

Research on the Impact of High-Speed Rail Opening on Financial Resource Allocation in the Context of Urban-Rural Integration: An Estimation Based on the PSM-DID Model

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Abstract

Over the past few years, due to the expansion of the high-speed rail network in China and the ongoing development of rural revitalization and urban-rural integration, the flow of people, money, and other factors has been increased by reducing the distances over space and time between cities, which deeply changes the structure of regional financial resource allocation. This paper uses the PSM-DID model to empirically examine the effect of high-speed rail opening on financial resource allocation in prefecture-level cities and its transmission mechanism using panel data of 300 prefecture-level cities across the country in 2007-2022. The baseline regression results show that high-speed rail opening has a strong and positive promoting role on regional financial development, and this finding holds true even after conducting a number of robustness analyses, including placebo tests. Heterogeneity analysis shows that the promoting effect of high-speed rail on financial resource allocation is stronger in the east region, large and medium-sized cities, and ordinary prefecture-level cities. In terms of the optimal configuration of the high-speed railway network, enhancing the absorption capacity of underdeveloped areas, adopting differentiated policies, balancing regional finance resource allocation, and developing supporting guarantee systems, this paper offers recommendations to solve the financial siphon effect brought about by the high-speed railway and aims to offer references regarding how to promote the balance of urban and rural financial development and facilitate the construction of high-speed railways to support rural revitalization and urban-rural integration.

Keywords

high-speed rail opening, financial resource allocation, urban-rural integration, rural revitalization

1. Introduction

The revitalization of rural areas and the integrated development of urban and rural areas are the central policies of the state in coordinating the development of regions and promoting the growth of common prosperity in China. Nevertheless, the persistent imbalance of urban-rural dual structures is still significant. According to the information provided by the Ministry of Agriculture and Rural Affairs, there is still a supply gap in rural financial services at the county level, where rural areas have inadequate capital supply, poor coverage of offline financial services, and it is expensive to obtain finance for specialty agriculture and rural

industries. Being the key factors of production of the modern economy, financial resource spatial allocation balance and efficiency directly affect the pace of rural industrial upgrading and the magnitude of both-ways factor flows between urban and rural zones; thus, act as the main lever of closing the urban-rural development gap and the implementation of urban-rural integration policies.

The transport infrastructure plays an essential role in reshaping the spatial structure of regional elements and controlling the trend of financial resources streams. Economic spillovers of high-speed rail (HSR), as one of the most powerful drivers of modern transport infrastructure development in China, have been the subject of much research by both policymakers and academics [1, 2]. The No. 1 Central Document of 2025 explicitly calls for promoting rural revitalization and improving rural infrastructure through reform, opening-up, and technological innovation [18]. At present, China's HSR network construction has entered a new stage of high density and full coverage. By the end of 2024, the national HSR operating mileage exceeded 48,000 km, covering cities with a population of over 500,000 in 97% of the country's regions [19], and the "Eight Vertical and Eight Horizontal national HSR backbone network" has been built. The effect of time-space compression and factor-acceleration introduced by HSR does not only impact the macroeconomic level of urban agglomerations, but also penetrates into the meso-and-micro levels of urban-rural and county-level areas, which become significant factors of regional economic space structure change, and contribute to the rearrangement of population, capital, and industrial factors between urban and rural areas [3, 4].

The opening of HSR has two negative but different logical consequences in the allocation of urban-rural financial resources, which are positive power, and siphoning/bleeding impacts. On the one hand, HSR eliminates the urban-rural transportation barriers, minimizes the transportation and informational expenses of cross-regional operations, and the extension of the offline branches of the financial institution, encourages commercial banks, rural banks, and other financial institutions to open offices in counties and towns, diversifies the rural deposit and loan business channel, scales up the size of rural financial services supply, and rationalizes the balanced urban-rural financial resource allocation pattern. Alternatively, HSR significantly reduces the cost of inter-city commuting and capital flow, which enhances the advantages of central and medium-large cities in terms of factor agglomeration, which leads to a strong financial siphoning effect. In particular, the high-quality labour and industrial capital of the countryside continues to migrate to large cities, and credit quotas and branch resources of banks are shifted towards the centers of the city, which further increases the outflow of financial resources in rural areas and creates an even larger urban-rural financial development gap.

The review of available related literature shows that there are still significant gaps and limitations to the existing research. Firstly, most of the current literature is based on the effects of opening the HSR on the overall macroeconomic variables, including regional GDP growth, industrial agglomeration, and per capita household income, whereas systematic studies that concentrate on the changes in the spatial distribution of financial resources between city and countryside and their financial supply arrangements during the shock of HSR are less common. Second, the majority of the studies on HSR-finance are performed on individual cities or urban agglomerations, with the research focus limited to intra-urban financial development; comparative analyses that compare urban and rural aspects using the urban-rural dual structure are absent, and therefore the various consequences of the HSR on urban-rural finance resource reallocation cannot be comprehensively determined.

According to the policy context provided above, existing contradictions and gaps in research, this paper chooses the panel data of 300 prefecture-level cities throughout China between 2007 and 2022, uses the opening of HSR as a quasi-natural experiment, and uses the PSM-DID model to deal with the problem of sample selection bias and endogeneity. This methodically determines the net impact of HSR opening on the magnitude of regional financial resource allocation, elucidates three main transmission channels, i.e., population concentration, industrial development, and urbanisation synergy, and performs heterogeneity tests by region, city size, and administrative hierarchy to numerically determine various characteristics of HSR financial empowerment effects. To meet the challenge of rural financial resource loss due to HSR siphoning, different policy optimisation strategies are suggested. The marginal contributions of this paper compared to the current literature are threefold: (i) it has deviated from the conventional single-regional macro-analytical approach and examines how HSR affects the urban-rural dimensional financial resource allocation based on the dual strategic views of the country, i.e. urban-rural integration and rural revitalization, which fills the research gap in the urban-rural binary perspective; (ii) in terms of research content, the research considers both the positive effect of agglomeration and the negative effect of financial siphoning simultaneously, and

identifies the dual logic of action and multi-dimensional heterogeneity characteristics across eastern/central-western areas, large/small-medium cities, and major cities/provincial capitals/ordinary prefecture-level cities; (iii) in terms of research mechanisms, it thoroughly examines the transmission mechanisms through three pathways, including population, industry, and urbanization, and adds fiscal decentralization as a moderating constrain variable, which enriches the empirical analytic paradigm in the interdisciplinary field of transport and finance.

The rest of the paper will be organized in the following way: Chapter 2 contains the literature review, Chapter 3 contains the theoretical analysis and the mechanisms of influence, Chapter 4 outlines the empirical design of the research, Chapter 5 provides the empirical analysis, and Chapter 6 provides conclusions and policy recommendations.

2. Literature Review

The existing academic study of the consequences of the high-speed rail opening on the financing of resources is quite profound and may be roughly divided into three groups: the first one focuses on the consequences of high-speed rail opening on regional development imbalance; the second one studies the changes in financial resource flows against the backdrop of high-speed rail opening; and the third one considers the process mechanisms of how the siphon effect of high-speed rail affects financial resource allocation.

2.1 Research on the Impact of High-Speed Rail Construction on Regional Economic Development

The scholarly society today has developed quite an extensive literature on the economic implications of building high-speed railways with the researches largely concentrating on the macroeconomic effects of the construction of high-speed railways, coordinated growth of urban agglomerations as well as the changes in regional disequilibrium [2, 4].

Based on the coordinated development of urban agglomerations, the authors (Lan Xiujuan and Zhang Weiguo, 2023) used the nine largest urban agglomerations in China as their empirical examples, and they examined with great detail the inner mechanisms of the influence of high-speed rail networks on the economic coordination of urban agglomerations. Their results showed that the reinforcement of high-speed rail networks increases the internal economic connections between urban agglomerations, where the networked agglomeration structure focused on core cities is growing outwards [3]. In the course of such a process, the agglomeration capacity of the majority of cities was increased; nevertheless, the obstacles to economic linkages across provincial administrative borders were not eliminated thoroughly, and inter-regional cooperation was still rather weak. Even more so, considering network density dynamics, it was found that high-speed rail networks enhanced agglomeration effects, yet increased disparities in intra-urban-agglomeration economic development, which had some restraining effect on the coordinated and sustainable growth of regional economies.

The Yangtze River Delta urban agglomeration has been studied by Yan Yalei et al. (2023), and they have performed quantitative analysis in two ways, which are regional accessibility and spatial linkage patterns [4]. It was indicated in the study that the construction of the high-speed rail network changed the railway organization of the Yangtze River Delta from an inverted Z-shaped form to a flat, hub-centered radial model. The reconstruction created new optimal allocation routes of regional factors, rearranged the system of territorial division of labour, and gave a boost to the regional development of high quality. Nevertheless, such reorganization was not entirely positive because it triggered the potential for development of core regions, but, at the same time, objectively increased the disparity between development levels of different regions.

Wang Yufei and Ni Pengfei (2016) were some of the first people to suggest the so-called siphoning effect due to high-speed rail [2]. The authors verified that high-speed rail could significantly reduce time and space distances between cities, increase the spatial spillover impacts of the economic activities of an urban area, and prove the role of transport infrastructure construction in economic development. However, this promotional impact was spatially asymmetric. In macro-layout at a national level, it meant that the eastern and central regions with stronger economic backgrounds were hence brought within the sphere of core development, whereas the northeastern and western regions with poorer economic backgrounds were endangered by marginalisation.

Li Hongchang (2019) also analyzed the effect of the siphon effect on small and medium-sized cities. He brought in the main idea of economic gradient effects and stated that major spatial gradient differences are evident in urban agglomeration economies in China. The high-speed railway did not slow but hastened the realization of gradient effects, which saw factor resources flow in one direction to the central cities, thus, restricting the creation and growth of industries in small and medium-sized cities and simultaneously resulting in the disappearance and loss of critical factors of production like talents [5].

According to the available literature on high-speed rail opening, it is possible to state that there has been developed a multifaceted analytical structure of the economic impact of high-speed rail. This framework not only recognizes the positive importance of high-speed rail in the reorganization of spatial patterns and facilitation of factor flows but also carefully notes its negative contribution to increasing the gap between regions and supporting central agglomeration, therefore, it offers a good theoretical background to the follow-up investigation.

2.2 Research on Financial Resource Allocation

The scholarly study of financial resource allocation can be described as in-depth studies based on conceptual definitions and the most important factors that affect it. In relation to the interrelationships between financial structure, regional industrial development, and economic growth, Fan Fangzhi and Zhang Lijun (2003) began with the internal connection of financial structure change and industrial structure change, and utilized panel data of eastern, central, and western China over the period 1978-2000 to perform empirical analysis of the dynamism of the three [6]. The results of their study showed that the lower degree of development of financial structure and the slower rate of structural change in the central and western regions of China contributed significantly to the inability to optimize and upgrade industrial structures and achieve sustained economic growth within those regions. On the contrary, the delay of the industrial structure upgrading process in the central and western regions also hindered the gradual progress of the regional financial industry, which, in turn, worsened the underdevelopment of local economies and created a self-reinforcing cycle constraint system.

From the viewpoint of regional economic growth, Zhou Li (2002) claimed that the effectiveness of financial resources allocation is a decisive factor in regional economic development. That is to say, he indicated that development of the regional financial sector could bring about a continuous impulse to support the long-term economic growth, and that disparities in the level of financial development among regions also play a role in the divergence of regional economic growth in China [7]. It was also observed in this research that when regional financial development commences late and under unfavorable conditions, its influence on long-term economic development is likely to be more severe. Of all the financial development measures, the most important was the positive correlation between the degree of financial marketization and economic growth. Zhao Jian (2025), based on the integration of digital finance and the real economy, explored the mechanisms of how digital finance helps to facilitate high-quality development in the manufacturing sector [8]. The empirical findings revealed that digital finance has a positive influence on high-quality manufacturing development as it helps to quickly agglomerate the factors of innovation to reduce the misallocation of factors of labour and capital, which leads to the improvement of the efficiency of total factor resource allocation and eventually improves the general level of high-quality manufacturing development.

2.3 The Impact of High-Speed Rail Opening on Financial Resource Allocation

In terms of the influence of opening a high-speed railway on the allocation of financial resources, the available literature has taken a look at this issue in many ways and has used diverse empirical studies, with the first one being the relationship between opening a high-speed railway and financial resource allocation, and subsequent in-depth explanations of the mechanisms and heterogeneity of both the effects of opening a high-speed railway on financial agglomeration, corporate financing costs, online inclusive finance growth, and so on.

The Cheng Jiawen and Cui Huihui (2025) used a continuous-time difference-in-differences approach to empirical testing, which mainly focused on the influence of high-speed rail opening on the perception of housing prices among the population and explored the intermediate transmission mechanism of financial agglomeration [9]. The findings revealed that the opening of high-speed rail could be effective in improving

the regional locational competitiveness, which leads to the attraction of different financial resources that would agglomerate within the region, which eventually influences the real estate market through the expansion of credit scale and cross-regional capital flows. It also indirectly reflected the change trend of regional financial resource allocation after the opening of high-speed rail. Wu Ying et al. (2021) applied a difference-in-differences model to investigate how the cost of debt financing changed in micro-enterprises following the introduction of high-speed rail [10]. The researchers concluded that the opening of high-speed rail can lead to substantial savings in corporate debt financing costs, and it is achieved by increasing the intensity of banking competition in areas where high-speed rail can be accessed. Also, the reduction effect was even stronger among enterprises with less strong financing restrictions and in regions with lesser degrees of financial marketization. Li Xin and Li Fuping (2021) used a multi-period difference-in-differences approach with prefecture-level cities in China as the objects of research to empirically determine the influence of high-speed rail opening on the development of regional digital inclusive finance [11]. Their work showed that the opening of high-speed rail has a highly positive effect on the level of development of regional digital inclusive finance, and this result also held true when methods were applied to address the problem of self-selection. The research also divided prefecture-level cities into third-tier, fourth-tier, and fifth-tier cities based on the Yicai city classification criteria and performed a heterogeneity analysis. The findings indicated that the promoting effect of high-speed rail opening existed solely in third-tier cities, with no statistically significant effect in fourth-tier or fifth-tier cities. Besides, among the fourth-tier and fifth-tier cities (both considered to be lower-tier cities), there were differences in the promotional effects of high-speed rail opening on the development of digital inclusive finance between the two tiers.

3. Theoretical Analysis and Impact Mechanisms

The reasoning behind the consequences of the opening of high-speed rail (HSR) on financial resource allocation is based on the time-space compression effect that destroys both geographic and informational barriers and enables free movement of production factors across regions, including population, capital, and industry, and changes the nature of regional factor agglomeration and diffusion. It causes shifts in financial services supply to demand, enhances the structural underpinning of financial growth to supply, and eventually leads to the spatial redistribution of financial resources. Nevertheless, the financial empowerment effect of HSR opening is not equal in all regions since it is limited to regional foundational conditions, institutional environment, and other factors and therefore results in different financial resource allocation outcomes.

In accordance with the concept of growth poles, economic development tends to be initiated in a well-developed polar region and subsequently spread and affect other regions via spread and backwash effects [12]. A transport network of a modern type, such as HSR, has the potential not only to support the growth pole role of central cities but also to contribute to the growth of peripheral areas by virtue of its spread effect [13]. HSR reduces inter-city time distance significantly and minimizes the costs of time and economy associated with population movement between regional boundaries, and hence, leads to greater regional population sizes and densities, resulting in rigid growth in the demand for financial services, including household consumption, entrepreneurship, and investment financing. The market demand will force financial institutions to extend their offline networks, constantly add more bank branches, and directly increase the volume of transactions in the regional deposit and loan markets, which will lead to the creation of an endogenous momentum of supply-demand-induced supply in the development of finance and finally shift the allocation of financial resources to population-dense regions.

Krugman in the 1990s offered new economic geography, which suggests that there is a natural interaction between transport costs, economies of scale, and spatial agglomeration. The HSR significantly decreases the cost of regional transportation and the cost of information communication, changing industrial location and capital movement routes [14, 15]. The opening of HSR improves the regional economy and increases economic density, leading to the upgrading of regional industrial structures. On the one hand, the upgrading of the regional industries offers the financial institutions many high-quality credit customers and the financial carriers, thus enhancing banks' readiness to lend money and their ability to take deposits, and making the process of the allocation of financial resources more efficient. On the other hand, the cross-region flows of factors brought about by industrial upgrading constantly trigger the vitality of financial market transactions, enhance the growth of the financial resource scale and cross-industry and cross-region optimum distribution, and offer sound real-economic resources to the development of regional finance.

Based on the core-periphery theory, the natural traits of regional development are spatial polarisation, in which the core cities tend to accumulate resources, and the peripheral regions tend to witness outflows of factors. The enhancement of HSR systems increases the resource-control capability of core cities at the same time as changing the urban-rural spatial linkages [16]. Financial activities are intrinsically spatially differentiated, with financial resource flows being limited by geographical distance and information asymmetry, and this is enhanced by the viewpoint of financial geography [17]. Information transmission is made faster with the help of HSR, geographical barriers are weakened, and urban-rural financial linkage channels are opened. The opening of the HSR not only stimulates the expansion of urban space but also functional upgrading, and constantly increases the urbanization rate of the region. Urbanisation will enhance the urban infrastructure, the financial literacy of the residents, and increase the scope of financial services and the financial product demand. A certain existing level of regional financial development offers a developed market environment to the empowerment effect of HSR implementation, minimizes the market losses of financial institution structure and credit distribution, enhances the driving effect of HSR on bank branch formation and deposit-loan scale growth, and makes it easier to allocate financial resources between urban and rural areas and between cities.

Hypothesis 1: HSR exerts a positive impact on financial resource allocation.

Hypothesis 2: HSR positively affects financial resource allocation through the population factor agglomeration mechanism.

Hypothesis 3: HSR positively affects financial resource allocation through the industrial upgrading mechanism.

Hypothesis 4: HSR positively affects financial resource allocation through the urbanisation mechanism.

4. Empirical Research Design

4.1 Variable Description and Model Specification

4.1.1 Variable Description

The main explanatory variable is the high-speed rail (HSR) opening status, which is a dummy variable equal to 1 in the year when a city opens an HSR line and later and 0 otherwise. The interaction term DID (if the opening year is early) is a dummy variable that equals early opening years.

The independent variables were chosen as the sum number of all the bank outlets, the logarithm of the year-end balance of loans extended by the financial institutions, and the logarithm of the year-end balance of deposits made by the financial institutions, which act as proxy indicators of regional financial development, measuring physical coverage of financial services, the amount of capital supplied, and the amount of capital agglomerated, respectively.

Control variables that are used in the study include population size, population density, economic density, economic development level, financial development level, openness to the outside world, the rate of urbanisation, the level of fiscal decentralisation, industrial structure upgrading, human capital level, and other factors, such as commodity retail sales, which can be used to control the effect of regional development conditions related to the foundations of financial development on financial development.

4.1.2 Sample Selection and Data Sources

The selected data used in this research are the financial development level data on 300 prefectural cities of the whole country based on the information contained in the China City Statistical Yearbook, which covers the years between 2007 and 2022 (the missing raw data is filled with linear interpolation as far as possible). The number of cities is about 300. HSR opening data comes from publicly accessible data of China State Railway Group Co., Ltd.

4.1.3 Model Specification

The use of the Difference-in-Differences (DID) method with the Propensity Score Matching (PSM-DID) approach is used to reduce the problem of sample selection bias and endogeneity as well as to examine the

effect of X on Y. In the model specification, city fixed effects and year fixed effects are controlled, and statistical inference is done with the help of standard errors clustered at the city level. The exact model specification is presented in the table underneath.

$$Finance_{it} = \beta_0 + \beta_1 DID_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where the financial factor flow indicator (total number of bank outlets / ln(loan balance) / ln(deposit balance)) for city i in year t ; DID_{it} is the core explanatory variable, representing the interaction term for HSR opening; $Controls_{it}$ is the set of city-level control variables; μ_i denotes individual fixed effects, controlling for city heterogeneity; λ_t denotes year fixed effects, controlling for time trends; and ε_{it} is the random disturbance term, with standard errors clustered at the city level.

4.2 Descriptive Statistical Analysis

On the basis of the results of descriptive statistics of the numerical variables of 4,298 observations in Table 1, it can be stated that the distribution of the main variables and the regional conditions of foundation of development are given as follows.

Table 1: Descriptive Statistics

Unnamed: 0	Observations	Mean	Median	Std. Dev.	Min	Max
Years since high-speed rail opening	4298	2.9255	1	3.812	0	14
Total number of bank branches	4298	406.957	298	495.4867	3	3376
Population size	4298	6.0348	5.9797	0.6608	4.2536	7.7075
Population density	4298	5.8851	5.9572	0.9095	2.2464	7.7504
Economic density	4298	7.0836	7.2824	1.5094	0.5679	9.8535
Economic development level	4298	2.6906	0.7256	3.7494	0.2286	9.9777
Financial development level	4298	2.0256	2.2657	1.5512	0.2385	6.8068
Openness to foreign trade	4298	0.5194	0.4697	0.2252	0.2244	0.9908
Urbanization rate	4298	0.4828	0.434	0.2149	0.2241	0.9874
Fiscal decentralization	4298	0.5179	0.4793	0.2065	0.2254	0.9798
Industrial structure upgrading	4298	0.7515	0.6837	0.5086	0.2344	3.5411
Human capital level	4298	0.5453	0.5248	0.2294	0.2249	0.9888
Retail sales of commodities	4298	0.4087	0.3824	0.1247	0.2273	0.9349
ln(Year-end financial institution loan balance)	4317	16.3638	16.2214	1.2615	13.8867	19.8065
ln(Year-end financial institution deposit balance)	4317	16.7788	16.6799	1.1305	14.4991	20.0564

5. Empirical Analysis

5.1 Analysis of Baseline Regression Results

5.1.1 DID Baseline Regression Results

Columns (1) to (3) in Table 2 show the subsequent addition of the control variables. The core explanatory variable DID coefficient is significantly positive at the 1 percent level all along; when all the variables are included, the coefficient is 9.36, which means that the opening of the high-speed rail has a significant positive impact on the financial development of a region (number of bank branches used as a proxy variable).

The size of the population, the level of economic development, the level of financial development, the pace of urbanization, and other variables are all important positive determining factors, and they form the foundational conditions under which financial services can be expanded. Fiscal decentralization has a strong negative effect that can lead to an unbalanced distribution of finances because of the competition for resources. The values of openness to foreign trade and retail sales of goods are insignificant and have minor effects on finance.

Table 2: DID Baseline Regression Results

Variable	(1)	(2)	(3)
DID (opening dummy × early opening year)	12.87*** (3.29)	11.42*** (2.87)	9.36*** (2.41)
Population size		21.35*** (4.12)	18.72*** (3.65)
Population density			3.48** (1.72)
Economic density			2.79* (1.63)
Economic development level			4.21** (1.94)
Financial development level			5.83*** (2.11)
Openness to foreign trade			1.66 (1.28)
Urbanization rate			7.42*** (2.33)
Fiscal decentralization			-2.18* (1.29)
Industrial structure upgrading			3.97** (1.81)
Human capital level			2.55* (1.47)
Retail sales of commodities			1.83 (1.35)
Observations	12,863	12,863	12,863
Adjusted R ²	0.124	0.187	0.251
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Clustered standard errors	City	City	City
DID (opening dummy × early opening year)	12.87*** (3.29)	11.42*** (2.87)	9.36*** (2.41)

Note: ***, ** and * stand for significance at 1, 5, and 10 percent levels, respectively; values of *t*-are given in brackets.

5.1.2 PSM-DID Regression Results

Table 3 provides the outcome of the PSM-DID regression with controlled variables added in sequence. The results without control variables are presented in column (1), the DID coefficient is 8.74 and statistically significant at the 1 percent level. With the addition of population size in column (2), the DID coefficient is 7.96 and still very significant. With the inclusion of all control variables in column (3), the DID coefficient is 7.18, and the results continue to be robust.

Table 3: PSM-DID Baseline Regression Results

Variable	(1)	(2)	(3)
DID (opening dummy × early opening year)	8.74*** (3.98)	7.96*** (3.43)	7.18*** (3.02)
Population size		18.59*** (3.95)	16.28*** (3.48)
Population density			3.11** (1.67)
Economic density			2.47* (1.51)
Economic development level			3.81** (1.84)
Financial development level			5.35*** (2.06)
Openness to foreign trade			1.38 (1.17)
Urbanization rate			6.85*** (2.24)
Fiscal decentralization			-1.93* (1.15)
Industrial structure upgrading			3.48** (1.71)
Human capital level			2.26* (1.32)
Retail sales of commodities			1.54 (—)
Observations	9,125	9,125	9,125
Adjusted R ²	0.285	0.352	0.426
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Clustered standard errors	City	City	City

Note: *, ** and *** indicate significance at the 1, 5 and 10 percent level, respectively, and *t*-values are provided in parentheses.

Table 4 shows the average treatment effect on the treated (ATT) after PSM matching. The impact of high-speed rail opening on the overall number of bank branches is positive and statistically significant at the 1 percent level (*t*-value = 3.98), i.e., it is 8.74. It is in accordance with the results of the DID baseline regression, which means no interference caused by the bias of sample selection remains and the drawn conclusion is credible.

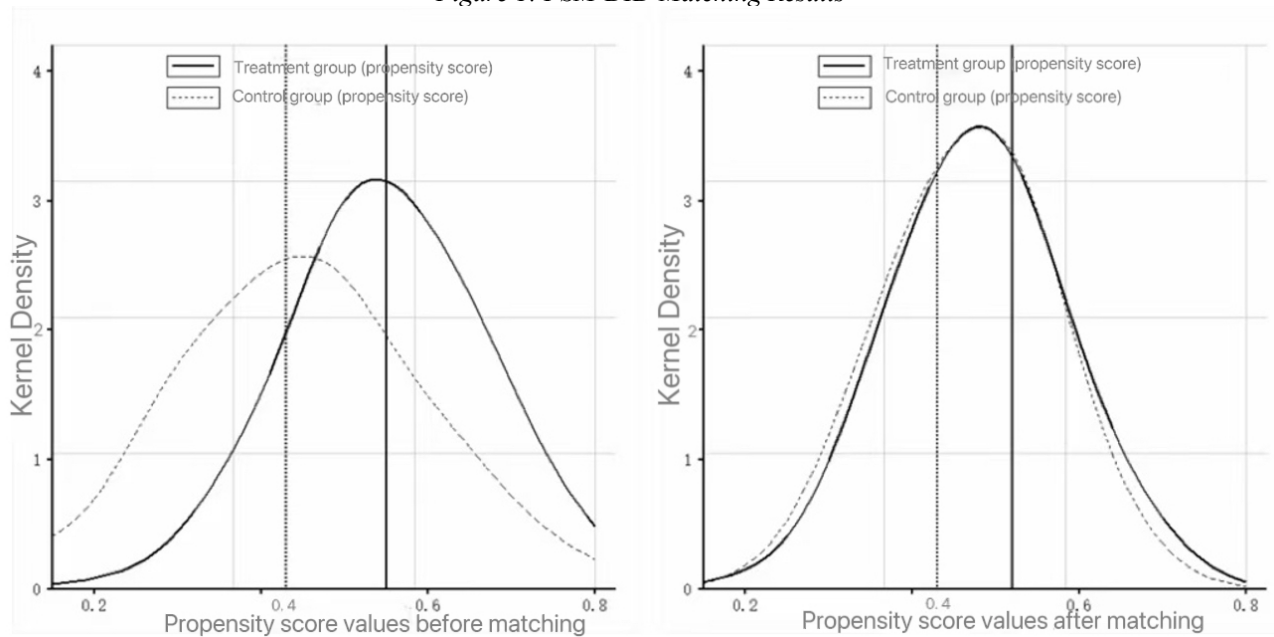
Table 4: Average Treatment Effect on the Treated (ATT) for PSM-DID

Variable	ATT	Std. Err.	t-value
Total number of bank branches	8.74***	2.19	3.98

Note: ***, ** and * are used to indicate significance at the 1 percent, 5 percent and 10 percent level respectively.

The PSM-DID matching results are shown in Figure 1.

Figure 1: PSM-DID Matching Results

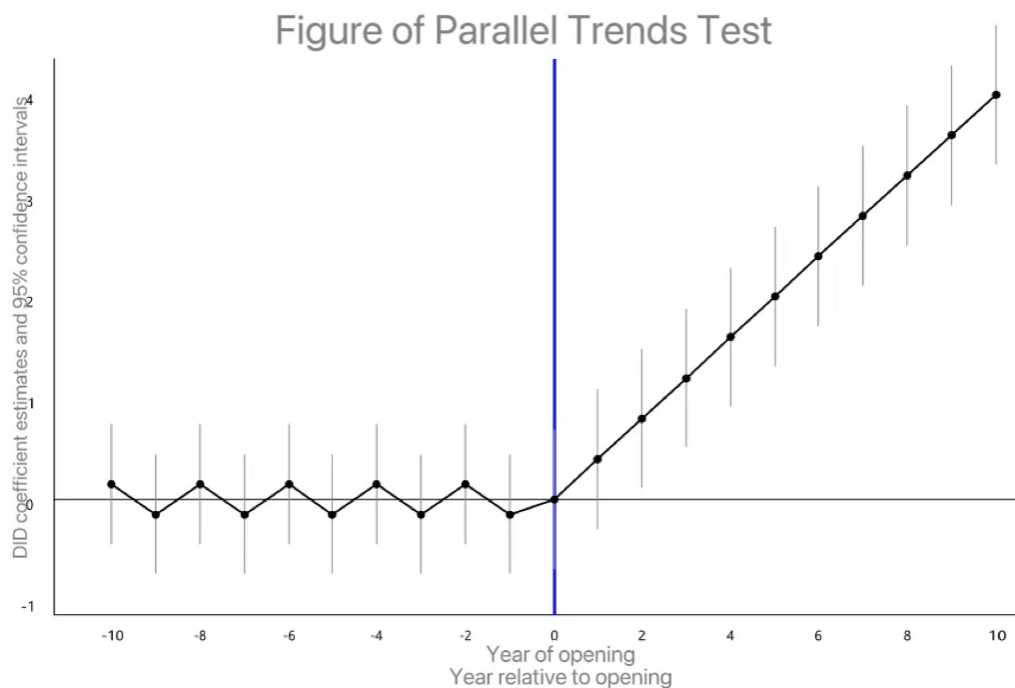


5.2 Robustness Checks

5.2.1 Parallel Trends Test

In order to check whether the difference-in-differences model is valid, a parallel trends test is carried out. The findings suggest that all pre-policy period coefficients are insignificant, thus it can be concluded that the treatment group and the control group meet the parallel trends assumption. Following the introduction of the policy, the coefficients are strongly positive and remain increasing with time, indicating that the policy impact of high-speed rail opening is real and emerging slowly, and the model specification is sensible and correct. Figure 2 shows the results of the parallel trends test.

Figure 2: Parallel Trends Test



5.2.2 Replacing the Dependent Variable

In order to ensure that the main conclusions are not sensitive to the selection of indicators, natural logarithms of loan balances, deposit balances, and the number of bank branches are taken as dependent variables. The results of the regression indicate that the DID coefficients are 0.166, 0.154 and 0.198, respectively, and statistically significant at the 1 percent level of significance, as expected in the baseline results.

5.2.3 Excluding Special Samples

Local governments have unique economic and financial foundations. Having excluded them, the sample interference of special samples disappears and it can be tested whether the findings are generalizable. The DID coefficient is 8.63 after the exclusion of municipalities, which is significant at the 1 percent level, thus demonstrating that the base rate results are not compromised due to special sample interference and that the results are strong and believable. Table showing the result of robustness tests.

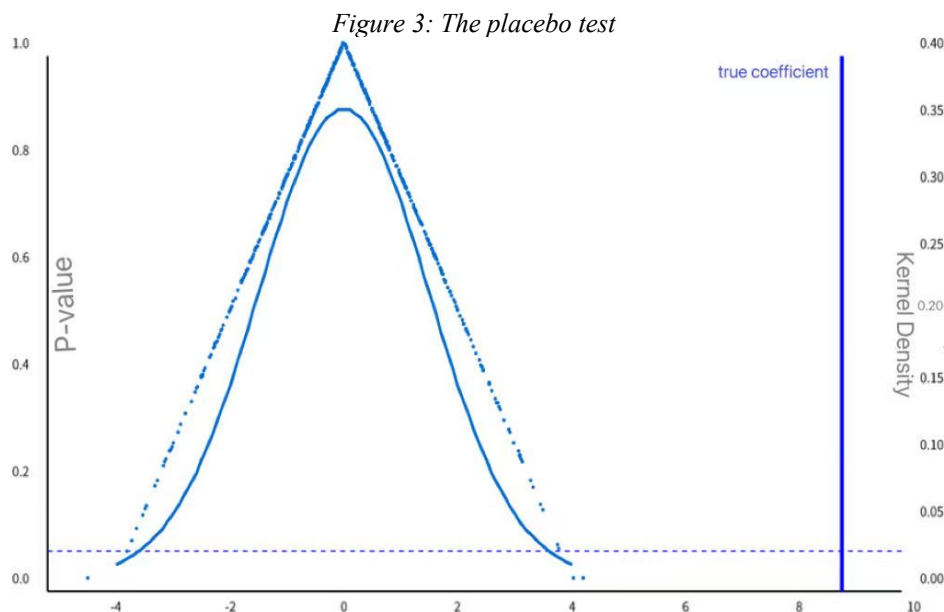
Table 5: Robustness Checks

Variable	(1) Replacing dependent variable: ln loan balance	(2) Replacing dependent variable: ln deposit balance	(3) Replacing dependent variable: ln number of bank branches	(4) Excluding municipalities
DID	0.166*** (4.18)	0.154*** (4.11)	0.198*** (4.07)	8.63*** (3.85)
Control variables	Controlled	Controlled	Controlled	Controlled
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	8,562	8,562	8,562	7,914
Adjusted R ²	0.685	0.671	0.702	0.656

Note: *** and **, and * represent the significance level of 1 percent, 5 percent and 10 percent respectively; t-values are given in brackets.

5.2.4 Placebo Test

The findings indicate that the coefficients of the fictitious policy shocks are centered on zero whereas the real policy coefficient is quite far away from the random distribution which means that the effect of the high-speed rail opening policy can be real and not due to any random effects, thus, excluding interference with omitted variables and randomness. The results of the placebo test are illustrated in Figure 3.



5.3 Heterogeneity Analysis

Heterogeneity is analyzed from three dimensions: region, city size, and administrative level.

5.3.1 Regional Heterogeneity

Table 6 displays the outcomes. By geographic area the coefficients of the DID for the eastern region are 10.82, which is statistically significant at the 1% level; the coefficients of the central and western regions are 3.69 and not significant. It means that the impact of the high-speed rail opening on financial resources distribution is stronger in the eastern region. This can be explained by the fact that the eastern region, due to the higher level of development of financial markets and the higher effectiveness of factor mobility, is more capable of taking advantage of the time-space compression dividends facilitated by high-speed rail, whereas the policy effect in the central and western regions has not been completely achieved yet.

5.3.2 Heterogeneity by City Size

As per the city size grouping, the DID coefficient of large cities is 9.57 which is significant at the 1 percent probability level, while the coefficient of small and medium-sized cities is 4.18 and is not significant. It implies that the impact of high-speed rail on financial resources is stronger in large cities. Large cities also have a greater density of financial institutions and corporate resources and can better attract and focus financial resources when the high-speed rail opens. Conversely, the basic conditions of small and medium-sized cities are relatively poor, and thus this driving effect is less visible.

5.3.3 Heterogeneity by Administrative Level

The grouped by administrative level DID coefficient of provincial capitals/central cities is 9.21, which is significantly positive at the 1 percent level; the coefficient of ordinary prefecture-level cities is 4.05 and insignificant. It indicates that financial resource allocation of provincial capitals and central cities is influenced by the opening of high-speed rail. Since they are the financial and economic centers of the region, these cities have better policy resources and financial service systems, and the high-speed rail strengthens this benefit. The financial attractiveness of ordinary prefecture-level cities is relatively weak, so the effect is not apparent.

Table 6: Heterogeneity Tests

Variable	(1) Regional heterogeneity - Eastern	(2) Regional heterogeneity - Central and Western	(3) City size heterogeneity - Large cities	(4) City size heterogeneity - Small and medium-sized cities	(5) Administrative level heterogeneity - Provincial capitals/Central cities	(6) Administrative level heterogeneity - Ordinary prefecture-level cities
DID	10.82*** (3.41)	3.69 (1.57)	9.57*** (3.08)	4.18 (1.69)	9.21*** (3.15)	4.05 (1.73)
Controls	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1386	2902	1924	2364	1204	3082
Adjusted R ²	0.708	0.593	0.691	0.617	0.695	0.613

6. Research Conclusions and Policy Recommendations

6.1 Research Conclusions

This study uses DID and PSM-DID techniques in analyzing the effects of high-speed rail (HSR) opening on the financial development of regions based on panel data of Chinese cities between 2007-2022 by using the total number of bank outlets and the balances of deposits and loans of financial institutions as proxy indicators. The reliability of the results of the research is guaranteed by means of parallel trend tests, robustness checks, and placebo tests. The results show that the opening of HSR has a significant and enduring positive empowerment impact on regional financial development. Not only does it increase the geographical reach of financial services, but it also increases the extent of regional capital availability and agglomeration, which acts as a valuable exogenous push factor in encouraging regional financial development. Both policy shocks and foundational conditions contribute to the development of regional financial development. Economic growth,

population agglomeration, financial deepening, advancements in urbanisation, industrial structure upgrading, and human capital enhancement are all vital drivers of financial development. Nevertheless, there is some degree of counterbalance to the balanced distribution of financial resources since fiscal decentralisation causes inter-regional resource competition.

The financial empowerment consequences of HSR opening are highly context-specific. With regards to city size, large and medium-sized cities, because of their larger population-economic agglomeration and stronger financial conditions, have much more capacity to absorb the dividends of factor flows, and the effect is therefore much higher than in small cities. Geographically speaking, the eastern region, which has a strong economic foundation and an active financial market, demonstrates a stronger agglomeration-strengthening effect of HSR on finance. Despite the fact that the central and western regions also enjoy enhanced factor mobility, the impact remains weaker because the industrial base and human capital remain limited. In line with the administrative hierarchy, the opening of HSR is more significant in terms of financial resource allocation in provincial capitals and central cities. They are the most complete centres of financial and economic activities in the region, and HSR contributes to them further. On the contrary, the financial attractiveness of ordinary prefecture-level cities is relatively weaker, and it is not as obvious. Also, parallel trends and placebo experiments support the idea that there is truly a causal connection between the opening of HSR and the development of finances at the level of the region, and the empowerment effect cannot be considered as resulting due to irrelevant factors like time trends or any other policy shock.

The HSR opening eliminates geographical boundaries, facilitates the movement of production factors between regions, and adds a new impulse to regional financial development. The scale at which this financial empowerment effect will be achieved depends directly on the regional developmental conditions of the foundation, hence offering an empirical proof of how coordinated financial development can be attained by optimizing the HSR network structure and enhancing the regional developmental bases.

6.2 Policy Recommendations

Using the results of the research, the following recommendations are suggested in order to use the positive aspects of HSR even more intensively in the promotion of the regional financial development, to gradually enhance and equalize the financial status of the regions, to reduce differences in the inter-regional financial development, and to create a more just and effective distribution of the financial means.

Initially, the layout of the HSR network must be optimized. It is necessary to ensure the accessibility and convenience of transport-deficient zones based on the travel needs of the residents in small and medium-sized cities, and the central and western regions. The transportation situation ought to be consistently made better in order to minimize time disparities as well as spatial space between cities and allow further underdeveloped areas to use the benefits of HSR to attract financial assets, thus establishing the basis of balanced regional financial development. The next step would be to reinforce the conditions of urban development, particularly in small and medium-sized cities. Continuous improvement of industrial environments, public services, and other forms of infrastructure should make cities more attractive in general. With a stronger development base alone, funds will be able to be kept in the city and financial institutions will be lured into opening branches so that the development potential offered by HSR does not just stop at the stage of better transport conditions.

Moreover, the concept of differential development strategies should be followed depending upon the peculiarities of the place and should not use a universal solution. Eastern region and major cities ought to utilize the benefits of HSR to develop the financial service capacity and innovation potential, and big and middle cities in the central and western regions need to reduce their weaknesses step-by-step depending on their specifics, constantly increase the financial development level, and gradually reduce the gaps between them and more developed areas in financial development. At the same time, unreasonable inter-regional competition should be minimized, and inter-regional coordination and cooperation enhanced to remove limitations created by administrative barriers. Finance needs to be steered to become more diversified, which would enhance the effectiveness of total capital use and make it easier to serve local economic growth and thus realize the supplementary and mutual reinforcement objectives of transport development and financial development. Also, once the HSR is opened, monitoring of various trends, including capital flows, institutional layouts, and credit scales, should continue to be dynamically monitored. The financial operation safety bottom

line in financial development promotion should be strictly adhered to, the risk prevention mechanism enhanced, and the stability, health, and sustainable development of regional finance guaranteed.

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Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

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