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## **VENTURE CAPITAL AND ESG PERFORMANCE: HINDRANCE OR HELP?**

***Abstract.** Enterprise Environmental, Social and Governance (ESG) is a highly concerned issue in theory and practice at present. However, the existing research pays little attention to the impact of venture capital on enterprise ESG. This paper takes data from Chinese A-share listed companies from 2012 to 2020 as a sample to study the impact of venture capital holdings on the ESG performance of investee enterprises. It is found that venture capital can significantly contribute to the ESG level of the invested enterprises. State-owned venture capital contributes more significantly to corporate ESG than non-state-owned venture capital. VC had a stronger ESG promotion effect on enterprises facing lower debt repayment pressure and lower pressure of enterprise market value. VC affected the ESG performance of enterprises by participating in corporate governance and improving the quality of information disclosure. This paper enriches the influence of external factors on enterprise ESG from the perspective of venture capital, and also provides a reference for the government to regulate and guide the development of venture capital.*

***Keywords:** Venture capital, enterprise ESG performance, corporate governance, information disclosure*

**JEL Classification: C02, C11, C45, C46, C63**

## 1. Introduction

ESG (Environmental, Social, and Governance) is a performance indicator that focuses on environmental protection, social responsibility, and enterprise governance. ESG is in line with the concept of orderly, high-quality development, and sustainable development (Bolton and Kacperczyk, 2021), and is also an important way to achieve the goal of "double carbon". Since this index was put forward, it has been highly concerned with theory and practice. (Avramov et al., 2021; Guo et al., 2022)

Existing research mainly focuses on the impact and consequences of ESG behaviours, such as investment portfolio and efficiency (Pedersen et al. 2021), market value and performance (Mrkajic et al., 2019; Wong and Zhang, 2022), innovation (Broadstock et al., 2020). In terms of the influencing factors for ESG behaviours, only a few studies have concentrated on the impact of female directors (De Masi et al., 2021), enterprise size (Drempetic et al., 2020), institutional investor shareholding (Bolton and Kacperczyk, 2021), and other factors. However, few studies have focused on the impact of venture capital on enterprise ESG.

With the continuous improvement and development of the capital market, the number and investment amount of China's venture capital institutions are increasing year by year, becoming an important force in China's capital market. Venture capital provides funds for the development of innovative and entrepreneurial enterprises through equity investment and promotes the growth and value appreciation of enterprises by means of capital management or value-added services. Existing research suggests that venture capital has capital, information and professional advantages and has the ability to exert influence on investee firms. First of all, venture capital has strong professional knowledge, research team, and information gathering and analysing ability (Bellon, 2020), which can implement better supervision on invested enterprises. Second, a higher shareholding not only allows the benefits of oversight to outweigh the costs of oversight for VCs, but also gives them higher voting power. They therefore have a stronger incentive and ability to influence the decisions of investee companies. (Krishnan et al., 2011). In addition, the threat of exit from venture capital plays a supervisory role. According to the "authentication hypothesis", in order to reduce agency contradictions and maintain and improve their own interests, venture capital will participate in corporate governance, supervise and influence the behaviour of enterprise management and major shareholders. In this view, venture capital is concerned with the long-term development of the company. However, according to the "grandstanding hypothesis", venture capital promotes immature companies to go public in order to build industry reputation, leading to the "upstart" effect. The "grandstanding hypothesis" holds that there is performance pressure on fund managers, which leads to venture capital not paying attention to the long-term development of enterprises and short-sighted supervisory behaviour. Existing studies seldom pay attention to the impact of venture capital on enterprise ESG, and there is a lack of systematic

theoretical analysis and empirical research on how venture capital affects the ability and willingness of enterprise ESG.

This paper took A-share listed enterprises from 2012 to 2020 in China as a sample to study the impact of VC on enterprise ESG performance and the possible effect mechanism. The contributions of this paper are as follows: First, this paper enriches the research on the external influences on firms' ESG. Existing research focuses on the impact and consequences of ESG behaviours. Existing research lacks antecedent variables, especially the external factors that influence ESG. This paper studies the relationship between VC and enterprise ESG. It finds that VC can significantly improve the ESG performance of invested enterprises and enriches the research on antecedent variables affecting ESG. Secondly, it explores the mechanism of the impact of VC on ESG. Existing studies focus on the influencing factors of ESG, but rarely involve the mechanism of action. Clarifying the mechanism is helpful for the development of enterprise ESG. This paper found that VC affects ESG by participating in enterprise governance and improving the quality of information disclosure, which complements the research on the mechanism of ESG. Thirdly, it studies the relationship between VC and invested enterprise from the perspective of ESG, supplementing the impact of VC on enterprise non-financial activities. Existing studies focus on the impact of VC on enterprise financial activities, while this paper focuses on the impact of VC on enterprise non-financial activities based on ESG.

## **2. Literature Review and Research Assumptions**

The existing research on the impact of VC on invested enterprise is mainly based on the “authentication hypothesis” and “grandstanding hypothesis”. These two hypotheses essentially represent two opposing investment ideas. Holding that VC focuses on the long-term development of invested enterprises, the “Authentication Hypothesis” represents responsible investment behaviour. Based on the concept of value investing, venture capital will bring continuous and effective financial and non-financial value-added services to the investee companies (Cheng et al., 2022; Kaplan and Stromberg, 2001). However, the “Grandstanding Hypothesis” holds that VC is short-sighted and speculative, hoping to exit in time with value-added benefits (Lee and Wahal, 2004; Bhandari and Javakhadze, 2017). It cares only about its own reputation and interests rather than the long-term development of the invested enterprises. This goes against the initial value investing philosophy.

ESG focuses on three types of non-financial indicators: environmental protection, social responsibility, and corporate governance. It emphasises that enterprises should pay attention to non-financial indicators in these three areas. (Avramov et al., 2021). But corporate ESG is a long-term process, and none of these three aspects can be accomplished overnight. In the long run, emphasising ESG is conducive to the sustainable development of enterprises, which in turn increases their value, which is also consistent with the long-term investment philosophy of

venture capital. In the short term, corporate ESG behaviour consumes corporate capital, human and material resources and is not effective, which is inconsistent with the investment philosophy of VC pursuing short-term and quick cash out under the “Grandstanding Hypothesis” (Cheng et al., 2022).

Therefore, both the “Authentication Hypothesis” and the “Grandstanding Hypothesis” are equally applicable to enterprise ESG. Based on these two opposing theories, this paper explores the impact of VC on enterprise ESG.

According to the “authentication hypothesis”, VC is motivated and capable of improving enterprise ESG. On the one hand, in the context of “dual carbon”, VC has an incentive to improve enterprise ESG. An excellent ESG will enhance enterprise value and bring various resources. Macro-policy is influential on micro-enterprise investment behaviour. The strong information advantage of VC enables it to analyse the promoting effect of ESG on invested enterprise value in the guidance of “dual carbon”; thus, VC will affect enterprise ESG before and after investment and help improve invested enterprise ESG in post-investment management (Shao and Sun, 2021). On the other hand, VC can improve enterprise ESG. Venture capital's accumulated industry knowledge, management experience, and social networks will lead investee companies to pay more attention to ESG and increase ESG investment, thus enhancing ESG levels (Cumming et al., 2016). In addition, VCs with a high shareholding in a portfolio company tend to have a board seat, which can influence corporate ESG behaviour by participating in the portfolio company's decision-making. (Borochin and Yang, 2017).

According to the “grandstanding hypothesis”, the impact of VC on enterprise ESG is negative. VC is not an absolute active investor because it may be short-sighted and speculative (Gompers, 1996). However, ESG behaviour is a long-term process that requires more time, capital, and human and material resources (Neubaum and Zahra, 2006). The effect is inconspicuous in the short term. Based on the “Grandstanding Hypothesis”, the VC philosophy contradicts enterprise ESG behaviours. VC expects to quickly withdraw from investment and realise value-added benefits. Therefore, stemming from the maintenance of interests, Venture capital can interfere with corporate ESG investments and other behaviours that are good for the long-term growth of a company, but can affect short-term returns. As a result, there may be serious phenomena such as non-compliance with waste disposal, insufficient social responsibility, unprotected employees' rights and interests, imbalance in the enterprise governance structure, and so on. It hinders sustainable business growth and is contrary to the core concepts of ESG, thus manifesting in poor ESG (Lee and Wahal, 2004).

Based on the above theoretical analysis, this paper proposes the following hypotheses:

- H1a: Compared to an enterprise without VC, the enterprise with VC performs ESG better.
- H2a: Compared to an enterprise without VC, the enterprise with VC performs ESG worse.

### **3. Materials and Methods**

#### ***3.1. Sample and Data***

In this paper, data from Chinese A-share listed companies from 2012 to 2020 is selected as the initial sample and screened based on the following labelling: (1) Excluding ST and \*ST enterprises; (2) Excluding the sample of firms in the financial industry; (3) Excluding samples with missing or incomplete data. There were 12,736 samples after screening. The enterprise ESG data comes from Hexun. Corporate financial data come from the CSMAR database. Whether the sample enterprise has venture capital shareholding, refer to the practice of Tian and Wang to determine (Tian and Wang, 2014). Firstly, the top 10 shareholders were identified, whose names included terms such as “venture capital”, “innovation investment”, “equity investment”, “industry investment,” and “fund management” investment agency in the prospectus. Then the institutions whose main business is “equity investment in unlisted enterprises” were identified as VC by internet searching. Institutions whose main business could not be determined or searched were confirmed using the CVSource database and the “China Venture Capital Development Report.” Finally, the collative VC data was checked against the CVSource to improve accuracy. To avoid the effect of extreme values, the continuous variables were trimmed at the 1% and 99% levels.

#### ***3.2. Variables Definition***

The dependent variable is the enterprise ESG performance, which can be divided into two categories: firms' ESG scores (ESG\_S) and ESG rating (ESG\_R). The ESG performance of listed enterprises is measured by using Hexun's ESG evaluation system. Hexun Web evaluates listed enterprise ESG based on 97 aspects including environment, social responsibility, and enterprise governance, and finally obtains the overall scores and rates. The ESG score is 100 points, and the higher the score, the better the enterprise ESG performs. The ESG rate is divided into 5 grades; A is the highest rank and is assigned a value of 5 and E is the lowest rank and is assigned a value of 1, and so on.

The Independent variable is whether there is venture capital holding (VC); VC is set as a dummy variable, 1 if there are venture capital holdings, and 0 otherwise.

Control variables refer to the practice of Dremptetic et al. (Dremptetic et al. 2020) to control other variables that affect enterprise ESG: enterprise age (Age), enterprise size (Size) , enterprise growth (Growth), enterprise performance (ROIC), asset–liability ratio (Lev), the price-to-earnings ratio (PE), board independence (Indepe), the shareholding ratio of the largest shareholder (Radio), and an equity balance indicator (Balance). In addition, both the year dummy variable (Year) and the industry dummy variable (Industry) are controlled.

### 3.3. Empirical Model

The basic regression model is defined as follows, we used the mixed OLS model for regression analysis, made cluster adjustments at the individual enterprise level, and used robust standard error.

$$ESG_{i,t} = \beta_0 + \beta_1 VC_{i,t} + \beta_2 Size_{i,t} + \beta_3 Age_{i,t} + \beta_4 Lev_{i,t} + \beta_5 Growth_{i,t} + \beta_6 ROIC_{i,t} + \beta_7 PE_{i,t} + \beta_8 Radio_{i,t} + \beta_9 Indepe_{i,t} + \beta_{10} Balance_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (1)$$

Among them, ESG represents the enterprise ESG, using ESG score (ESG\_S) and ESG rate (ESG\_R) in year i, respectively, and VC represents whether there is a venture capital holding.

## 4. Results and Discussion

### 4.1. Descriptive Statistics

Table 1 shows the descriptive statistics of the main variables. Overall, the ESG score of listed enterprises in China are not high, and most of them are rated D. Their ESG needs to be strengthened. The mean of independent variable VC is 0.279, and 3558 samples of 12736 observations have VC holdings.

**Table 1. Descriptive statistics of variables**

Variable	Obs.	Mean	SD	Min.	Mid.	Max.
ESG_S	12736	24.459	17.126	-4.930	21.850	76.010
ESG_R	12736	1.785	0.869	1.000	2.000	5.000
VC	12736	0.279	0.449	0.000	0.000	1.000

### 4.2. Univariate Test by Group

Table 2 shows the results of the univariate analysis. We find that the mean value of samples with venture capital holdings is significantly higher than that of samples without venture capital holdings at the level of 1%, indicating that enterprises with venture capital holdings have a higher ESG performance, which initially supports hypothesis H1a. For the test of the median, the samples with VC are distinctly different from the ones without VC at the level of 1%.

**Table 2. Univariate test by group**

Variable	VC=1			VC=0			Difference Test	
	Obs.	Mean	Mid.	Obs.	Mean	Mid.	Mean difference	Median difference
ESG_S	3558	25.393	23.460	9178	24.097	21.260	1.296*** (4.021)	2.200*** (79.920)
ESG_R	3558	1.829	2	9178	1.768	2	0.061*** (3.654)	0.000*** (11.218)

Note: t-values are in parentheses; \*\*\* indicates a 1% significant level.

**4.3. Regression Analysis**

Table 3 shows the regression analysis results of VC on enterprise ESG. The dependent variables are ESG\_S in columns (1) and (2) and ESG\_R in columns (3) and (4). Columns (1) and (3) only add independent variables for regression. We find that the coefficient of VC is significantly positive at the level of 1%, which verifies hypothesis H1a. Control variables were added to columns (2) and (4) for regression. Both coefficients are significant at the level of 5%. It demonstrates that the enterprises with VC perform ESG better compared to those without VC. Therefore, hypothesis H1a is verified, which supports the “Authentication Hypothesis”. Venture capital seeking long-term benefits believes in corporate ESG consistent with its investment philosophy. When involved in corporate decision-making, they actively monitor and promote corporate ESG behaviour, thus showing a positive impact.

**Table 3. Regression results between VC and enterprise ESG**

Variable	(1)	(2)	(3)	(4)
	ESG_S	ESG_S	ESG_R	ESG_R
VC	3.100*** (9.476)	0.613** (2.009)	0.149*** (8.870)	0.034** (2.104)
Controls	NO	YES	NO	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
N	12736	12736	12736	12736
R-squared	0.175	0.315	0.154	0.228

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

**4.4 Further Research**

**4.4.1 Test of the Role of State-Owned VC Institutions**

According to the ownership of VC institution, the nature of VC can be divided into two types: state-owned and non-state-owned. Each type of VC has different systems, environments, and backgrounds, so they have different investment philosophies. They focus on corporate ESG performance for very different reasons. When state-owned venture capital intervenes in enterprise management, it is for the purpose of promoting enterprises to improve the environment, maintain social stability, and actively fulfil social responsibilities and other non-economic benefits (Abrardi et al., 2019). The starting point of non-state-owned venture capital is centered on economic interests. They pay more attention to the fact that good ESG performance of enterprises symbolises the sustainability of development, and the long-term development of enterprises is related to their own long-term earnings.

Based on the above, for the 3558 samples with VC, a dummy variable VC\_State is set to represent the nature of VC. If the VC is state-owned, the value is 1; otherwise, it is 0. A further study on the impact of different types of VC on enterprise ESG was conducted through empirical research. The results are shown in Table 4. Columns (1) and (3) show the regression results with only independent variables added. The coefficients are significantly positive at the level of 1%. Columns (2) and (4) use all variables for regression. Both are still significantly positive at the level of 1%, which indicates that enterprises with state-owned VC backgrounds have better ESG. Compared to non-state-owned VC, the responsibility orientation makes state-owned VC more active in responding to the call of both society and government. The importance of ESG is now deeply rooted in businesses, but popularisation still requires the joint effects of the whole society. State-owned VC will be more willing to set an example and implement the ESG philosophy in enterprise management. This shows that state-owned venture capital plays a role of certification and value-added, guiding invested enterprises to improve the performance of ESG.

**Table 4. Regression results for different types of VC**

Variable	(1)	(2)	(3)	(4)
	ESG_S	ESG_S	ESG_R	ESG_R
VC_State	2.619*** (3.661)	3.870*** (5.163)	0.135*** (3.635)	0.213*** (5.343)
Controls	NO	YES	NO	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
N	3558	3558	3558	3558
R-squared	0.268	0.177	0.257	0.230

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

#### 4.4.2 Test of the Role of Enterprise Financial Risk

The sample can be divided into two types according to the financial risk of the particular enterprise: high financial risk and low financial risk. The higher the financial risk of the enterprise, the greater the debt service pressure it faces, and the less it can assume social responsibility for the company (Bellon, 2020). In this paper, Lev is used to measure enterprise financial risk and the dummy variable risk is set: when the Lev of an enterprise is greater than or equal to the annual industry median, the financial risk of the enterprise is considered to be high, that is, risk is set as 1; otherwise, the financial risk is low, and risk is set as 0. The results are shown in Table 5. The results show that whether the dependent variable is ESG-S or ESG-R, VC has a stronger ESG promotion effect on enterprises when they face lower debt repayment



pressure. That is to say, the enhancement effect of venture capital on ESG of invested enterprises is more significant in enterprises with less financial risk. Enterprise ESG investment, as a non-economic project with obvious externalities, requires a large amount of capital input and increases enterprise costs. Enterprises with high financial risks are more willing to invest in projects that can obtain profits in the short term to reduce financial risks, so the motivation to invest in environmental protection investment and social responsibility is relatively weak. Even though venture capital has the motivation and ability to improve corporate ESG, the high financial risk makes the invested enterprises have difficulties in ESG investment and restricts their ESG performance. Compared to enterprises with high financial risk, enterprises with low financial risk have fewer concerns and restrictions when making ESG investment. Therefore, under the guidance and help of venture capital, the ESG performance of enterprises with low financial risk will be more excellent.

**Table 5. Regression results for high and low enterprise financial risk**

Variable	ESG_S		ESG_R	
	risk = 0	risk = 1	risk = 0	risk = 1
VC	1.053*** (2.576)	-0.041 (-0.090)	0.069*** (3.193)	-0.017 (-0.700)
Controls	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
N	6538	6198	6538	6198
R-squared	0.175	0.363	0.244	0.316

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

#### 4.4.3 Test of the Role of Tobinq

The sample can be divided into two types according to the pressure of the enterprise market value: high pressure of the enterprise market value and low pressure of the enterprise market value. The higher the pressure of enterprise market value, the less ESG attention companies may have (Borochin and Yang, 2017). In this paper, Tobinq is used to measure the pressure of the enterprise market value, and the dummy variable Tobinq is set: when the Tobinq of an enterprise is greater than or equal to the annual industry median, the pressure of the enterprise market value is considered to be high, that is, Tobinq is set as 1; otherwise, the pressure of the enterprise market value is low and Tobinq is set as 0. The results are shown in Table 6. The results show that whether the dependent variable is ESG-S or ESG-R, venture capital has a stronger ESG promotion effect on enterprises when they face

lower pressure of enterprise market value. In other words, when venture capital is facing enterprises with a high market value pressure, its enhancement effect on ESG performance is not as significant as that of enterprises with a low market value pressure. This is because when faced with ESG investment, a non-economic project with obvious externalities, enterprises with high market value pressure have little incentive to invest in environmental protection and social responsibility for the consideration of short-term market valuation. Too many concerns and pressure, even venture capital certification, its ESG performance is still limited. However, enterprises with low market value pressure are different. They do not have such pressure and concerns, so under the guidance and support of venture capital, they will show better ESG performance.

**Table 6. Regression results for high and low pressure of enterprise market value**

Variable	ESG_S		ESG_R	
	Tobinq = 0	Tobinq = 1	Tobinq = 0	Tobinq = 1
VC	0.7430* (1.938)	-0.026 (-0.052)	0.033* (1.661)	0.010 (0.695)
Controls	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
N	8141	4595	8141	4595
R-squared	0.332	0.309	0.293	0.266

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

#### **4.5. Mechanism Test**

##### *4.5.1 Enterprise Governance Mechanism*

To safeguard their own interests, VC institutions often intervene in the management and decision-making of invested enterprises with their excellent professional capabilities or resource advantages after providing capital support (Cumming et al., 2016). Focusing on the long-term development of enterprises, they will play the role of active investors and send staff to the board of directors of the invested enterprises to participate in ESG investment decisions and guide enterprises to make better ESG performance (Avramov et al., 2021).

Referring to the method of Tian and Wang (Tian and Wang, 2014), whether the members are dispatched by VC institutions is judged through the resumes of the board disclosed in the CSMAR database. After processing the initial samples with VC and excluding those without resident directors, 10755 observations were obtained. As shown in columns (1) and (2) of Table 7, the coefficient of VC is

significant at the level of 1% and 5%. Combined with columns (2) and (4) of Table 3, it is found that after VC participates in enterprise governance, it has a deeper impact on the ESG of invested enterprises, indicating that VC affects enterprise ESG by intervening in enterprise governance.

#### 4.5.2 Information Disclosure Quality Mechanism

According to information asymmetry theory, high-quality information disclosure can eliminate the hidden dangers caused by information asymmetry, strengthen the supervision of VC institutions on enterprise investment behaviours, avoid moral hazard problems, and ensure the role of VC institutions in involving management; therefore, VC institutions are more motivated to influence enterprise ESG (Christensen et al., 2022).

Based on the above, the intermediary variable Information Disclosure Quality (IDQ) is set. According to the rate of the Shenzhen Stock Exchange on the information disclosure of listed enterprises, grades A and B are assigned as 1 and the grades C and D are assigned as 0. Then the samples with missing data are excluded, resulting in 7527 observations. Based on the benchmark regression model, we construct a two-stage regression model to explore the transmission mechanism of venture capital's impact on enterprise ESG performance through information disclosure. The model is set as follows:

$$IDQ_{i,t} = \beta_0 + \beta_1 VC_{i,t} + \theta controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (2)$$

$$ESG_{i,t} = \beta_0 + \beta_2 VC_{i,t} + \beta_3 IDQ_{i,t} + \theta controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (3)$$

The mediation mechanism inspection process is as follows: Firstly, check the regression coefficient of VC on enterprise ESG. As shown in Table 3, all the results are significant. Secondly, check the regression coefficient of VC on IDQ. If the result is significant, then IDQ will be added to the model. If the coefficients of both are significant, it indicates that there is a partial mediation effect. If the coefficient of IDQ is significant while the coefficient of VC is not significant, it is a complete mediation effect.

As shown in column (3) of Table 7, when the dependent variable is IDQ, the coefficient of VC is 0.060, which is significant at the level of 1%, meeting the requirement of the second step. Combining Table 3 and columns (4) and (5) of Table 7, both coefficients are significantly positive at the level of 1%. That is, IDQ has a partial mediation effect on the impact of VC on enterprise ESG.

**Table 7. Regression results for inspection mechanism**

Variable	Enterprise Governance		Information Disclosure Quality		
	(1)	(2)	(3)	(4)	(5)
	ESG_S	ESG_R	IDQ	ESG_S	ESG_R
IDQ				8.459*** (18.124)	0.309*** (12.569)
VC	1.173*** (2.773)	0.053** (2.407)	0.060*** (6383)	0.797** (2.089)	0.047*** (2.355)
Controls	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES
N	10755	10755	7527	7527	7527
R-squared	0.318	0.276	0.092	0.281	0.228

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

**4.6. Robustness Tests**

*4.6.1 Replacing Enterprise ESG Measurement*

For the measurement of the dependent variable, ESG, the ESG rate of the Sino-Securities index is used for testing. The highest value of grade AAA is 9, the lowest value of grade C is 1, and so on. The sample size is slightly reduced due to the removal of missing entries in the Sino-Securities index. Columns (1) and (2) of Table 8 show the regression results of mixed OLS models after replacing the measurement of enterprise ESG. It can be seen that the coefficient of VC is still significantly positive, which shows that the conclusions of this paper are robust.

*4.6.2 Regression Using a Fixed-Effects Model*

The mixed OLS model is used to verify the hypothesis above. To check the robustness of the results, a fixed-effects model is used instead. The regression results are shown in columns (3) and (4) of Table 8. Both coefficients are significantly positive, which proves that the conclusions of this paper are robust.

**Table 8 Regression results for robustness tests**

Variable	Replacing dependent variable		Fixed effects model	
	(1)	(2)	(3)	(4)
	ESG_R	ESG_R	ESG_S	ESG_R
VC	0.435*** (17.165)	0.267*** (11.541)	0.613** (2.009)	0.034** (2.104)
Controls	NO	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
N	12491	12491	12736	12736
R-squared	0.033	0.222	0.170	0.142

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

4.6.3 Regression Using a Fixed Effects Model

(1) Lagged Dependent Variables (LDV)

To alleviate the problem of possible reverse causality between VC and enterprise ESG, the dependent variable is lagged by a period. The regression results are shown in columns (1) and (2) of Table 9. Both coefficients are significantly positive, which proves that the conclusions of this paper are robust.

(2) Propensity Score Matching (PSM)

The propensity score matching method was used to match the samples, all control variables and year were selected as covariables, and 1:1 matching analysis was carried out. After PSM, 7116 samples are obtained. Columns (3) and (4) of Table 9 show the regression results after pairing. We find that the VC coefficients are all significantly positive at the 1% level, further validating the results of the benchmark regression.

(3) Heckman Two-Step Method

The Heckman two-stage method was used to deal with the endogeneity problems caused by sample selection bias. The instrumental variable VC\_Loc is set to determine whether the enterprise is located at a gathering place of VC institutions. According to the "China Venture Capital Development Report", the value of the enterprises located in Beijing, Jiangsu, and Zhejiang is 1, and the value of the rest is 0. The enterprises in a gathering of VC institutions are more likely to get VC investment. However, there is no direct impact on enterprise ESG. The two-step results are shown in Table 9. Column (5) corresponds to the first-step regression: VC\_Loc significantly affects the probability of VC selection at the level of 1%. Columns (6) and (7) correspond to the second-step regression. It shows that the coefficient of VC is still significantly positive after controlling the endogeneity issues, which proves that the results of this paper are robust.

**Table 9. Regression results for endogenous processing**

Variable	LDV		PSM		Heckman Two-Step Method		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ESG_S	ESG_R	ESG_S	ESG_R	VC	ESG_S	ESG_R
VC	1.147*** (3.741)	0.056*** (3.500)	1.442*** (4.480)	0.072*** (4.159)		0.645** (2.114)	0.036** (2.237)
VC_Loc					0.098*** (3.285)		
IMR						10.488*** (3.465)	0.691*** (4.372)
Balance	YES	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES
N	12736	12736	7116	7116	12736	12736	12736
R-squared	0.310	0.269	0.280	0.240	0.147	0.310	0.270

Note: t-values are in parentheses; \*\*\*, \*\*, and \* indicates a 1%, 5%, and 10% significant level.

## 5. Conclusions

This paper selected A-share listed enterprises from 2012 to 2020 in China as a sample to analyse the relationship between VC and enterprise ESG from the perspective of external factors that affect enterprise ESG. This study found that the enterprises with VC perform ESG better, supporting the “Authentication Hypothesis”. It is found that state-owned VC had a stronger role in promoting ESG of invested enterprises than non-state-owned VC. Further, it is found that venture capital plays a greater role in improving ESG of investee enterprises with lower financial risk and market valuation. The reason why venture capital plays a role is that venture capital affects enterprise ESG performance by participating in the corporate governance of invested enterprises and influencing their information disclosure. After replacing the measurement of variables, changing the model specifications, and excluding endogeneity issues, the original conclusions remained robust.

Based on the research conclusions above, the following policy inspiration can be drawn: Firstly, VC can improve enterprise ESG; therefore, the enterprise should introduce more VC to increase the certification effect of VC. As an active investor, VC can help to improve enterprise ESG by accumulating industry knowledge, management, social network, etc. Meanwhile, state-owned VC can promote ESG more effectively. Therefore, businesses should participate in enterprise investment and assume social responsibility. Secondly, VC improves ESG by participating in enterprise governance and improving information disclosure. Firstly, VC should participate as much as possible in governing and influencing ESG by being involved in the decision-making of invested enterprises. Secondly, VC should supervise enterprises to disclose information as much as possible. In addition to mandatory disclosure, non-mandatory information should also be reflected to an increased extent. At the same time, the nation should also unify the information disclosure standards of the top-level design as soon as possible to improve enterprise ESG. Thirdly, VC can improve enterprise ESG. Therefore, when evaluating the investment performance of VC, not only should the current economic benefits be considered, but also the long-term social benefits delivered by VC jointly contributing to the sustainable development of ESG.

This paper studies the impact of VC on enterprise ESG and draws relatively robust conclusions. However, there are still some limitations that can be expanded in future research. Firstly, in addition to the enterprise governance and information disclosure mechanism mentioned in this paper, if the information on VC contracts can be obtained in the future, more in-depth research can be conducted on other related mechanisms of VC affecting ESG, such as the signing of valuation adjustment mechanism. Secondly, after controlling the characteristics of enterprise finance and governance, propensity score matching methods, replacement of variable measurements, change of regression models, and other methods can be used to reduce the possible endogeneity issues. However, due to the lack of exogenous shock events and superior instrumental variables, the interference of endogeneity issues cannot be completely eliminated. In the future, this issue can be solved by identifying suitable instrumental variables.

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