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High-speed railway opening and urban green productivity in the post-COVID-19: Evidence from green finance

Qunxi Kong a, Chenrong Shen a, Rongrong Li a, Zoey Wong b, *

a School of Industrial Development, Nanjing University of Finance & Economics, Nanjing, 210003, China
b School of Business, Nanjing University, Nanjing, 210093, China

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ABSTRACT

In an era during which the COVID-19 pandemic continues to spread, high-speed railway (HSR), as one of the key influencers of urban green development, has a significant impact on urban green finance and green productivity. This paper uses HSR as a quasi-natural experiment to study the effect of HSR openings on green productivity in Chinese cities. The empirical results show that, first, the opening of HSR is conducive to the sustained improvement of green productivity in Chinese cities. Second, the opening of HSR makes a significant contribution to the improvement of green productivity in large-scale cities as well as cities in the east and central regions. Third, the opening of HSR can positively impact urban green productivity through the mechanism of green finance development. However, this positive impact tends to first increase and then decrease over time. As the relationship between “finance” and “environment,” green finance has an important impact on the green development of cities. These findings will provide positive and useful references for cities to formulate reasonable green development plans in the post-COVID-19 era.

1. Introduction

Over the past 40 years of reform and increased global trade, China’s rapid economic growth has been accompanied by the process of urbanization. In order to meet growing travel demands and promote urban economic growth, China’s State Council approved the Medium- and Long-Term Railway Network Plan in 2004 to connect the country’s major cities with bullet trains. The plan’s goal was to reach a total of 100,000 km of railroads by 2020, with 12,000 km of high-speed railroads operating at 200 km/h and above. Since 2008, China’s high-speed railway (HSR) construction has accelerated. In February of 2008, the Ministry of Railways and the Ministry of Science and Technology signed a cooperation agreement to develop a new generation of high-speed trains; in August, the Beijing-Tianjin Intercity Railway was opened for operation. This was the first high-speed railroad in China with fully independent intellectual property rights on the global stage. In October of the same year, the State Council approved the Medium- and Long-Term Road Network Planning (2008 Adjustment) (after this referred to as Planning), which set the construction target at 120,000 km by 2020. The Planning also focuses on the “four vertical and four horizontal”

1 The four verticals include: Beijing–Shanghai high-speed railroad, connecting Beijing and Tianjin to the economically developed eastern coastal region of the Yangtze River Delta; Beijing–Hong Kong passenger special line, connecting northern and southern China; Beijing–Harbin passenger special line, connecting northeast China and the Guangzhou region; and the Hangzhou–Fuqiu–Shenzhen passenger special line (southeast coastal passenger special line), connecting the Yangtze River, the Pearl River Delta, and the southeast coastal region. The four crosses include: Shanghai–Hangzhou high-speed railroad, connecting southwest and eastern China; Xulan passenger line, connecting southwest, central and eastern China; Shanghai–Kunshan high-speed railroad, connecting southwest and eastern China; and the Qintai passenger line, connecting north and eastern China.

* Corresponding author.
E-mail address: zoey.wong2020@foxmail.com (Z. Wong).

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and other small passenger lines, along with intercity passenger transport networks in economically developed and densely populated areas. By the end of 2019, the national railroad network reached 139,000 km, including 35,000 km of HSR, accounting for more than 70% of the world’s HSR.\(^2\) China has already achieved the world’s longest HSR network, more than the rest of the world’s HSR tracks combined, with HSR construction projects still ongoing. Even more ambitious plans to extend China’s HSR network to Europe and Singapore are in the works, along with plans to have an “eight vertical and eight horizontal” HSR network by 2030. HSR is changing and reshaping the urban and economic geography of China.

However, the January 2020 outbreak of COVID-19 in Wuhan, a major railroad transportation hub in China, led to partial or even total traffic blockades in most cities across the country, seriously affected the normal operations of high-speed railroad transportation and disrupted the orderly flow of people and materials. Especially considering that the outbreak occurred during the Spring Festival and lasted for a long time, it impacted the nationwide flow of resources and even economic productivity. Urban economic growth was severely affected by the delayed return of workers to jobs in the city under the impact of the pandemic—a large number of enterprises shut down or reduced production, there was a significant reduction in the transportation activities of industrial manufacturing goods and production-oriented raw materials, and a basic stagnation of short-term development in certain manufacturing and infrastructure investment activities set in. Simultaneously, foreign economic policies toward China became highly uncertain due to the pandemic, which in turn has continued to affect China’s economic performance (Kong, Peng, Ni, Jiang, & Wang, 2020; Lei & Song, 2020). Foreign policy shocks may affect China’s factor markets, financial markets, and the investment behavior of its firms (Zhang, Guo, & Chen, 2020; Kong, Guo, Wang, & Zhou, 2020; Kong, Tong, Peng, & Chen, 2021), while free trade can improve the overall information efficiency of financial markets (Baig, Blau, & Sabah, 2021). Therefore, this paper argues that, in the context of the COVID-19 pandemic, it is crucial to examine the impact of HSR openings on urban productivity from a green finance perspective.

The construction of HSR has not only changed the way people travel and transport goods but has also had a profound impact on the regional economic distribution patterns, resource allocation, and industrial structure in China, bringing opportunities for urban green development (Ran, Zhang, & Yang, 2020; Sun, Pofoura, Mensah, Li, & Mohsin, 2020). The opening of HSR can have a direct impact on the improvement of urban green productivity. Firstly, total factor productivity positively impacts expansion in the number of foreign investments by enterprises (Kong, Peng, Zhang, & Wong, 2021), and HSR construction directly affects urban green total factor productivity by increasing regional capital investment (Peng & Wang, 2019). The opening of HSR facilitates foreign and industrial capital from developed to developing and rural cities. It improves the factor utilization efficiency of less advanced cities through the demonstration and technology spillover effects, thus promoting urban green innovation (Sun, Edziah, Kporsu, Sarkodie, & Taghizadeh-Hesary, 2021). Secondly, compared with traditional railroad transportation, HSR also plays a positive role in promoting energy conservation, emission reduction, and energy use efficiency. The relationship between pollution emissions and economic development is critical to the goal of sustainable growth. The construction of HSR can stimulate companies to develop green energy technologies, which can effectively improve energy use efficiency and promote a sustainable green economy (Zhang, Mohsin, Rasheed, Chang, & Taghizadeh-Hesary, 2021; Zhang & Vigne, 2021).

The question therefore becomes, does the opening of HSR affect urban green productivity indirectly through other paths, in addition to its direct effect on urban green productivity? Existing studies show that the opening of HSR can affect the allocation of resources, particularly green financial resources. Meanwhile, innovation plays a crucial role in enterprise development, and a good financing environment to support enterprise R&D investment is conducive to promoting enterprise innovation activities (Zhang & Guo, 2019; Zhang, Zhuge, & Freeman, 2020). Green finance is an important way to influence green production efficiency (Naem et al., 2021). Financial institutions can encourage green and energy-saving enterprises to innovate, upgrade, and improve their own production efficiency (Yoshino et al., 2019). Financial institutions can also attract private participation in green project investment by improving green credit guarantees and increasing green financial investment opportunities, thus promoting green economic development (Taghizadeh-Hesary and Yoshino, 2019). Therefore, this paper argues that green finance is an important means to influence the relationship between HSR openings and green total factor productivity.

Based on the above analysis, this paper’s motivation is to examine the impact and effects of HSR construction on green total factor productivity in Chinese cities, from the perspective of green finance and in the context of the current reality of the COVID-19 pandemic. First, this paper uses the panel data of 285 prefecture-level and above cities in China from 2003 to 2018 to measure urban green total factor productivity using the Super Slack-based Measure (SBM) model with “non-expected output.” Second, this paper adopts the difference-in-difference method (DID) to study the effect of HSR on the green total factor productivity of the urban economy. This paper further examines the heterogeneous effects of HSR construction on green total factor productivity in Chinese cities by dividing different city subsamples. Finally, based on the perspective of green finance, the mechanism of the effect of HSR openings on green total factor productivity in Chinese cities is examined.

The main contributions of this paper are primarily in the following three aspects: (1) With the increasing threat of environmental problems due to industry, green total factor productivity has received more and more attention as the key to achieving green economic development. However, existing studies have mainly focused on the impact of HSR construction on total factor productivity. Only a small number of scholars to date have explored the relationship between infrastructure and specifically green total factor productivity. This paper enriches existing research by studying the impact of HSR openings on urban green total factor productivity from the macro-institutional context of HSR construction in China. (2) Existing studies generally agree that HSR construction has a significant impact on productivity but lack a rigorous causal identification framework for the relationship between the two. For this paper, a quasi-natural experiment has been conducted with the opening of HSR, and a difference-in-difference (DID) method was used to test the empirical evidence. The potential endogeneity problem is solved by replacing variable measures and instrumental variables to ensure the robustness of this paper’s findings while providing reliable empirical support for related studies. (3) Green finance, as the

\(^2\) Data from the 2019 Transportation Industry Development Statistics Bulletin.
relationship between “finance” and “environment,” will have an important impact on the green development of cities. This paper incorporates green finance into the analysis framework and provides an in-depth analysis of the path of green total factor productivity in cities due to the opening of HSR, which provides a useful reference for cities to formulate reasonable green development plans in the post-COVID-19 era.

The structure of the remainder of this paper is organized as follows: Section 2 reviews the relevant literature; Section 3 develops identification strategies and conducts validity tests; Section 4 consists of empirical tests and analysis of results; Section 5 discusses the mechanism of the effect of HSR openings on urban green productivity based on a green finance perspective; Section 6 presents the conclusions and policy recommendations of this paper.

2. Literature review

The relationship between transportation infrastructure development and various aspects of economic development has been richly studied in academia (Diao, Leonard, & Sing, 2017; Dong & Zhu, 2016; Pan & wen Luo, 2020). Scholars in China and abroad have discussed the impact of transportation infrastructure construction on economic growth in terms of long-term economic growth effects, trade gains, land value, technology spillover from local markets, residential employment, population growth, and urbanization (Zhu & Diao, 2016). These studies largely focus on two main aspects of the problem. The first aspect is concerned with the causal relationship between transportation infrastructure construction and economic growth. The second aspect is concerned with the relationship between transportation infrastructure construction and regional economic agglomeration—does the reduction in transportation costs lead to the diffusion of economic activities to the surrounding areas, or does it reinforce the concentration of production in existing urban centers? Empirical research efforts have focused on assessing the firm performance, economic benefits, and social welfare of the construction of infrastructure such as rail networks, road networks, interstate highway systems, and intra-city rail transit systems in cities across countries over time (Banerjee, Duflo, & Qian, 2012; Wang, Lin, & Gao, 2020).

Regarding HSR construction and green economic growth, some scholars found that the opening of HSR will promote urban air quality improvement and enhance green development in cities along the constructed route (Sun & Zhang, 2021). It will also promote green total factor productivity in cities by alleviating the distorted situation of labor factor allocation, especially the significant effect on green total factor productivity in large and medium-sized cities (Peng & Wang, 2019). HSR investments can enhance the externalities of firm agglomeration and increase productivity by increasing urban density, generating “broader economic benefits” (Huang & Wu, 2020; Venables, 2007; Zhang, Sun, & Yao, 2019). Thus, HSR construction and urban development can mutually reinforce each other and jointly promote economic development. As long as the three conditions of “positive economic externalities” (e.g., agglomeration, labor market economics, and labor quality), “investment factors” (including the availability, size, location, and timing of investment), and “political factors” (including any accompanying policy measures) are present, urban economies will achieve sustainable growth (Banister & Berechman, 2001; Zhang & Li, 2019; Cheng, Wang, Peng, & Kong, 2020).

The construction of HSRs can promote the concentration of local financial resources. The impact of railroads in neighboring regions on the concentration of local financial resources is manifested as the spatial agglomeration effect and the spatial spillover effect (Wang et al., 2020). The spatial agglomeration of financial services also positively impacts the quality of urban economic growth (Wong, Li, Zhang, Kong, & Cai, 2021). Zhang et al. (2021) found that the concentration of green financial resources can attract capital and technology-oriented production activities by studying the development of green economies along the Belt and Road. Taghizadeh-Hesary et al. (2020, 2021) also found that green finance plays a crucial role in promoting the development of green industries by studying the new energy economy in Japan. Green financial markets take environmental costs into account to internalize the negative externalities of environmental pollution (Zhang, Du, Zhuge, et al., 2019; Zhang, Tong, & Li, 2020), prompting economic agents with high environmental costs and low factor productivity to withdraw from market competition (Zhang, Du, & Chen, 2019) and thereby improving the green total factor productivity. Cities are one of the most important vectors of socio-economic development in China. The development of cities and surrounding metropolitan areas promotes industrial infrastructure development, urban-rural development, information sharing, technological development, and environmental protection. Through these integrations, common economic benefits and social welfare are generated across urban areas (Fang & Yu, 2017; Kong, Shen, Sun, & Shao, 2020; Ni, 2008). In the case of China, combined with the current context of green development, transportation, as one of the three major areas of energy consumption and carbon emissions in the economy and society, must practice ecological civilization, strengthen energy conservation and emission reduction, and meet additional requirements to achieve green urban development through green finance.

3. Identification strategy and validity test

3.1. Data sample

The opening of the Qin–Shen passenger line in 2003 launched China’s railroad system into the era of high speed. This paper takes 2003 as the starting point of the study to examine the impact of the opening of HSRs on green total factor productivity in Chinese cities. Since the State Council adjusted the establishment of individual prefecture-level cities during this study’s sample examination, four cities, Lhasa, Sansha, Haidong, and Chaohu, were excluded from the screening sample for the sake of uniformity. This study selected 285 prefecture-level and above cities in China from 2003 to 2018 as the research sample and obtained 4560 city-annual observations. Information regarding cities opening HSR has been taken mainly from the China Railway Yearbook, the China Railway Corporation website, and the National Railway Administration of the People’s Republic of China. The economic data at the prefecture city level, such as GDP, population, industry, and government expenditure, have mainly been obtained from the China City Statistical Yearbook and the
China Regional Statistical Yearbook. In response to the missing data of some cities, this paper supplements certain data by adopting the mean value and smoothing methods.

3.2. Variable definition

Urban Green Total Factor Productivity (GTFP) is the main explained variable in this study. The inclusion of environmental factors in the analysis framework of traditional total factor productivity improves traditional total factor productivity. This improvement is also more in line with China’s current demand for the high-quality economic development of “innovation + green.” In this paper, each city is considered as a production decision unit to construct the best practice boundary for urban development in each period. Using the Super Slack-based Measure (SBM) model with “undesired outputs,” this paper uses MaxDEA7 Ultra software to measure urban green total factor productivity under environmental constraints by integrating desired and undesired outputs into a unified analytical framework.

The input, desired output, and non-desired output indicators used in measuring green total factor productivity are: (1) Input variables, including capital input and labor input. Capital inputs are calculated using the perpetual inventory method and are calculated as follows: $k_t = k_{t-1}(1 - \delta) + l_t/p_t$, $k_0$ and $k_{t-1}$ are the capital stocks in periods $t$ and $t - 1$. Depreciation rate ($\delta$) is set to 10.96% regarding Shan (2008) article, $l_t$ is fixed asset input, and $p_t$ is the investment price index of the city’s province in the current period. The labor input is measured by the number of employees in each city in the calendar year. (2) Desired output is measured by using the real GDP of each city in constant 1990 prices. (3) The non-desired output uses industrial wastewater, industrial sulfur dioxide, and industrial smoke (dust) emissions. It should be noted that because of the high correlation between these three pollutants, this paper refers to Li, Liu, and Wang (2019) to represent the non-desired output with the composite pollution index calculated using the entropy method.\(^3\)

The interaction term $\text{HSR} \times \text{post}$ is the key explanatory variable in this paper. $\text{HSR}$ represents a dummy variable for whether the city opened the HSR. If city $i$ opened HSR in year $t$, then the value is 1; otherwise, the value is 0. $\text{post}$ represents the time variable of HSR opening. If a year is the year of HSR opening in city $i$ or after, it takes the value of 1; otherwise, it takes 0.

Seven control variables are selected in this paper, namely foreign capital dependence ($\text{fdi}$), industrial structure ($\text{ind}$), infrastructure level (road), administrative level ($\text{aeg}$), government financial support ($\text{gov}$), population size ($\text{poe}$), and economic development level ($\text{pgdp}$). Foreign capital dependence ($\text{fdi}$) is expressed by the proportion of the main business income of the three enterprises to the total income of the high-tech industry in the region. Industrial structure ($\text{ind}$) is expressed using the ratio of tertiary industry output value to secondary industry output value in the city, referring to He, Luo, and Chen (2020). Infrastructure level (road) refers to Wang and Miao (2015) and uses the road area per capita as a proxy variable for infrastructure. Administrative level ($\text{aeg}$) is a dummy variable. It takes the value of 1 if the city is the province’s capital city; otherwise, it takes the value of 0. Government financial support ($\text{gov}$) is expressed using the ratio of government financial expenditure to regional GDP. Population size ($\text{poe}$) is measured using the number of permanent residents in the city. Economic development level ($\text{pgdp}$) is measured using the growth rate of urban real GDP per capita. The information on the variable measures is summarized in Table 1.

3.3. Identification strategy

To test the effect of the opening of HSR on urban green total factor productivity, this paper uses a difference-in-difference model (DID) for empirical analysis. The DID method is the result of a foreign economics community which emerged in the late 1980s, an econometric method based on experimental design or quasi-experimental design (Zhao, 2017) which uses the idea of randomized experiments as the basis of causal effects and can effectively solve the endogeneity problem in regression (Angrist & Pischke, 2009). The empirical model is set as follows:

$$GTFP_{it} = \delta_0 + \delta_1 \text{HSR}_{it} \times \text{post}_{it} + \delta_2 \text{controls}_{it} + u_i + \lambda_t + \varepsilon_{it}$$

where $GTFP_{it}$ is the explanatory variable of this paper’s study and denotes the urban green total factor productivity of city $i$ in year $t$. $\text{HSR}_{it}$ denotes whether city $i$ opened high in year $t$, and $\text{post}_{it}$ denotes the time variable for the opening of HSR in city $i$. The interaction term coefficient $\delta_1$ is the coefficient of focus in this model, capturing the effect of the initiative of HSR opening on the green total factor productivity of the city. $\text{controls}_{it}$ represents the set of all control variables. $u_i$ is the city fixed effect, which captures other city characteristics that do not vary over time; $\lambda_t$ is the year fixed effect, which controls for factors that vary over time but cannot be observed; and $\varepsilon_{it}$ is the random disturbance term.

3.4. Validity test

This paper uses a univariate DID method to investigate the effect of the opening of HSR on urban green total factor productivity. Table 2 presents the estimated results for the control and experimental groups before and after the opening of HSR. Table 2 shows that the regression results are divided into the control and experimental groups. The coefficient estimates before and after the opening of HSR are positive, and the coefficient of the experimental group is larger than that of the control group. Horizontally, Diff is positive for both, and Diff of the experimental group is larger than Diff of the control group; vertically, Diff is significantly negative before the opening of HSR, but it is significantly positive after the opening of HSR. The above results indicate that the experimental group’s green

\(^3\) The specific content of the indicators and the measurement process are not shown here due to space constraints, but are kept for reference.
total factor productivity has improved after the opening of HSR. In terms of economics, the opening of HSR increases the green total factor productivity of cities in the control group by 0.022 units and increases the green total factor productivity of cities in the experimental group by 0.039 units. Therefore, the empirical results show that the opening of HSR can promote the green total factor productivity of cities.

4. Empirical results and analysis

4.1. Baseline regression results

Referring to Banister and Berechman (2001), this paper further applies the DID method to examine the impact of HSR openings on urban green total factor productivity. The results are shown in Table 3. The coefficient estimates of the interaction terms $HSR \times before1$ and $HSR \times before2$ are negative but not significant, indicating that the model passed the parallel trend test. Meanwhile, the coefficient estimates of the interaction terms $HSR \times post$, $HSR \times post1$, $HSR \times post2$, and $HSR \times post3$ are all positive and pass the significance test at the 1% level. This indicates that the opening of HSR has a longer-term promotion effect on the improvement of green total factor productivity in cities. Therefore, combining the regression results in Tables 3 and 4, this paper concludes that the opening of HSR can promote urban green total factor productivity. In addition, the regression results of control variables show that the level of industrial structure, infrastructure level, government financial support, real GDP per capita growth rate, and whether the city in question is a provincial capital city have positive effects on the enhancement of green total factor productivity in cities. In contrast, the foreign investment dependence and population sizes of cities have a negative impact on the enhancement of green total factor productivity in cities.

4.2. Robustness tests

4.2.1. Sample of different periods

To examine the impact of HSR openings on urban green total factor productivity as well as to exclude the impact of other events on the level of urban economic development during the sample period, the sample interval of 2011–2018 has been retained for robustness testing. First, as Table 4 shows, the sample interval in column (1) is 2011–2012, column (2) is 2013–2014, column (3) is 2015–2016, and column (4) is 2017–2018. Each column has a time interval of two years, and the time interval is narrowed for more precise results and more robust conclusions. Second, the explanatory variable $HSR \times post$ is significantly positive at the 1% level in each column, indicating that the opening of HSR is beneficial to the improvement of urban green total factor productivity. After adding the control variables, the explanatory variable $HSR \times post$ is still significantly positive, verifying the basic conclusion of this paper. Thus, the results of the benchmark regression are consistent with the conclusion that the opening of HSR can promote the improvement of urban green total factor productivity.

4.2.2. Re-measure urban GFTP

In order to ensure the robustness and reliability of the estimation results, this paper remeasures GTFP after adjusting the expected output indicator by drawing on Zhang and Luo (2019). Urban green development is a comprehensive concept, and the desired output

### Table 1
Variable names and measurement methods.

| Variable name | Measurement method |
|---------------|--------------------|
| Urban Green Total Factor Productivity (GTFP) | Inputs, desired outputs, and non-desired outputs. |
| Foreign capital dependence (FDI) | The main business income of the three enterprises/the total income of the high-tech industry. |
| Industrial structure (ind) | The ratio of tertiary industry output value to secondary industry output value. |
| Infrastructure level (road) | The road area per capita. |
| Administrative level (AEG) | A dummy variable: if the city is the province’s capital city, it takes 1; otherwise, it takes 0. |
| Government financial support (Gov) | The ratio of government financial expenditure to regional GDP. |
| Population size (poe) | The number of permanent residents in the city. |
| Economic development level (PGDP) | The growth rate of urban real GDP per capita. |

Organized by the author.

| Table 2 |
| Univariate DID results. |
| GTFP | Control group | Experimental group | Diff |
| Before | 0.0177 | 0.0034 | $-0.0143^{***} (-6.1011)$ |
| Post | 0.0221 | 0.0394 | $0.0173^{***} (5.5563)$ |
| Diff | 0.0044 (0.4659) | 0.0360 (0.5741) | $0.0316^{***} (7.5676)$ |

*, **, and *** denote significance levels of 10%, 5%, and 1%; t-values are in parentheses. Diff denotes the mean GTFP value of cities with high-speed rail minus the mean GTFP value of cities without high-speed rail; Diff1 denotes the mean GTFP value of cities in the Post period minus the mean GTFP value of cities in the Before period.
Table 3
Impact of HSR openings on urban green total factor productivity: DID test.

| Variables | Urban Green Total Factor Productivity (GTFP) |
|-----------|---------------------------------------------|
|           | (1)                     | (2)                     | (3)                     | (4)                     | (5)                     | (6)                     |
| HSR × before1 | −0.0003 (−0.2244) | −0.0008 (−0.6531) |
| HSR × before2 | −0.0012 (−0.8008) | −0.0080 (−0.5508) |
| HSR × post1 | 0.0125*** (4.6685) | 0.0711*** (6.0494) | 0.0044*** (4.3743) | 0.0777*** (5.8083) |
| HSR × post2 | 0.0012 (0.8008) | 0.0080 (0.5508) | 0.0040*** (6.2429) | 0.0664*** (5.5514) |
| HSR × post3 | 0.0044*** (4.3743) | 0.0777*** (5.8083) | 0.0206*** (5.0474) | 0.0671*** (5.6600) |
| FDI       | 0.0094** (2.1349) | 0.0186** (2.0636) | 0.7346** (2.2196) |
| ind       | 0.1099*** (6.1607) | 0.1515*** (5.2103) | 0.5240*** (4.1641) |
| road      | 0.0218*** (5.8258) | 0.0382*** (4.3365) | 0.0228*** (6.3732) |
| AEG       | 0.0013*** (6.3106) | 0.0035*** (4.5530) | 0.0283*** (5.8083) |
| Gov       | 0.0633*** (3.4495) | 0.0314*** (4.5163) | 0.0861*** (5.5367) |
| poe       | −0.0467 (−1.0754) | −0.1305 (−0.9744) | −0.0774 (−0.6291) |
| PGDP      | 0.0419*** (4.2078) | 0.0398*** (5.7704) | 0.0104*** (4.2080) |
| Cons      | 0.0301 (1.0156) | 0.0029 (0.3863) | 0.0167 (0.4495) | 0.0569 (0.7260) |
| Year      | Yes                    | Yes                    | Yes                    | Yes                    |
| City      | Yes                    | Yes                    | Yes                    | Yes                    |
| N         | 4560                    | 4560                    | 4560                    | 4560                    |
| R²(Within) | 0.5003             | 0.6023             | 0.6586             | 0.3863             |

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; t-values are in parentheses. Year denotes time fixed effects and city denotes city fixed effects.

Table 4
Regression results of samples at different time periods.

| Variables | Urban Green Total Factor Productivity (GTFP) |
|-----------|---------------------------------------------|
|           | 2011–2012 | 2013–2014 | 2015–2016 | 2017–2018 |
|           | (1) | (2) | (3) | (4) |
| HSR × post | 0.0079*** (5.4145) | 0.0601*** (3.8386) | 0.0188*** (2.8365) | 0.0035*** (3.1844) |
| FDI       | −0.0587*** (−2.7410) | −0.1130*** (−2.1836) | −0.0502*** (−2.2948) | −0.0035*** (−2.4884) |
| ind       | 0.1129*** (2.8802) | 0.1389*** (4.3125) | 0.0327*** (3.2349) | 0.0058*** (3.4723) |
| road      | 0.1402*** (2.3238) | 0.6787*** (3.2963) | 0.7401*** (3.6085) | 0.0006*** (3.0968) |
| AEG       | 0.6937*** (3.3176) | 0.0250*** (3.0747) | 0.0305*** (3.7331) | 0.0046*** (2.4398) |
| Gov       | 0.0247*** (3.0591) | 0.0083*** (3.6122) | 0.0035*** (4.4069) | 0.0012*** (2.0150) |
| poe       | −0.0038 (−0.6158) | −0.0544 (−0.7736) | −0.1248 (−1.0804) | −0.0023 (−0.3170) |
| PGDP      | 0.0537*** (3.7632) | 0.0454*** (4.6037) | 0.0206*** (3.1695) | 0.0238*** (4.5041) |
| Cons      | 0.0023 (0.3143) | 1.1591 (1.0116) | 0.0023 (0.3170) | 1.1144 (0.6671) |
| Year      | Yes | Yes | Yes | Yes |
| City      | Yes | Yes | Yes | Yes |
| N         | 570 | 570 | 570 | 570 |
| R²(Within) | 0.5701 | 0.4063 | 0.5098 | 0.6662 |

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; t-values are in parentheses.
should include economic aspects, social welfare, and ecological environment aspects. Therefore, this paper selects multiple output indicators from economic growth output, social welfare, and ecological environment; applies the principal component analysis to downscale them; and combines them into desired output indicators. Specifically, the real GDP of each city in constant 1990 prices is selected to measure the economic output of the city; the total retail sales of social consumer goods per capita, public library collections per 100 people, and hospital and health center beds per 10,000 people are selected to reflect the social welfare level of the city; and the green area per capita is selected to measure the ecological environment output.

The regression results obtained using the remeasured GTFP are shown in Table 5. From Table 5, it can be seen that the coefficient estimates of the key explanatory variables $HSR \times post$, $HSR \times post1$, $HSR \times post2$, and $HSR \times post3$ are significantly positive. This indicates that urban green total factor productivity continues to increase immediately after the opening of HSR, as well as one, two, and three years after the opening of HSR. This means that the impact effect of HSR opening has some dynamic persistence. In addition, the results of the control variables are also fundamentally consistent with the results in Table 4. With the exceptions of foreign capital dependence ($FDI$) and population size ($Poe$), all items are significantly positive. It can therefore be concluded that the baseline regression results have not changed significantly, and the results of this paper are robust.

4.2.3. Instrumental variable method

Considering the potential endogeneity issues that may affect the impact of HSR openings on green total factor productivity, this study used the 2SLS method to re-run the regression to further test the robustness of the empirical results. Before conducting the regression, this study used spatial geographic information to calculate the geographic development cost as an instrumental variable for the opening of HSR. The regression results are shown in Table 6, where control variables are added in the even columns (not in the odd columns). Observing Table 5, it is evident that columns (1)–(2) are the regression results of the first stage, the IV (minimum spanning tree) results are significantly negative, and the F-value of the first stage is 63.0829, which excludes the problem of weak instrumental variables. Columns (3)–(4) show the regression results of the second stage, and the coefficient estimates of the key explanatory variable $HSR \times post$ are significantly positive at the 1% level. As can be seen, solving the endogeneity problem also did not change the baseline regression results, indicating that the conclusions of this paper are reliable.

4.3. Heterogeneity analysis

In this paper, the total sample is divided into large-scale cities and small- and medium-scale cities by city size; the sample is also divided and into eastern, central, and western cities by city region. This study conducted a heterogeneity analysis of the impact effect of the opening of HSR. The empirical results are shown in Table 7. The results of the grouped regression based on city size show that the

| Variables | Remeasured Urban Green Total Factor Productivity(GTFP) |
|-----------|--------------------------------------------------|
|           | (1)     | (2)     | (3)     | (4)     |
| $HSR \times post$ | 0.0136*** | 0.0162*** |          |          |
|            | (3.0241) | (4.1859) |          |          |
| $HSR \times post1$ |          | 0.0075*** | 0.0056*** |          |
|            |          | (3.5448) | (3.3121) |          |
| $HSR \times post2$ |          | 0.0503** | 0.0082*** |          |
|            |          | (2.0153) | (4.7379) |          |
| $HSR \times post3$ |          | 0.0195*** | 0.0023*** |          |
|            |          | (2.9410) | (3.1585) |          |
| $FDI$ | -0.0086** |          | -0.0711** |          |
|            | (-2.1309) |          | (-2.2473) |          |
| $ind$ | 0.0086 |          | 0.0855 |          |
|            | (0.8309) |          | (0.7134) |          |
| $road$ | 0.0094*** |          | 0.0276** |          |
|            | (3.8243) |          | (2.7451) |          |
| $AEG$ | 0.0518*** |          | 0.0305** |          |
|            | (0.4538) |          | (0.0745) |          |
| $Gov$ | 0.0970 |          | 0.0449 |          |
|            | (1.3458) |          | (0.7755) |          |
| $poe$ | -0.0240 |          | -0.0999 |          |
|            | (-0.5821) |          | (-1.5369) |          |
| $PGDP$ | 0.0221*** |          | 0.0044*** |          |
|            | (4.8774) |          | (3.1194) |          |
| $Cons$ | 0.0038 |          | 0.0263 |          |
|            | (0.4814) |          | (0.5857) |          |
| $Year$ | Yes | Yes | Yes | Yes |
| $City$ | Yes | Yes | Yes | Yes |
| $N$ | 4560 | 4560 | 4560 | 4560 |
| $R^2(Within)$ | 0.4706 | 0.5025 | 0.6805 | 0.5942 |

*, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; t-values are in parentheses.
coefficient estimates of $HSR \times post$, $HSR \times post1$, $HSR \times post2$, and $HSR \times post3$ are positive in each column and pass the 1% significance level test. This indicates that the impact effect of HSR opening is not affected by the heterogeneity of city size. The results based on different regional groupings show that the coefficient estimates of the core explanatory variables pass the significance level test of at least 5% in the eastern and central regions, although they are not significant in the western region. This indicates that the opening of HSR makes a significant contribution to the improvement of green total factor productivity in cities in the eastern and central regions, but that this contribution is not significant for cities in the western region. Meanwhile, a longitudinal comparison of the magnitude of the coefficient of $HSR \times post$ reveals that the opening of HSR gives a longer-term boost to urban green total factor productivity. This effect gradually strengthens over time in large-scale and central cities; however, the opposite is true in small- and medium-scale cities and eastern cities. Therefore, this paper concludes that there are differences in the impact of HSR openings on green total factor productivity in cities of different sizes and regions. The differences are manifested in whether the boosting effect on green total factor productivity is significant and whether this boosting effect gradually strengthens over a certain period.

5. Mechanism testing: a green finance perspective

The empirical results in the previous section show that the opening of HSR significantly increases the green total factor productivity of cities. The next question to be considered is, how does the opening of HSR affect urban green total factor productivity? That is, what is the mechanism of action by which the opening of HSR affects the green total factor productivity of cities? The opening of HSR facilitates the flow and development of financial capital between cities, which in turn promotes the movement of green financial resources between cities. Therefore, from the perspective of green finance, this paper examines how the opening of HSRs can "lend" green finance to green development in order to investigate the mechanism of influence of the opening of HSRs on the green total factor productivity of cities.

5.1. Impact of HSR on GFTP from a green finance perspective

To illustrate the mechanism of action by which the opening of HSR promotes the development of green finance and thus urban green total factor productivity, the model in this section is set up as follows:

$$GTFP_{it} = \partial_0 + \partial_1 HSR_{it} \times post_{it} \times GF_{it} + \partial_2 HSR_{it} \times GF_{it} + \partial_3 post_{it} \times GF_{it} + \partial_4 controls_{it} + u_i + \lambda_t + \epsilon_{it}$$  \hspace{1cm} (2)

where $GF_{it}$ denotes the green financial resources of city $i$ in year $t$. At present, scholars measure green financial resources in the following ways: (1) Yin, Sun, & Xing (2021) constructed an evaluation index system of green finance development levels, including five secondary index systems of green credit, green securities, green insurance, green investment, and carbon finance. They used a combination of subjective and objective weighting methods to measure the regional green finance development level. The indicator

Table 6

| Variables          | HSR (1) | HSR (2) | GF (3) | GF (4) |
|--------------------|---------|---------|--------|--------|
| $IV$ (Minimum Spanning Tree) | $-0.0356^{***}$ | $-0.0131^{***}$ | $0.0377^{***}$ | $(5.0328)$ |
| $FDI$              | $-0.1126$ | $-0.0098^{**}$ | $-0.1450^{**}$ | $(-2.2563)$ |
| $ind$              | $0.1130$ | $(-1.907)$ | $0.0378$ | $(1.3130)$ |
| $road$             | $0.0220^{***}$ | $(3.8384)$ | $0.0034^{***}$ | $(3.5427)$ |
| $AEG$              | $0.0013^{***}$ | $(4.3092)$ | $0.0309^{***}$ | $(5.5075)$ |
| $Gov$              | $0.0635$ | $(4.1535)$ | $0.1293$ | $(1.0551)$ |
| $poe$              | $-0.0469$ | $(-1.0789)$ | $-0.0301$ | $(-0.7727)$ |
| $PGDP$             | $0.0319^{***}$ | $(3.2076)$ | $0.0608^{***}$ | $(4.0532)$ |
| $Cons$             | $0.1718$ | $(0.5293)$ | $0.1776$ | $(0.5477)$ |
| $Year$             | Yes     | Yes     | Yes    | Yes    |
| $City$             | Yes     | Yes     | Yes    | Yes    |
| N                  | 4560    | 4560    | 4560   | 4560   |
| $R^2$(Within)      | 0.6124  | 0.5565  | 0.4823 | 0.5964 |

* *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; $t$-values are in parentheses.
Table 7
Regression results for subgroups.

| Variables | Panel A: Grouped by City Size | Panel B: Grouped by Urban Area |
|-----------|-------------------------------|-------------------------------|
| Large-scale cities | Small and medium-sized cities | East area | Central area | West area |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| HSR×post | 0.1594*** (3.4034) | 0.0172*** (4.3552) | 0.1154*** (3.8547) | 0.0317** (2.0912) | 0.0156 (1.1267) |
| HSR×post1 | 0.1485*** (3.4253) | 0.0488*** (4.0526) | 0.1640*** (3.4098) | 0.0178*** (3.5638) | 0.0081 (1.0854) |
| HSR×post2 | 0.2540*** (4.2889) | 0.0295*** (3.4174) | 0.1183*** (3.7726) | 0.0753*** (3.3574) | 0.0163 (0.9652) |
| HSR×post3 | 0.2820*** (5.6667) | 0.0060*** (3.8212) | 0.1047*** (4.6868) | 0.0591** (2.2176) | 0.0478 (1.2053) |
| Cons | 0.0044 (0.0486) | 0.0022 (0.2077) | 0.0524 (0.4672) | 0.0070 (0.8707) | 0.0611 (0.5908) | 0.0063 (0.7520) | 0.0461 (0.4747) | 0.0073 (0.6702) | 0.0219 (0.5071) | 0.0052 (0.7125) |
| controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| City | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2016 | 2016 | 2544 | 2544 | 1616 | 1616 | 1744 | 1744 | 1200 | 1200 |
| R²(Within) | 0.4043 | 0.5222 | 0.6047 | 0.5392 | 0.5226 | 0.6158 | 0.6073 | 0.5198 | 0.5370 | 0.5936 |

(1) Cities with populations above 1 million are classified as large-scale cities and those with populations below 1 million are classified as small- and medium-scale cities by city size; (2) *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; t-values are in parentheses. Controls denote a set of control variables controlling for the previously described.
weights refer to the weights of Li and Xia (2014) in the China Green Finance Report (2014). (2) Zhu, Zhu, Huang, and Huang (2021) measured with the scale of green bonds owned by cities. Wen, Lin, and Liu (2021) argued that the indicator of the allocation of financial resources in the green environmental protection field can be used as a proxy indicator of green finance, representing the greening of the financial industry’s operation and investment decisions, i.e., all financial activities that support the green energy-saving industry belong to the scope of green finance. The measurement is as follows: green finance indicator = financial resources of green industries/financial resources of all industries. The third approach is consistent with the frontier trend of modern green finance research.

This paper also draws on that approach by dividing the loans obtained by energy-saving and environment-friendly enterprises in a city by the loans obtained by all listed companies in that city as an indicator of green finance activities. The calculation formula is: \( GF_{it} = \text{the sum of borrowings of environmental protection enterprises in city } i \text{ in year } t / \text{the sum of borrowings of enterprises in all industries in city } i \text{ in year } t \). If the coefficient of \( \partial \) is significantly positive, it indicates that the opening of HSR promotes the factor flow of green financial resources between cities; if the coefficient of \( \partial \) is significantly negative, it indicates that the opening of HSR hinders the factor flow of green financial resources between cities. The meanings of the remaining explanatory variables are consistent with the baseline regression model, and the regression results are shown in Table 8.

In Table 8, the coefficient estimates of the interaction term \( HSR \times post1 \times GF_{it} \) are positive and pass the significance level test of at least 5%. This indicates that green financial resources enhance the positive impact of HSR opening on green total factor productivity. Meanwhile, comparing the coefficient magnitudes of \( HSR \times post1 \times GF_{it} \), \( HSR \times post2 \times GF_{it} \), and \( HSR \times post3 \times GF_{it} \) reveals that the opening of HSR can have a positive effect on green total factor productivity in a longer period. However, the effect of this contribution tends to first increase and then decrease. The above results indicate that the opening of HSR can positively affect urban green total factor productivity through the mechanism of promoting the development of green finance.

### 5.2. Heterogeneity test from a green finance perspective

Table 9 presents the results of grouped regressions on the impact of HSR opening on urban green total factor productivity from green finance. When the regression samples include large-scale cities, small- and medium-sized cities, and east and central cities, the coefficient estimates of the interaction term \( HSR \times post \times GF_{it} \) are positive and pass the 1% significance level test. When the regression sample includes western cities, the coefficient estimates of the interaction term \( HSR \times post \times GF_{it} \) are positive but insignificant. The above results indicate that with the development of green finance, the opening of HSR has a significant contribution to the green total factor productivity development of large-scale cities, small- and medium-sized cities, and cities in the east and central regions, but that the effect on the green total factor productivity development of cities in the west is not significant. Meanwhile, the regression coefficients of \( HSR \times post1 \times GF_{it} \), \( HSR \times post2 \times GF_{it} \), and \( HSR \times post3 \times GF_{it} \) show that the opening of HSR will have a boosting effect on urban green total factor productivity through the development of green finance over a certain period of time. This boosting effect tends to strengthen gradually in large-scale cities. However, this result is reversed in small- and medium-sized, eastern, and western cities. Therefore, the impact of HSR opening on green total factor productivity development is different in cities of different sizes and regions from the perspective of green finance. The above results further support the theoretical mechanism that the opening of HSR triggers the development of green finance and thus affects urban green total factor productivity.

### 6. Conclusions and policy implications

Investments in transportation infrastructure are thought to promote local economic growth by improving accessibility. The
Table 9
Mechanisms testing the impact of HSR openings on urban GTFP: Regression in difference groups.

| Variables | Panel A: Grouped by City Size | Panel B: Grouped by Urban Area |
|-----------|-------------------------------|------------------------------|
|           | Large-scale cities            | Small and medium-sized cities| East area | Central area | West area |
|           | (1)                           | (2)                          | (3)       | (4)          | (5)       |
| HSR×post×GF_{it} | 0.1271*** (3.4954) | 0.0195*** (4.3727) | 0.2453*** (4.2722) | 0.0599*** (3.7942) | 0.0619 (1.2874) |
| HSR×post1×GF_{it} | 0.1043*** (4.0906) | 0.0464*** (5.8027) | 0.1451*** (5.4566) | 0.0845*** (4.9723) | 0.0643 (0.9054) |
| HSR×post2×GF_{it} | 0.1487** (2.1124) | 0.0123*** (4.2872) | 0.1172*** (4.3825) | 0.0631** (2.0189) | 0.0452 (1.1768) |
| HSR×post3×GF_{it} | 0.1686*** (4.5213) | 0.0062*** (4.5532) | 0.0906** (2.3146) | 0.0598** (2.0545) | 0.0245 (0.6592) |
| Cons      | 0.0456 (0.4865) | 0.0756 (0.8677) | 0.0345 (0.0082) | 0.03492 (0.2956) | 0.0141 (0.4092) | 0.0238 (0.1863) | 0.0770 (0.7427) | 0.0634 (0.5803) | 0.0234 (0.7427) | 0.0318 (0.6157) |
| controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year      | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| City      | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N         | 2016 | 2016 | 2544 | 2544 | 1616 | 1616 | 1744 | 1744 | 1200 | 1200 | 1200 |
| R^2(Within) | 0.5173 | 0.6222 | 0.7047 | 0.6392 | 0.5026 | 0.6558 | 0.4673 | 0.6198 | 0.5364 | 0.6815 |

(1) Cities with populations above 1 million are classified as large-scale cities and those with populations below 1 million are classified as small- and medium-scale cities by city size; (2) *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively; t-values are in parentheses. Controls denote a set of control variables controlling for the previously described.
construction of HSR in China provides an empirical setting to study the impact of transportation infrastructure development on urban economic growth. This paper uses data from a sample of 285 prefecture-level and above cities in China from 2003 to 2018, using the opening of HSRs as a quasi-natural experiment to conduct an empirical regression on the opening of HSRs and green total factor productivity in Chinese cities based on the DID method.

The benchmark regression results show that the opening of HSR is conducive to the sustained improvement of green total factor productivity in Chinese cities. After a series of robustness and endogeneity tests, the regression coefficients of the core explanatory variables remain significantly positive and the conclusions of the benchmark regression still hold. The heterogeneity regression results show that, first, after dividing the total sample into large-scale cities and small- and medium-scale cities by city size, the coefficient estimates of the core explanatory variables are all significantly positive, and the coefficient estimates are larger for the large-scale city sample. This indicates that the opening of HSR is more conducive to promoting green total factor productivity in large-scale cities. Second, after dividing the total sample by urban areas, the coefficient estimates of the core explanatory variables are significantly positive only for the eastern and central urban samples. This indicates that the opening of HSR can play a positive contribution to green total factor productivity in cities in the east and central regions. The results of the mechanism test show that, first, the opening of HSR can positively impact urban green total factor productivity through the promotion of green finance development. This positive impact shows a trend of first increasing and then decreasing. Second, there are differences in the impact of HSR openings on green financial development at different scales and in different regions. Specifically, the opening of HSR makes a significant contribution to the development of green finance in large-scale cities, small- and medium-scale cities, and eastern and central cities, but the impact on the development of green finance in western cities is not significant.

The above findings provide useful insights for understanding the changing urban economy in China, especially as the rapidly expanding HSR network plays an important role in this process. The findings of this paper can also help policymakers and micro enterprises in developing and emerging economies understand the spatial changes in the urban economy from the perspective of green financial development and maximize the benefits of HSR-induced economic growth in the post-COVID-19 pandemic period. Firstly, the government should establish a green credit guarantee system in response to the non-optimistic investment expectations caused by the pandemic. Using fiscal funds as guarantee leverage, government departments should moderately enlarge the scale of bank investment in green credit, encourage investment in cross-regional and transportation-dependent sectors, and mitigate the impact of the pandemic on cross-regional investment. Secondly, government departments should also reasonably diversify the credit risks of commercial banks in supporting the financing of external sustainable infrastructure projects through fiscal subsidies and tax incentives, thus leveraging and leading a large amount of social capital into external green projects and green industries in the post-COVID-19 pandemic period. They must also give full play to the positive effects of HSR networks on urban economic development. Developing and emerging economies should increase investment in rail networking in city clusters and metropolitan areas to increase the density of urban HSR networks. In this way, local economies can take advantage of HSR connections and benefit from involvement in a virtuous cycle by ensuring frequent and efficient HSR services. Finally, China should strengthen green financial cooperation with countries along the “Belt and Road” and improve the ability and level of financial institutions to “go global”. Financial institutions should actively integrate into sustainable investment-oriented investment and financing networks and practice responsible investment and value investment, so as to better face the uncertainty of the economic environment. The government should vigorously develop new infrastructure construction such as intercity high-speed railroads and urban railways in China, and increase support for green infrastructure and green industries in developing countries. The government should also guide firms to carry out green production capacity, technology and investment and financing cooperation with host countries and relevant market players, and give focused financial support to green technology innovation and advanced management models.

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References

Angrist, J. D., & Pischke, J.-S. (2009). Mostly harmless econometrics: An empiricist’s companion number 8769. Economics Books. Princeton University Press.
Baar, A. S., Blau, B. M., & Sabah, N. (2021). Free trade and the efficiency of financial markets. Global Finance Journal, 48, Article 100545.
Banerjee, A., Duflo, E., & Qian, N. (2012). On the road: Access to transportation infrastructure and economic growth in China. National Bureau of Economic Research.
Banister, D., & Berechman, Y. (2001). Transport investment and the promotion of economic growth. Journal of Transport Geography, 9(3), 209–218.
Cheng, H., Wang, Z. Q., Peng, D., & Kong, Q. (2020). Firm’s outward foreign direct investment and efficiency loss of factor price distortion: Evidence from Chinese firms. International Review of Economics and Finance, 67, 176–188.
Diao, M., Leonard, D., & Sing, T. F. (2017). Spatial-difference-in-differences models for impact of new mass rapid transit line on private housing values. Regional Science and Urban Economics, 67, 64–77.
Dong, Y. M., & Zhu, Y. M. (2016). Can high-speed rail construction reshape the layout of China’s economic space——Based on the perspective of regional heterogeneity of employment, wage and economic growth. China Industrial Economics, 10, 92–108.
Fang, C. L., & Yu, D. L. (2017). Urban agglomeration: An evolving concept of an emerging phenomenon. Landscape and Urban Planning, 162, 126–136.
He, X. G., Luo, Q., & Chen, J. L. (2020). High-quality human capital and upgrading of urban industrial structure in China: Evidence from enrolment expansion. Economic Review, 4, 3–19.
Huang, Z. Y., & Wu, L. C. (2020). Impact of Beijing-Shanghai high-speed railway on the economy of cities along the route: An empirical analysis based on the theory of space economics. Macroeconomics, 2, 165–175.
Kong, Q. X., Guo, R., Wang, Y., Sui, X. P., & Zhou, S. M. (2020). Home-country environment and firms’ outward foreign direct investment decision: Evidence from Chinese firms. Economic Modelling, 85, 390–399.
