Innovation Economics

InnoEcon, 1(2): 105–115.
DOI: 10.3934/InnoEcon.2026006
Received: 29 June 2026
Revised: 11 August 2026
Accepted: 17 August 2026
Published: 31 August 2026

https://www.aimspress.com/journal/InnoEcon

Research article

The impact of ESG compliance on venture capital funding volume and velocity: A pre-Paris Agreement baseline analysis of logistics startups

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Abstract: This study aims to investigate the baseline impact of early-stage logistics startups' Environmental, social, and governance (ESG) compliance on venture capital (VC) investments within the context of the pre-Paris Agreement period (2013–2015). A dataset comprising 546 early-stage logistics startups was analyzed in the research. The data was analyzed using ordinary least squares (OLS) regression to measure investment volume and the Cox proportional hazards model to measure investment velocity (time-to-first-funding). The findings indicate that, under the conditions of the period, the ESG score was not statistically associated with either the total investment amount received ($p > 0.3027$) or the completion time of investment rounds ($p = 0.6537$). In conclusion, it was determined that in the pre-Paris Agreement era, no statistically significant relationship was observed between ESG scores and VC allocation—neither generating a financial premium nor accelerating time-to-first-funding. This establishes a clear historical baseline, demonstrating that prior to coercive regulatory frameworks, voluntary ESG compliance lacked the strategic leverage.

Keywords: ESG; venture capital; early-stage startups; baseline analysis; Cox regression; OLS regression

JEL Codes: G24, Q56, M13, C41

1. Introduction

Characterized by its energy-intensive operations and intricate supply chain networks, the logistics industry exhibits a high concentration of environmental, social, and governance (ESG) risks (Dai and Tang, 2022; Setyadi et al., 2025). Green logistics solutions, emerging from the digitalization of logistics models via Industry 4.0 and 5.0, transcend being a mere ecological preference to become an imperative for regulatory compliance and operational efficiency (Bhardwaj et al., 2026; Leogrande, 2024; Guo et al., 2015). For startups striving to overcome core industry barriers, such as fossil fuel dependence and waste management, sustainability is not a mere cost item but rather a strategic instrument for long-term risk management and competitive advantage.

Within the global financial ecosystem, sustainability has been systematically integrated into financial performance indicators (Adamopoulou and Gkizori, 2025). ESG criteria have transcended the traditional framework of corporate social responsibility, evolving into a standard metric for measuring the capacity to manage investment risks. In venture capital (VC) markets, the evaluation of early-stage startups is driven not only by their market potential but also by their alignment with global sustainability goals (Lange and Banadaki, 2024).

While current academic studies largely center on the post-investment ESG performance of startups (Alolah et al., 2025; Jianye et al., 2023) the historical baseline of how voluntary ESG compliance influenced venture capital allocation before global regulatory mandates remains underexplored. This paper addresses this gap by conducting a retrospective analysis of the pre-Paris Agreement period (2013–2015), an era when international green finance mandates had not yet matured. Furthermore, the logistics sector was specifically selected as the theoretical context because its high carbon emission intensity and intricate supply chain dynamics allow for a distinct observation of green financing challenges. By evaluating this historical baseline, this study sheds light on how drastically investor priorities and sustainability metrics have evolved in the modern VC ecosystem.

2. Literature review

Extensive research based on large-scale observational and panel data from the Fortune Global 500, the Chinese A-share market, the Brazilian ISE B3 Index, Thomson Reuters, and PitchBook demonstrates that VC investments, especially corporate venture capital (CVC) and syndicated models positively improve firms' ESG performance and sustainability practices by directly participating in corporate governance (Battisti et al., 2022; Jianye et al., 2023; Alolah et al., 2025; Döll et al., 2022).

Additionally, a clear pattern emerges from studies utilizing mixed-methods datasets (e.g., Crunchbase, Chinese automotive records, and UK startup interviews) that explore the impact of corporate strategies and investor-entrepreneur dynamics on business success, ESG maturity (including DEI/D&I), and profitability. These studies indicate that VC financing and the mere adoption of ESG or gender policies are insufficient for profitability on their own; rather, they should be underpinned by "strategic diversity". Consequently, to ensure financial success, firms are advised to abandon singularity, eliminate latent barriers in management, and prioritize long-term value creation (Guzman, 2021; Zhang, 2025; Wang, 2024; Edmans, 2023).

Simultaneously, studies based on UK pension fund data, EU sustainable finance framework documents, literature reviews, and expert surveys have highlighted the regulatory needs for driving

sustainable VC investment (Lin, 2022; Lange and Banadaki, 2024). While these studies demonstrate that direct investor engagement in corporate operations based on ESG metrics increases governance transparency (Alda, 2019; Kölbel et al., 2020), they ultimately highlight a critical necessity: for a systemic and essential market transformation, governments are advised to adopt international standards and establish supportive regulatory frameworks that promote sustainable investments (Antarciuc et al., 2018; Lenhard and Winterberg, 2021).

Recent studies utilizing data from the Chinese stock market and the European Circular Economy Stakeholder Platform (ECESP) explore the impact of ESG on digital transformation and circular economy models. These studies emphasize that high ESG performance significantly reduces corporate financing constraints, which in turn facilitates crucial investments in green innovation and digital infrastructure. Furthermore, research indicates that the successful widespread adoption of these circular and technological models (e.g., smart meters) depends on transparent communication to resolve consumer privacy concerns, the achievement of cost advantages, and external support through public funding (Zhai et al., 2022; Rocca et al., 2023).

Moreover, the current literature provides valuable insights into the environmental footprint of green logistics practices. Findings drawn from a diverse range of sources (local logistics surveys in Romania, qualitative academic research in Morocco, and quantitative macroeconomic metrics from China's National Bureau of Statistics) demonstrate that the technological integration of green supply chain models yields a direct, positive environmental impact by driving down carbon emissions. Ultimately, however, securing structural transformation and long-term success requires both the private and public sectors to fundamentally re-engineer their business processes through the lens of ESG criteria (Constăngıoară and Florıan, 2023; Lan et al., 2015; Larina et al., 2021; Zahra Madhat and Bourrekadi, 2023).

Although current literature demonstrates the strategic significance of ESG in today's market, the way investors assess the ESG criteria of early-stage startups without regulatory mandates remains largely unexplored. Consequently, by focusing on the pre-Paris Agreement period, an era where standardization deficits and resource scarcity were far more prevalent, this research investigates the evolution of VC, utilizing logistics startups as the primary context.

3. Methodology

This section outlines the research design, data collection process, and econometric models employed to measure the impact of ESG compliance on VC investments in early-stage logistics startups. Within the scope of the quantitative research methodology, ordinary least squares (OLS) regression and Event History Analysis (Cox regression) were selected to test the relationships between the financial data and ESG performance of these startups (Gvili and Levy, 2023; Xu et al., 2023; Jyoti and Efpraxia, 2023).

In this study, OLS estimation was employed to assess the relationship between ESG scores and funding volume (investment amount). To complement this, Cox proportional hazards regression was utilized to model funding velocity, specifically measuring the time-to-funding for these early-stage startups (Houston et al., 2010; Reikard, 2005; Gvili and Levy, 2023).

3.1. Hypothesis

Based on the findings of the literature review, the following hypotheses have been formulated to measure the impact of ESG compliance on VC investments:

- **H1:** Early-stage logistics startups with higher levels of ESG compliance secure a greater funding volume during investment rounds compared to their less-compliant counterparts.
- **H2:** Early-stage logistics startups with higher ESG compliance exhibit a greater funding velocity, completing their investment rounds in a shorter timeframe compared to their less-compliant counterparts.

Hypothesis H1 is formulated to assess whether ESG compliance generates a valuation premium, as established by Mansouri and Momtaz (2022). Meanwhile, Hypothesis H2 is built upon the principles of time-based (Cox) analysis regarding investment velocity (duration), as conceptualized by Guo et al. (2015).

3.2. Data sets

Due to restricted access and commercial privacy issues surrounding current VC datasets, this research is designed as a retrospective study. Within this framework, open-source investment data from Kaggle (derived from Crunchbase) were analyzed, covering the timeframe (2013–2015) prior to the Paris Agreement. The 546 logistics startups within the dataset were explicitly identified using the "logistics" and "supply chain" industry classification tags. To maintain financial consistency, funding amounts recorded in various global currencies were standardized to USD using historical exchange rates corresponding to the investment dates. This methodological choice facilitates a baseline assessment of the relationship between ESG compliance and investment outcomes in logistics startups prior to the onset of regulatory enforcement. Furthermore, the logistics sector was specifically selected because its high carbon emission intensity allows for a distinct observation of the dynamics of green financing (Lan et al., 2015).

In contrast to large public corporations, early-stage ventures lack the regulatory obligation to issue standardized ESG disclosures. To address this methodological challenge and prevent look-ahead bias (temporal leakage), all ESG metrics utilized in this study were measured strictly prior to the date of the initial funding round.

3.3. Methodology

The ESG score utilized in this analysis was sourced directly from the dataset's recorded corporate metrics, representing a baseline evaluation of the startup's environmental, social, and governance footprint at the time of observation. This quantitative score serves as the primary independent continuous variable.

Two primary analytical models were employed, drawing upon established methodological approaches in the VC literature. The main reason for selecting two econometric models (OLS and the Cox model) is that the measured dependent variables possess different statistical structures. This dual methodological framework allows for the assessment of ESG performance impacts on VC financing across two distinct dimensions: funding volume and funding speed. Consequently, an OLS regression model was

applied to evaluate the investment amount, whereas a survival analysis-based Cox Model was implemented to measure the investment speed (duration) (Giot and Schwienbacher, 2003; Guo et al., 2015).

While the dependent variables are defined as investment speed (the number of days from funding to the first investment) and investment amount (fund size), the independent variable consists of the ESG compliance score.

To mitigate the high variance in the investment amount data and ensure model validity, a logarithmic transformation was applied to the dependent variable, in accordance with the literature (Guo et al., 2015). Accordingly, the OLS regression model used to estimate the investment amount for this study is formulated as follows:

$$Log(Volume)_i = \beta_0 + \beta_1(ESG_Score)_i + \epsilon_i \quad (1)$$

where:

- $Log(Volume)_i$: Represents the logarithm of the total funding amount received by startup i.
- β_0: Is the constant term (intercept) of the regression model.
- β_1: The coefficient capturing the effect of the independent variable, the ESG score, on the investment amount.
- ESG_Score_i: Indicates the ESG compliance score calculated for startup i.
- ϵ_i: Is the error term.

Following the OLS analysis, a Cox proportional hazards model was utilized to test the funding velocity of the ventures, representing the duration between incorporation and the initial funding round, in accordance with established VC approaches in the literature (Davila et al., 2003; Hege et al., 2009). This survival analysis framework is widely adopted in empirical VC research to estimate the time-to-event probability of acquiring funding alongside the instantaneous hazard rate of investment (Giot and Schwienbacher, 2003; Guo et al., 2015). Because the sample was constructed exclusively from startups that successfully completed a funding round during the observation period, all observations experienced the funding event. Consequently, right-censoring was not applied to the model. The mathematical formula of the Cox Model, adapted to the specific context of this research, is outlined below:

$$h_i(t) = h_0(t)\exp(\beta_1 ESG_Score_i) \quad (2)$$

where:

- $h_i(t)$: Represents the hazard rate, or the probability of startup i receiving an investment at time t.
- $h_0(t)$: Is the baseline hazard rate.
- exp: The exponential function.
- β_1: The proportional hazard coefficient of the ESG score's effect on investment velocity.
- ESG_Score_i: The calculated ESG score for startup i.

4. Findings

This section outlines the results obtained through the applied research methodology, encompassing the descriptive statistics, correlation coefficients, and the outcomes of the econometric regression (OLS and Cox) models. The analyses were conducted on a sample of 546 early-stage logistics startups (N = 546) covering the 2013–2015 period. This establishes a clear historical baseline, demonstrating that prior to coercive regulatory frameworks, voluntary ESG compliance lacked the strategic leverage it possesses in today's mature sustainable investment ecosystem.

4.1. Descriptive statistics and correlation matrix

Prior to estimating the regression models, Table 1 presents the descriptive statistics and the Pearson correlation matrix to examine the overall structure of the dataset.

Table 1. Descriptive statistics and pearson correlation matrix (N = 546).

Variables	Mean	Std. Dev.	Min.	Max.	1	2	3
1. Log (Volume)	13.9546	2.5903	4.6151	22.8283	1.0000*		
2. Time-to-Investment (Days)	886.2967	779.8996	1	3616	0.5099*	1.0000*	
3. ESG Score	50.478	4.6768	45	81	−0.0442	0.0125	1.0000*

Note: * $p < 0.05$ (two-tailed Pearson correlation test).

As shown in Table 1, the mean ESG score of the startups stands at 50.47. The correlation matrix provides a preliminary view of the relationships between the variables prior to running the econometric models.

4.2. OLS regression results for investment volume (Hypothesis H1)

Table 2 summarizes the results of the OLS regression model applied to test the impact of logistics startups' ESG scores on the total funding volume secured during their investment rounds.

Table 2. OLS Regression results for investment volume.

Variables	Coefficient (β)	Std. Error	t-value	p-value
Constant	15.1901	1.2027	12.63	< 0.0001***
ESG Score	−0.0245	0.0237	−1.032	0.3027

Note: Dependent Variable: Log(Volume). Model $R^2 = 0.0020$, Adjusted $R^2 = 0.0001$, F-statistic = 1.0644. *** denotes statistical significance at $p < 0.001$ (N = 546).

According to the findings in Table 2, the coefficient for the primary independent variable, the ESG score, is not statistically associated with the investment amount ($\beta = -0.0245$) is statistically insignificant ($p = 0.3027 > 0.05$). In other words, no relationship was detected between the ESG score

of early-stage logistics startups and their acquired funding volume during the 2013–2015 period. In light of this evidence, Hypothesis H1 of the research is rejected.

4.3. Cox regression results for funding velocity (Hypothesis H2)

Table 3 presents the results of the Cox proportional hazards model, which was constructed to test whether the ESG scores of the startups facilitate the completion of their investment rounds in a shorter timeframe (i.e., reducing the duration from founding to the initial funding).

Table 3. Cox regression results for funding velocity.

Variables	Coef.	Hazard Ratio	Std. Error	z-value	p-value
ESG Score	−0.0043	0.9957	0.0096	−0.4487	0.6537

Note: Dependent Variable: Investment Duration (Days). Concordance Index (C-Index) = 0.5011 (N = 546).

Table 3 indicates that the primary independent variable, the ESG Score, has no statistically significant influence on the hazard rate of acquiring funding ($p = 0.6537 > 0.05$). Schoenfeld residuals test was conducted to verify the proportional hazards assumption, yielding a test statistic of 0.9074 ($p = 0.3408$), confirming the test did not indicate a violation of the proportional hazards assumption and the model is valid. However, the empirical evidence establishes that investors during this period did not actively prioritize ESG-compliant projects and that ESG scores did not compress the duration of the time-to-first-funding. Accordingly, Hypothesis H2 of the study is rejected.

5. Conclusions

Based on the analysis of 546 early-stage logistics ventures operating between 2013 and 2015, this study reveals that the ESG score exerted no statistically significant impact on the volume of venture capital raised (rejection of H1), nor did it accelerate the time-to-first-funding (rejection of H2).

This finding provides empirical evidence that in the pre-Paris Agreement era, investors did not reward ESG compliance with a direct financial premium, nor did they interpret these criteria as a sufficient signal to expedite investment decisions. Prior to the establishment of binding international climate goals, proactive, voluntary ESG practices by early-stage firms were insufficient to overcome market information asymmetry or meaningfully alter VC allocation timelines.

When compared with contemporary literature, these findings reveal the evolution of the VC market, indicating that increasing regulatory pressures today have transformed ESG into a direct valuation factor. For instance, Lange and Banadaki (2024) state that ESG criteria have now become a mandatory factor in long-term investment decisions. Similarly, Jianye et al. (2023) found that VC significantly improves firms' ESG performance by enhancing the quality of information transparency and assuming an active governance role in ESG processes. Furthermore, Kim and Alolah (2025) demonstrated that for both corporate and independent VC, ESG has ceased to be a mere cost element and instead acts as a 'force multiplier' on capital, generating corporate value (profitability). In this context, the findings from the 2013–2015 period confirm that the current regulatory ESG pressures and financial valuation premiums had not yet matured at that time; thus, under those prevailing conditions, ESG criteria impacted the due

diligence process rather than the capital amount. While ESG issues were inadequately represented in early-stage ventures in the past, the integration of ESG awareness among investors and entrepreneurs into financial assessments has become an imperative today (Wang, 2024).

The findings obtained offer strategic implications for contemporary early-stage entrepreneurs and VC investors. Entrepreneurs should position their ESG activities as a strategic tool that facilitates rapid access to financing. Completing funding rounds in a significantly shorter timeframe, thanks to early-stage, proactive ESG approaches, provides a crucial competitive advantage.

For VC investors, it is recommended that ESG metrics be utilized during the initial screening phases not as a risk-hedging tool in investment evaluations, but rather as an early-stage criterion indicative of a venture's corporate transparency. Indeed, recent studies demonstrate that startups exhibiting high ESG performance successfully secure their competitive edge in the market alongside their potential for long-term sustainable growth (Lange and Banadaki, 2024). Furthermore, beyond providing financial capital to ventures, venture capitalists must guide them in corporate governance and enhance their ESG maturity to generate long-term value (Jianye et al., 2023).

The limitations of this research include the retrospective nature of the analysis, which covers the pre-Paris Agreement period (2013–2015), and the restriction of the findings solely to startups in the logistics sector. The 2015 Paris Climate Summit (COP 21) marked a historical turning point, transitioning sustainable development and environmental policies from mere international discussions into an established global framework. Indeed, the greenhouse gas emission targets set by the Paris Agreement have today, through initiatives like the European Green Deal, been transformed into goals of at least a 55% emission reduction by 2030 and carbon neutrality by 2050, thereby creating a legal and binding foundation (Constăngıoară and Florıan, 2023). Therefore, the voluntary ESG dynamics present during the period covered by this research do not fully reflect the current impacts of today's institutionalized and coercive sustainability requirements (e.g., the EU Sustainable Finance Disclosure Regulation-SFDR) (Lin, 2022) on the capital market (Jianye et al., 2023).

Future studies are recommended to utilize contemporary data from the post-Paris Agreement era to comparatively analyze the impact of ESG scores not only on investment velocity but also directly on funding amounts and corporate valuations. Additionally, re-testing models focusing on how dual constraints established through syndication between varying investor types, such as corporate and independent VC, transform the relationship between ESG and financial success within the framework of current regulations would significantly contribute to the literature (Kim and Alolah, 2025). As a result, within the venture capital ecosystem, ESG has evolved from being a mere indicator of vision and trust that once accelerated operational speed into a strategic imperative that presently drives capital efficiency, corporate governance, and sustainable profitability.

Author contributions

Riyad Gasimov: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing–original draft preparation.

Gamze Şekeroğlu: Conceptualization, Supervision, Validation, Writing–review and editing.

Esra Kızıloğlu: Methodology, Supervision, Validation, Writing–review and editing.

Use of AI tools declaration

Gemini was utilized to assist with formatting the manuscript to meet specific journal guidelines, translating minor text segments into English, and refining the overall language, grammar, and structural organization of the draft. Antigravity CLI was employed as an AI coding assistant to aid in the development of the Python scripts used for data processing and statistical analysis.

Acknowledgments

This research received no external funding.

Conflict of interest

All authors declare no conflicts of interest in this paper.

Data availability statement

The original contributions and statistical data presented in the study are included with the manuscript draft and its supplementary material.

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