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# *Impact of ESG Performance on Enterprise Innovation Investment*

## *--Evidence from China Listed Enterprises*

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***Abstract:*** Innovation is also playing an increasingly important role in the process of transitioning to high-quality economic development. Therefore, it is imperative that enterprises, as micro-entrepreneurs improving the quality of economic growth, pay attention to the enhancement of their R&D capabilities. So how can positive ESG performance by firms alleviate financing constraints and thus promote R&D investment? Therefore, this paper investigates the impact of ESG performance and financing constraints on R&D investment, which is of great significance in promoting enterprises to pay attention to ESG management, alleviating financing constraints, and promoting the enhancement of R&D capability. The results of this study show that corporate ESG performance has a positive effect on R&D investment; corporate ESG performance has a negative effect on financing constraints; financing constraints play a partly intermediary role in the process of corporate ESG performance affecting R&D investment.

***Keywords:*** ESG, R&D investment, innovation investment, financing constraints.

## 1. Introduction

Since the concept of ESG (Environmental, Social and Governance) was first formally put forward in the 2004 UN report "He Who Cares is a Winner", the United Nations, international organizations, major economies and international ESG rating agencies have made unremitting efforts to build a unified and coordinated mechanism for disclosure of listed companies' ESG information. International ESG disclosure has been developed in developed countries and regions for many years, and although China's ESG disclosure is at a preliminary stage, all sectors of society have paid great attention to the ESG performance of enterprises in recent years. 2021, the release of the "dual carbon target" explicitly included in the "Report on the Work of the Government" has increased the level of attention paid to ESG by the society. The concept of ESG sustainability has attracted more and more researchers to empirically examine the factors that can improve ESG performance [1].

ESG is an acronym for Environment, Social and Governance, and can also be referred to as Sustainable Socially Responsible Investment (SRI). In 2004, the United Nations Environment Programme (UNEPFI) explicitly proposed the concept of ESG investment and launched the ESG Initiative [2]. The ESG evaluation is refers to a company's performance in environmental, social

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responsibility and governance, and it is the international community's standard for measuring the green and sustainable development of enterprises [3].

The core of stakeholder theory is that enterprises should comprehensively balance the interest requirements of each stakeholder, not only focusing on the accumulation of shareholder wealth. Stakeholders in this context include not only pressure groups such as the enterprise's trading partners and government departments, but also objects affected by the enterprise's business activities such as the natural environment [4]. The China Securities Regulatory Commission (CSRC) issued the revised Code of Governance for Listed Companies (China Securities Regulatory Commission Announcement [2018] No. 29), which adds content requiring corporate responsibility in environmental and social aspects, clearly articulates corporate responsibility to stakeholders and other aspects, and establishes a basic framework for ESG disclosure. This makes it more likely for investors to judge their investment direction through a company's ESG performance. Liu Huiyuan [5] argues that this is conducive to the formation of positive interactions between investors and investee companies, thus further developing the integration of green finance with high quality.

R&D, or research and development activities, aims to explore new ideas using existing knowledge and apply the new technologies resulting from the exploration to productive practices, ultimately realising the transformation and upgrading of products and the improvement of service quality.

## 2. Research Hypothesis

Based on the theory of resource dependence, a better ESG performance will lead to a deeper connection between the enterprise and its stakeholders, which is conducive to the enterprise's continuous access to the resources needed for R&D and innovation activities. Stakeholders of an enterprise come from different industries and have different backgrounds, and hold some advantageous resources such as knowledge and technology that are difficult for the enterprise to obtain through its own accumulation, and these diversified information resources are crucial to the enterprise's innovative development and R&D capability.

These diversified information resources are crucial to the innovation and development of enterprises and the improvement of their R&D capability. The close relationship between the enterprise and its stakeholders will lead to the sharing of external information by the stakeholders, enriching the enterprise's internal knowledge reserve, making it easier to stimulate the enterprise's innovation capability and increase the conversion rate of the enterprise's R&D investment. Enterprises have an incentive to meet stakeholder expectations by actively taking ESG responsibility to obtain the resources needed for R&D and innovation to realize their innovative development. Here the first hypothesis is proposed as follow:

H1: ESG performance of an enterprise has positive impact on R&D investment, which means the better ESG performance is, the more investment in R&D will be.

Based on the pecking order theory, internal financing is the preferred financing method for enterprises because of its cost advantage, and enterprises will consider external financing only when their internal funds are insufficient. R&D activities not only require enterprises to have sufficient sources of funds, but also require enterprises to have a stable capital chain, while the internal funds of enterprises cannot meet the needs of R&D activities, so enterprises have to turn to the external capital market to seek financial support. By actively fulfilling ESG responsibilities and making timely and accurate disclosure, enterprises can send a positive signal to the outside world that they have great development potential and strength, and while accumulating a good reputation for the enterprise, they also make more capital suppliers, especially institutional investors who pay attention to ESG performance, optimistic about the future development trend of the enterprise, and are willing to provide funds to help the enterprise to carry out R&D activities. At the same time, based on stakeholder theory, good ESG performance of enterprises can enhance the relationship between

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enterprises and government agencies, and it is easier to obtain financial subsidies, tax incentives and policy support from the government, which in turn broadens the financing channels of enterprises and provides favourable economic conditions for R&D and innovation. Based on the above analysis, good ESG performance can alleviate the problem of "expensive and difficult financing" faced by enterprises to a certain extent, reduce the financial pressure faced by enterprises, and support their R&D and innovation behaviors. Therefore, this paper puts forward the following hypotheses:

H2: An enterprise which has a high ESG rating may invest more in R&D through mitigating its financing constraint.

## 3. Research design

### 3.1. Sample and Data

Data are collected from a variety of resources. ESG value is searched from Sino-Securities Index Information Service (Shanghai). Other data such as research development and financing constraints are sourced from CSMAR. The criteria for data selection referring to existing scholars' papers are as follows: (1) Time period of this essay starts from 2010 to 2022. (2) Sample corporations: All enterprises are China A-share listed companies. (3) This essay excludes companies in the ST and PT categories and also companies in the financial sector. (4) Samples which miss important values are deleted. Finally, there are 31270 complete observations.

### 3.2. Variable Description

#### 3.2.1. Dependent Variable

Investment on research & development is the dependent variable which is calculated as the percentage ratio of R&D investment and revenue [6].

#### 3.2.2. Independent Variable

Currently, the number of global ESG rating agencies has exceeded 600, while the number of Chinese rating agencies is about 20. Famous domestic rating agencies include Shanghai CSI Index Information Service Co. and China Securities Investment Funds Association. Taking CSI as an example (CSI ESG), it generates 26 ESG key indicator scores by constructing an ESG standardized database and conducting data processing based on objective data from the ESG standardized data platform based on the characteristics of China's listed companies and industries on a quarterly basis; based on the indicator scores and weighting matrices, it calculates ESG scores. The CSI ESG indicator system takes environment, society and corporate governance as the three pillars, with a total of 14 themes, such as green products, social business activities, corporate governance structure, etc., containing 26 key indicators and more than 130 sub-indicators for a comprehensive score. The CSI ESG rating gives the subject an "AAA-C" rating with nine grades, and the total ESG score, primary, secondary and tertiary indicators are all standard scores ranging from 0-100, with higher scores indicating better performance.

In the study, the existing literature mainly adopts the method of assigning ESG ratings from low to high in order of 1-10 points to measure the performance (if the CSI is used, it will be assigned 2-10 points), and the higher the score indicates that the company's ESG performance is better [7] [8] . This paper will take a similar approach by dividing ESG ratings into 9 grades and assigning scores from 1 to 9 from low to high as the table shown below. The higher the score, the better the performance of the rated subject on the indicator.

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Table 1: Transformation from ESG performance rating into score

| Rating | AAA | AA | A | BBB | BB | B | CCC | CC | C |
|---|---|---|---|---|---|---|---|---|---|
| Score | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

### 3.2.3. Intermediary Variable

Financial constraint is researched as an intermediary variable. It is shown that there are various methods to measure financial constraint in current research papers. Dominant measuring methods include using index such as KZ, SA and WW index. SA index is picked as the measuring method because it is the only one that do not exist endogenous issues for it is calculated by size and age according to Hadlock & Pierce [9]. It avoids to use specific financial index. The calculation equation is shown below:

$$SA = -0.373 \times Size + 0.043 \times Size^2 - 0.04 \times Age \quad (1)$$

In order to conveniently analyze, the absolute SA value is substituted to be the intermediary variable to measure financial constraint.

### 3.2.4. Controls

Referring to current literatures [10] relevant to ESG performance and research & development investment, this research controls corporate age (Age), corporate size (Size), financial leverage (Lev), return on assets (ROA) and first shareholder shareholding (Shrer).

Table 2: List of variables

| Type | Abbreviation | Variable | Description |
|---|---|---|---|
| Dependent Variable | RD | Research & Development | R&D investment/revenue * 100% |
| Independent Variable | ESG | ESG Performance | CSI ESG rating index (1–9) |
| Intermediary Variable | FC | Financial Constraints | Refer to SA index |
| Controls | Age | Corporate Age | Years of listing of corporate |
| | Size | Corporate Size | ln (Total Assets) |
| | Lev | Financial Leverage | Total liabilities/Total assets |
| | ROA | Return on Assets | Net Profit/Net Assets |
| | Shrer | First Shareholder Shareholding | First shareholder shareholding ratio |

## 3.3. Model Specifications

For hypotheses H1: Using the data above, this paper constructs a fixed effects logistic regression model by taking ESG performance (ESG) as the independent variable and research & development investment (RD) as the dependent variable, and further considering industry and year fixed effects after controlling for company idiosyncratic variables, as well as joining the companies for the clustering of the standard error to alleviate heteroskedasticity brought about by the differences in the companies. The regression model is obtained as follows:

$$RD_{i,t} = \alpha + \beta_1 ESG_{i,t} + \beta_2 Controls + IndFE + YearFE + \varepsilon_{i,t} \quad (2)$$

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# 4. Empirical Results

## 4.1. Descriptive Statistics

Table 3 demonstrates the result of descriptive statistics of main variables, which shows the number of observations, mean, median, standard deviation, and maximum and minimum values for each variable after winsorizing the first and last 1% extremes. It is clearly indicated that the mean value of the samples is about 4, which means the average ESG performance of these enterprises is level B. Also, its 1.055 standard deviation value implies a quite great difference between each observation. The great range of investment shows that the results of the descriptive statistics of the control variables are within a reasonable range and the distribution of each data is sufficiently dispersed to have a high degree of reliability for empirical research.

Table 3: Result of descriptive statistics

| | Obs | Mean | Median | SD | Min | Max |
|---|---|---|---|---|---|---|
| ESG | 31270 | 4.173 | 4.000 | 1.055 | 1 | 8 |
| RD | 31270 | 4.883 | 3.700 | 5.087 | 0 | 29.38 |
| SA | 31270 | 3.807 | 3.808 | .257 | 3.136 | 4.438 |
| Size | 31270 | 8.327 | 8.117 | 1.275 | 6.182 | 12.422 |
| Age | 30714 | 2.893 | 2.944 | .342 | 1.792 | 3.526 |
| Lev | 25019 | .421 | 0.415 | .195 | .063 | .881 |
| ROA | 28174 | .039 | 0.039 | .062 | -.239 | .204 |
| Shrer | 28076 | 34.083 | 31.935 | 14.423 | 9.13 | 73.13 |

## 4.2. Correlation Analysis

The Pearson and Spearman correlation analysis is reported in Table 4. It shows that the correlation between research & development (RD) investment and ESG performance (ESG) is positively and significantly relevant (0.035***). In order verify the multicollinearity problem between variables, the variance inflation factor (VIF) of all independent variables and control variables is calculated. The average VIF coefficient is 1.29, which is below critical value 10 so that there is no multicollinearity problem in this research.

Table 4: Correlation analysis

| | RD | ESG | Size | Age | Lev | ROA | Shrer |
|---|---|---|---|---|---|---|---|
| RD | 1 | 0.0385* | -0.3040* | -0.0720* | -0.3289* | 0.0675* | -0.1950* |
| ESG | 0.035*** | 1 | 0.1833* | -0.005 | -0.0629* | 0.2119* | 0.0833* |
| Size | -0.235*** | 0.156*** | 1 | 0.2143* | 0.4909* | -0.0044 | 0.1606* |
| Age | -0.092*** | -0.030*** | 0.221*** | 1 | 0.1175* | -0.0727* | -0.0804* |
| Lev | -0.307*** | -0.067*** | 0.486*** | 0.128*** | 1 | -0.3891* | 0.0539* |
| ROA | -0.041*** | 0.212*** | 0.009 | -0.085*** | -0.337*** | 1 | 0.1041* |
| Shrer | -0.178*** | 0.088*** | 0.188*** | -0.094*** | 0.060*** | 0.130*** | 1 |

*** p<0.01, ** p<0.05, * p<0.1

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## 4.3. Regression Results

Since correlation analysis tests only the relation between two different variables without considering the joint influence of multiple factors, the results have limitations and therefore do not accurately and truly reflect the correlation between the variables.

The correlation between the two variables cannot be accurately and truly reflected. In order to further examine the impact of ESG performance on R&D investment, this paper uses Stata 17.0 software to conduct regression analysis on the sample data, so as to make the empirical results more informative, and the regression results are shown in Table 5.

Table 5: Analysis of ESG, financial constraints and R&D investment regression

| Variables | RD | FC | RD |
|---|---|---|---|
| | (1) | (2) | (3) |
| FC | | | -0.997*** |
| | | | (0.27) |
| ESG | 0.140*** | -0.007*** | 0.262*** |
| | (0.04) | (0.001) | (0.028) |
| Size | -0.03 | -0.027*** | -0.275*** |
| | (0.05) | (0.003) | (0.030) |
| Age | -0.1.418*** | 0.708*** | 0.063 |
| | (0.21) | (0.007) | (0.214) |
| Lev | -5.565*** | 0.029*** | -7.526*** |
| | (-0.374) | (0.010) | (0.188) |
| ROA | -8.249*** | 0.136*** | -10.724*** |
| | (0.864) | (0.020) | (0.510) |
| Shrer | -0.016*** | -0.000*** | -0.049*** |
| | (0.004) | (0.000) | (0002) |
| Constant | 11.625*** | 2.01*** | 14.674*** |
| | (0.725) | (0.031) | (0.638) |
| Industry FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Adjusted-$R^2$ | 0.4247 | 0.830 | 0.1451 |
| Observations | 24383 | 24383 | 24383 |

### 4.3.1. Dominant Regression analysis

The regression result of equation (2) is shown in the column (1) in table 5. It shows that the correlation between R&D development investment is 0.14 and it is significantly relevant at 1% level after controlling both industry and year fixed effect. Additionally, the positive symbol indicates that as ESG performance improves, R&D development investment is likely to increase. The higher the ESG score rates, the better performance on environment, society and governance the corporation will have. This result implies that a corporation which pays more attention on ESG performance is more likely to invest and pay more on its research and development part in order to improve its manufacturing and products quality, lift manufacturing and service efficiency so that its customers may have more opportunities to enjoy better products and service.

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### 4.3.2. Analysis of the Mediating Effects of Financing Constraints

The result of mediating effects of financing constraints is shown in the table 5. The research uses Bootstrap to check the results to obtain the proportion of direct effect and the significance from confidence interval. From the column (2), it clearly indicates that ESG performance has a negative impact on financial constraints since its coefficient figure is -0.007, which is statistically significant. Also, the negative coefficient between financial constraint and R&D investment implies that as the financing difficulties gain serious in an enterprise, it is likely to lead a lower investment in R&D. Therefore, it may analyze that ESG performance stimulates investment in R&D through mitigating a company's financial problems.

Table 6: Result of Bootstrap test

| Financial Constraint | Observed Coefficient | Bootstrap std. err. | z | P>\|z\| | Normal_based [95% conf. interval] | |
|---|---|---|---|---|---|---|
| Indirect effect | 0.0143587 | 0.0039596 | 3.63 | 0.000 | 0.0065981 | 0.0221194 |
| Direct effect | 0.4129263 | 0.0292333 | 14.13 | 0.000 | 0.35563 | 0.4702226 |

## 4.4. Robustness Check

The mean of the ESG performance of other listed firms in the same province where each sample firm is registered each year (ESG_mean) is used as the instrumental variable. Firstly, due to the influence of regional policies and cultural environment, enterprises in the same city have a certain degree of similarity in ESG performance; secondly, the ESG performance of other enterprises in the place of registration of each enterprise is less likely to directly affect the R&D investment of the enterprise. Therefore, the mean ESG performance of other listed companies in the same province in the same year meets the condition of being used as an instrumental variable. The results of the first stage regression show that the instrumental variable (ESG_mean) is significantly and positively related to the endogenous variable ESG at the 1% level, suggesting that the instrumental variable is desirable. The second stage regression results show that ESG performance and R&D investment are still significantly positively correlated at the 1% level, indicating that the main hypothesis of this paper still holds after considering the endogeneity problem.

Table 7: Robustness checks: 2SLS regression

| | First stage: RD | Second stage: RD |
|---|---|---|
| ESG | 0.268*** | |
| | (0.0281) | |
| ESG_mean | | 2.251*** |
| | | (0.270) |
| Size | -0.242*** | -0.716*** |
| | (0.0285) | (0.0736) |
| Age | -0.651*** | -0.594*** |
| | (0.0928) | (0.111) |
| Lev | -7.555*** | -6.196*** |
| | (0.188) | (0.323) |
| ROA | -10.89*** | -16.53*** |
| | (0.508) | (0.879) |

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Table 7: (continued).

| | | |
|---|---|---|
| Shrer | -0.0480*** | -0.0501*** |
| | (0.00207) | (0.00252) |
| Constant | 12.64*** | 8.151*** |
| | (0.320) | (0.775) |
| Observations | 24383 | 21506 |
| Industry FE | Control | Control |
| Year FE | Control | Control |

## 5. Conclusion

Good ESG performance can significantly boost firms' R&D investment. This paper draws on the research of previous scholars to take the ratio of R&D investment to operating income as a measure of the level of R&D investment, and uses the CSI ESG rating data to quantify the ESG performance of enterprises, and conducts empirical analyses on the relationship between the ESG performance of enterprises and their R&D investment. The results of the study show that the higher the score of ESG performance, the higher the level of R&D investment. This paper argues that enterprises that actively fulfil their ESG responsibilities tend to pay more attention to the realisation of long-term corporate value, and R&D, as an investment activity that can significantly enhance the core competitiveness of enterprises, is crucial to the long-term development of enterprises, so R&D investment has become an important way for enterprises to fulfil their ESG responsibilities to their stakeholders; at the same time, enterprises focusing on their ESG performance are more concerned about the diversified needs of stakeholders, and the relationship between ESG performance and R&D investment is more important than ever. In order to improve the satisfaction of consumers, employees, and government, companies will actively participate in R&D activities to upgrade and innovate their products, services, and technologies; in addition, good ESG performance can help companies build up a public image of integrity and responsibility, which will help them gain a better reputation in the society.

In addition, good ESG performance can help enterprises establish a public image of integrity and responsibility. With the widespread concern of the society and investors, enterprise managers are forced to give up the pursuit of private interests due to the pressure of performance and reputation, and turn to the rational allocation of resources through scientific decision-making, so that resources can be channeled to areas that can enhance the operation of the enterprise.

Instead, they will make rational allocation of resources through scientific decision-making, so that resources will flow to R&D activities that can improve the business performance of the enterprise.

Financing constraints partially mediate the relationship between firms' ESG performance and R&D investment. The improvement of R&D and innovation capability is an important way for enterprises to achieve high-quality development, but R&D, as an activity with high capital demand, long investment cycle and confidentiality, makes enterprises face the problems of expensive and difficult financing. Based on the information asymmetry theory, the positive ESG performance of enterprises can provide investors with transparent non-financial information, which not only meets the demand of investors for decision-making usefulness, but also wins the trust of stakeholders, and enterprises can not only get more financial support, but also obtain lower-cost commercial loans by virtue of good development prospects and lower financial risks, thus reducing the negative impact of financing constraints on R&D investment. This reduces the negative impact of financing constraints on R&D investment. Thus, financing constraints become an intrinsic channel for ESG performance to promote R&D.

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