

The Impact of High-Speed Rail Construction on China's Provincial Industrial Structure

Minghao Liu

Faculty of Business and Management, Beijing Normal University-Hong Kong Baptist University
United International College, Zhuhai, China

1010674136@ldy.edu.rs

Abstract. Against the backdrop of accelerated globalization and regional economic integration, the rapid development of China's rapid rail transportation system signifies the critical role of modern transportation networks in driving economic growth and adjusting industrial structures. Particularly in Eastern China, high-speed rail not only reduces the distance between cities but also potentially has a profound impact on the transformation of manufacturing facilities in the provinces along its routes. To address this issue, the present research utilizes the Difference-in-Differences (DID) analysis technique, with an emphasis on evaluating the impacts resulting from the development of high-speed railway infrastructure from 2008 onwards on the industrial structure of these provinces, especially in relation to changes in the ratios between industry and services, and resource distribution patterns among capital and labor. By comparing provinces that inaugurated high-speed rail services in 2008 (treatment group) with those that did not have such services between 2009 and 2011 (control group), this research aims to deeply understand the contribution of high-speed rail to the advancement of industrial modernization and economic model transformation in Eastern China. To narrow down the focus of this investigation and make it more precise and informative, the researchers decided to limit it to the East of China, taking into account the fact that there are specific features in the Western region as well.

Keywords: High-speed rail, industrial structure, DID.

1. Introduction

In the context of globalization and regional integration, high-speed rail, as a crucial component of China's modern transportation network, has been instrumental in shaping the outcome of the adjustment of industrial structures and the transformation of economic development models in the Pearl River Delta area [1]. High-speed rail has emerged as one of the key driving forces in facilitating regional economic development, especially in the current era of heightened economic globalization and integration at regional levels [2]. Being itself an infrastructural component of the modern-day transport system, high-speed rail today no longer plays a passive supporting role but proactively helps stimulate economies through efficiently moving large amounts of resources from one area to another within the region [3]. A vivid case is China, which has witnessed profound changes in the context of industrial infrastructure and fostering economic growth patterns as a result of high-speed rail [4].

The core objective of this paper is to explore the economic impact of high-speed rail construction on the transformation of the industrial structure in the provinces of Eastern China. In this paper, the study adopts the DID technique, an economic tool, to measure the impact of high-speed rail on three major components of the economy - the primary sector consisting of agriculture (FI), the secondary sector that includes manufacturing and construction (SI), and the tertiary sector relating to services (TI). The aim of this research is to investigate changes in the proportions of the secondary and tertiary sectors contributing to the national output. Such shifts can serve as a benchmark to measure the effects that a high-speed rail system would bring about on industrial upgrading and economic transformation, especially in cases where traditional agriculture is being replaced by new services and industry. Furthermore, this study will examine the changes in capital-labor ratios. This will involve evaluating how capital-intensive and labor-intensive sectors are affected and how high-speed rail contributes to enhancing capital flow efficiency and effective labor distribution across regions.

2. Contextual Information and Research Hypothesis

2.1. Background

Although current research takes a comprehensive look at the influence of impact of high-speed rail on the industrial framework, it may be missing a more nuanced comparison of the actual effects across cities [5, 6]. Moreover, when discussing changes in the industrial structure, the article might not fully explain why some industries have clustered while others have diminished. In order to overcome these shortcomings, the present study aims to conduct an in-depth analysis of the data at the level of provinces to determine how different types of provinces are influenced by high-speed rail (including large cities and small cities within them) and what particular changes occur in their industrial structure. Other research offers a thorough examination of the influence exerted by high-speed rail, it might not fully consider the heterogeneity and differences in economic development levels among provinces and cities [7]. Additionally, the study may lack targeted policy recommendations, especially regarding differentiated strategies for different types of provinces [8]. To investigate these problems from another angle and ensure a more comprehensive and profound analysis, an example can be given by looking at the economic as well as social differences between the provinces. Another direction for further study might be to develop specific policy directions by taking into account the economic profile of eastern Chinese provinces and then using them to further increase precision in addressing specific needs. A primary objective of this paper is to investigate the profound changes brought about via a high-speed train in the industry composition of eastern Chinese provinces with respect to its influence on industrial upgrading promotion, economic efficiency improvement, and balance between regions.

Based on statistics, the development of China's high-speed rail commenced in the year 2008 and ever since then, it has been growing steadily to become the largest rapid transit railway system in the world. At the current moment, the Chinese high-speed rail network is continuing its expansion and upgrading that is well-planned, reaching out to 30 provinces, direct-controlled municipalities, and autonomous regions, linking hundreds of cities where over 40,000 kilometers are in operation, making up a significant proportion of global high-speed rail mileage [9]. In the "14th Five-Year Plan," China aims to further increase the high-speed rail mileage, thereby showing its ambition in infrastructure construction as well as the modernization of the transport system. This expansion not only showcases China's technological and managerial capabilities in the field of transportation but also provides new momentum for the development of national and regional economies [10].

2.2. Hypothesis

Hypothesis 1: This study posits that the building and functioning of rapid rail transportation have facilitated industrial upgrading in specific regions and conditions, particularly in promoting the transition of certain cities and provinces from traditional industries to more advanced, knowledge-intensive industries. Influence of this kind is not universally present in all the provinces but depends on indicators of economic growth, industrialization, and geographic situation that serve as its background.

Hypothesis 2: One possible hypothesis is that there exists a parallelism in the pattern of development within the industrial structure between the treatment group, including provinces with high-speed rail, and the control group, containing provinces without it prior to high-speed rail emergence. This assumption is based on detailed data analysis and testing, providing a strong background for using the Difference-in-Differences method. In addition to that, the validation of parallel trends enhances the reliability of the research findings, guaranteeing the precision of the assessment regarding the influence of high-speed rail development on enhancing industrial structure and facilitating economic model transition.

3. Research Design

3.1. Model

The study employs the Difference-in-Differences (DID) approach to examine how the development of high-speed rail infrastructure affects the economic composition of urban areas. In this analysis, the industrial structure sophistication index of cities will serve as the dependent variable $Y_{i,t}$. In this connection, the study will also incorporate some control variables $X_{i,t}$ to offset the impact of other variables that may affect the industrial structure.

$$Weight_{it} = \alpha + \beta_1 HSR_{it} + \beta_2 year_i + X_{it} + \varepsilon_{it} \quad (1)$$

In Model (1), α reflects the baseline level of the dependent variable in the absence of the treatment effect and control variables. β_1 represents the effect of high-speed rail construction. It quantifies the average change in the dependent variable (weight) for provinces that underwent high-speed rail construction (treated provinces) relative to those that did not receive the treatment (control group). $X_{i,t}$ denotes the control variables, and $\varepsilon_{i,t}$ is the error term, representing factors affecting the model that are not observed. The outcome variable $Weight_{it}$ means added value of second sector+added value of tertiary sector/GDP. The treatment variable HSR_{it} denotes whether the province had high speed railway during the time period. Group province includes 12 samples. There are 7 years, 2005-2011, and the treatment begins in 2008. $\beta_2 year_i$ measures the time effect on the outcome variable.

3.2. Data Description

The Panel data in the study is from World Bank (2005-2011). The 31 provinces (Chinese mainland), of which 6 western provinces are not included: Gansu, Neimeng, Ningxia Qinghai, Xinjiang and Tibet. because the study needs to control the baseline characteristics for the control group and treatment group to avoid the selection bias. Furthermore, the paper excludes the province that build HSR during 2009 to 2011 so only 12 provinces left. According to world bank, the operation of high-speed railway in China begins in 2008.

The treatment group (6 province) are Liaoning, Hebei, Beijing, Tianjin, Anhui, Jiangsu., and the control group (6 province) includes Heilongjiang, Guangxi, Chongqing, Sichuan, Guizhou and Yunnan. The description of variables are as follows (shown in the Table 1).

Table 1. Variable description

Variable	Obs	Mean	Std. dev.	Min	Max
Province ID	84	12.25	8.62	1.00	24.00
year	84	4.00	2.01	1.00	7.00
weight	84	0.88	0.06	0.76	0.99
HSR	84	0.21	0.41	0.00	1.00
WFAI	84	0.62	0.17	0.32	1.15
WExIm	84	0.39	0.43	0.04	1.61

4. Result Analysis

Table 2 below presents the output from a difference-in-differences regression analysis with covariates, aimed at assessing the influence of the implementation of high-speed rail projects on diverse economic metrics among different provinces. Among the variables, it is expected that the coefficients of fixed asset investment weight, the weight of exports and imports in GDP, as well as year two through year seven after treatment, will show how these effects change over time.

The estimates of the coefficients -0.0189 and -0.0178 indicate a slightly negative impact, but their p-values do not pass the threshold level of 0.05, implying that they are not statistically significant. Therefore, no such result can be expected with confidence as a marginal effect for these variables on the outcome of the dependent variable. The coefficients for the years following the introduction of the high-speed rail (from the second year to the seventh year) show a positive and statistically significant impact, growing progressively stronger over time. This pattern demonstrates a clear trend of increasing benefits associated with the high-speed rail development over the years, starting from a 1.35% impact in the second year to a 4.31% impact by the seventh year. The coefficient for the variable associated with the construction of high-speed rail indicates a slight negative impact (-0.0140) on the outcome variable. However, the impact of the construction of high-speed rail does not achieve statistical significance, which implies that the impact of high-speed rail construction is weak or possibly slightly negative immediately after taking into account other controlling factors. The constant term (0.878) reflects a positive baseline level for the dependent variable in the absence of treatment effects and without considering the control variables, significant at the 1% level.

The analysis of 84 provinces and time periods has been considered in this work to provide a broader understanding. In the parentheses, robust standard errors indicate how large the estimate of the coefficient variance is, which means its statistical significance. To describe in detail and point out the subtle results of establishment of the high-speed railway on each regional economy, this analysis using regression does not forget to emphasize that the benefits are definitely endless and stresses why other issues needs to be considered while considering the infrastructural facilities of rapid transit systems.

Table 2. DID regression result

Variable	ATET	Controls
WFAI		-0.0189 (0.0398)
WExIm		-0.0178 (0.0213)
2.year		0.0135*** (0.00366)
3.year		0.0176*** (0.00426)
4.year		0.0221*** (0.00508)
5.year		0.0351*** (0.00829)
6.year		0.0426*** (0.00992)
7.year		0.0431*** (0.00905)
r1vs0.HSR	-0.0140 (0.0100)	
Constant		0.878*** (0.0269)
Observations	84	84

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, *p<0.1

5. Interpretation and Discussion

This study highlights the significant impact of provincial differences in economic development levels, industrial foundations, and geographic locations on the economic benefits of rapid transit systems construction. The findings of the study suggest that it is imperative to further explore the relationship between high-speed rail as well as the attributes of regions.

With regard to the fact that industrial upgrading and structural optimization do not only depend on transportation infrastructure improvement, they also require supportive policies, industrial strategies, and innovation ecosystems. This suggests that high-speed rail, as a piece of physical infrastructure alone, might have limited direct influence over industrial structure, and consequently, it has to be further amplified by other means to maximize its economic benefits. Although the effects may not be apparent in the short term, the finalization of the high-speed railway system could create more favorable conditions for regional economic development and industrial upgrading in the long run.

Through these improvements, the hypotheses section will more accurately reflect the actual research findings and provide a solid theoretical foundation for subsequent policy formulation and research.

6. Conclusion

The comparison of HSR impact of the development of high-speed railway on the economic landscape and industrial structure in the different Chinese provinces that this research examined revealed many subtler impacts. This kind of examination is based on the regression method known as Difference-in-Differences or DID, where the study minutely delves into this pattern, focusing on the intricacy of their effects concerning this nation's huge expansion drive for infrastructure. The study presents detailed findings obtained from this research and then outline the strategic actions suggested for better exploitation of HSR.

Moderate Influence on Industrial Structure: Despite the anticipated transformative power of the HSR on integration of economies within a specific region plus industrial structure refinement, the empirical evidence suggests a moderated impact. The DID analysis revealed a statistically significant yet modest positive influence on the value added by the secondary and tertiary sectors. This outcome points to the complex relationships among HSR and industrial conditions, which implies that high-speed rail can act as a driver of major economic transformations only when considering many aspects apart from the simple availability of this mode.

To maximize the economic dividends of HSR, there is a critical need for synergistic investments in complementary infrastructures, such as logistics and industrial parks. The government should not solely concentrate on the rail system itself but also give due attention to the supporting infrastructure components that help for the effective use of the HSR. The reason behind this is that its contribution towards local area development and industrial re-arrangement can be much greater if other parallel infrastructure systems are enhanced simultaneously rather than just high-speed rail.

It is crucial to realize that the diversity of impacts calls for the creation of region-based strategies for development. The states' particular economic conditions and industry evolution paths have to be taken into account in crafting these policies in such a way that the two sectors become mutually supportive and interregional relations grow organically. Among the different ways to provide industrial modernization incentives, HSR becomes an alternative way of industry restructuring. Specific kinds of incentives must be introduced to encourage and incentivize companies to make full use of this infrastructure for their growth and innovative pursuits. A few forms of incentives are those that facilitate the HSR implementation in areas where it can strengthen competitiveness and support access to markets, as these could be important catalysts for driving technological progress and industrial change.

Ongoing research and the creation of a policy-making system that can change as new empirical truths arise are necessary elements. Since the potential economic consequences of implementing high-speed rail is constantly being reassessed over time, it is imperative that HSR's economic analysis and

subsequent contributions to policy formulation remain dynamic and adaptable. An orientation for policymaking that is based on the evidence-based approach will ensure that development strategies match evolving goals effectively through monitoring evidence, economic dynamics by region, and responsive policies.

To sum up, it can be stated that although HSR does not appear to have had the expected and desired industrial transformation effect throughout China, its strategic significance as part of China's transport system in ensuring regional connectivity, economic vitality, and enhanced competitiveness is undeniable. In fact, in order to accelerate economic modernization and decrease disparities between provinces, this action should be an inseparable element of the broader economic policies so as to strike a balance between the benefits of mega cities and the rural areas. Such an integrated approach would ensure sustained progress for HSR beyond immediate outcomes, benefiting from it, thereby reinforcing China's long-term vision.

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