

Can the Opening of High Speed Rail Boost Corporate ESG?

- Empirical Evidence from China

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Abstract: ESG provides quantitative indicators of corporate sustainable development, which is currently an important reference basis for evaluating the development of enterprises in various countries. However, fewer scholars have studied corporate ESG performance based on the perspective of high-speed railway opening. Therefore, this paper takes China, where high-speed rail is developing rapidly, as the study area, and uses the relevant data of Chinese listed companies from 2010 to 2021 to study the relationship between high-speed rail opening and corporate ESG performance. We find that (1) the opening of high-speed rail will enhance firms' ESG performance. (2) Firms with higher external attention have better ESG performance. (3) Financing constraints play a moderating role.

Keywords: high-speed rail opening, ESG performance, Financing constraints

1. Introduction

By November 2023, China's high-speed railway mileage will reach 43,700 kilometres. It has an important role to play in the development of various societies. Firstly, high-speed rail itself has low carbon emissions, which can reduce the pollution produced by enterprises in the production process [1]. At the same time, high-speed rail also has a green spillover effect [2]. In other words, the opening of high-speed rail in order to promote the technological upgrading of enterprises is also conducive to the exercise of the right of supervision by various external actors. Secondly, the opening of high-speed rail increases the fairness between enterprise management and ordinary employees [3]. In addition, the opening of high-speed railway strengthens the connection between enterprises and customers and protects the rights and interests of customers. Finally, the opening of high-speed rail makes the cost and difficulty of shareholder monitoring will be greatly reduced, alleviating possible agency problems and improving internal corporate governance [4]. Therefore, this study selects Chinese listed companies for empirical testing. It is found that the opening of high-speed railway improves firms' ESG performance. In addition, we find that market attention also affects the impact relationship. Our study also shows that the greater the firm's own financing constraints, the smaller the impact of the opening of a high-speed railway on the firm's ESG performance.

This paper has some contributions. First, ESG is affected by various aspects such as politics, culture [5-6], and fundamental firm characteristics [7-8]. However, fewer scholars have examined the influence of HSR on environmental, social and governance (ESG) performance, and our study enriches existing research. Secondly, many scholars have explored the impact of high-speed rail

opening on firms' cost, performance and innovation with the new economic geography theory and signalling theory [9-10], but there is a lack of exploring firms' ESG performance, and this study expands the application of related theories to a certain extent.

2. Data and Summary Statistics

2.1. Data and Sample

We selected Chinese listed companies from 2010 to 2021 for this study. The ESG score data in this study is from Bloomberg database, and the HSR station data and other data are from China Research Data Service Platform (CNRDS), which makes the data of this study more reliable. In addition, in order to make the sample selected for this study more representative, listed companies in the financial and real estate industries as well as companies in risk warning status were excluded from this study. After the downsizing process, the present study finally obtains 11,413 observations.

In order to control the influence of other factors on this study, financial leverage, firm size, board size, firm growth, firm age, Tobin's Q and book-to-market ratio are selected as control variables in this study, controlling for industry and year. As shown in Table 1.

Table 1: Variable definitions.

Variables	Description
ESG	Bloomberg ESG Rating Score
HSR	The value is 0 before the opening of the high-speed railway and 1 after the opening of the high-speed railway
Size	Logarithm of total assets at the end of the period
Board	Board of Directors
Growth	Operating income growth/year-earlier operating income
LEV	Total liabilities/total assets
Age	Statistical year-opening year+1
TB	TB Tobin's Q
BK	BK Shareholders' Equity/Market Capitalization
Time	Year Dummy variable
Industry	Industry Dummy Variable

2.2. Summary Statistics

Table 2 aggregates the summary statistics and correlation matrix of the main variables in our study. Panel A shows the quantitative characteristics of the sample.. We can find that the standard deviation of ESG scores of listed companies is 8.81, which tentatively suggests that the ESG performance of Chinese listed companies is mixed and there is much room for improvement. Panel B of Table 2 reports the results of the Pearson correlation test. It can be tentatively concluded that the opening of high-speed railways is positively correlated with firms' ESG scores. This result tentatively supports our conjecture.

Table 2: Summary statistics.

Panel A: Summary statistics of variables									
Variables	N		Mean	SD		Min	Median		Max
ESG	11413		28.15	8.810		11.72	27.28		55.30
HSR	11413		0.890	0.320		0	1		1
LEV	11413		0.480	0.200		0.0700	0.490		0.900
Size	11413		23.19	1.330		20.45	23.07		26.97
Board	11413		9	1.860		5	9		15
TB	11413		2.180	1.600		0.850	1.620		10.01
Bk	11413		0.670	0.270		0.110	0.670		1.220
Age	11413		13.02	7.270		0	13		27
Growth	11413		0.180	0.400		-0.510	0.110		2.610
Panel B: Correlation matrix									
Variables	ESG	HSR	LEV	Size	Board	TB	Bk	Age	Growth
ESG	1	0.207	0.073	0.457	0.02	-0.027	0.129	0.193	0.016

3. Main Results

3.1. High-speed rail opening and corporate ESG performance

This subsection examines how the opening of high-speed rail affects firms' ESG performance. We first introduce our empirical model and then provide the estimation results.

In order to examine the link between high speed rail turn-up (HSR) and firms' ESG performance, we developed the following model:

$$ESG_{i,t} = \alpha_0 + \alpha_1 HSR_{i,t} + \sum Controls_{i,t} + \sum Industry_{i,t} + \sum Time_{i,t} + \varepsilon_{i,t} \quad (1)$$

where i and t represent sample, and time, respectively. We also include time-industry fixed effects. In line with other scholars, we cluster firm-level standard errors in order to eliminate serial correlation.

The estimation of the hypotheses is shown in Table 3. We find that the impact coefficient of the opening of the HSR is 1.032, which is significantly at the 1 per cent level. We also conducted an additional empirical analysis of the sub-scores. The column 2-4 shows the results of our further estimation. We can observed that the coefficients of HSR opening on environmental score, social score and governance score are 1.194, 0.779 and 1.384 respectively, which further proves that the opening of high-speed railway can promote the performance of listed companies in many ways, and therefore improve the rating agencies' scores of the companies.

Table 3: The Impact of High Speed Rail Opening on Corporate ESG Performance.

Variables	(1)	(2)	(3)	(4)
	ESG	E	S	G
HSR	1.032***	1.194**	0.779**	1.384***
	(3.49)	(2.65)	(2.21)	(3.22)
Observations	11,413	11,413	11,413	11,413
R-squared	0.566	0.566	0.315	0.165
Control variables	YES			
Industry fixed effects	YES			
Time fixed effects	YES			

3.2. Comparing trends before and after the opening of the HSR

Using a multi-period DID model to detect policy effects does not allow for direct inferences about whether the results are affected by factors such as time [11]. To avoid possible errors, we tested for parallel trends.

We can find the results of the parallel trend test in Figure 1. When the opening point is "-4" to "-2", the confidence interval for the significance of the data contains 0, i.e., the coefficients are not significant. On the contrary, the coefficients of the data with opening points from "1" to "5" are significant. This means that our estimates pass the parallel trend test. We also note that ESG performance is significantly positive 1-5 years after the opening of the HSR, further supporting our hypothesis.

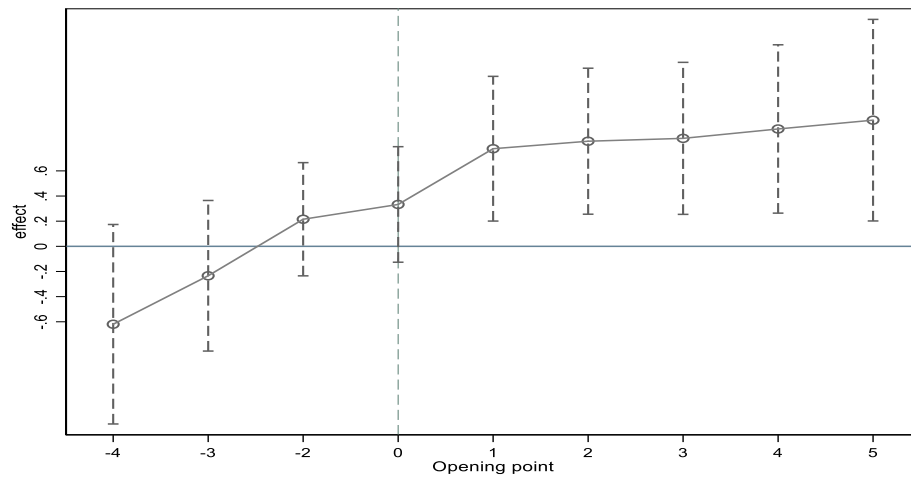


Figure 1: parallel trend test.

3.3. propensity score matching

Existing research suggests that propensity score matching can mitigate endogeneity in econometrics [12]. Therefore, this study conducted 1-to-2 matching of control variables to obtain matched samples for regression analyses. We can notice from Table 4 that there is no endogeneity problem in this study.

Table 4: Estimates after propensity score matching.

Variables	(1)	(2)
	ESG	ESG
HSR	1.027***	0.960***
	(3.57)	(3.07)
Observations	11,367	11,367
R-squared	0.460	0.566
Control variables	NO	YES
Industry fixed effects	YES	
Time fixed effects	YES	

3.4. Replacement of ESG measurement

In addition to Bloomberg's ratings of ESG performance, there are also numerous domestic institutions that rate ESG, such as the Huazheng ESG Index launched in 2018, which adopts the retrospective

method to rate ESG by quarter, and is recognised by many scholars in China. In other Chinese scholars' studies, year-end values and annual averages were used to measure firms' ESG performance, respectively [13]. Therefore, this study also uses these two methods to replace ESG rating data to further demonstrate the robustness of this study.

The estimates after replacing the ESG measure are shown in Table 5. Column (1) shows the results using the yearly average value of the huazheng ESG index, and column (2) shows the results using the year-end value of the huazheng ESG index, and it can be found that the coefficients of the impact of the opening of the high-speed railway on the ESG performance of the firms are 0.08 and 0.07, respectively, indicating that the results are robust.

Table 5: Using the Huazheng ESG Index as an ESG measure.

Variables	(1)	(2)
	ESG(Annual average)	ESG(value at end of year)
HSR	0.080***	0.070**
	(2.69)	(2.21)
Observations	37,562	35,746
R-squared	0.204	0.221
Control variables	YES	
Industry fixed effects	YES	
Time fixed effects	YES	

4. Additional analysis

4.1. Heteroskedasticity analysis

In this subsection, we further investigate whether the external characteristics of a firm's location mitigate or exaggerate the impact of the opening of high-speed rail on a firm's ESG performance. One study found that analyst attention is an important indicator of capital market attention to firms [14]. Therefore, we use market attention as a proxy for external characteristics and group them by median. Table 6 shows the estimation results. We observe that firms with a high market focus (Coverage = 1) are more affected.

Table 6: Heterogeneity of external concerns.

Variables	(1) ESG	(2) ESG
	Coverage=1	Coverage=0
HSR	1.410***	0.608*
	(3.54)	(1.75)
Observations	5,350	6,063
R-squared	0.611	0.539
Control variables	YES	
Industry fixed effects	YES	
Time fixed effects	YES	

4.2. The moderating role of financing constraint

In our previous analyses, we found that the availability of high-speed rail affects firms' ESG performance. In this section, we explore whether financing constraints have an impact on this relationship.

The main reason why financing constraints arise is because of information differences between firms and lending institutions [15]. In layman's terms, financing constraints refer to the difficulty of obtaining financing for a firm. When corporate financing constraints are high, firms are more willing to invest their funds in financial or physical assets with fast returns and high yields so that firms can recover their funds quickly [16]. Good environmental, social and governance performance cannot be achieved without corporate investment in projects for environmental protection and charitable donations. However, these investments do not generate profits in the short term. Therefore, enterprises with lower financing constraints can optimise their production structure and improve their ESG performance by obtaining more financial support [17], for example, by increasing the number of energy-saving equipment purchases and strengthening technological transformation.

In order to empirically investigate the above possible moderating effects, we collected data on the financing constraints of each firm from the Chinese CSMAR database. We built the following regression model to study the above channels:

$$ESG_{i,t} = \beta_0 + \beta_1 HSR_{i,t} + \beta_2 HSR_{i,t} * SA_{i,t} + \sum Controls_{i,t} + \sum Industry_{i,t} + \sum Time_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $SA_{i,t}$ is the firm's financing constraint, in which t denotes the year and i denotes the firm. All regressions include year-industry fixed effects. Control variables are consistent with equation (1).

Table 7 reports the estimation results. The coefficient of high speed rail opening (HSR) is significant at 10.569, while the cross-multiplier term is significant at -2.531, which supports our hypothesis with the results. It suggests that financing constraints have a negative moderating effect on the relationship between HSR opening and firms' ESG performance.

Table 7: The moderating role of financing constraints.

Variables	ESG
HSR	10.569**
	(2.14)
HSR*SA	-2.531*
	(-1.92)
Control variables	YES
Observations	11,413
R-squared	0.568
Industry fixed effects	YES
Time fixed effects	YES

5. Conclusion

We select China, where high-speed railway construction and ESG ratings are developing rapidly, as the study area, and select a sample of listed companies over an 11-year period to empirically investigate the relationship between the opening of high-speed railways and firms' ESG performance. We find that high-speed rail can positively affect firms' ESG through resource and capital flows. Meanwhile, our study also shows that we also conduct a heterogeneity analysis and find that the opening of high-speed rail has a greater impact on firms with a higher level of concern. In addition, when firms' financing constraints are high, firms can only rely on existing accumulation to overcome negative market externalities, which leads to the negative moderating effect of financing constraints on the opening of high-speed rail on firms' ESG performance.

Our findings provide a better understanding of the micro impacts of the opening of HSR. It also reveals the additional benefits of accelerated high-speed railway construction, informing

policymakers in China and other countries that are making significant efforts to develop high-speed railways. This study also has limitations. Firstly, the data in this study also lacks time span in the time dimension, which is mainly due to the late start of ESG ratings in China. Second, this study does not consider possible intermediation mechanisms, the possible channels of which can be explored in a further study.

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