

The Impact of High-speed Railway Opening on Enterprise Digital Transformation

-- Taking the Perspective of Capital Investment and Technological Innovation as an Example

Yaqi You

School of International Economics and Trade, Guilin University of Technology, Guilin 541004, China

18990568958@163.com

Abstract. Since the "digital economy" was officially written into the report of the 19th National Congress of the CPC in 2017, the digital transformation of enterprises has become the only way for the sustainable development of enterprises. In this paper, high-speed railway, which is also in the stage of rapid development, is selected as the research object, and the influence of the opening of high-speed railway stations in 284 cities on the digital transformation of listed companies from 2011 to 2021 is investigated empirically. The main research found that the opening of high-speed rail significantly promoted the degree of digital transformation of enterprises. Mechanism analysis shows that the opening of high-speed rail can promote the digital transformation of enterprises by promoting digital capital investment and technological innovation. Heterogeneity analysis shows that the impact of the opening of high-speed rail on enterprises' digital transformation is from depth to depth in the eastern region, the western region and the central region. From the perspective of enterprise scale, the degree of impact from large to small is medium-sized enterprises, large enterprises, small and micro enterprises. The research conclusion of this paper shows the positive impact brought by the opening of high-speed rail, provides ideas for enterprises to integrate into the modernization development and strengthen the digital transformation, confirms the development mechanism to help enterprises carry out the digital transformation, and provides methodological guidance for enterprises to carry out the digital transformation.

Keywords: The Opening of High-speed Rail; Enterprise Digital Transformation; Capital Input; Technological Innovation.

1. Introduction and Literature Review

Cyberspace Affairs Commission of the CPC Central Committee issued the 14th Five-Year Plan for National Informatization in December 2021. During the 14th Five-Year Plan period, informatization entered a new stage of accelerating digital development and building a digital China. It was proposed to establish a sound, standardized and orderly digital development and governance system, promote the creation of an open, healthy and safe digital ecology, and accelerate the construction process of digital China. Meanwhile, the high-speed railway construction of our country is also developing in full swing. By the end of 2022, China will have 42,000 kilometers of high-speed rail in operation, ranking first in the world. With the completion of the "Four vertical and four horizontal" network and the rapid progress of the "eight vertical and eight horizontal" network, high-speed rail connectivity has been completed in the four major regions of east, central, west and Northeast China, and an efficient high-speed rail network with extensive coverage, reasonable layout and clear hierarchy has been basically formed.

The opening of high-speed railway reconstructs the economic spatial structure of cities and regions, and promotes the spillover effect of economic development. The negative impact of the opening is less than the positive one, thus promoting the overall economic development of cities and strengthening the growth effect and structural effect of economic development. And through the important mechanism of population flow and capital flow, the gap between urban and rural areas is shortened (Wang Yufei and Ni Pengfei, 2016; Dong Yanmei and Zhu Yingming, 2016; Chen

Fenglong et al., 2018). Among them, the opening of high-speed railway accelerates the flow of production factors such as capital and labor, changes the regional factor allocation pattern, and further affects the efficiency of resource allocation (Li Qiang and Yang Yiman, 2023), and can significantly improve the capital mismatch and labor mismatch of station cities through the development of new business forms of high-speed railway economy (Wang Xing and Zhang Shuai, 2022). In addition, the improved market accessibility caused by the opening of high-speed rail can strengthen the spatial distribution pattern of product quality between cities by easing the financing constraints of enterprises and promoting the employment of urban labor force (Lu Angdi and Hua Zesu, 2023).

Therefore, the opening and construction of high-speed railway strongly stimulates the overall development of the cities where it is located, promotes the flow of capital, labor and other factors while optimizing the allocation of resources, and strengthens the spatial distribution pattern of product quality by improving market accessibility. It has an important impact on the development of digitalization, especially the digital transformation of enterprises. Research shows that the factors influencing enterprise digital transformation mainly focus on the five dimensions of technological innovation, organizational change, individual cultivation, collaborative development and business model, including 12 aspects such as technological empowerment and boundary breakthrough, organizational development strategy adjustment, corporate culture, value creation and social demand (Zhang Jingxiao et al., 2022). Based on the above, it can be found that the impact of the opening of high-speed rail coincides with the factors affecting the digital transformation of enterprises in many aspects, so it is reasonable to speculate that the opening of high-speed rail can promote the digital transformation of enterprises.

However, at present, there is little academic research on the impact of high-speed rail opening on enterprises' Digital transformation. Existing research only finds that high-speed rail opening can promote enterprises' Digital transformation in terms of research and development, financing, and human resources (Fang Qiaoling et al., 2023), and the relationship between high-speed rail proximity and enterprise digitalization (Mao Ning et al., 2022). It can be seen that in the existing research, the specific mechanism of the impact of high-speed rail on enterprises' Digital transformation lacks favorable evidence support.

In this paper, the data of listed companies from 2011 to 2021 is matched with the opening situation of high-speed railway in each city. Based on the digital transformation index of listed companies of Guotaian Financial economy Database, the empirical test is conducted to investigate the impact of the opening of high-speed railway on the digital transformation of enterprises from the aspects of action mechanism, heterogeneity, robustness and endogeneity. The empirical results show that the opening of high-speed rail has a significant impact on the digital transformation of enterprises, and this research conclusion has strong robustness. Mechanism study found that on the one hand, the opening of high-speed rail can increase the investment of digital capital, reduce the shackles of capital, and promote the digital transformation of enterprises; On the other hand, the opening of high-speed rail is conducive to promoting technological innovation, providing technical support for the digital development of enterprises, and thus promoting the digital transformation of enterprises. In addition, based on the heterogeneity analysis of different enterprises' regional differences and sizes, it is proved that the opening of high-speed rail has a significant impact on enterprises' digital transformation in the eastern region, the western region and the central region from large too small. In terms of scale, the digitalization of enterprises is affected by the opening of high-speed railway in a significant degree from large to small, which are medium-sized enterprises, large enterprises, small and micro enterprises. Therefore, this paper proposes to strengthen the macro-planning and top-level design of high-speed railway construction, and strengthen the construction of western railway network; On the other hand, enterprises actively attract and absorb digital capital and create an overall ecology of technological innovation.

The marginal contribution of this paper is mainly reflected in the following aspects: (1) The opening of high-speed rail plays an important role in national and regional economic development. A large number of literatures have paid attention to the direct effect, indirect effect and institutional

effect of the opening of high-speed rail, but few articles have linked the opening of high-speed rail with the digital transformation of enterprises. (2) The impact mechanism of the opening of high-speed railway on the digital transformation of enterprises is explored, the factors affecting the digital transformation of enterprises are expanded, and the impact of the opening of high-speed railway on the digital transformation of enterprises in the level of digital capital investment and technological innovation is analyzed in detail with empirical analysis, providing ideas for promoting the digital transformation of enterprises. (3) It further enriched the literature on digital development of enterprises caused by high-speed railway construction. In the existing literature, there are a large number of studies on the impact of transportation facilities construction represented by high-speed railway on the economy and the factors and development direction of enterprise digitalization, but there is a lack of relevant research literature on the correlation between high-speed railway and enterprise digitalization transformation and the transmission mechanism. The research in this paper enriches the existing theories and provides a useful reference for the scientific decision-making of enterprises.

2. Theoretical Mechanism and Research Hypothesis

Research shows that through corporate financing, investment from all parties can be absorbed more efficiently, funds can be used, and all kinds of funds can be put into operation and research and development. In the process of digital transformation of enterprises, a major problem is the lack of relevant equipment and tools. Through financing, the equipment and maintenance of hardware facilities can be satisfied to solve this problem. In addition, the introduction of digital human resources adds new forces for the development of enterprises. On the one hand, it keeps approaching to grasp the current frontier level of science and technology. On the other hand, it promotes the enterprise's digital management and strategy formulation, which can play an important role in product research and development and decision-making management. Therefore, the digital transformation of enterprises can be promoted by increasing enterprise financing and attracting talents extensively, and its promoting effect is more obvious in backward areas (Fang Qiaoling et al., 2023).

In addition, empirical studies have proved that the degree of digitalization of enterprises is directly proportional to the degree of proximity between enterprises and high-speed railway stations. Especially, when enterprises are located within 30 kilometers around high-speed railway stations, the degree of digital transformation of enterprises can be significantly improved, and the digitalization level of enterprises can also be improved simultaneously.

H1: The opening of high-speed rail can promote the digital transformation of enterprises.

High-speed rail has played an important role in promoting the economic development of our country. This paper believes that the opening of high-speed rail also has an impact on the digital transformation of enterprises, and its impact mechanism mainly includes the following two aspects:

On the one hand, the opening of high-speed rail can promote the digital transformation of enterprises by expanding the investment of digital capital. High-speed railway effectively establishes information intercommunication, promotes capital flow and resource sharing, and reduces the financing constraints of enterprises (Bai Xiangting, 2022), and there is no time lag effect in this effect (Xu Liyuan, 2021). At the same time, the opening up of the capital market can boost the digital transformation of enterprises by easing financing constraints and weakening the short-sightedness of executives (Dai Bin and Zhai Yuhao, 2022). In addition, in addition to domestic capital, FDI can also promote the digital transformation of enterprises in host countries (Yang Yaping and Chen Kai, 2023).

On the other hand, the opening of high-speed rail can promote digital transformation by promoting technological innovation of enterprises. Research shows that the opening of high-speed rail has a positive impact on enterprise innovation input with favorable policies (Liu Hongwei et al., 2021), and the opening of high-speed rail and the increase in its frequency improve the comprehensive technical efficiency and scale technical efficiency on the whole (Wu Ran, 2021). Through the improvement of technological innovation efficiency and geographical spillover of technological innovation, the

agglomeration and specialization of manufacturing technology innovation in neighboring regions are promoted, and the spatial effect of geographical spillover of technological innovation is formed (Xu Xing et al., 2023), thus promoting the digital transformation of enterprises.

H2: Through digital capital investment and technological innovation, the opening of high-speed railway can significantly promote the digital transformation of enterprises.

The impact of the opening of high-speed rail on enterprises' digital transformation may be heterogeneous. On the one hand, there are regional differences in the impact of the opening of high-speed rail on enterprises' digital transformation. Taking China as an example, the eastern region has relatively perfect transportation infrastructure of all kinds and strong market demand, and all factors are fully flowing and overflowing. However, in the past, the transportation construction of the central and western region lagged behind the eastern region, which hindered the flow of factors in the central and western region. After the completion of high-speed railway, the flow of various factors will be greatly promoted for the central and western regions, especially the backward regions, and its opening will have a more prominent impact on the central and western regions and large-scale cities (Gao Hongwei, 2023). At the same time, for different regions, the impact of high-speed rail opening has two different forms: diffusion effect and polarization effect (Li Hao, 2019), and compared with the eastern region, the remote investment brought by high-speed rail opening in the central and western regions has a significant positive time cumulative effect (Bao Yuanjuan, 2021). On the other hand, the impact of the opening of high-speed rail on the digital transformation of enterprises is different in the size of enterprises. The opening of high-speed rail does not have the same positive effect on all enterprises. Enterprises with too small scale or insufficient diversification are not able to absorb the risk of R & D failure. Empirical studies have proved that the opening of high-speed rail in the sample of non-small and micro enterprises will have a more obvious promoting effect on enterprise innovation level (Zhang Yuli, 2021).

H3: The impact of the opening of high-speed rail on the digital transformation of enterprises will be heterogeneous due to the size of enterprises and the region where enterprises are located.

3. Data Sources and Measurement Models

3.1 Data Source

The data in this paper are obtained from the following sources: Opening data of high-speed railway stations According to the train schedule of National Railway Administration, the information table of the opening years of high-speed railway stations in 284 cities across the country is obtained; The basic information of listed companies, the digital development level of enterprises, the current situation of domestic digital construction and other data come from the Guotai 'an Economic and Financial Research Database (CSMAR). Among them, the enterprise digital transformation index is the enterprise digital transformation index, which is respectively composed of strategic-driven, technology enabling, organizational enabling, environmental enabling, digital achievement and digital application in proportion, and each subdivision index is the standardized post-value. The target of digital capital investment plan is the total amount of funds raised for digital-related projects; The digital infrastructure construction, artificial intelligence technology, cloud computing technology, big data technology and blockchain technology in the control variables are all taken as indicators by the corresponding word frequency number, that is, the total frequency of the feature words of the technology appearing in the annual report.

Among them, considering the lag of the impact brought by the opening of high-speed rail, and the relevant information of listed companies will not be released until the next year, this paper selects listed companies from 2011 to 2021 as research samples, and carries out the following processing: eliminate ST and delisting samples during the period, eliminate data missing samples, and finally get 33,078 sample observed values. In addition, in the endogeneity test, due to the large difference in the data range of the number of patents (applied), logarithmic processing was carried out to add 1 to the data in order to obtain accurate results.

3.2 Model Setting

This paper mainly investigates the impact of the opening of high-speed rail on the digital transformation of enterprises. The specific benchmark regression model is set as follows:

$$Y_{i,t} = \alpha_0 + \alpha_1 \text{Railway} + \alpha_2 \text{control}_{i,t} + \text{Year}_{i,t} + \text{Enterprise}_{i,t} + \varepsilon_{i,t}$$

In the formula, variable subscript i represents enterprise samples of listed companies, and t represents each year from 2011 to 2021. The explained variable Y represents the digital transformation of enterprises, and the opening status of high-speed Railway in 284 cities is selected as the main explanatory variable of the model. control variables (control) are measured from five aspects: digital infrastructure construction (DIC), artificial intelligence technology (AIT), cloud computing technology (CCT), big data technology (BDT) and blockchain technology (BCT) owned or available by the enterprise. And the fixed effects of time (Year) and Enterprise; Finally, ε is a random error term.

4. Empirical Analysis

4.1 Reference Regression

Table 1. Baseline regression result

VARIABLES	EDT
Railway	3.195*** (0.182)
DIC	1.563*** (0.106)
AIT	0.0131 (0.116)
CCT	0.398*** (0.118)
BDT	1.047*** (0.162)
BCT	3.959*** (0.251)
Constant	32.27*** (0.172)
Enterprise	control
Year	control
Observations	33,078
R-squared	0.150

Table 1 shows the baseline regression results of the impact of the opening of high-speed rail on the digital transformation of enterprises. All regressions control the variables of enterprises and years. All subsequent data processing is subject to these two controls. The opening of high-speed rail has a positive impact on the digital transformation of enterprises at the significance level of 1%, indicating that the opening of high-speed rail in a city also effectively improves the degree of digital transformation of enterprises in the city. Among the control variables, the coefficient values of blockchain technology, digital infrastructure construction, big data technology and cloud computing technology are all positive and significant, while the positive correlation of artificial intelligence technology is not significant. Among them, blockchain technology can provide computing power support and storage space for multiple blocks, while big data technology can complete data collection, sorting and analysis in a short period of time, and cloud computing technology can fully deploy network resources, break the whole into pieces, solve problems and then unify and merge. All three are compatible with digitalization. In addition, the construction of digital infrastructure can provide basic environmental foundation and hardware support for digitalization, and ensure the stability of the network and various carriers required for digitalization. The insignificance of artificial intelligence technology may be due to the fact that the development of artificial intelligence

technology is in its infancy, and it is only concentrated in the Beijing-Tianjin-Hebei, Sichuan-Chongqing, Yangtze River Delta, Pearl River Delta and other areas with rich industrial investment and financing and rapid economic development. Besides its limited scope of influence, it also faces such technical problems as vulnerability, high complexity, opacity, and unbalanced training data. As well as social governance problems such as big data killing and information leakage in its development, all need to be further studied and developed, so the influence of artificial intelligence technology on economic and social development is relatively limited for the time being (Guo Xiaoyu et al., 2023).

According to the existing research, a large number of literatures prove that the above control variables, as the underlying digital technology, are important factors in the digital transformation of enterprises (Yu Feifei and Jiang Qing, 2023; Wang Hai et al., 2023; Zhang Yeqing et al., 2021; Qi Yudong and Xiao Xu, 2020; Zhang Jingru and Huang Xiaojing, 2019), whose positive coefficient indicates that there is no significant error in the setting of the model, which further proves that the opening of high-speed rail does have a significant positive effect on the digital transformation of enterprises. Therefore, hypothesis H1 in this paper is supported.

4.2 Test of Action Mechanism

4.2.1 The Perspective of Digital Capital Investment

Digital capital investment can alleviate the financing constraints of enterprises, and there will be a significant inverted "U" shaped nonlinear interval effect between the financialization of real enterprises and the efficiency of the main business due to the differences in financing constraints (Wu Yiting et al., 2021). At the same time, financing also plays a role in optimizing enterprise management environment and reducing short-sighted behaviors of management (Tian Lihui and Wang Kedi, 2019). Therefore, this part uses digital capital input to test the mechanism.

Table 2. The first mechanism regression analysis

VARIABLES	Capital	EDT
Railway	0.403** (0.160)	
Capital		0.136*** (0.00604)
DIC	0.311*** (0.0933)	1.512*** (0.103)
AIT	0.00529 (0.102)	0.0325 (0.114)
CCT	0.121 (0.104)	0.360*** (0.115)
BDT	0.0606 (0.143)	1.113*** (0.159)
BCT	0.942*** (0.221)	3.982*** (0.246)
Constant	31.07*** (0.151)	30.55*** (0.196)
Enterprise	control	control
Year	control	control
Observations	33,078	33,078
R-squared	0.009	0.152

To examine the underlying mechanism, we first need to examine the impact of the opening of high-speed rail on digital capital investment. The opening of high-speed railway can facilitate the travel of investors, shorten the cost of external communication and investigation, expand the scope of investors' capital influence, and then give investors more confidence in investment, so as to promote investors to expand investment and improve the volume of capital input obtained by enterprises. In the Capital column of Table 2, regression analysis is conducted. The regression results

show that the opening of high-speed rail has a positive impact on digital capital investment at the significance level of 1%. This paper believes that the opening of high-speed railway reshapes the spatial structure between cities, shortens the time cost of going out for investigation, provides convenience for investors to further investigate, and then provides confidence for capital investment, so as to achieve the effect of promoting capital investment.

Then, it further verifies the influence of digital capital investment on enterprise digital transformation. The regression analysis of EDT in Table 2 shows that digital capital input has a positive impact on enterprise digital transformation at the significance level of 1%. This paper believes that the sufficient capital brought by capital investment has reduced the financial constraint for enterprises, and enterprises will use more funds to carry out related work of digital transformation. At the same time, financial support can cope with the high trial and error cost in research and development, so enterprises will carry out more digital technology development and innovation, and promote enterprises to spend more time and energy on digital transformation.

Combined with the conclusion of benchmark regression, it can be seen that the opening of high-speed rail can promote the digital transformation of enterprises through the increase of digital capital investment.

4.2.2 The Perspective of Technological Innovation

Digital technology innovation can greatly improve operational efficiency and generate new digital business models through the optimization of multiple forms and information computing technologies. Secondly, digital innovation can help enterprises improve organizational performance. It can enhance the dynamic capability of enterprises, change the way of value acquisition and creation of enterprises, and create new value (Liu Yang et al., 2020). To this end, this part uses technological innovation to test the mechanism.

Table 3. The second mechanism regression analysis

VARIABLES	Tech-inn	EDT
Railway	3.065*** (0.376)	
Tech-inn		0.227*** (0.00229)
DIC	2.045*** (0.219)	1.082*** (0.0924)
AIT	0.944*** (0.240)	-0.192* (0.101)
CCT	1.056*** (0.244)	0.174* (0.103)
BDT	3.000*** (0.336)	0.421*** (0.142)
BCT	7.332*** (0.520)	2.425*** (0.220)
Constant	31.76*** (0.355)	27.05*** (0.0900)
Enterprise	control	control
Year	control	control
Observations	33,078	33,078
R-squared	0.106	0.325

Firstly, it verifies the impact of high-speed railway opening on technological innovation. The regression analysis in Table 3 shows that the opening of high-speed rail has a positive impact on technological innovation at the significance level of 1%. This paper holds that, for the external environment, the opening of high-speed rail can promote the full flow of resources, and its flow degree provides sufficient support for technological innovation. As for the internal environment, the opening of high-speed railway provides convenient learning and communication for technical

personnel and senior decision-makers of enterprises, improves the technological innovation literacy and ability of enterprises, and further promotes the technological innovation of enterprises.

Then, the impact of technological innovation on enterprises' digital transformation is further verified. The regression analysis is conducted in Table 3, and the results show that technological innovation has a positive impact on enterprises' digital transformation at 1% significance level. In this paper, digital development is highly dependent on the development of underlying digital technologies such as big data, blockchain and cloud computing. Technological innovation can create good conditions and opportunities for the development of digital development, lay a good technical foundation for digital transformation, and then promote the development of enterprises' digital transformation.

Based on the conclusion of benchmark regression, it can be seen that the opening of high-speed rail can promote the digital transformation of enterprises by creating an innovative atmosphere and promoting technological innovation. So far, hypothesis H2 in this paper has been supported.

4.3 Heterogeneity Test

4.3.1 The Heterogeneity of Regional Differences

Table 4. Regional heterogeneity regression results

VARIABLES	(1) Eastern region EDT	(2) Central region EDT	(3) Western region EDT
Railway	2.997*** (0.262)	1.545*** (0.365)	2.337*** (0.399)
DIC	2.190*** (0.157)	1.901*** (0.175)	-0.301 (0.196)
AIT	-0.749*** (0.165)	0.139 (0.236)	3.480*** (0.310)
CCT	-0.377** (0.168)	0.155 (0.234)	3.053*** (0.284)
BDT	0.565*** (0.210)	2.019*** (0.708)	4.858*** (0.636)
BCT	3.641*** (0.275)	5.467*** (1.170)	5.277*** (0.783)
Constant	33.07*** (0.253)	32.44*** (0.334)	30.73*** (0.330)
Enterprise	control	control	control
Year	control	control	control
Observations	24,099	5,465	3,514
R-squared	0.148	0.150	0.171

According to Gao Hongwei's research results, this paper divides the sample enterprises into three regions: east, middle and west, based on the provinces where the enterprises are located. The regression results are shown in Table 4, where (1) represents the eastern region, (2) represents the central region, and (3) represents the western region. According to the regression results, when the three regions are significant, the significance of the impact of high-speed rail opening on enterprises' digital transformation is from large to small: eastern region, western region and central region. However, unmatched with the level of regional socio-economic development, the central region, which originally developed more strongly, is less significant than the western region. The reasons for this may be resource and policy. First of all, the western region is remarkable because it has abundant computing resources. Because the western region is located in the first step, the altitude is high and the temperature is low, which is conducive to the heat dissipation of the calculation equipment. At the same time, the western region has abundant undeveloped idle land resources and clean energy such as wind power and water power, making it an ideal location for large-scale computing equipment. Secondly, in the east count west project start. In February 2022, the state launched the project to build

national computing hub nodes and national data center clusters in Beijing-Tianjin-Hebei, Yangtze River Delta, Chengdu-Chongqing, and Mongolia, Guizhou, Gansu and Ningxia, transferring data from the east to the west for computing, enabling cross-domain flow of data elements, giving full play to the advantages of computing resources in the west, and enabling digital development. Under this new development plan, the western region will receive more preferential policies than the central region, so that its digital construction can be more fully guaranteed. In this context, various conveniences brought by the opening of high-speed rail will be fully combined with the local digital policies in the western region, and further promote the digital transformation of enterprises in the western region.

4.3.2 Heterogeneity of Firm Size

As enterprises of different sizes have certain differences in development, this paper refers to the "Measures for the Division of Large, small, medium and micro-Enterprises in Statistics" of the National Bureau of Statistics, and divides all enterprises into large enterprises, medium-sized enterprises, small and micro enterprises. The regression results are shown in Table 5, where (3) represents large enterprises, (2) medium-sized enterprises and (1) small and micro enterprises. According to the regression results, the influence of small and micro enterprises is not significant, and there is a significant positive correlation between medium-sized enterprises and large enterprises, and the coefficient value of medium-sized enterprises is larger, about twice of that of large enterprises. The reason for this result may be that although firm size is positively correlated with overall innovation performance and strategic innovation performance, the growth rate is decreasing (Zhang Hongjie, 2022). This relationship indicates that when the enterprise scale does not reach the peak, external positive factors such as the opening of high-speed railway studied in this paper will strongly promote the overall innovation pace of enterprises and promote the rapid development of enterprises' digital transformation. However, when the enterprise scale has surpassed most competitors and become a large or super-large enterprise, the further development of the enterprise will be affected by two factors: on the one hand, the large scale will bring difficulty to management, personnel miscellaneous, tedious communication between levels, poor information transmission and other problems will reduce the efficiency of digital transformation; On the other hand, when the scale is too large, the top management and key decision makers such as shareholders can gain rich economic benefits with the help of economies of scale, thus weakening its development impetus and slowing down the speed of enterprise digital transformation.

Table 5. Scale heterogeneity regression results

VARIABLES	(1) Small and micro enterprises EDT	(2) Medium-sized enterprise EDT	(3) Large enterprise EDT
Railway	0.612 (1.082)	4.659*** (0.521)	2.838*** (0.196)
DIC	-0.0609 (0.329)	0.118 (0.235)	2.038*** (0.121)
AIT	3.425*** (1.017)	1.075*** (0.279)	-0.421*** (0.131)
CCT	4.993*** (1.456)	2.048*** (0.278)	-0.108 (0.134)
BDT	14.75*** (5.294)	2.139*** (0.436)	0.598*** (0.179)
BCT	0.156*** (0.170)	4.620*** (0.645)	3.808*** (0.273)
Constant	28.14*** (0.962)	30.25*** (0.494)	32.63*** (0.185)
Enterprise control		control	control
Year control		control	control
Observations	875	3,975	28,228
R-squared	0.191	0.125	0.158

So far, hypothesis H3 in this paper has been supported.

4.4 Robustness Test

The benchmark regression results show that the opening of high-speed rail can significantly promote the digital transformation of enterprises. In order to ensure the robustness of the research conclusions, the method of replacing core variables is further used for testing. Considering that the digital transformation of enterprises largely depends on the development of technology, this paper considers the robustness test by replacing the degree of digital transformation with the number of patents of enterprises.

For the number of patents, the number of patents (applied) in Guotaian data was selected for integration, and the missing residual values were removed. The number of patents was uniformly added by 1 and logarithmically processed, resulting in 33078 sample observations. The regression analysis results are shown in Table 6. The analysis results indicate that the opening of high-speed rail and the number of patent applications by enterprises are significantly positive, and both are significant at the 1% level. The results are still robust.

Table 6. Robustness test

VARIABLES	Ln Patent
Railway	0.267*** (0.0668)
DIC	0.0453 (0.0472)
AIT	0.0232 (0.0495)
CCT	-0.0372 (0.0503)
BDT	-0.0209 (0.0609)
BCT	-0.120 (0.0740)
Constant	3.370*** (0.0631)
Enterprise	control
Year	control
Observations	33,078
R-squared	0.009

4.5 Endogeneity Test

In order to avoid the impact of endogeneity, referring to existing research results, we replaced it with Total Telecommunications Service (TVTS), End of Year Mobile Phone Users (EPU), and International Internet Users (interusers), and retested hypothesis H1 using these three indicators.

From Table 7, it can be seen that the opening of high-speed rail has a positive impact on the instrumental variable at the 1% significance level. Then it was substituted for the explanatory variable and brought into the main regression equation, and the results showed that the regression coefficient was still significantly positive at the 1% level. All results have F values greater than 10, and there is no problem with weak instrumental variables. The above results show that after solving a series of endogenous problems, the opening of high-speed railway can significantly improve the degree of Digital transformation of enterprises, which is consistent with the benchmark regression results in this paper.

5. Conclusion and Suggestion

With the continuous development of high-speed railway construction from "four vertical and four horizontal" to "eight vertical and eight horizontal", the digitalization degree of enterprises has been accelerated. The digital transformation of enterprises is not only a rescue measure to help enterprises, but also an important way to improve their competitiveness. This paper investigates the impact and

mechanism of the opening of high-speed rail on enterprises' digital transformation, and uses the data from 2011 to 2021 for empirical test. The results show that the opening of high-speed rail can significantly promote the degree of enterprises' digital transformation, and this research conclusion has strong robustness. In terms of mechanism test, this paper finds that the opening of high-speed railway can not only promote the digital transformation of enterprises by expanding the investment of digital capital, but also promote the digital transformation of enterprises by promoting technological innovation. Heterogeneity analysis shows that the opening of high-speed rail has a significant impact on the digital transformation of enterprises in the eastern and western regions, and the most significant impact on medium-sized enterprises in terms of scale. The endogeneity test shows that after solving a series of problems, the opening of high-speed rail can still significantly promote the digital transformation of enterprises, which is consistent with the baseline regression.

Table 7. Endogeneity test

VARIABLES	TVTS		EPU		interusers	
	Railway	EDT	Railway	EDT	Railway	EDT
TVTS	0.151*** (0.512)	16.53*** (1.148)				
EPU			0.641*** (0.127)	18.83*** (0.734)		
interusers					0.641*** (0.127)	18.83*** (0.734)
DIC	0.0130*** (0.00352)	1.321*** (0.122)	0.00807** (0.00317)	1.351*** (0.119)	0.0101*** (0.00340)	1.286*** (0.118)
AIT	-0.00937** (0.00388)	0.231* (0.134)	-0.00602* (0.00347)	0.155 (0.130)	-0.00739** (0.00376)	0.275** (0.130)
CCT	-0.00952** (0.00398)	0.668*** (0.137)	-0.00856** (0.00355)	0.531*** (0.133)	-0.00855** (0.00387)	0.698*** (0.134)
BDT	-0.0163*** (0.00585)	1.577*** (0.201)	-0.0148*** (0.00499)	1.305*** (0.187)	-0.0117** (0.00565)	1.552*** (0.196)
BCT	0.0156 (0.00991)	4.349*** (0.341)	0.00298 (0.00773)	3.657*** (0.289)	0.0155 (0.00993)	4.377*** (0.344)
Constant	0.849*** (0.00218)	20.15*** (1.054)	0.785*** (0.00267)	18.31*** (0.692)	0.777*** (0.00303)	20.37*** (0.734)
Enterprise	control	control	control	control	control	control
Year	control	control	control	control	control	control
Observations	33,078	33,078	33,078	33,078	33,078	33,078
R-squared	0.031		0.077		0.064	

Based on the rapid development of high-speed rail and the trend of digital transformation of enterprises, the study of this paper provides some enlightenment for a more comprehensive understanding of the impact of high-speed rail opening and how enterprises should carry out digital transformation. Therefore, the following policy suggestions are put forward:

At the government level, the macro-planning and top-level design of high-speed railway line construction should be strengthened, the actual situation of various regions should be fully taken into account, and local conditions should be adapted to make line construction planning and promote high-speed railway construction as soon as possible. At the same time, in the aspect of route planning, we can focus on strengthening the construction in the western region. On the one hand, the construction of the transport network in the western region is more backward than that in the central and eastern regions, and the demand for transport is more urgent. On the other hand, the western region now bears

the calculation task of number in the east and calculation in the west, and the transport construction is conducive to convenient equipment construction and maintenance and the implementation of policies. In addition, technological innovation and capital investment can be appropriately tilted to encourage relevant technological development and guide capital investment of all parties, so as to provide more development opportunities for enterprises' digital transformation.

At the enterprise level, in terms of attracting investment, enterprises should actively carry out PPP financing mode with the government to win the financial support of the government. At the same time, large-scale financing plans should be formulated to prevent attracting social idle capital by making risk-matching transaction prices and ideal exit methods, so as to provide adequate financial support for the digital development of enterprises. In the aspect of technological innovation, we should cultivate and introduce digital technical talents, build high-level technical and management teams, formulate strategies to deal with institutional obstacles to enterprise innovation, strengthen the protection of enterprise patents and other intellectual property rights, and optimize and improve the overall ecology of technological innovation.

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