

Ma, Xinxiao; Dou, Xiaochen; Tang, Taijie

Article

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Construction of transportation infrastructure and the mixed ownership reform of state-owned enterprises: based on the perspective of high-speed rail opening

Xinxiao Ma^a, Xiaochen Dou^b and Taijie Tang^c

^aManagement College, China Business Working Capital Management Research Center, Ocean University of China, Qingdao, Shandong, China; ^bChinese Academy of Fiscal Sciences, Beijing, China; ^cSchool of Business, Nanjing University, Nanjing, Jiangsu, China

ABSTRACT

We study the impact of transportation infrastructure construction on the degree of mixed-ownership reform of local state-owned enterprises. We find that the opening of high-speed rail can significantly promote the mixed ownership reform process of local state-owned enterprises. Mechanism testing shows that the opening of high-speed rail can promote inter-regional market integration and reduce the transaction costs of potential private investors participating in mixed-ownership reform, and improve the operational activities and management characteristics of state-owned enterprises, and strengthen the intrinsic motivations of potential private investors to participate in mixed-ownership reform, thereby having a positive impact on the degree of mixed-ownership reform of local state-owned enterprises. Further research finds that the above-mentioned effects are sustainable and more obvious among local state-owned enterprises and state-owned enterprises in competitive industries with weak government influence, which can ultimately improve the capital market value and labour productivity of state-owned enterprises.

KEYWORDS

State-owned enterprises; mixed ownership reform; construction of transportation infrastructure; high-speed rail opening

1. Introduction

Since the reform and opening up, the reform of state-owned enterprises has always been a topic of widespread concern, whether in the fields of national governance, academic research or social practice. In the past reform process, state-owned enterprises have gone through three stages: ‘delegation of power and profit’, ‘system innovation’ and ‘development of state-owned assets’. While achieving certain results, there are still problems such as insufficient corporate governance mechanisms, which not only prevents state-owned enterprises from becoming stronger, better and bigger, but also restricts the transformation and upgrading of Chinese economic structure and the orderly advancement of socialist modernisation (Cai, Liu, et al., 2018; Huang & Yu, 2013). Under this circumstance, the mixed ownership reform of state-owned enterprises in the new era provides an unconventional

CONTACT Xiaochen Dou ✉ xiaochendou@yeah.net 📠 Chinese Academy of Fiscal Sciences, 28#Fucheng Road, Haidian Zone, Beijing, China

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solution. Through mixed ownership reform, private shareholders can hold shares in state-owned enterprises and participate in governance, realise their own interests in the process of improving the operating efficiency of state-owned enterprises, and ultimately have a positive impact on distributing social resources more fairly and promoting the common development of capital of all types of ownership (Huang, 2014). In fact, many domestic scholars have fully explored the socio-economic benefits of mixed ownership reform of state-owned enterprises and found that mixed ownership reform can strengthen internal control (Liu et al., 2016), improve the quality of accounting information (Zeng et al., 2017), improve manager compensation contracts (Cai, Zheng, et al., 2018) and reduce audit fees (Tang et al., 2020), thereby improving the governance mechanism of state-owned enterprises and improving operating performance (Hao & Gong, 2017; Liu, 2004; Megginson et al., 1994). Therefore, mixed ownership reform constitutes a 'breakthrough' for the high-quality development of state-owned enterprises in the new era. How to effectively deepen the mixed ownership reform of state-owned enterprises has become a very important research topic in national governance and social practice.

However, existing academic research on the influencing factors of mixed ownership reform of state-owned enterprises mainly focuses on state-owned shareholders and government agencies (Cai, Liu, et al., 2018), which not only ignores the equally important role of potential private investors in the mixed-ownership reform of state-owned enterprises, but also fails to pay enough attention to the positive impact of the business 'hard environment' of Chinese vigorous promotion of transportation infrastructure construction over the years. Practice has shown that moderately advanced transportation infrastructure construction not only helps local enterprises develop and grow (Tan et al., 2019), but also promotes the high-quality economic and social development of a country and the happiness of people's lives. The opening of high-speed rail, which is Chinese business card, is a typical example (Zhao et al., 2018). Specifically, high-speed rail has become a brilliant feature of China today. The media pointed out that Chinese high-speed rail has transported more than 10 billion passengers since 2008. By the end of 2018, Chinese high-speed rail was 29,000 kilometres long, accounting for more than 60% of the world's total high-speed rail. The rapidly developing high-speed rail has become an integral part of public life and daily business operations. Furthermore, the opening of high-speed rail can promote the optimisation of inter-regional resource allocation and the operational development of economic entities (Zheng & Kahn, 2013), thus having a profound impact on the participation costs and intrinsic motivations of potential private investors in mixed-ownership reform. However, the existing literature has not paid enough attention to this issue. Ma et al. (2020) pointed out that the opening of high-speed rail will help economic entities in different regions deepen mutual investment. Therefore, researching whether and how the construction of transportation infrastructure, with the opening of high-speed rail as a typical example, affects the degree of mixed ownership reform of local state-owned enterprises will be an important issue that needs to be solved urgently at the academic research level.

In 2020, the '14th Five-Year Plan' focuses on 'promoting infrastructure construction as a whole' and 'deepening the reform of state-owned assets and state-owned enterprises, and making state-owned capital and state-owned enterprises stronger, better, and larger'. Based on this, we collect and manually check the data on the nature of shareholders, shareholding ratios and appointed directors disclosed in annual reports to research

whether and how transportation infrastructure construction, with the opening of high-speed rail as a typical example, affects the mixed ownership reform characteristics of state-owned enterprises. We find that based on the two dimensions of non-state shareholders' shareholding in state-owned enterprises and participation in high-level governance, the opening of high-speed rail can significantly promote the mixed ownership reform process of local state-owned enterprises. Mechanism testing shows that the opening of high-speed rail can promote inter-regional market integration and reduce the transaction costs of potential private investors participating in mixed-ownership reform, and improve the operational activities and management characteristics of state-owned enterprises and strengthen the intrinsic motivations of potential private investors to participate in mixed-ownership reform, thereby having a positive impact on the degree of mixed-ownership reform of local state-owned enterprises. Further research finds that the above-mentioned effects are sustainable and more obvious among local state-owned enterprises and state-owned enterprises in competitive industries with weak government influence, which can ultimately improve the capital market value and labour productivity of state-owned enterprises. Furthermore, the results remain unchanged after robustness checks.

The contribution is reflected in the following three parts. On the one hand, based on the perspective of mixed ownership reform of state-owned enterprises, we usefully expand the academic literature on the economic consequences of transportation infrastructure construction represented by the opening of high-speed rail. Existing studies have shown that the opening of high-speed rail can reduce transportation costs, promote regional market integration, and facilitate the flow of information (Jiang et al., 2016; Rao et al., 2019; Zheng & Kahn, 2013), thus contributing to the good operation and development of local economic entities. For example, the opening of high-speed rail has a positive impact on economic characteristics such as local enterprises' investment attraction ability, capital market performance, supply chain coordination effectiveness, and independent innovation level (Long et al., 2017; Zhao et al., 2018). However, it has neglected to conduct targeted research on state-owned enterprises that have serious principal-agent problems and where mixed ownership reform urgently needs to be promoted. It has also not paid sufficient attention to the important position of potential private investors in the mixed ownership reform of state-owned enterprises. Therefore, we take a unique approach, starting from the dual dimensions of ownership structure and high-level governance, and find that the opening of high-speed rail can promote inter-regional market integration and improve the operating activities and management characteristics of state-owned enterprises, thus having a positive impact on the economic costs and intrinsic motivations of potential private investors to participate in the mixed-ownership reform of local state-owned enterprises, which provides an important addition to the academic literature on the economic consequences of transportation infrastructure construction.

On the other hand, based on the background of Chinese high-quality promotion of high-speed rail construction, we make an incremental contribution to the academic literature on the influencing factors and promotion methods of mixed ownership reform of state-owned enterprises. The mixed ownership reform of state-owned enterprises is a prerequisite for non-state shareholders to play their governance role. Early research on the mixed reform of state-owned enterprises mainly focused on the perspective of

ownership structure and privatisation reform, and explored its role in promoting micro-enterprise performance (Liu, 2004; Ma et al., 2015). In recent years, domestic scholars have gradually emphasised the importance of non-state shareholders participating in the high-level governance of state-owned enterprises (Cai, Zheng, et al., 2018; Liu et al., 2016; Tang et al., 2020), which is the key to the mixed ownership reform of state-owned enterprises in the new era paying more attention to promoting substantive supporting measures at the board of directors' governance level and promoting the transformation of state-owned enterprises from superficial equity balances to substantive governance optimisation. On this basis, unlike Cai, Liu, et al. (2018) who only discussed the influencing factors of mixed-ownership reform of state-owned enterprises from the perspective of state-owned shareholders and the government, we take potential private investors, who are equally important participants in the mixed ownership reform of state-owned enterprises, as an entry point and find that the opening of high-speed rail can promote the mixed ownership reform process of local state-owned enterprises, thereby having a positive impact on their capital market value and labour productivity, which makes an important expansion of the academic literature on the influencing factors and corresponding consequences of mixed ownership reform of state-owned enterprises.

In addition, this paper has certain policy reference value. Since the Third Plenary Session of the 18th CPC Central Committee in 2013, the mixed ownership reform of state-owned enterprises has been the focus of top-level design. As a socialist country in China, state-owned enterprises play an irreplaceable and key role in promoting the development and growth of the socialist public economy and maintaining national economic stability and social stability. Therefore, we find that transportation infrastructure construction, with the opening of high-speed rail as a typical example, can promote the mixed development process of state-owned enterprises, which has good policy reference value for senior decision-makers to deepen the reform of state-owned enterprises and promote the high-quality development of the state-owned economy through moderately advanced infrastructure construction without losing the control rights of state-owned shareholders or causing the loss of state-owned assets.

2. Literature review and theoretical analysis

2.1. *The institutional background and new era connotation of mixed ownership reform of state-owned enterprises*

State-owned enterprises are an important material and political foundation for socialism with Chinese characteristics and an important pillar and source of support for the Party to govern and rejuvenate the country. Mixed ownership reform provides a key path for making state-owned enterprises stronger, better, and bigger. In fact, mixed ownership reform is not a new concept. Although the current mixed ownership reform of state-owned enterprises is in the same vein as the corporate and joint-stock reforms of state-owned enterprises that began in the 1990s, however, it also highlights the clear goals and practical forms of progress under the national conditions with Chinese characteristics in the new era, which transcends the unity of opposites in the mixed reform of traditional state-owned enterprises.

Specifically, on the one hand, in terms of progress goals, the traditional mixed ownership reform of state-owned enterprises mainly pursues the micro-level goals of liquidating loss-making state-owned enterprises and developing and growing high-quality state-owned enterprises, and there is a hesitant discussion on whether state-owned enterprises need to continue to exist (Liu, 2004). In comparison, under the guidance of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, the mixed ownership reform of state-owned enterprises in the new era is based on the firm direction of making state-owned capital and state-owned enterprises stronger, better, and larger, and strives to achieve the macro-strategic goal of the public-owned economy and the non-public-owned economy complementing each other, promoting each other, and developing together (Huang, 2014). On the other hand, in practice, the traditional mixed reform of state-owned enterprises mainly focuses on the superficial form of the reduction of the shareholding ratio of state-owned shareholders from wholly-owned shares to non-wholly-owned shares. In comparison, the mixed ownership reform of state-owned enterprises in the new era pays more attention to the optimisation of state-owned enterprise governance mechanisms and the internal effectiveness of the true realisation of reform goals, which not only continue to vigorously promote the corporate restructuring of wholly state-owned enterprises and enterprises owned by the whole people with backward systems, especially a large number of enterprises at the state-owned group level, but also pays more attention to effectively optimising the governance mechanism and exerting the positive effects of mixed reform in state-owned enterprises that have already carried out 'traditional mixed-ownership reform', that put forward mixed reform requirements and provide policy support from many aspects such as employee stock ownership, dividend rights incentives, and better participation of private shareholders in governance (Huang, 2014). Therefore, the progress goals and practical forms of mixed ownership reform of state-owned enterprises in the new era not only require state-owned shareholders and government agencies to effectively implement the top-level design requirements of mixed ownership reform of state-owned enterprises, but also more fairly respect and protect the legitimate rights and interests of potential private investors. Thus, potential private investors can become the main participants and decision-makers on whether the mixed-ownership reform of state-owned enterprises can be successfully implemented in the new era. In other words, the implementation process of mixed-ownership reform of state-owned enterprises in the new era is a contractual and consensual relationship reached in accordance with the law between state-owned enterprises, state-owned shareholders and private investors on the basis of equality and reciprocity, which is not that government departments use administrative intervention to 'order' private investors to participate in mixed-ownership reform. This allows potential private investors to make decisions about participating in the mixed reform of state-owned enterprises more freely under economic dynamics and following market logic (Ma et al., 2021). Therefore, the mixed reform process of state-owned enterprises is significantly affected by the behaviour of potential private investors.

On this basis, how to effectively stimulate the intrinsic motivation of potential private investors to participate in the mixed ownership reform of state-owned enterprises and reduce their transaction costs has become the key to the smooth advancement of the mixed ownership reform of state-owned enterprises in the new era. However, few literatures pay detailed attention to the aforementioned issues. Cai, Liu, et al. (2018)

examined the impact of government decentralisation purely from the perspective of state-owned shareholders. However, it has not fully discussed how institutional factors, such as transportation infrastructure construction as a typical example, affect the motivation and cost of potential private investors' participation in mixed reform, and then affect the mixed reform process of state-owned enterprises. The void in this direction restricts the further advancement of the current mixed ownership reform of state-owned enterprises. In particular, the opening of high-speed rail can promote the optimisation of inter-regional resource allocation and the development of economic entities (Zheng & Kahn, 2013), which will have a profound impact on the costs and motivations of potential private investors to participate in mixed-ownership reform. Therefore, we use the typical scenario of high-speed rail opening to study the effect of transportation infrastructure construction on the mixed reform of state-owned enterprises.

2.2. Literature review on the socio-economic impact of high-speed rail opening

The construction of high-speed rail not only makes China an innovator and leader in large-scale technological systems, but also has a positive impact on the lives of residents, business operations, and economic and social development of cities along the line (Zhao et al., 2018). As an infrastructure investment, the construction of high-speed rail has a direct effect on promoting economic growth, and it can directly improve the economic growth and employment levels of residents along the cities through a multiplier effect. Compared with the direct effect, the opening of high-speed rail also has the indirect effect of promoting the flow of factor resources between regions (Wang & Ni, 2016). The construction of high-speed rail has optimised the original transportation network between cities to a great extent, compressed the time and space distance, and promoted the free flow and integrated allocation of production factors such as capital, labour, information, and data, which has a certain positive impact on the information circulation, resource acquisition and operation improvement of local enterprises.

Specifically at the micro enterprise level, on the one hand, the opening of high-speed rail will help improve the quality of financial information of local enterprises (Zhao et al., 2018) and the service effects of intermediaries (Cai et al., 2019; Yang et al., 2019), reduce the degree of information asymmetry between enterprises and their stakeholders (Zhang & Ping, 2019), thereby improving their capital market performance and increasing corporate value (Zhao et al., 2018). On the other hand, the opening of high-speed rail has good real economic effects. For example, the opening of high-speed can attract funds to local enterprises (Long et al., 2017; Ma et al., 2020), optimise the investment decisions (Wen et al., 2019), improve the supply chain coordination (Rao et al., 2019) and human capital structure (Ji & Yang, 2020) and independent innovation capabilities (Tan et al., 2019). Therefore, the opening of high-speed rail has a positive impact on the business behaviour and information transparency of enterprises.

2.3. The opening of high-speed rail and mixed ownership reform of state-owned enterprises

Theoretically, the opening of high-speed rail can promote inter-regional market integration and reduce the transaction costs of potential private investors participating

in mixed-ownership reform, as well as improve the operating activities and management characteristics of state-owned enterprises and strengthen the intrinsic motivations of potential private investors to participate in mixed-ownership reform, which will have a positive impact on the mixed ownership reform process of local state-owned enterprises.

On the one hand, the opening of the high -speed rail can promote information flow and market integration between regions, reduce the information communication costs and various transaction costs that potential private investors participate in the mixed reform of local state-owned enterprises, and improve their expected net income for mixed reform decisions, which has a positive impact on the mixed reform process of local state-owned enterprises. Specifically, the opening of the high -speed rail has strengthened the convenience of transportation between the place where the state-owned enterprise is located and other areas (Jiang et al., 2016), which reduces the time cost of travel. This time and space convergence enables the capital, labour, and information markets of state-owned enterprises to better integrate with the factors such as capital, labour, and information with cities and surrounding areas, and accelerate the reasonable flow and effective allocation of various resources (Deng et al., 2020). Furthermore, potential private investors in other places have been more convenient to investigate and obtain ‘soft information’ for local government and state-owned shareholders to promote mixed ownership reform

(Long et al., 2017), and exercise shareholders’ rights and participate in state-owned enterprise governance in the subsequent mixed reform process. Therefore, the opening of the high -speed rail can enhance the expected net income and practical feasibility of potential private investors to participate in the mixed reform of the local state-owned enterprise, thereby promoting the latter’s mixed reform process. Among them, ‘Soft Information’ is a kind of implicit knowledge that is difficult to quantify, non-standardised, subjective, and generally relies on the way of contact in person to convey, which allows potential private investors to investigate many times to make mixed reform decisions, which has strengthened the positive impact of high -speed rail opening. In addition, the opening of the high-speed rail also helps media, auditors, analysts and other intermediary organisations and stakeholders more convenient and timely investigate and supervise local state-owned enterprises (Cai et al., 2019) to improve the quality of the latter’s financial information and reduce the level of information asymmetry (Zhao et al., 2018). And this also helps reduce the cost of trading costs for potential private investors to participate in mixed ownership reforms, and prompt them to make better mixed reform decisions. For example, Long et al. (2017) pointed out that the information flow effect opened by the high-speed rail can help local companies get more sufficient foreign venture capital.

On the other hand, the opening of the high-speed rail can effectively improve the operating activities and management characteristics of local state-owned enterprises, and enhance the expectations of potential private investors to participate in the equity appreciation and capital proliferation of high-quality state-owned enterprises, and improve the inherent willingness to make mixed reform decisions, which has a positive impact on the mixed ownership reform process of local state-owned enterprises. In practice, the ‘profit-seeking nature’ of private investors determines that it is more inclined to participate in the mixed ownership reform activities of state-owned enterprises with high economic efficiency

and a complete governance mechanism (Ma et al., 2021), which not only helps it to continue to obtain investment income with the help of holding equity and participation in governance, but also can promote the development of its own original business through the significant influence of high-quality state-owned enterprises. Specifically, the opening of the high-speed rail has a more comprehensive and positive impact on various operating activities and management characteristics of local state-owned enterprises. First of all, the opening of the high-speed rail can optimise the human capital structure of local state-owned enterprises (Ji & Yang, 2020) to help them get more highly educated talents (Du & Peng, 2017), which has a positive impact on the independent innovation capabilities of state-owned enterprises (Tan et al., 2019). Secondly, the opening of the high-speed rail helps local state-owned enterprises to broaden the business and improve the level of operation and management, which not only can carry out business and expand export trade with more distant suppliers (Rao et al., 2019), but also can improve economic efficiency in operation activities such as inventory management and cash holding. Finally, the opening of the high-speed rail can help local state-owned enterprises to better seize investment opportunities and improve investment results (Wen et al., 2019). As a result, state-owned enterprises have more effective operation and management activities under the influence of high-speed rail opening, which can effectively stimulate the inherent motivation of potential private investors to participate in the pursuit of economic benefits of the former, and has a positive impact on local state-owned enterprises' mixed ownership reform.

In summary, the opening of the high-speed rail can reduce the transaction cost of potential private investors to participate in mixed ownership reform by promoting the integration of regional markets, and improve the operating activities and management characteristics of state-owned enterprises to strengthen the internal motivation of potential private investors to participate in mixed reforms, which has a positive impact on the mixed ownership reform of local state-owned enterprises. Thus, we put forward the following research hypotheses:

H1: If other conditions remain unchanged, the opening of high-speed rail can significantly promote the mixed ownership reform process of state-owned enterprises.

3. Research design

3.1. Model settings and variable definitions

Drawing on existing research (Cai, Liu, et al., 2018; Cai, Zheng, et al., 2018; Zhao et al., 2018), we construct the following regression model to test the impact of the opening of high-speed rail on the mixed ownership reform of state-owned enterprises:

$$HUNGAI_{i,t} = \beta_0 + \beta_1 HSR_i \times POST_{i,t} + \beta_2 CONTROLS_{i,t} + \sum FIRM_i + \sum YEAR_t + \varepsilon_{i,t} \quad (1)$$

First, *HUNGAI* is the explained variable, measuring the degree of mixed ownership reform of state-owned enterprises. The mixed ownership reform of state-owned enterprises in the new era emphasises the introduction of strategic investors who can effectively play a governance role. We comprehensively describe the existence of non-state shareholders who truly play a governance role and assume the role of strategic investors from the dual dimensions of non-state shareholders' shareholding levels and governance participation

in state-owned enterprises. In terms of ownership structure, we measure the sum of shareholding ratios of non-relational non-state shareholders among the top ten shareholders (*SHD_NONSOE*). In terms of high-level governance, we measure the ratio of directors appointed by non-relational non-state shareholders to the total number of board members of sample state-owned enterprises (*D_NONSOE*).

Secondly, *HSR* and *POST* are the explanatory variables, measuring whether the city where the sample state-owned enterprises are located has opened high-speed rail and before and after its opening. Specifically, when the city where the sample state-owned enterprise is located has experienced the opening of high-speed rail during the sample period, the sample state-owned enterprise belongs to the experimental group, and the value of *HSR* is 1, otherwise it is 0. When the city where the sample state-owned enterprise is located has opened high-speed rail, the value of *POST* is 1, otherwise it is 0. If the city where the sample state-owned enterprise is located has not opened high-speed rail, the value of *POST* is always 0. The coefficient of the interaction term $HSR \times POST$ measures the difference in the change in the degree of mixed ownership reform of state-owned enterprises in the experimental group before and after the opening of the high-speed rail compared with the change in the degree of mixed ownership reform of state-owned enterprises in the control group. We predict that the coefficient is significantly positive, that is, the opening of high-speed rail promotes the mixed ownership reform of state-owned enterprises.

Finally, following the existing literature (Cai, Liu, et al., 2018; Zhao et al., 2018), we select many corporate financial and governance characteristics as control variables. These factors may have an impact on the mixed ownership reform of state-owned enterprises. In particular, Cai, Liu, et al. (2018) pointed out that the government's willingness to decentralise power is an important influencing factor in the mixed reform of state-owned enterprises. Therefore, we use the 'Reducing Government Intervention in Enterprises' index in Chinese provincial marketisation index compiled by Wang et al. (2019) to measure the government's willingness to decentralise power (*DECENTRALIZE*), and controls it in the model.¹ In addition, we control company and year fixed effects in the model. All continuous variables are winsorised at the 1% level to avoid the interference of outliers on the research results. Regressions are treated with robust standard errors clustered at the firm level. The detailed definitions of all variables are reported in the Appendix.

3.2. Data sources and sample selection

In terms of sample selection, we take A-share state-owned listed companies on the Shanghai and Shenzhen stock exchanges from 2008 to 2018 as the research sample. On the one hand, the mixed ownership reform of state-owned enterprises in the new era must not only accelerate the progress of mixed ownership among existing wholly state-owned enterprises, state-owned absolute holding companies, and group companies of state-owned listed companies to release the vitality of

¹The 'Reducing Government Intervention in Enterprises' index compiled by X. Wang et al. (2019) ended in 2016, but the sample period of this paper ended in 2018. Considering that the degree of government intervention in various regions of China will not change significantly in a relatively short period of time. Therefore, in the process of empirical testing, we replace the 'Reducing Government Intervention in Enterprises' index in 2017 and 2018 of the location of the sample state-owned enterprises with the index in 2016.

state-owned enterprises, but also pay more attention to effectively protecting the legitimate rights and interests and exercise of rights of non-state shareholders in state-owned enterprises that have undergone mixed reform and introduced non-state shareholders, especially state-owned listed companies (Huan, 2014). In particular, the rights of non-state shareholders to appoint directors and participate in high-level governance are protected (Cai, Zheng, et al., 2018; Liu et al., 2016), which can be studied in more detail in state-owned listed companies. On the other hand, unlisted state-owned enterprises are generally wholly owned by the government, and their financial and governance data are difficult to obtain, and non-state shareholders rarely participate in governance (Cai, Liu, et al., 2018; Wei et al., 2017). State-owned listed companies usually have larger scales, wider business scope, and stronger social influence. Research on state-owned listed companies can lead to more scientific and reliable conclusions.

In terms of data sources, referring to Wei et al. (2017) and Cai, Zheng, et al. (2018), the non-state shareholders' governance data used was obtained through self-collection and manual verification of the nature of the top ten shareholders, shareholder relationships, shareholder shareholdings, and appointed directors disclosed in the annual reports of listed companies. The high-speed rail opening time and cities it passes are from the CNRDS database, and are manually checked with the data on the National Railway Administration website. The address of the listed company's office location comes from Wind. Other corporate financial and governance data mainly come from the CSMAR database. Referring to the existing literature (Cai, Liu, et al., 2018; Cai, Zheng, et al., 2018; Zhao et al., 2018), we eliminate samples of listed companies in the financial industry, with abnormal financial data (such as asset-liability ratio greater than 1), and missing data on major variables, and finally obtains 9,320 state-owned enterprise-annual observations.

4. Empirical results and analysis

4.1. Descriptive statistics

Table 1 shows the descriptive statistics. First of all, during the sample period, the average shareholding ratio of non-state shareholders (*SHD_NONSOE*) among the top ten shareholders of state-owned listed companies during the sample period is 9.28%, which is far lower than the average shareholding ratio of the largest state-owned shareholder (*SHDSOE*) of 39.88%. This means the 'one share dominates' phenomenon of state-owned shares is still prevalent among state-owned listed companies. Second, in the dimension of high-level governance, the proportion of *D_NONSOE* appointed by non-state shareholders is 2.62%, which is far lower than the average of 9.28% held by non-state shareholders. This may be the situation that non-state shareholders have the situation of 'same shares with different rights' in state-owned enterprises, and their right to appoint directors cannot be fully exercised. Nevertheless, the standard deviation of *D_NONSOE* is about 2.85 times of the mean value, indicating that the degree of participation of non-state shareholders in high-level governance of different state-owned enterprises is quite different. In addition, the remaining control variables are

Table 1. Descriptive statistics.

VARIABLES	N	Mean	Std	Minimum	Median	Maximum
<i>SHD_NONSOE</i>	9320	0.0928	0.0867	0.0052	0.0616	0.3988
<i>D_NONSOE</i>	9320	0.0262	0.0747	0.0000	0.0000	0.4000
<i>HSR</i>	9320	0.8872	0.3163	0.0000	1.0000	1.0000
<i>POST</i>	9320	0.6526	0.4762	0.0000	1.0000	1.0000
<i>SIZE</i>	9320	22.6183	1.3878	19.8942	22.4581	26.5727
<i>LEV</i>	9320	0.5194	0.2007	0.0787	0.5307	0.9340
<i>ROA</i>	9320	0.0311	0.0504	−0.1640	0.0279	0.1813
<i>GROWTH</i>	9320	0.1640	0.4626	−0.5224	0.0898	3.1424
<i>AGE</i>	9320	2.5523	0.5456	0.6931	2.7081	3.2581
<i>CONCENTRATE</i>	9320	0.1973	0.1279	0.0216	0.1727	0.5930
<i>SHDSOE</i>	9320	0.3988	0.1522	0.1166	0.3946	0.7695
<i>BOARDSIZE</i>	9320	2.2098	0.1987	1.6094	2.1972	2.7081
<i>INDEP</i>	9320	0.3697	0.0546	0.3000	0.3333	0.5714
<i>DUAL</i>	9320	0.0923	0.2894	0.0000	0.0000	1.0000
<i>DECENTRALIZE</i>	9320	4.67103	2.7962	−3.6988	4.5500	11.3284

consistent with the existing literature (Cai, Liu, et al., 2018; Zhao et al., 2018), and no significant difference in the results.

4.2. Main results

Table 2 shows the basic regression results between the launch of high-speed rail and the mixed-ownership reform of state-owned enterprises. Among them, in terms of ownership structure, the coefficients of $HSR \times POST$ in columns (1) and (2) are both significantly positive at the 1% level, which means that the opening of high-speed rail helps private investors better hold the equity of local state-owned enterprises, thereby improving the degree of mixed reform of state-owned enterprises at the ownership structure level. In terms of high-level governance, the coefficients of $HSR \times POST$ in columns (3) and (4) are also positively and significant at the 1% level, which indicates that transportation infrastructure construction represented by the opening of high-speed rail can promote non-state shareholders to better participate in the corporate governance of state-owned enterprises, and improve the degree of mixed reform of state-owned enterprises to a higher governance level. Thus, the hypothesis of our article is supported.

4.3. Robustness check

To validate our results, we conduct an additional four robustness tests. First, to alleviate the conclusion bias caused by variable measurement errors, we change the measurement methods of the explanatory variables and the explained variables and re-run the regression. On the one hand, in terms of changing the measurement method of explanatory variables, we advance the opening of high-speed rail in the location of the sample state-owned enterprises by one year and delay it by one year to conduct a placebo test. Columns (1) to (4) of Table 3 report the corresponding results, it can be found that the coefficients of $HSR \times POST$ are not significant, which shows that the conclusion is more robust after mitigating the measurement error of the explanatory variables. On the other hand, to alleviate the measurement error of the explained variable, we divide the sum of the shareholding ratios of non-state shareholders of sample state-owned enterprises by

Table 2. Effect of transportation infrastructure construction on mixed ownership reform of state-owned enterprises.

VARIABLES	<i>Dep Var = SHD_NONSOE</i>		<i>Dep Var = D_NONSOE</i>	
	(1)	(2)	(3)	(4)
<i>HSR</i> × <i>POST</i>	0.0144*** (3.72)	0.0118*** (3.30)	0.0073*** (2.77)	0.0080*** (3.12)
<i>SIZE</i>		0.0133*** (3.74)		−0.0004 (−0.15)
<i>LEV</i>		−0.0741*** (−4.68)		−0.0006 (−0.06)
<i>ROA</i>		0.0565** (2.11)		0.0047 (0.26)
<i>GROWTH</i>		0.0064*** (3.73)		0.0004 (0.33)
<i>AGE</i>		−0.0572*** (−5.74)		0.0086 (0.91)
<i>CONCENTRATE</i>		0.4446*** (4.47)		0.1080** (2.22)
<i>SHDSOE</i>		−0.5720*** (−6.47)		−0.0801* (−1.72)
<i>BOARDSIZE</i>		0.0224** (1.99)		−0.0008 (−0.09)
<i>INDEP</i>		−0.0255 (−0.76)		0.0046 (0.21)
<i>DUAL</i>		0.0015 (0.40)		−0.0013 (−0.45)
<i>DECENTRALIZE</i>		0.0002 (0.27)		−0.0006 (−1.06)
<i>CONSTANT</i>	0.0637*** (14.44)	0.0581 (0.66)	0.0328*** (10.25)	0.0304 (0.43)
Firm/Year FE	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320
Adj R-squared	0.513	0.562	0.621	0.621

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

the shareholding ratio of state-owned shareholders (*BALANCE*), and the first-order difference of the high-level governance participation level of non-state shareholders (*ChD_NONSOE*) to re-characterise the degree of mixed ownership reform, and regress these two as explained variables. The results are shown in columns (5) and (6) of Table 3. It can be found that the coefficient of *HSR* × *POST* is significantly positive at least at the 5% level, which indicates that the conclusion of this paper remains robust after alleviating the measurement error of the explained variable.

Second, we try to mitigate the impact of sample selection bias on research conclusions. On the one hand, to avoid the influence of sample state-owned enterprises that have never experienced the opening of high-speed rail or have no non-state- shareholders participating in high-level governance during the sample period, we eliminate these two parts of the sample and re-regress model (1). Table 4 shows the corresponding regression results. It can be found that the coefficients of *HSR* × *POST* in columns (1) and (3) are still significantly positive at the 1% level, and the coefficients of *HSR* × *POST* in columns (2) and (4) are at least significantly positive at the 10% level, indicating that the conclusion is relatively robust. On the other hand, we use the propensity score matched samples to conduct regression, that is, whether the sample state-owned enterprises are located in locations where high-speed rail is not opened, using all company-level control variables in the regression model as the basis variables, and using the nearest neighbour matching

Table 3. Mitigating measurement errors.

VARIABLES	Placebo test (1 year lead time)		Placebo test (postponed 1 year)		Change the measurement method of the explained variable	
	SHD_NONSOE	D_NONSOE	SHD_NONSOE	D_NONSOE	BALANCE	ChD_NONSOE
	(1)	(2)	(3)	(4)	(5)	(6)
<i>HSR</i> × <i>POST</i>	−0.0064 (−0.29)	0.0053 (0.26)	0.0043 (1.24)	0.0019 (0.74)	0.0490*** (3.59)	0.0038** (2.19)
CONTROLS	YES	YES	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320	9,320	8,026
Adj R-squared	0.561	0.621	0.560	0.620	0.647	0.064

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

method with a caliper of 0.05, we conduct a meaningful propensity score match. After propensity score matching of 1:3 with replacement, the balance test results show that after matching, each variable is balanced between the treatment group and the control group, and the matching effect is good. Furthermore, we only retain the matched research samples and re-regress using model (1). The results are shown in columns (5) and (6) of Table 4. It can be found that the coefficients of *HSR* × *POST* are significantly positive at the 5% level. The conclusions of this paper remain robust after alleviating the sample selection problem.

Third, we may have biased conclusions caused by omitted variables, that is, omitted factors such as the city's economic, social, and political status have simultaneous effects on the opening of local high-speed rail and the mixed ownership reform of state-owned enterprises. Referring to the existing literature (Zhao et al., 2018), we control the following factors before conducting regression. First, in terms of urban characteristics, we measure local economic development by the per capita GDP of the city where the sample state-owned enterprises are located in that year. Transportation convenience is measured by the road area per 10,000 people in the city where the sample state-owned enterprises are located in that year. Labour mobility level is measured by the total passenger volume in the city where the sample state-owned enterprises are located, and the local information is measured by the total number of mobile phones in the city where the sample state-owned enterprises are located in that year. The level of local financial development is measured by the financial market size of the city where the sample state-owned enterprises are located. Secondly, in terms of the

Table 4. Mitigating sample selection bias.

VARIABLES	Exclude high-speed rail that has never been opened		Eliminate directors who have not been appointed		propensity score matching	
	SHD_NONSOE	D_NONSOE	SHD_NONSOE	D_NONSOE	SHD_NONSOE	D_NONSOE
	(1)	(2)	(3)	(4)	(5)	(6)
<i>HSR</i> × <i>POST</i>	0.0121*** (3.24)	0.0052* (1.93)	0.0374*** (4.08)	0.0607*** (5.60)	0.0147** (2.45)	0.0106** (2.40)
CONTROLS	YES	YES	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES	YES	YES
Observations	8,269	8,269	2,572	2,572	3,598	3,598
Adj R-squared	0.563	0.629	0.620	0.498	0.598	0.600

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

government characteristics of the city where the sample state-owned enterprises are located, we measure the government revenue level by dividing the fiscal revenue of the city where the sample state-owned enterprises are located by GDP. The fiscal revenue of the city where the state-owned enterprises are located in the current year minus fiscal expenditures is divided by the GDP to measure the government surplus level. The urban surveyed unemployment number in the city where the sample state-owned enterprises are located in the current year is divided by the annual average population to measure the government employment management level. Thirdly, the number of listed companies in the local area is measured by the total number of listed companies in the city in that year plus 1 and then takes the logarithm. Fourthly, to measure the development prospects of the industry, we use the Herfindahl index of the operating income of the industry in which the sample state-owned enterprises are located in that year to measure it. The degree of industry competition is determined by whether the industry in which the sample state-owned enterprises are located is an encouraged, supported, key development or vigorously developed industry mentioned in the 'Tenth Five-Year Plan', 'Eleventh Five-Year Plan', 'Twelfth Five-Year Plan' or 'Thirteenth Five-Year Plan'. Fifthly, regarding the characteristics of state-owned enterprise shareholders, we measure the administrative level of shareholders by whether the sample state-owned enterprises are centrally controlled and then use the separation of ownership and cash flow rights of the actual controllers of the sample state-owned enterprises to detect the self-interested motives of shareholders. The regression results are shown in columns (1) and (2) of Table 5 and can be found that the coefficient of $HSR \times POST$ is still significantly positive at the 1% level, which indicates that the conclusions of this paper remain unchanged after mitigating omitted variable bias.

Fourth, to alleviate the reverse causality problem caused by insufficiently strict exogenous factors in the opening of high-speed rail, we use instrumental variables to conduct a two-stage regression. Specifically, following Bian et al. (2019) and Yang et al. (2019), we use the average terrain slope ($SLOPEAVE$) of the city where the sample enterprise is located as an instrumental variable. On the one hand, the geographical slope reflects the basic terrain conditions of a region, which can directly affect the comprehensive cost of high-speed rail construction. For example, the construction cost of high-speed rail in plain areas is significantly lower than that in mountainous or hilly areas, and high-speed rail construction practice fully considers cost factors, which indicates that instrumental variables meet the requirements of correlation. On the other hand, the terrain slope is an objective natural geographical condition that exists in the long-term historical process of each region. It has a low correlation with the degree of mixed ownership reform of local state-owned enterprises at the current stage, which meets the requirements of exogeneity. The results of the two-stage regression are shown in Table 6. It can be found that the average terrain slope ($SLOPEAVE$) in column (1) is significantly negative at the 1% level, indicating that complex terrain will reduce the possibility of high-speed rail construction, consistent with the theoretical analysis, and the coefficients of $HSR \times POST$ in columns (2) and (3) are both significantly positive at the 1% level, and the regression passes the weak instrumental variable test, which shows that the results remain robustness after using instrumental variables to alleviate the reverse causality problem,

Table 5. Mitigating omitted variable bias.

VARIABLES	Dep Var = SHD_NONSOE (1)	Dep Var = D_NONSOE (2)
<i>HSR</i> × <i>POST</i>	0.0096*** (2.64)	0.0082*** (3.13)
CONTROLS	YES	YES
Firm/Year FE	YES	YES
Observations	9,320	9,320
Adj R-squared	0.564	0.634

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively;
 (2) The t-value is in parentheses.

Table 6. Mitigating reverse causality bias.

VARIABLES	First-step Dep Var = <i>HSR</i> × <i>POST</i> (1)	Second-step Dep Var = SHD_NONSOE (2)	Second-step Dep Var = D_NONSOE (3)
<i>SLOPEAVE</i>	−0.0040*** (−4.16)		
<i>HSR</i> × <i>POST</i>		0.2511*** (3.32)	0.1552*** (2.75)
CONTROLS	YES	YES	YES
Firm/Year FE	YES	YES	YES
Observations	9,320	9,320	9,320
Adj R-squared	0.564	-	-
Minimum Eigenvalue Statistic: 17.308			

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

5. Further analysis

5.1. Dynamic effects of high-speed rail opening

To research the dynamic effects of changes in the degree of mixed ownership reform of state-owned enterprises before and after the opening of high-speed rail, we construct the following model concerning Yang et al. (2019) and Armstrong et al. (2012).

$$\begin{aligned}
 HUNGA_{i,t} = & \beta_0 + \beta_1 HSR_i \times POST_{i,t-2} + \beta_2 HSR_i \times POST_{i,t-1} + \beta_3 HSR_i \times POST_{i,t} \\
 & + \beta_4 HSR_i \times POST_{i,t+1} + \beta_5 HSR_i \times POST_{i,t \geq 2} + \beta_6 CONTROLS_{i,t} \\
 & + \sum FIRM_i + \sum YEAR_t + \varepsilon_{i,t}
 \end{aligned} \quad (2)$$

The empirical results obtained by regression using model (2) are shown in Table 7. In the first two years and the year before the high-speed rail was opened where the state-owned enterprises are located, the coefficient of *HSR* × *POST* is not significant. In the year after the high-speed rail was opened, one year after, two years, and beyond, the coefficient of *HSR* × *POST* is significantly positive at least at the 5% level.

5.2. Mechanism test

The previous conclusion shows that the opening of high-speed rail has a positive impact on the mixed ownership reform process of local state-owned enterprises. We further test the mechanism.

Table 7. Dynamic effects.

VARIABLES	Dep Var = <i>SHD_NONSOE</i> (1)	Dep Var = <i>D_NONSOE</i> (2)
$HSR \times POST_{-2}$	-0.0007 (-0.19)	0.0004 (0.19)
$HSR \times POST_{-1}$	0.0001 (0.02)	0.0009 (0.35)
$HSR \times POST_0$	0.0767*** (3.75)	0.0119*** (2.65)
$HSR \times POST_1$	0.0830*** (4.07)	0.0124*** (3.14)
$HSR \times POST_{\geq 2}$	0.0769*** (3.81)	0.0113*** (3.74)
CONTROLS	YES	YES
Firm/Year FE	YES	YES
Observations	9,320	9,320
Adj R-squared	0.564	0.634

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

First of all, the opening of high-speed rail can promote inter-regional information flow and market integration, reduce the transaction costs borne by potential private investors in participating in the mixed reform of local state-owned enterprises, and increase the expected net benefits of their mixed reform decisions, thus having a positive impact on the mixed reform process of local state-owned enterprises. Therefore, we examine the impact from two dimensions, potential private investors and market intermediaries. On the one hand, in terms of potential private investors, we refer to the approach of Cao et al. (2015), using the price index method to measure the market segmentation index of the province where the sample state-owned enterprises are located, taking the reciprocal and then finding the standard deviation to characterise the local market integration degree (*MI*), and the degree of factor market development in the marketisation index report (Wang et al., 2019) is used to measure the market integration level (*MIFAN*) of the province where the sample state-owned enterprises are located. The two can more comprehensively measure the areas where state-owned enterprises are located that potential private investors face. The degree of market integration is used to test the mechanism. The regression results are shown in Table 8. It can be found that the coefficients of $HSR \times POST$ in columns (1) and (4) are both significantly positive at the 5% level, indicating that the opening of high-speed rail can significantly improve the local market integration level. Furthermore, the coefficients of *MI* in columns (2) and (3) are both significantly positive at the 1% level, and the coefficients of *MIFAN* in columns (5) and (6) are also significantly positive at the 1% level, and the regressions all passed Sobel test of the intermediary effect, which shows that the opening of high-speed rail can enhance the mixed development process of local state-owned enterprises through the mechanism of promoting regional market integration.

On the other hand, from the market intermediary dimension, the opening of high-speed rail can also help intermediary organisations such as auditors and analysts to conduct convenient and timely research and supervision of local state-owned enterprises and reduce the potential of private investors to participate in mixed reform. It can prompt them to make better decisions on mixed-ownership reform by improving the quality of the latter's financial information and decreasing transaction costs. Referring to Zhao et al. (2018), we use the absolute value of accrued earnings management (*EM*) calculated by the

Table 8. Inter-regional market integration mechanism 1.

VARIABLES	MI (1)	SHD_NONSOE (2)	D_NONSOE (3)	MIFAN (4)	SHD_NONSOE (5)	D_NONSOE (6)
MI		0.0210*** (3.05)	0.0156*** (2.62)			
MIFAN					0.0025*** (2.69)	0.0021*** (2.84)
HSR × POST	0.0148** (2.28)	0.0114*** (3.22)	0.0078*** (3.02)	0.1989** (2.48)	0.0112*** (3.17)	0.0076*** (2.94)
CONTROLS	YES	YES	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320	9,320	9,320
Adj R-squared	0.642	0.563	0.622	0.841	0.563	0.622
Sobel-Z		9.10***	3.17***		2.25**	6.30***

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

modified Jones model and the natural logarithm of the number of analysts following (*ANALYST*) of sample state-owned enterprises in the current year to depict the degree of information asymmetry. The regression results are shown in Table 9. It can be found that the coefficient of *HSR* × *POST* in column (1) is significantly negative at the 1% level, and the coefficient of *HSR* × *POST* in column (4) is significantly positive at the 5% level, indicating that high-speed rail opening can reduce the degree of information asymmetry of local state-owned enterprises and achieve information market integration. Furthermore, the coefficients of *EM* in columns (2) and (3) are both significantly negative at the 5% level, and in columns (5) and (6) The coefficients of *ANALYST* are all significantly positive at the 5% level, and the regressions all pass the Sobel mediation effect test, which shows that the opening of high-speed rail can indeed improve the mixed development process of local state-owned enterprises through the mechanism of promoting inter-regional market integration.

Secondly, the opening of high-speed rail can effectively improve the operational activities and management characteristics of local state-owned enterprises, and enhance the equity appreciation expectations and capital growth motivation of potential private investors participating in the mixed reform of state-owned enterprises. Referring to Liu et al. (2016), we use the Dibo internal control index (*IC*) and administrative expense ratio (*AGENCY*) of the sample state-owned enterprises in that year to describe their operating activities and management characteristics, to conduct a mechanism test. The regression results are shown in Table 10. It

Table 9. Inter-regional market integration mechanism 2.

VARIABLES	EM (1)	SHD_NONSOE (2)	D_NONSOE (3)	ANALYST (4)	SHD_NONSOE (5)	D_NONSOE (6)
EM		−0.0277** (−2.02)	−0.0205** (−2.00)			
ANALYST					0.0026** (2.10)	0.0024** (2.33)
HSR × POST	−0.0091*** (−3.47)	0.0115*** (3.23)	0.0078*** (3.04)	0.1404** (2.05)	0.0114*** (3.20)	0.0077*** (2.96)
CONTROLS	YES	YES	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320	9,320	9,320
Adj R-squared	0.263	0.562	0.621	0.724	0.562	0.622
Sobel-Z		2.57**	5.09***		7.59***	5.89***

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

can be found that the coefficient of $HSR \times POST$ in column (1) is significantly positive at the 5% level, and the coefficient of $HSR \times POST$ in column (4) is significantly negative at the 1% level, indicating that high-speed rail opening can promote the optimisation of operational activities and management characteristics of local state-owned enterprises. Coefficients of IC in columns (2) and (3) are significantly positive at least at the 5% level, and the coefficients of $AGENCY$ in columns (5) and (6) are both significantly negative at the 5% level, and the regressions all passed the Sobel testing, which shows that the opening of high-speed rail can enhance the mixed ownership reform process of local state-owned enterprises through the mechanism of optimising their operating activities and management characteristics.

5.3. The moderating role of administrative levels and industry characteristics of state-owned enterprises

The market forces represented by the opening of high-speed rail are influenced by many factors, among which the administrative levels and industry characteristics of state-owned enterprises are particularly important. Therefore, we examine how the characteristics of state-owned enterprises themselves affect the relationship between the opening of high-speed rail and the degree of mixed ownership reform. Specifically, centrally controlled and monopolised industry state-owned enterprises generally have larger scales, diversified operations, and involve various interests. Personnel and management authority are often controlled by state-owned shareholders and higher-level governments (Wei et al., 2017). Market forces are difficult to have a significant impact on the mixed reform process of such state-owned enterprises. At the same time, centrally controlled and monopolised industry state-owned enterprises usually have more social and economic resources, occupy leading positions in the industry, and are crucial to national strategic security. Therefore, state-owned shareholders and government agencies have strong leadership and control over the mixed reform process of such state-owned enterprises. Merely relying on the market influence of transportation infrastructure construction is insufficient to have a significant effect on their mixed reform process. Therefore, we believe that compared with locally controlled and competitive industry state-owned enterprises, the promotion of high-speed rail opening has a weaker effect on the mixed reform process of centrally controlled and monopolised industry state-owned enterprises.

Table 10. Management optimisation mechanism.

VARIABLES	IC (1)	SHD_NONSOE (2)	D_NONSOE (3)	$AGENCY$ (4)	SHD_NONSOE (5)	D_NONSOE (6)
IC		0.0016*** (2.79)	0.0006** (2.13)			
$AGENCY$					-0.0544** (-2.03)	-0.0363** (-2.22)
$HSR \times POST$	0.1767** (2.42)	0.0115*** (3.22)	0.0079*** (3.08)	-0.0120*** (-3.97)	0.0111*** (3.10)	0.0076*** (2.95)
CONTROLS	YES	YES	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320	9,320	9,320
Adj R-squared	0.207	0.562	0.621	0.603	0.562	0.622
Sobel-Z		2.67***	2.45**		2.60***	1.90*

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

Table 11. The moderating role of administrative level and industry characteristics.

VARIABLES	Dep Var = <i>SHD_NONSOE</i>		Dep Var = <i>D_NONSOE</i>	
	(1)	(2)	(3)	(4)
<i>HSR</i> × <i>POST</i> × <i>CENTRAL</i>	−0.0152*** (−2.66)		−0.0105*** (−2.69)	
<i>HSR</i> × <i>POST</i> × <i>MONOPOLY</i>		−0.0163** (−2.06)		−0.0106** (−2.31)
<i>HSR</i> × <i>POST</i>	0.0166*** (4.13)	0.0151*** (4.04)	0.0119*** (4.42)	0.0100*** (3.69)
CONTROLS	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320
Adj R-squared	0.562	0.571	0.635	0.624

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

On the one hand, referring to Liu et al. (2016), we divide sample state-owned enterprises into central state-owned enterprises and local state-owned enterprises. When the sample is a central state-owned enterprise, the dummy variable *CENTRAL* takes the value of 1, otherwise 0. On the other hand, according to Yue et al. (2010), the petroleum and natural gas extraction industry, tobacco products industry, petroleum processing, coking, and nuclear fuel processing industry, electricity, gas, and water production and supply industry, railways, water, and air transport industry, postal industry, and telecommunications and other information transmission service industry are divided into monopolised industries, while the rest are competitive industries. When the sample belongs to a monopolised industry, the dummy variable *MONOPOLY* takes the value of 1, otherwise 0. By setting the interaction terms of high-speed rail opening with the above two dummy variables as explanatory variables, heterogeneity tests are conducted. The regression results are shown in Table 11, from which it can be found that the coefficients of *HSR* × *POST* × *CENTRAL* and *HSR* × *POST* × *MONOPOLY* in columns (1) to (4) are both significantly negative at least at the 5% level. This indicates that only in local state-owned enterprises and competitive industry state-owned enterprises with weak government control can the opening of high-speed rail better promote the process of mixed ownership reform, while there is a lack of corresponding effects in cases of strong government control.

5.4. Research on economic consequences

Finally, we research the economic consequences of the further advancement of mixed ownership reform of state-owned enterprises under the influence of the opening of high-speed rail. Specifically, we use the Tobin Q value of sample state-owned enterprises to measure their capital market value (*TOBINQ*) and use the total factor productivity of sample state-owned enterprises measured according to the OP method to measure their labour productivity (*TFP*), and these two are used as explained variables. Thereby, we conduct a test of economic consequences. The regression results are shown in Table 12, from which we can find that the coefficient of *HSR* × *POST* in column (1) is significantly positive at the 1% level, indicating that the opening of high-speed rail can significantly increase the capital market value of local state-owned enterprises. And at the same time, the coefficients of *SHD_NONSOE* and *D_NONSOE* in columns (2) and (3) are significantly positive at least at the 5% level. The regression passes the Sobel intermediary effect test, which shows that the

Table 12. Economic consequences.

VARIABLES	Dep Var = TOBINQ			Dep Var = TFP		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>HSR</i> × <i>POST</i>	0.2523*** (5.06)	0.2424*** (4.89)	0.2416*** (4.79)	0.1890*** (4.60)	0.1840*** (4.49)	0.1835*** (4.45)
<i>SHD_NONSOE</i>		0.8384*** (3.02)			0.4248** (2.15)	
<i>D_NONSOE</i>			1.3412** (1.98)			0.6789** (2.04)
CONTROLS	YES	YES	YES	YES	YES	YES
Firm/Year FE	YES	YES	YES	YES	YES	YES
Observations	9,320	9,320	9,320	9,320	9,320	9,320
Adj R-squared	0.514	0.515	0.516	0.654	0.655	0.655
Sobel-Z		3.86***	7.50***		3.73***	4.10***

(1) ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively; (2) The t-value is in parentheses.

opening of high-speed rail can improve the capital market of local state-owned enterprises by promoting the mixed ownership reform process. On the other hand, in column (4), the coefficient of *HSR* × *POST* is significantly positive at the 1% level, indicating that high-speed rail opening can significantly enhance the labour productivity of local state-owned enterprises. Meanwhile, in columns (5) and (6), the coefficients of *SHD_NONSOE* and *D_NONSOE* are both significantly positive at the 5% level, and the regression passes the Sobel mediation effect test, indicating that high-speed rail opening can enhance labour productivity of local state-owned enterprises through promoting the process of mixed ownership reform. Therefore, it can be seen that the opening of high-speed rail has positive socio-economic benefits for the mixed ownership reform in state-owned enterprises.

6. Conclusion

How to comprehensively deepen the reform of mixed ownership in state-owned enterprises from the perspective of private investors has become a key factor determining the success or failure of state-owned enterprises' reform in the new era. We focus on whether and how the construction of typical transportation infrastructure, represented by the opening of high-speed rail, affects the process of mixed ownership reform in state-owned enterprises. We find that based on the dimensions of non-state shareholders' shareholding in state-owned enterprises and their participation in high-level governance, the opening of high-speed rail can significantly promote the process of mixed ownership reform in local state-owned enterprises. Mechanism tests indicate that the opening of high-speed rail can promote inter-regional market integration, reduce transaction costs for potential private investors participating in mixed ownership reform, improve the operational activities and management characteristics of state-owned enterprises, and strengthen the intrinsic motivation of potential private investors to participate in mixed-ownership reform, thereby positively influencing the degree of mixed ownership reform in local state-owned enterprises. Further research reveals that these effects are sustainable and more pronounced in local state-owned enterprises and competitive industry state-owned enterprises with weaker government influence, ultimately enhancing the capital market value and labour productivity of state-owned enterprises.

We offer the following policy recommendations for better promoting mixed-ownership reform in state-owned enterprises in the new era. Firstly, further deepening

mixed-ownership reform in state-owned enterprises should start with better improving the construction of transportation infrastructure. In fact, since 2013, many provinces and cities in China have successively introduced various mixed ownership reform plans for state-owned enterprises. However, the effectiveness of mixed ownership reform in state-owned enterprises varies from place to place, largely due to the difficulty for potential non-state shareholders to clearly understand and trust local reform intentions and the actual operations of state-owned enterprises. Therefore, central and local governments should be aware of the influence of potential investors' economic motives when deepening mixed ownership reform, and ensure that the reform progresses continuously and orderly by proactively providing potential investors with local state-owned enterprises information through advanced transportation infrastructure construction and reducing transaction costs for participating in governance.

Secondly, the promotion of mixed ownership reform should effectively safeguard the legitimate rights and interests of non-state shareholders. After dividing mixed ownership reform into two dimensions: equity structure and high-level governance, we find that in recent years, mixed ownership reform in various places has to some extent stagnated at the equity level, and some state-owned enterprises even engage in behaviours of 'mixing' for the sake of 'mixing'. This is inconsistent with the emphasis in the domestic academic and practical circles on implementing more supporting measures at the level of the board of directors and governance mechanisms. Government intervention in promoting mixed ownership reform through transportation infrastructure construction may have certain obstacles. Therefore, better promoting mixed ownership reform requires a balance between government delegation of power and improvement of the external environment.

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References

- Armstrong, C. S., Balakrishnan, K., & Cohen, D. (2012). Corporate governance and the information environment: Evidence from state antitakeover laws. *Journal of Accounting and Economics*, 53(1–02), 185–204. <https://doi.org/10.1016/j.jacceco.2011.06.005>

- Bian, Y., Wu, L., & Bai, J. (2019). Does the opening of high-speed rail promote regional innovation? *Journal of Financial Research*, 06, 132–149. In Chinese. http://www.jryj.org.cn/CN/volumn/volumn_51.shtml
- Cai, C., Huang, H., & Zhao, L. (2019). Research on the effect and mechanism of reducing audit delays due to the opening of high-speed rail. *Accounting Research*, 06(2), 72–78. In Chinese. <https://doi.org/10.35248/2472-114X.18.6.185>
- Cai, G., Liu, J., & Ma, X. (2018). Non-state shareholders' governance and state-owned enterprise executive compensation incentives. *Management World*, 05, 137–149. <https://doi.org/10.3969/j.issn.1002-5502.2018.05.011> In Chinese.
- Cai, G., Zheng, G., Ma, X., & Lu, R. (2018). Government decentralization willingness and mixed ownership reform of state-owned enterprises. *Economic Research Journal*, 09, 99–115. In Chinese. <http://erj.cn/cn/gwqk2.aspx?m=20100918141426890803>
- Cao, C., Zhou, D., Wu, C., & Zhang, T. (2015). Market segmentation and distribution of off-site subsidiaries. *Management World*, 09, 92–103. In Chinese <https://doi.org/10.3969/j.issn.1002-5502.2015.09.011>
- Deng, H., Yang, L., & Pan, X. (2020). Can the opening of high-speed rail help upgrade the industrial structure: Facts and mechanisms. *Journal of Financial Research*, 06, 34–48. In Chinese <https://doi.org/10.16538/j.cnki.jfe.2020.06.003>
- Du, X., & Peng, M. (2017). Will the opening of high-speed rail promote the flow of senior talents in enterprises? *Economic Management Journal*, 12, 89–107. <https://doi.org/10.19616/j.cnki.bmj.2017.12.006>
- Hao, Y., & Gong, L. (2017). Mixed state-owned and private equity participation and company performance improvement. *Economic Research Journal*, 03, 122–135. In Chinese. <http://erj.cn/cn/gwqk2.aspx?m=20100918141426890803//>
- Huang, S. (2014). Research on mixed ownership reform of China's state-owned enterprises. *Economic Management Journal*, 07, 1–10. <https://doi.org/10.19616/j.cnki.bmj.2014.07.003> In Chinese.
- Huang, Q., & Yu, J. (2013). New ideas in the new era: Classification reform and governance of state-owned enterprises. *China Industrial Economics*, 11, 5–17. In Chinese <https://doi.org/10.19581/j.cnki.ciejournal.2013.11.001>
- Jiang, B., Chu, N., Wang, Y., Ma, Y., & Zhang, X. (2016). Research review and prospects on the impact of the high-speed railway on urban and regional space. *Human Geography*, 01, 16–25. <https://doi.org/10.13959/j.issn.1003-2398.2016.01.003>
- Ji, Y., & Yang, Q. (2020). Can the opening of high-speed rail promote enterprise innovation: Research based on quasi-natural experiments. *Journal of World Economy*, 02, 147–166. <https://doi.org/10.19985/j.cnki.cassjwe.2020.02.008> In Chinese.
- Liu, X. (2004). Analysis of the effect of privatization and restructuring on China's industrial efficiency - analysis of 2001 national census industrial data. *Economic Research Journal*, 08, 16–26. In Chinese. <http://erj.cn/cn/gwqk.aspx?m=20100918141426890802>
- Liu, Y., Zheng, Q., & Cai, G. (2016). Do non-state shareholders improve the quality of internal control of state-owned enterprises? empirical evidence from state-owned listed companies. *Accounting Research*, 11, 61–68. In Chinese <https://doi.org/10.3969/j.issn.1003-2886.2016.11.009>
- Long, Y., Zhao, H., Zhang, X., & Li, Y. (2017). Venture investment under time and space compression-high-speed rail opening and regional changes in venture capital. *Economic Research Journal*, 04, 195–208. In Chinese. <http://erj.cn/cn/gwqk2.aspx?m=20100918141426890803/>
- Ma, G., Cheng, X., & Yang, E. (2020). How transportation infrastructure promotes capital flow - research based on the opening of high-speed rail and off-site investment of listed companies. *China Industrial Economy*, 06, 5–23. <https://doi.org/10.19581/j.cnki.ciejournal.2020.06.001> In Chinese.
- Ma, X., Tang, T., & Zheng, G. (2021). Non-state shareholders' governance and tax avoidance and tax contribution of state-owned enterprises: From the perspective of mixed ownership reform. *Management World*, 06, 128–141. <https://doi.org/10.19744/j.cnki.11-1235/f.2021.0082> In Chinese.

- Ma, L., Wang, L., & Zhang, Q. (2015). Prioritization of mixed ownership: The logic of the market. *China Industrial Economics*, 07, 5–20. <https://doi.org/10.19581/j.cnki.ciejournal.2015.07.001> In Chinese.
- Meggison, W. L., Nash, R. C., & Van Randenborgh, M. (1994). The financial and operating performance of newly privatized firms: An international empirical analysis. *The Journal of Finance*, 49(2), 403–452. <https://doi.org/10.1111/j.1540-6261.1994.tb05147.x>
- Rao, P., Wang, D., & Li, X. (2019). High-speed rail opening and supplier distribution decisions. *China Industrial Economics*, 10, 137–154. In Chinese <https://doi.org/10.19581/j.cnki.ciejournal.2019.19.001>
- Tan, J., Ding, H., & Tan, Z. (2019). High-speed rail opening and enterprise innovation: A quasi-natural experiment based on high-speed rail opening. *Journal of Shanxi University of Finance and Economics*, 03, 60–70. <https://doi.org/10.13781/j.cnki.1007-9556.2019.03.005> In Chinese.
- Tang, T., Wu, J., Ma, X., & Song, X. (2020). Non-state shareholders' governance and audit fees: Empirical evidence based on mixed ownership reform of state-owned enterprises. *Auditing Research*, 01, 68–77. In Chinese. <https://doi.org/10.3969/j.issn.1002-4239.2020.01.010>
- Wang, X., Fan, G., & Hu, L. (2019). *China's provincial marketization index report (2018)*. Social Sciences Literature Press.
- Wang, Y., & Ni, P. (2016). Economic growth spillover and regional spatial optimization under the influence of high-speed railway. *China Industrial Economics*, 02, 21–36. <https://doi.org/10.19581/j.cnki.ciejournal.2016.02.003> In Chinese.
- Wei, M., Cai, G., & Liu, J. (2017). Research on classified governance of Chinese state-owned listed companies. *Journal of Sun Yat-Sen University (Social Science Edition)*, 04, 175–192. In Chinese <https://doi.org/10.13471/j.cnki.jsysusse.2017.04.019>
- Wen, W., Huang, Y., & Song, J. (2019). Does transportation infrastructure construction improve corporate investment efficiency? A quasi-natural experiment based on the opening of China's high-speed rail. *Journal of Zhongnan University of Economics and Law*, 02, 42–52. In Chinese <https://doi.org/10.19639/j.cnki.issn1003-5230.2019.0020>
- Yang, Q., Ji, Y., & Wang, Y. (2019). Can high-speed rail improve the accuracy of analysts' earnings forecasts? evidence from listed companies. *Journal of Financial Research*, 03, 168–188. In Chinese. http://www.jryj.org.cn/CN/volumn/volumn_48.shtml
- Yue, X., Li, S., & Shi, T. (2010). Discussion on the issue of high income in monopoly industries. *Social Sciences in China*, 03, 77–93. In Chinese. <http://sscp.cssn.cn/zgshkx/201101/>
- Zeng, S., Cai, G., & Cheng, M. (2017). Can non-state shareholders improve the quality of accounting information? Empirical evidence from competitive state-owned listed companies. *Accounting and Economic Research*, 04, 28–44. <https://doi.org/10.16314/j.cnki.31-2074/f.2017.04.003> In Chinese.
- Zhang, H., & Ping, F. (2019). Geographic distance of independent directors, high-speed rail opening, and financial restatement. *Accounting and Economic Research*, 05, 21–37. In Chinese <https://doi.org/10.16314/j.cnki.31-2074/f.2019.05.002>
- Zhao, J., Huang, J., & Liu, F. (2018). High-speed rail opening and stock price crash risk. *Management World*, 01, 157–168. <https://doi.org/10.19744/j.cnki.11-1235/f.2018.01.014> In Chinese.
- Zheng, S., & Kahn, M. E. (2013). China's bullet trains facilitate market integration and mitigate the cost of megacity growth. *Proceedings of the National Academy of Sciences*, 110(14), E1248–E1253. <https://doi.org/10.1073/pnas.1209247110>

Appendix Variable definitions

Variable	Definition
<i>SHD_NONSOE</i>	The degree of mixed ownership reform of state-owned enterprises in the ownership structure dimension, which is measured by the sum of the shareholding ratios of all non-state shareholders among the top ten shareholders
<i>D_NONSOE</i>	The degree of mixed ownership reform of state-owned enterprises in the high-level governance dimension, which is measured by the ratio of the number of directors appointed by non-state shareholders to the total number of directors on the board of directors of state-owned enterprises.
<i>HSR</i>	A dummy variable indicating whether the high-speed rail is open. The value is 1 if the city where the company is located has opened a high-speed rail during the sample period and 0 otherwise.
<i>POST</i>	The dummy variables before and after the high-speed rail is opened. If the city where the company is located has opened high-speed rail, it should be 1, otherwise it should be 0. If the city where the company is located has not yet opened high-speed rail, the value should be 0.
<i>SIZE</i>	Company size, the natural logarithm of the company's total assets at the end of the year
<i>LEV</i>	The company's year-end asset-liability ratio, which is total liabilities divided by total assets
<i>ROA</i>	Company profitability, expressed as return on total assets for the year
<i>GROWTH</i>	Company growth, main business income growth rate for the year
<i>AGE</i>	Take the logarithm of the company's listing years plus 1
<i>CONCENTRATE</i>	Company ownership concentration, measured by the sum of the squares of the shareholding ratios of the top five shareholders
<i>SHDSOE</i>	Shareholding ratio of the company's largest state-owned shareholder
<i>BOARDSIZE</i>	The size of the company's board of directors, the natural logarithm of the total number of people on the board of directors
<i>INDEP</i>	Independence of the company's board of directors, the proportion of independent directors to the total number of board members
<i>DUAL</i>	A dummy variable indicating the combination of two positions. If the chairman and general manager are both held by one person, it is 1, otherwise it is 0.
<i>DECENTRALIZE</i>	The government's willingness to decentralise power is measured by the 'Reducing Government Intervention in Enterprises' index in the province where the company is located.