
	(X)	(X)	(X)
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

TABLE 6

Identification Using Negative Twitter Shocks

$$Financing\ Outcome_{i,t} = PostAcquisition_t \times BVenture_i + PostAcquisition_t + BVenture_i + Controls$$

Panel (A): Baseline Results

This table will leverage Elon Musk's Twitter acquisition as a negative Twitter shock. Since Musk's takeover, Twitter usage in the U.S. has declined by more than 20%. When both biodiversity and climate-related ventures experience a similar exogenous decrease in Twitter activities, we aim to demonstrate how changes in Twitter activity for biodiversity ventures impact their funding outcomes (potentially in a stronger way) relative to those of climate ventures, thereby strengthening our identification strategies. The control group consists of climate-related ventures focused on green energy generation and carbon capture because they are the most similar to biodiversity ventures in many aspects compared to general private ventures. $PostAcquisition_t$ is an indicator variable equal to one if *t* is after the acquisition.

	Financing Outcome$_{i,t}$		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investor per round*
$PostAcquisition_t \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$BVenture_i$	X	X	X
	(X)	(X)	(X)
$PostAcquisition_t$	X	X	X
	(X)	(X)	(X)
HasTwitter	X	X	X
	(X)	(X)	(X)
Age	X	X	X
	(X)	(X)	(X)
#Emp	X	X	X
	(X)	(X)	(X)
CEOConnections	X	X	X
	(X)	(X)	(X)
CEOGender	X	X	X
	(X)	(X)	(X)
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

TABLE 6 – Cont.

Panel (B): Parallel Trend Analysis

This table examines the parallel trend assumption underlying Panel (A). $Acquisition_{t-2}$ *(*$Acquisition_{t-1}$*)* is an indicator variable equal to one if *t* is two (one) periods ahead of the acquisition of Twitter by Elon Musk. If the coefficients of $Acquisition_{t-2} \times BVenture_i$ and $Acquisition_{t-1} \times BVenture_i$ are not significantly different from zeros, it will support the parallel trend assumption. Other variables are defined similarly as in Panel (A).

	Financing Outcome$_{i,t}$		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investor per round*
$Acquisition_{t-2} \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$Acquisition_{t-1} \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$PostAcquisition_t \times BVenture_i$	X	X	X
	(X)	(X)	(X)
$BVenture_i$	X	X	X
	(X)	(X)	(X)
HasTwitter	X	X	X
	(X)	(X)	(X)
Age	X	X	X
	(X)	(X)	(X)
#Emp	X	X	X
	(X)	(X)	(X)
CEOConnections	X	X	X
	(X)	(X)	(X)
CEOGender	X	X	X
	(X)	(X)	(X)
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

TABLE 7

Cross-sectional Analysis: The Effects of Twitter Activities and Investor Types

Flammer, Giroux, and Heal (2023) discuss biodiversity business can be financed by both private venture capitals (VCs) and hybrid investors including VCs, non-profit organizations and philanthropic investors. We divide the primary investor types as VC only and others. This table echoes the first channel in the proposal which assesses the impact on different investor types. Specifically, it studies the differential effects of Twitter activities on attracting funding from private VCs and other types of investors. Potentially, we expect that the effects of Twitter activities will be stronger for non-VC funders such as non-profit organizations, since VCs have more alternative ways for networking, e.g., roadshows. For biodiversity venture *i* and period *t*, we calculate the funding received from VCs and non-VCs, respectively.

	Financing Outcome$_{i,t}$		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investor per round*
TwitterActivity$_{i,t}$ ×*NonVCFunder*	X	X	X
	(X)	(X)	(X)
TwitterActivity$_{i,t}$	X	X	X
	(X)	(X)	(X)
NonVCFunder	X	X	X
	(X)	(X)	(X)
Controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

TABLE 8

Cross-sectional Analysis: The Effects of Twitter Activities on Financing during COVID-19

This table echoes the second channel in the proposal which examines other tools to remedy funding disparities to circumvent the challenge of in-person networking. Specifically, this table studies the differential effects of Twitter activities during the Covid period defined as the calendar years of 2020 and 2021.

	Financing Outcome$_{i,t}$		
	(1)	(2)	(3)
	Total funding amt	*Avg funding per round*	*#Investor per round*
TwitterActivity$_{i,t}$ ×*Covid*	X	X	X
	(X)	(X)	(X)
TwitterActivity$_{i,t}$	X	X	X
	(X)	(X)	(X)
Covid	X	X	X
	(X)	(X)	(X)
Controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

TABLE 9

Cross-sectional Analysis: The Effects of Twitter Activities and Information Asymmetry

This table echoes the third channel in the proposal which studies how the effects of Twitter activities vary with information asymmetry between CEOs and investors. We use two measures to gauge the information asymmetry: (a) the average distance between the biodiversity venture and investors; (b) the CEO's connections on the LinkedIn.

	Financing Outcome$_{i,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	Total funding amt	*Avg funding per round*	*#Investor per round*	*Total funding amt*	*Avg funding per round*	*#Investor per round*
TwitterActivity$_{i,t}$ × *LessConnectedCEO*	X	X	X			
	(X)	(X)	(X)			
TwitterActivity$_{i,t}$ × *DistantFirmInvestor*				X	X	X
				(X)	(X)	(X)
LessConnectedCEO	X	X	X			
	(X)	(X)	(X)			
DistantFirmInvestor				X	X	X
				(X)	(X)	(X)
TwitterActivity$_{i,t}$	X	X	X	X	X	X
	(X)	(X)	(X)	(X)	(X)	(X)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

3. Timeline of delivery

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