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Does high-speed rail boost tourism growth? New evidence from China

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ABSTRACT

This paper evaluates the impact of high-speed rail (HSR) on tourism growth using China's city panel data from 2004 to 2015. The empirical results from the difference-in-differences method show that HSR connection does not promote tourism revenue but does boost tourist arrivals, leading to a negative effect of HSR connection on tourism revenue per arrival; these results are further confirmed by the instrumental variable method to address the issue of endogenous HSR route placement, and by various robustness checks. Further investigation shows that the effect is heterogeneous. By connecting to HSR, less-developed central and western regions have attracted more arrivals than the developed eastern region, and cities with unique tourism resources, although they attract less arrivals, gain more revenue than cities without those resources.

1. Introduction

Engel's law states that food consumption decreases with residents' income. The share of expenditures on education, housing, and travel keeps increasing. Tourism is among those expenditures. People nowadays like to relax and enjoy themselves after intense and fast-paced work. Modern fast forms of transport, like aeroplanes and highways, facilitate such demands for comfortable tourism by increasing the accessibility of tourism destinations in remote areas. Among the various modern forms of transport, high-speed rail (HSR) has emerged as one of the most popular, providing comfortable, fast, punctual, and convenient transport services. During the past decade, China has become the largest HSR country by vigorously rolling out HSR construction and expects to form an “8 vertical and 8 horizontal” backbone HSR framework with a total length of over 30,000 km connecting 80% of China's large cities by the end of 2020 (see also Appendix A1 for the fast rollout of HSR).[1]

It has been well argued that transportation improvement can produce real effects on the regional economy, directly or indirectly (Arbués, Baños, & Mayor, 2015; Banerjee, Duflo, & Qian, 2012; Banister & Berechman, 2001; Donaldson, 2018; Garrison & Souleyrette, 1996; Kilkenny, 1998). As a novel transport tool, HSR is also expected to influence the local economy. Extant studies have shown that HSR is indeed pertinent to local socioeconomic development, although the evidence is mixed, with some studies arguing that HSR connection produces local effects by dispersing the economy to connected peripheral areas (Ke, Chen, Hong, & Hsiao, 2017; Zheng & Kahn, 2013), while others find that it polarizes the economy and thus central cities rather than peripheral areas benefit from connecting to HSR (Faber, 2014; Gao, Song, Sun, & Zang, 2018; Qin, 2017), or find heterogenous effects of HSR on growth in terms of city tiers (Diao, 2018).

When referring to the HSR–tourism nexus, it is not hard to reckon that HSR influences tourism by enhancing accessibility and mobility (Cascetta, Papola, Pagliara, & Marzano, 2011; Levinson, 2012; Su & Wall, 2009; Wang, Qian, Chen, Zhao, & Zhang, 2014). However, both a negative and a positive effect can be expected. On the one hand, HSR enhances the accessibility of cities and enables tourists to travel easily and comfortably to connected destinations. As a result, the accessibility improvement brought by HSR is expected to increase tourism arrivals. On the other hand, HSR brings about asymmetric accessibility improvement favouring central cities, where tourism resources are concentrated and professional tourism services are provided. HSR may be more beneficial to the tourism in central areas. Thus, the net impact of accessibility exerted by HSR on tourism outcomes is determined jointly by the two competing forces.

Extant studies have examined that effect but provided mixed

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[1] See the promulgated mid-to long-term railway network plan by the National Development and Reform Commission in July 2016, jointly with the Ministry of Transport of China and the National Railway Administration of China, under the approval of the State Council of China, at: http://www.ndrc.gov.cn/zcfb/zcfbtz/201607/t20160720_811696.html.

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evidence. Albalate and Fageda (2016) examined the effect of HSR on the tourism demand in Spain but found that HSR does not promote tourist arrivals and overnight stays due to its substitution role regarding airport traffic. Similar results were obtained by Albalate, Campos, and Jiménez (2017), also with panel data from Spain. Masson and Petiot (2009) argued that the HSR system would strengthen the attractiveness of central cities as tourist destinations due to the agglomeration forces brought by transportation improvement. Pagliara, La Pietra, Gomez, and Vassallo (2015) found, through a revealed preference survey conducted in Madrid, that the Spanish HSR system encourages tourists to visit other cities close to Madrid but does not influence their choice of Madrid as a destination. Chen and Haynes (2012), using the dynamic panel data model, found that HSR promotes the international tourism demand but the effect is limited.

The present paper complements the extant literature by providing new evidence on the impact of HSR on tourism growth using Chinese city panel data. China has become the largest HSR country in the world, and its HSR mileage keeps increasing. The fast rollout of HSR construction provides a natural experiment enabling us to evaluate how accessibility improvement influences the tourism demand. Although the extant literature has studied the accessibility and mobility impact of China's HSR (Cao, Liu, Wang, & Li, 2013; Jiao, Wang, & Jin, 2017; Shaw, Fang, Lu, & Tao, 2014; Wang, Liu, Sun, & Liu, 2016) and the effect of HSR on regional tourism development (Wang, Huang, Zou, & Yan, 2012; Wang, Niu, & Qian, 2018) and international tourists (Chen & Haynes, 2015a), it lacks empirical specifications to identify the causal effect of China's HSR connection on tourism growth. Moreover, China's transitional context, characterized by a vast territory and contrasting urban–rural and east–west development gaps, may also enable us to test the differences between the existing findings regarding the HSR–tourism nexus and our findings concerning transitional China. In this paper, following Albalate and Fageda (2016) and Albalate et al. (2017), we use the difference-in-differences (DID) method to identify the impact of HSR connection on the tourism demand, further considering the endogenous HSR route placement with the straight-line strategy proposed in previous studies (Atack, Haines, & Margo, 2008; Banerjee et al., 2012; Faber, 2014; Gao et al., 2018; Hornung, 2015) to construct instrumental variables for HSR connection. We also test the regional and city-tier heterogeneity effects of HSR connection on tourism growth and conduct various robustness checks.

We find with the DID method that HSR connection does not promote tourism revenue growth, while it does increase tourist arrivals by 5.9% and thus reduces the tourism revenue per arrival by 7.9%. The heterogeneity analysis shows that cities in less developed western and central regions gain more tourist arrivals from connecting to HSR but that more arrivals do not bring more revenue. Moreover, we find that cities with unique tourism resources attract fewer tourists but gain more tourism revenue than those without unique tourism resources. The effect that HSR connection boosts tourist arrivals but does not increase tourism revenue is consistent with robustness checks removing observations from central cities, tourism cities, and cities with World Heritage Sites as well as robustness checks with different time horizons, falsification tests, and more instrumental variables.

Our paper has strong implications for local governments, which may lobby hard to have their cities connected by HSR, expecting to develop their tourism industry. Our results indicate that this would be a one-sided wish, since HSR connection has been shown not to have a significant effect on tourism revenue despite its positive effect on tourist arrivals. A persistent effect of HSR on tourism growth requires peripheral cities to provide tourists with a professional and enjoyable visiting experience and thus attract both newcomers and repeat customers.

The rest of the paper is structured as follows. The related literature is reviewed in section 2, in which we summarize the effects of HSR connection on tourism outcomes and the mechanisms behind them. We specify the empirical strategy in section 3, in which the empirical methods, variables, and data are introduced. The empirical results are reported in section 4, in which we display the baseline results from the DID method and IV methods and the heterogeneity effects. Section 5 provides various robustness checks. Section 6 discusses the empirical results, and section 7 concludes the paper.

2. Literature review

The fast HSR rollout across the world during the past decades has attracted considerable research interest in various fields, including economics, management, and geography. Two theories provide somewhat contrasting predictions concerning the effect of HSR connection on the regional economy. First, new economic geography (NEG) (Fujita, Krugman, & Venables, 2001; Helpman & Krugman, 1985; Krugman, 1991) argues that a reduction in trade costs will lead to economic polarization. Second, urban economics (Alonso, 1964; Baum-Snow, 2007; Baum-Snow, Brandt, Henderson, Turner, & Zhang, 2017; Muth, 1969), however, argues that transportation improvement will produce local effects, dispersing the economy from central cities to connected peripheral areas. As a novel transport tool, HSR also functions to reduce transport costs and enhance commuting efficiency. Thus, the economic impact of HSR connection inferred from NEG differs from that from urban economics.

The extant literature has provided evidence for arguments developed from both theories. On the one hand, HSR has been found to polarize the economy by reallocating employment and restructuring industries to focus on central cities and thus exerting adverse effects on peripheral areas (Banister & Berechman, 2001; Gao et al., 2018; Qin, 2017; Vickerman, 2015). On the other hand, dispersing the economy and producing local effects in connected peripheral areas have been highlighted in the form of rising urbanization, house prices, and market integration (Chen & Haynes, 2015b; Zheng & Kahn, 2013) and thus HSR promotes the local economy (Chen, Xue, Rose, & Haynes, 2016; Ke et al., 2017). Moreover, some empirical studies from China have shown that HSR stimulates innovation by facilitating face-to-face communication among skilled labourers and thus the diffusion of ideas, knowledge, and technology (Dong, Zheng, & Kahn, 2018), or found that the HSR accessibility benefits more to the second tier cities with large population by attracting more investment (Diao, 2018).

One of the fundamental channels through which HSR takes effects is by improving accessibility and mobility among cities (Cao et al., 2013; Diao, 2018; Shaw et al., 2014). However, as argued by Sasaki, Ohashi, and Ando (1997), such accessibility is asymmetric in favouring central cities, because metropolitan areas have concentrated advanced resources in most fields, like education, health care, culture, economy, governance, and tourism. As a result, central cities may benefit more from HSR connection and thus the regional economy is polarized to connected central cities. Such an agglomeration effect of HSR on tourism was also discussed by Masson and Petiot (2009) in relation to the forthcoming South European HSR lines between Perpignan and Barcelona. Given China's long-lasting urban-biased policies and government-driven economy (Sicular, Ximing, Gustafsson, & Shi, 2007; Yang & Cai, 2003), such asymmetric accessibility improvement of HSR favouring central cities is even more considerable. Thus, HSR connection in China may facilitate tourism growth by enhancing accessibility, while it may not necessarily lead to tourism growth in peripheral areas.

There are indeed some studies on the effect of HSR on tourism development, which are naturally close to ours. Evidence from China, Japan, Spain, France, and so on has shown that HSR connection increases mobility, accessibility, and the choice of connected peripheral areas as tourism destinations while it also strengthens the role of central cities as tourism centres (Albalate & Fageda, 2016; Delaplace, Pagliara, Perrin, & Mermet, 2014; Kurihara & Wu, 2016; Masson & Petiot, 2009; Pagliara et al., 2015; Wang et al., 2014). The evidence on the impact of HSR on tourism development is mixed and conditional on many other socioeconomic factors. As reviewed by Albalate and Fageda (2016), hypothetically, HSR connection produces both substitution and complementarity effects on tourism. The former argues that HSR substitutes other forms of transport, like airlines and roads. When HSR brings more tourists to its connected areas, it also reduces tourist arrivals by airlines. The complementarity effects indicate that HSR lines complement other forms of transport to attract tourists by enhancing accessibility. Both effects have been observed in European markets, while overall the substitution effect overwhelms the complementarity effects (Albalate, Bel, & Fageda, 2015; Dobruszkes, 2011; Dobruszkes, Dehon, & Givoni, 2014), resulting in an insignificant impact of HSR connection on tourist arrivals and the number of overnight stays (Albalate et al., 2017; Albalate & Fageda, 2016).

How the two opposing effects work in China remains to be disentangled. Despite an increasing number of works evaluating the various impacts of China's HSR system, including its effect on international tourist arrivals, the empirical studies on the influence of HSR connection on China's tourism growth have been quite limited. For example, Wang et al. (2012) found that HSR strengthens the role of central cities as the first-choice tourism destination, implying that tourism in central cities benefits more from HSR connection. Chen and Haynes (2012, 2015a) found, with the dynamic panel data model, that China's HSR promotes the international tourism demand with a limited effect, a result that somewhat supports the complementarity effects of the HSR connection with airlines in attracting international tourist arrivals. This is because international airlines are mostly opened in central cities. HSRs aiming to connect central cities also enhance the accessibility of connected peripheral cities and facilitate foreign tourists' visits to them.

In addition to the two previously mentioned opposing effects, Wang et al. (2018) and Wang et al. (2012) emphasized the competition effects of HSR on China's tourism market, especially for those in peripheral areas. HSR intensifies local tourism competition not only from peers in central cities with better tourism resources, services, and amenities but also from those in connected peripheral cities. The large tourism demand brought by HSR also attracts more entries, strengthening competition in the local tourism market. Thus, how those mixed effects triggered by HSR connection aggregate into a net effect on tourism growth remains an empirical issue needing further investigation.

This paper complements the existing literature and tries to bridge the gap in the extant literature by estimating the effect of China's HSR connection on domestic tourism growth. HSR construction in China also provides a plausible natural experiment enabling us to examine how transportation improvement influences tourism development. The primary aim of HSR construction is to connect China's central cities with a fast and convenient transport tool. However, the HSR does not follow the shortest route between two central cities due to the geographic conditions or the intention to connect certain important cities. In other words, it is endogenous to some omitted variables, which may jointly determine HSR connection and tourism outcomes. For example, local officials with strong willingness to develop tourism economy might also lobby hard to have their cities connected by HSR. But that willingness is private information of local officials and unobservable to us, leading to an up-biased OLS estimation of the effect of HSR connection on tourism growth.

To address the issue of endogenous route placement regarding transportation, previous studies have either used historical information (Baum-Snow et al., 2017; Donaldson, 2018; Dong et al., 2018; Michaels, 2008; Zheng & Kahn, 2013) or further combined it with a straight-line strategy (Atack et al., 2008; Banerjee et al., 2012; Faber, 2014; Gao et al., 2018; Hornung, 2015). As argued by Baum-Snow et al. (2017), historical road information is highly correlated with the present information due to geographic conditions but not directly related with the present socioeconomic variables and thus can be used to construct qualified instrumental variables for actual road connection. The straight-line strategy is justified by the arguments that HSR aims to connect large central cities while a straight line among them defines the nearest route. A city that is either on that line or not is considered to be exogenous and thus can be used to construct IVs for actual transportation routes. This straight-line strategy was also developed by Gao et al. (2018) to identify the impact of HSR on the local economy. Inspired by such IV strategies, we complement the extant empirical studies (Albalate et al., 2017; Albalate & Fageda, 2016; Chen & Haynes, 2015a) using the difference-in-differences method to identify the impact of HSR connection on tourism growth but further considering the issue of endogenous HSR route placement with the straight-line strategy to construct IVs for actual HSR connection. Specifically, in addition to providing new evidence on the HSR-tourism nexus from China, our DID framework considers further endogenous HSR route placement, tests the common trends assumption, analyzes the heterogeneity effects with respect to regions and city tiers, and conducts various robustness checks, aiming to identify the real causality of HSR connection on the tourism economy. Our results are also different from those in existing ones (Albalate et al., 2017; Albalate & Fageda, 2016; Chen & Haynes, 2015a) in that while HSR does not promote tourism revenue, it does increase tourist arrivals but with heterogeneities.

3. Empirical strategy

3.1. Method

To estimate the effect of HSR connection on tourism growth, following the extant literature on empirical growth (Acemoglu, Naidu, Restrepo, & Robinson, 2014; Barro, 1991; Gerring, Bond, Barndt, & Moreno, 2005) as well as above-mentioned empirical studies on HSR-tourism nexus, we use the difference-in-differences (DID) method embedded in the following two-way fixed-effects panel data model:

$$Ln(Tour_{it}) = \rho Ln(Tour_{i,t-1}) + \alpha HSR_{i,t-1} + \gamma Controls_{it} + c_i + \theta_t + v_{it} \tag{1}$$

where *Tour* is the tourism outcome variable, *HSR* is the HSR connection variable, and *Controls* denotes a vector of control variables. Subscripts i and t are cities and year, respectively, and thus c_i and θ_t indicate city fixed effects and year fixed effects. v_{it} is random disturbances. We use the one-year lag term of HSR connection variable because many China' HSR lines are opened at the end of the year. By subtracting the one-year lag of Tour on both sides of equation (1), we can rewrite the empirical model as:

$$Tour\_Growth_{it} = (\rho - 1)Ln(Tour_{i,t-1}) + \alpha HSR_{i,t-1} + \gamma Controls_{it} + c_i + \theta_t + v_{it} \tag{2}$$

where *Tour_Growth* is the natural logarithm growth rate of tourism outcomes. Thus, α measures the effect of HSR connection on tourism growth, regardless of whether we estimate equation (1) or equation (2). An estimate of ρ smaller than 1 indicates that cities with larger tourism outcomes in last period grows smaller, evidence of the convergence nature of tourism economy according to the empirical growth literature.

It is agreed that the common trend assumption, that is, the treated group and the control group share the same trend over time, is required to be fulfilled to reach a real causality reference using the DID method. Like Autor (2003), we use the following model to test that assumption.

$$Ln(Tour_{it}) = \rho Ln(Tour_{i,t-1}) + \sum_{k=-m}^{q} \beta_k HSR_{i,t}(t = o + k) + \gamma Controls_{it} + c_i + \theta_t + v_{it} \tag{3}$$

where o is the year when a city is connected to HSR, $q > 0$, $m \geq 0$, and $k \leq 0$. When $k < 0$, β_k measures the lead effect of HSR connection on tourism growth; when $k = 0$, it measures the current effect of HSR connection, and when $k > 0$, β_k measures the lag effect of HSR connection. If the lead effects are statistically insignificant while the lag effects are statistically significant, we tend to believe that the common trend assumption is not violated. However, the lead effects can also be interpreted as expectation effects of connecting to HSR on tourism growth.

One may further consider the endogenous route placement of HSR. HSR aims to shorten the travel time between central cities or megacities, like Shanghai, Beijing, and Guangzhou. Cities that are economically and politically important are more likely to be connected by HSR lines. Moreover, omitting variables that determine both HSR connection and tourism outcomes will result in biased estimation of the impact of HSR connection on tourism growth. For example, local officials with strong willingness to develop the tourism economy may also lobby hard to connect their cities by HSR lines. Meanwhile, cities with abundant tourism resources are also more likely to be connected by HSR in priority. Failure to control for such unobservable variables will lead to an up-bias in OLS estimation. To address such endogeneity, we use the instrumental variables (IVs) method. Following Faber (2014), Gao et al. (2018), and Hornung (2015), we use the straight-line strategy to construct the potential HSR connection variable as the instrumental variable of the actual HSR connection variable. We draw straight lines between two end cities of HSR lines, which are usually provincial capitals. Prefectural cities located on those lines are constructed as the potential HSR connected cities. We assign them an HSR opening year that is the same as the earliest opening year of the segmentations on the actual HSR line. For those cities connected by multiple HSRs, we also assign their HSR opening time to match the first one. Since HSRs at the early stage are aimed to connect central cities and a straight line defines the shortest distance between two places, the potential HSR connection constructed by that straight-line strategy is closely correlated with the actual one. Whether a city is on one or more of those straight lines, however, to a large extent for some, is exogenous. Gao et al. (2018) showed that, after controlling for some socioeconomic variables, potential HSR connection constructed with the straight-line strategy is a qualified IV of actual HSR connection. Thus, we also use the straight-line strategy to construct an IV for actual HSR connection by drawing straight lines between two end cities of each HSR line. The two-stage least-square (2SLS) method embedded in equation (1), using the potential HSR connection variable as the IV, is given as follows.

$$Ln(Tour_{it}) = \rho Ln(Tour_{i,t-1}) + \alpha HSR_{i,t-1} + \gamma Controls_{it} + c_i + \theta_t + v_{it} \tag{4-1}$$

$$HSR_{i,t-1} = \lambda PHSR_{i,t-1} + \eta Ln(Tour_{i,t-1}) + \phi Controls_{it} + k_i + \delta_t + \varepsilon_{it} \tag{4-2}$$

where *PHSR* is the potential HSR connection variable and equation (4-2) is the first-stage estimation.

Finally, to estimate further the heterogeneity of that effect, we include the interactions of HSR connection with variable(s) regarding spatial differences, city tiers, and the abundance of tourism resources in equation (1), that is,

$$Ln(Tour_{it}) = \rho Ln(Tour_{i,t-1}) + \alpha HSR_{i,t-1} + \beta D_j \times HSR_{i,t-1} + \gamma Controls_{it} + c_i + \theta_t + v_{it} \tag{5}$$

where D_j denotes the dummy variable(s) leading to heterogeneous effects of HSR connection on tourism growth. Equation (5) is also known as a Difference-in-Differences-in-Differences (DDD) framework. Specifically, we want to see how the impact of HSR connection on tourism growth changes across China's three regions, east, centre, and west, how that impact changes with the three city tiers, prefectural, municipality, and provincial capital, and how it changes with unique tourism resources.

3.2. Variables

Extant literature differs in selecting measures on tourism outcome variable and its determinants, depending on the research subject and the data available. When measuring local tourism economy, Massidda and Etzo (2012) used the bilateral tourism flows among twenty Italian regions as the dependent variable. When measuring tourism economy in Spain, Albalate and Fageda (2016) first used the total number of tourists and the mean number of overnights to measure tourism outcome, and further used the number of visitors, overnight stays, average stay, national visitors, foreign visitors and occupation rate as the dependent variable (Albalate et al., 2017). In the literature related to China's tourism, Chen and Haynes (2015a) focused on international tourist arrivals and revenue which are further used by Campa, López-Lambas, and Guirao (2016) in a case study from Spain. In this paper, we use three variables to measure domestic tourism outcome, total domestic tourism revenue, domestic tourist arrivals, and domestic tourism revenue per arrival, which is calculated as the average domestic revenue per tourist arrival. The explanatory variable we are interested in here, HSR connection, is a dummy variable that takes the value of 1 in years in which any city is connected by at least one HSR line (have at least one HSR station) and 0 otherwise, which is also used in related literature (Albalate et al., 2017; Albalate & Fageda, 2016; Chen & Haynes, 2015a; Dong et al., 2018; Gao et al., 2018; Qin, 2017). Thus, the parameter of HSR in equation (1) measures the effect of HSR connection on the growth of tourism outcomes.

The inclusion of the control variables also refers to extant empirical works. We first control for GDP per capita, which is the most critical indicator of the local economy and also controlled in many existing empirical studies (Albalate et al., 2017; Albalate & Fageda, 2016; Chen & Haynes, 2015a; Massidda & Etzo, 2012). Since GDP per capita is also an outcome variable of other socioeconomic variables, control of it can reduce the likelihood of omitting variables that jointly determine tourism outcomes and HSR connection.

Secondly, the number of 5A scenic spots measures the capability of cities to develop local tourism resources.[2] We do not use the number of World Heritage Sites to measure that capacity, because it is much less time varying than the number of 5A scenic spots.[3] However, we do indeed use the number of World Heritage Sites to construct dummy variables for the existence of unique tourism resources, which are used in the heterogeneity analysis and robustness checks.

The third categories of control variables are related to road mode and air transport. Roads and railways are found either a substitute to or a complement with HSR in determining local tourism economy (Albalate et al., 2017; Albalate & Fageda, 2016). To capture those effects, extant literature either controls for road model with highway kilometres (Massidda & Etzo, 2012), passenger railway ridership and railway length (Chen & Haynes, 2015a), or controls for air transports with variables such as airport traffic, low-cost airlines, airport enlargement, and the hub of a network carrier (Albalate et al., 2017; Albalate & Fageda, 2016). According to the data available, we use passenger road ridership and a dummy on having an airport to measure those alternative transport models.

Finally, we control for variables regarding public expenditures, population size and its density, and resident income which differ remarkably across Chinese cities. Public spendings measure the capacity of local governments to finance and provide public infrastructures that facilitate tourism and to organize cultural or sports events that attract

[2] 5A (AAAAA) scenic spots represent the highest level of tourist scenic spots certificated by the National Tourism Administration of China (NTAC), followed by certification levels of 4A, 3A, 2A, and A. In 2007, 66 tourist spots were certificated by the NTAC as the first batch of 5A scenic spots. By 2017, the number of 5A spots had increased to 249. To be certificated as a 5A scenic spot, an attraction needs to meet the criteria promulgated by the NTAC regarding transportation, guides, sanitation, safety, tourist arrivals, amenities, management, and so on. See: https://en.wikipedia.org/wiki/AAAAA_Tourist_Attractions_of_China.

[3] Although not reported, adding the number of World Heritage Sites as an additional control variable only produces very small changes to the coefficients estimated in the present paper, which are available on request.

tourists. The importance of public supports in tourism development has long been discussed in previous studies (Felsenstein & Fleischer, 2003; Mules & Dwyer, 2005). Population density and population are used to control for the market size and the potential for labour division and specialization, which are also controlled in Albalate et al. (2017), Albalate and Fageda (2016), and Massidda and Etzo (2012). While population measures market potential, population density further measures the intensity and connection of human activities which may have larger positive externality and spillovers and be more worthy of visiting and touring. Meanwhile, cities with higher population density are usually historically important in terms of economy, location or politics and thus have more cultural and historical sites that can be explored as tourist attractions. Besides, tourism arrivals and revenue are found correlated with resident income (Louca, 2006; Stronge & Redman, 1982), as Engle's Law has long argued that food expenditures decrease while other spendings including traveling increase, with income.

3.3. Data

The city-level panel data are matched with the data collected from various sources. First, we collect the data on tourism outcomes and their determinants from the provincial statistics yearbooks of each of China's provinces and municipalities. Second, information on 5A scenic spots and World Heritage Sites is taken from the websites of the Ministry of Culture and Tourism of China and World Heritage China, respectively. Since the National Tourism Administration of China (NTAC) began to provide the certification of 5A scenic spots in 2007, we assign 0 to all the values before 2007. One may concern that assigning 0 to the number of 5A scenic spots before 2007 may bias our estimation because high-quality tourist attractions existing before 2007 is not captured. However, we argue that it should not be a worry because here the number of 5A scenic spots is used to measure the capacity of government to develop local tourism resources. Since there is not such government accreditation before 2007, local governments need not to use such capacity regarding developing and applying for 5A scenic spots. Those capacities related to other types of high-quality tourist attractions are at least partially controlled by local public expenditures. Meanwhile, the natural and historical tourism resources which change little over time can be controlled by city fixed effects. Besides, we also conduct robustness checks in Section 5 with the data excluding tourist cities which are accredited by NTAC. Third, HSR connection information is manually collected according to the China HSR online map by Li (2016). The definition of HSR follows that of the National Railway Administration of China, referring to passenger transport railway with a designed speed of at least 250 km/h and an operation speed of at least 200 km/h. We check each HSR line to construct a dummy variable regarding which cities are connected by HSR lines and when they were connected. The HSR connection variable takes the value of 1 for any city in years in which it is connected by HSR and 0 otherwise. Such a dummy variable can best capture the sudden switch of a city from the state of "not connecting to HSR" to "connecting to HSR" and is broadly taken in related studies (Donaldson, 2018; Faber, 2014; Gao et al., 2018; Shao, Tian, & Yang, 2017). Finally, we collect the data on the list of airports from the website of Civil Aviation Administration of China and then manually check the opening time of each airport by searching its online introduction at Baidu Encyclopedia or 360 Encyclopedia. We match various sources of data according to the city name and year and finally construct panel data for 288 cities, including 257 peripheral prefectural cities, 27 provincial capitals, and four municipalities, from 2005 to 2015. Due to many missing values for tourism information in 2014 and 2015, the constructed panel data are unbalanced. (See also Appendix A2 for details on data sources.).

Fig. 1 graphs the trends of HSR connection and tourism outcomes. It shows that all these variables increase fast over time. The number of cities connected by HSR grows dramatically from 7 in 2008 to 149 in 2014. Meanwhile, the figure shows that tourist arrivals increase faster than tourism revenue. However, the real effect of HSR connection on tourism outcomes needs to be identified by empirical tools. Table 1 further reports the summary statistics with all the observations as well as by city groups that are connected and unconnected by HSR. We find that the panel data are unbalanced due to some missing values, 22% of observations are connected by HSR, and there are significant differences in variables between cities that are connected and cities that are unconnected by HSR (see Panel B). Thus, we cannot simply infer that HSR connection promotes tourism, because other things are not equal.

4. Results

4.1. Baseline results

Table 2 reports the treatment effect of HSR connection on domestic tourism growth estimated from equation (1). The results from the DID method show that HSR connection increases tourist arrivals (see columns (4) and (5)) but does not have a significant effect on tourism revenue after controlling for the GDP per capita, 5A scenic spots, passenger road ridership, having an airport, and other explanatory variables (see columns (1)–(3)). As a result, HSR connection is associated with a significant reduction in tourism revenue per arrival (see columns (6) and (7)). Specifically, HSR connection increases tourist arrivals by 5.9% and decreases tourism revenue per arrival by about 7.9%. The estimator of the one-year lag term of the dependent variable is smaller than 1, indicating the convergence nature of tourism outcomes, which is faster for tourism revenue per arrival.[4] Among other control variables, we only observe that the GDP per capita, 5A scenic spots, and population have a statistically significant effect on tourism revenue and tourist arrivals but that the effect of 5A scenic spots is negative (see also columns (2)–(5)). This is probably due to the reduction effect of the expensive tickets for 5A scenic spots on the tourism demand. Passenger road ridership is negatively related to tourism revenue per arrival while having an airport is positively associated with tourism revenue and its per arrival average. The varying effects of HSR connection on tourism revenue with more controls also indicate that HSR connection is somewhat endogenous to other socioeconomic variables (see columns (1) and (2)). However, after controlling for the GDP per capita, 5A scenic spots, passenger road ridership, and having an airport, more controls do not change the size of the effects of HSR connection (see column (2) and the rest of the columns), indicating a less concern of the endogeneity due to omitted unobservables. The results indicate that after controlling for GDP per capita, additional controls for its determinants, that is, population, population density, public expenditures and the average salary of urban workers, in the right side of equation (1) is not necessary. Thus, in the following analysis, we do not control for these variables that are highly correlated with GDP per capita.

The test results on the common trend assumption are reported in Table 3. We find that there are basically no lead effects of HSR connection on tourism revenue and tourist arrivals at the significance level of 5% except in columns (4) and (5), in which a significantly negative one-year and three-year lead effect of HSR on tourism arrivals and tourism revenue per arrival, respectively, is observed. However, that negative effect of tourist arrivals might also reflect the expectation that tourists are waiting to visit upcoming HSR cities. Additionally, the lagged effects of HSR connection on tourism revenue and tourist

[4] As shown in equation (2), this can be seen from the minus one-year lag term of the dependent variable on both sides of equation (1) and thus a negative effect of the one-year lag term of the dependent variable on the growth of tourism outcomes, which is larger for tourism revenue, indicating larger tourism revenue, and tourist arrivals are associated with a larger growth reduction of tourism revenue and tourist arrivals.

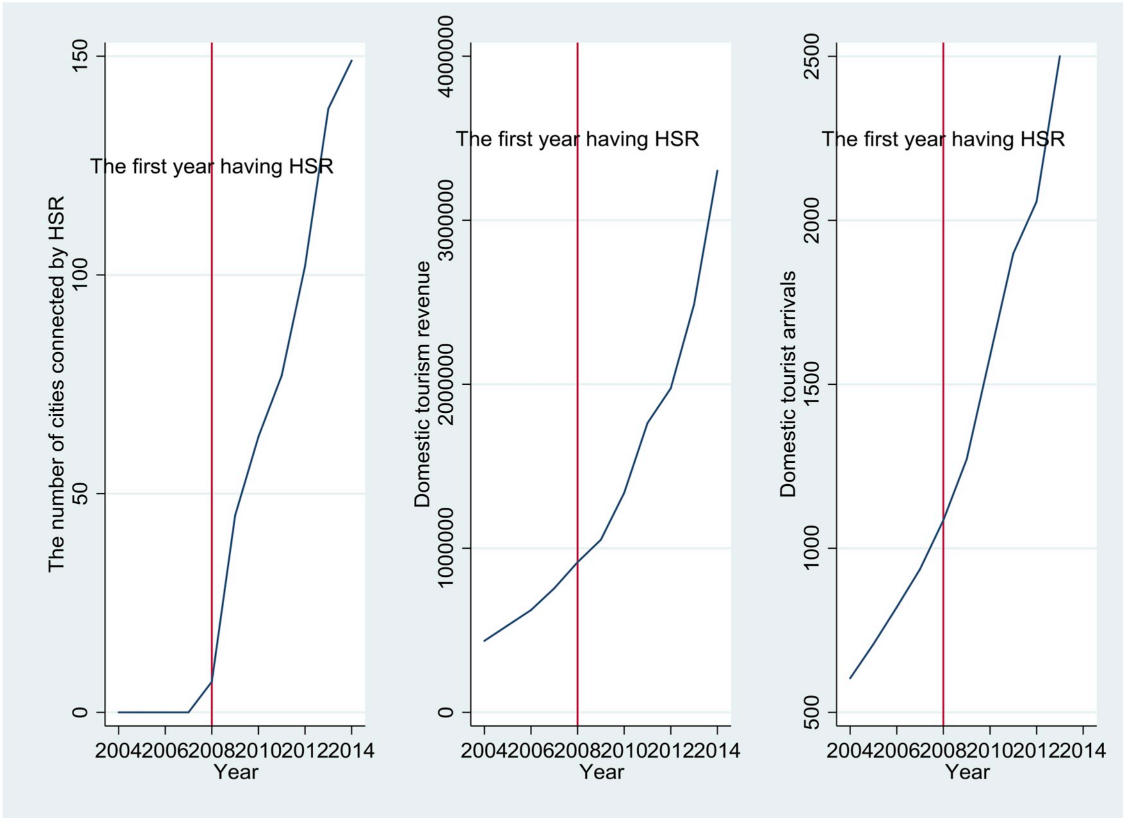

Fig. 1. The trends of HSR connecting cities and tourism outcomes.
Note: Both domestic tourism revenue and tourist arrivals are in tens of thousands.

arrivals are statistically significant in some years after HSR is opened. Thus, the common trend assumption basically stands but with flaws that there is some evidence of an expectation effect of HSR connection on tourist arrivals and a three-year lead effect of HSR connection on tourism revenue per arrival.

4.2. Results from the IV method

To address the underlying endogeneity of HSR route placement, we conduct 2SLS estimation based on equation (4) and report the results in Table 3. The estimate of potential HSR connection and F value from the first-stage estimation reported at the odd-number columns of Table 4 show that the IV, potential HSR connection, is closely correlated with the endogenous variable, actual HSR connection. The 2SLS estimation results are consistent with those DID results in Table 2, an insignificant effect of HSR connection on tourism revenue, and significant but over 3.7 times larger effects of HSR connection on tourist arrivals and tourism revenue per arrival. The huge difference in the effect from 2SLS and DID exists in the fact that our IV is constructed by drawing straight lines between two end cities of HSR lines rather than between provincial capitals in existing HSR lines used by Gao et al. (2018). Our straight-line strategy leads to a smaller first-stage estimate and thus a much larger second-stage estimate, because the second stage estimate is the ratio of the reduced-form estimate to the first-stage estimate (Angrist & Pischke, 2014: chapter 3). Alternative IVs that are more correlated with actual HSR will lead to a smaller estimate closer to DID method, as being shown with peripheral cities in section 5. Again, we find that the effect of HSR connection on tourism income and tourist arrivals only decreases slightly with more controls.[5] Thus, results with IV method also support the use of a short model controlling only for the one-year lag of the dependent variable, GDP per capita, 5A scenic spots, passenger road ridership and having an airport. Moreover, because the effect of HSR connection on per-arrival tourism revenue is a natural result of the effects of HSR connection on tourism revenue and tourist arrivals, to keep simplicity, in the following sections, we only use tourism revenue and tourist arrivals as the dependent variable.

4.3. Heterogeneity

Two types of heterogeneity are first investigated here, regional heterogeneity across China's three regions, the eastern, the central, and the western region, and city heterogeneity among China's three tiers of cities, municipalities, provincial capitals, and peripheral prefectural cities.[6] We use the DDD method by adding the interactions of the dummies regarding the three regions and city tiers with HSR connection to equation (1), as shown in equation (4). The results are reported in Table 5. We find from columns (1)–(4) that, while no regional and city-tier heterogeneities are observed in terms of tourism revenue, we do observe regional and city-tier heterogeneities regarding the effect of HSR connection on tourist arrivals. Specifically, compared with the eastern region, HSR connection promotes the number of tourists in the

[5] The 2SLS results with more controls are not reported but available upon request.

[6] The three regions are the eastern region, the central region, and the western region, which have changed over time. According to the most recent classification under the China West Development Strategy, the eastern region consists of eleven provinces or municipalities, Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; the central region consists of eight provinces, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan; and the western region includes eleven provinces and one municipality, Sichuan, Guizhou, Yunnan, Guangxi, Inner Mongolia, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang and Chongqing.

Table 1
Summary statistics.

Panel A: All data	Obs.	Mean	Std. Dev.	Min.	Max.
Tourism revenue (10,000 RMB yuan)	2979	13	1.461	7.074	17.504
Tourist arrivals (10,000 persons)	2853	6.630	1.147	1.099	11.947
Tourism revenue per tourist arrival (RMB yuan)	2820	6.453	0.702	1.681	9.518
HSR connection	3456	0.220	0.414	0	1
GDP per capita (RMB yuan)	3456	10.100	0.775	7.662	12.456
Population (10,000 persons)	3441	5.848	0.700	2.819	8.124
Public expenditures (RMB yuan per capita)	3441	8.120	0.878	5.842	11.819
Population density (persons/square km)	3435	5.715	0.915	1.609	7.887
Average salary of an urban worker (RMB yuan)	3421	10.234	0.508	8.509	12.678
Passenger road ridership (10,000 persons)	3430	8.537	0.970	4.407	12.566
Having an airport	3456	0.431	0.495	0	1
No. of 5A scenic spots	3456	0.288	0.700	0	7
No. of World Heritage Sites	3456	0.462	0.765	0	7
Potential HSR connection	3456	0.280	0.449	0	1

Panel B: By groups	HSR unconnected cities		HSR connected cities		Mean difference
	Obs.	Mean	Obs.	Mean	
Tourism revenue (10,000 RMB yuan)	1121	12.542	1858	13.54	−0.997***
Tourist arrivals (10,000 persons)	1094	6.098	1759	6.96	−0.862***
Tourism revenue per tourist arrival (RMB yuan)	1074	6.374	1746	6.502	−0.129***
HSR connection	1308	0	2148	0.354	−0.354***
GDP per capita (RMB yuan)	1308	9.921	2148	10.21	−0.289***
Population (10,000 persons)	1293	5.571	2148	6.014	−0.443***
Public expenditures (RMB yuan per capita)	1293	8.118	2148	8.122	−0.004
Population density (persons/square km)	1287	5.188	2148	6.031	−0.843***
Average salary of an urban worker (RMB yuan)	1285	10.202	2136	10.253	−0.051***
Passenger road ridership (10,000 persons)	1284	8.098	2146	8.800	−0.701***
Having an airport	1308	0.492	2148	0.394	0.098***
No. of 5A scenic spots	1308	0.157	2148	0.368	−0.211***
No. of World Heritage Sites	1308	0.518	2148	0.427	0.090***
Potential HSR connection	1308	0.166	2148	0.349	−0.183***

Notes: All variables except for HSR connection, Having an airport, 5A scenic spots, World Heritage Sites, and potential HSR connection are in natural logarithm; the unit of the variable is in parentheses; *** denotes the significance level of 1%.

Table 2
HSR connection and tourism growth: DID method.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ln(Total tourism revenue)			Ln(Number of tourist arrivals)		Ln(Tourism revenue per arrival)	
Dependent variable (t-1)	0.428*** (0.027)	0.403*** (0.024)	0.406*** (0.024)	0.514*** (0.050)	0.507*** (0.050)	0.395*** (0.021)	0.400*** (0.021)
HSR connection (t-1)	−0.067*** (0.024)	−0.013 (0.023)	−0.014 (0.023)	0.059* (0.032)	0.059* (0.032)	−0.079** (0.032)	−0.079** (0.032)
Ln(GDP per capita)		0.283*** (0.054)	0.253*** (0.061)	0.124** (0.054)	0.086* (0.051)	0.137** (0.062)	0.148** (0.064)
Number of 5A scenic spots		−0.077*** (0.014)	−0.072*** (0.014)	−0.053*** (0.012)	−0.050*** (0.012)	−0.004 (0.016)	−0.004 (0.016)
Ln(Passenger road ridership)		−0.003 (0.019)	−0.011 (0.019)	0.024 (0.017)	0.018 (0.018)	−0.046** (0.021)	−0.046** (0.023)
Having an airport		0.081* (0.043)	0.081* (0.044)	−0.034 (0.043)	−0.032 (0.043)	0.106** (0.048)	0.104** (0.048)
Ln(Population)			0.208 (0.154)		0.362** (0.162)		−0.159 (0.168)
Ln(Public expenditures)			0.163** (0.071)		0.135** (0.065)		0.029 (0.061)
Ln(Population density)			−0.059 (0.039)		−0.032* (0.019)		−0.025 (0.040)
Ln(Average salary)			−0.170 (0.133)		−0.049 (0.050)		−0.142 (0.148)
Constant	7.020*** (0.324)	4.696*** (0.530)	4.601*** (1.453)	1.635*** (0.492)	−0.320 (1.278)	2.857*** (0.595)	4.939*** (1.625)
Observations	2918	2897	2878	2781	2762	2735	2716
R-squared	0.780	0.781	0.787	0.843	0.844	0.273	0.280
Number of cities	288	288	288	288	288	288	288

Notes: Robust standard errors clustered at the city level are in parentheses; *, **, and *** denote the significance level of 10%, 5%, and 1%, respectively; all the results are estimated using the DID method embedded in the fixed-effects panel data model; both year and city fixed effects are controlled in all the columns.

central and western regions, and HSR connection decreases tourist arrivals in provincial capitals by 12.1%. Moreover, we observe that central cities have an 11.5% lower growth rate in tourist arrivals than peripheral cities (see column (6)), which is due mainly to a lower level of tourist arrival growth in provincial capitals (see column (4)). The results are consistent with a recent case study from Spain that shows that HSR does not change central cities as tourism destinations but increases the connected peripheral cities to be visited (Pagliara et al., 2015). Thus, the heterogeneity analysis is consistent with the previous results indicating that HSR connection only increases tourist arrivals but further reports that peripheral cities attract more arrivals than central cities.

Further heterogeneity analysis concerns tourism resources. Cities with unique tourism resources are likely to attract more tourists than those without tourism resources, have better tourism amenities, and can provide more professional tourism services. As a result, the effect of

Table 3
Test of the common trend assumption.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Tourism revenue		Tourist arrivals		Tourism revenue per arrival	
HSR (−3)	−0.117* (0.064)		0.025 (0.016)		−0.142** (0.065)	
HSR (−2)	−0.111* (0.058)	−0.050 (0.035)	−0.004 (0.017)	−0.032 (0.026)	−0.112* (0.059)	−0.020 (0.044)
HSR (−1)	−0.005 (0.040)	0.043 (0.053)	−0.037 (0.026)	−0.047** (0.021)	0.032 (0.040)	0.092* (0.054)
HSR (0)	0.010 (0.040)	−0.001 (0.040)	−0.015 (0.021)	−0.012 (0.020)	0.048 (0.047)	0.033 (0.047)
HSR (1)	0.119 (0.456)	0.122 (0.442)	0.203*** (0.068)	0.206*** (0.066)	0.096 (0.521)	0.085 (0.501)
HSR(2)	−0.209 (0.457)	−0.143 (0.446)	−0.201*** (0.074)	−0.215*** (0.070)	−0.203 (0.519)	−0.108 (0.503)
HSR(t-3)	−0.068** (0.027)	−0.046** (0.023)	−0.028 (0.041)	−0.026 (0.037)	0.003 (0.048)	0.020 (0.044)
Constant	4.901*** (0.622)	4.712*** (0.565)	1.845*** (0.532)	1.719*** (0.496)	3.022*** (0.673)	2.799*** (0.608)
Observations	2672	2817	2599	2746	2567	2712
R-squared	0.743	0.768	0.845	0.848	0.258	0.276
Number of cities	288	288	288	288	288	288

Notes: Robust standard errors clustered at the city level are in parentheses; *, **, and *** denote the significance level of 10%, 5%, and 1%, respectively; all the results are estimated with the DID method embedded in the fixed-effects panel data model; both year and city fixed effects are controlled in all the columns; the other controls are the same as for column (2) of Table 2.

HSR connection on tourism growth might be heterogeneous to tourism resources. Here we use a dummy showing whether a city has at least one world cultural or natural heritage site to indicate whether the city has unique tourism resources. By also adding an interaction of HSR connection with the world heritage dummy on the right side of equation (1), we estimate the heterogeneity of HSR connection regarding tourism resources. The results are shown in columns (7) and (8) of Table 5. We find that HSR connection leads to a lower growth level of tourist arrivals in cities with World Heritage Sites but a higher growth level of tourism revenues in those cities compared with cities without any World Heritage Sites. Such heterogeneity concerning World Heritage Sites stems from the fact that the accessibility to World Heritage Sites is improved less than that to other tourism spots because World Heritage Sites are usually targeted destinations for domestic and foreign tourists due to their widespread reputation. Endowed with unique tourism resources, these cities suffer less from peer competition from HSR connected central cities and thus gain more from connecting to HSR.

5. Robustness checks

Here we further provide several robustness checks of the main results reported in Table 2. The first robustness check involves using the data only from peripheral cities by removing the observations from municipalities and provincial capitals. The argument is that HSR aims to connect central cities, which are both economically and politically important. Using the data of peripheral cities may alleviate the extent of endogenous route placement. The results are reported in columns (1)–(2) of Table 6. We see again that HSR connection increases tourist arrivals by 8.3%, which is larger than the estimate obtained from all the data (see column (4) of Table 2), but it does not have a significant effect on tourism revenue. The result is consistent with the intuition that HSR attracts more visitors to its connected peripheral cities by enhancing their accessibility.

Another source of endogenous HSR route placement is the greater likelihood of cities with unique tourism resources being targeted as HSR connected cities. Local officials in these cities also have a strong incentive to lobby hard to have their city connected by HSR and thus to exert their advantages fully in the developing tourism economy. Omitting such factors will result in biased estimation of the effect of HSR connection on tourism outcomes. To address this endogeneity, we remove observations from tourism cities from our data. We define tourism cities according to the criterion proposed by the NATC in 1998, that is, the *Inspection standards of China's excellent tourist cities (trial)*, based on which 54 cities are accepted as the first batch of excellent tourist cities, including 3 municipalities, 14 sub-provincial-level central cities, 25 prefectural-level cities, and 12 county-level cities. The results excluding observations from these tourist cities are reported in columns (3) and (4) of Table 6. Again, we find consistent results that HSR connection promotes tourist arrivals but does not have a statistically significant effect on tourism revenue. After controlling for the endogenous selection of HSR connection to tourist cities, HSR connection produces a larger growth effect on tourist arrivals, that is, 9.7%. Similar results are found if we remove the observations from cities with World Heritage Sites, which might also be the source of endogenous HSR route placement (see columns (5) and (6) in Table 6). Larger estimates with the subsets also indicate that accessibility improvement brought by HSR benefits more to the peripheral areas only by attracting more arrivals.

We also test the robustness of the previous results by changing the time horizon of our data. One may argue that a shorter pre-treatment

Table 4
HSR connection and tourism growth: Results from the IV method.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	HSR (t-1)	Tourism revenue	HSR(t-1)	Tourist arrivals	HSR(t-1)	Tourism revenue per arrival
HSR (t-1)		−0.092 (0.079)		0.223** (0.098)		−0.299*** (0.106)
Potential HSR (t-1)	0.282*** (0.042)		0.293*** (0.043)		0.275*** (0.043)	
Observations		2897		2781		2735
Number of cities		288		288		288
First-stage F value	21.91***		20.47***		21.59***	

Notes: Robust standard errors clustered at the city level are in parentheses; ** and *** denotes the significance level of 5% and 1%, respectively; results in odd-number columns are the first-stage estimation while those in even-number columns are second-stage estimation; the first-stage F value is the F value in the first-stage estimation; all the results are estimated with the DID method embedded in the fixed-effect panel data model; both year and city fixed effects are controlled in all the columns; other controls include the one-year lag of the dependent variable, the GDP per capita, the number of 5A scenic spots, passenger road ridership, and having an airport; the instrumental variable is potential HSR connection constructed with the straight-line strategy.

Table 5
The heterogeneity effect of HSR connection on tourism growth.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals
HSR (t-1)	−0.032 (0.042)	−0.051** (0.025)	−0.003 (0.025)	0.085** (0.039)	−0.003 (0.025)	0.085** (0.039)	−0.041* (0.025)	0.106** (0.045)
Western region × HSR (t-1)	0.050 (0.061)	0.372** (0.153)						
Central region × HSR (t-1)	0.025 (0.046)	0.104*** (0.030)						
Municipality × HSR (t-1)			−0.045 (0.067)	−0.070 (0.098)				
Provincial capital × HSR (t-1)			−0.053 (0.052)	−0.121** (0.057)				
Central city × HSR (t-1)					−0.052 (0.049)	−0.115** (0.053)		
World heritage city × HSR (t-1)							0.087** (0.042)	−0.145*** (0.051)
Observations	2897	2781	2897	2781	2897	2781	2897	2781
R-squared	0.781	0.845	0.781	0.843	0.781	0.843	0.781	0.844
Number of cities	288	288	288	288	288	288	288	288

Notes: Robust standard errors clustered at the city level are in parentheses; *, **, and *** denote the significance level of 10%, 5%, and 1%, respectively; all the results are estimated using the DID method embedded in the fixed-effects panel data model; both year and city fixed effects are controlled in all the columns. Other controls include the one-year lag of the dependent variable, the GDP per capita, the number of 5A scenic spots, passenger road ridership, and having an airport.

period should be used to make the estimation more accurate, because a longer pre-treatment period may include other noisy shocks in the data. Columns (7)–(10) of Table 6 report the results with data after 2005 and after 2006. Despite the shorter time horizons, HSR connection is again found to attract more tourist arrivals but not to generate more tourism revenue. Moreover, a shorter time horizon before the year when HSR is connected leads to a larger effect of HSR connection on tourist arrivals.

In Table 7, we further provide falsification tests by constructing a fake HSR connection in the data before 2008, when the first HSR line was opened. Specifically, we move the opening time of all the HSR lines forward by 2–4 years and regress it with outcome variables. Since the new HSR connection variable is forged, it is expected not to have a significant effect on tourist outcomes. As reported in Table 7, we find that this fake HSR connection does not affect tourism revenue and tourist arrivals. Thus, the falsification test also supports the previously reported effects of HSR connection on tourism growth.

Finally, we provide some robustness checks with the IV method by subsamples. The results in columns (1)–(4) of Table 8 show that HSR connection only increases tourist arrivals in peripheral cities. Since until now we have only used one instrumental variable, preventing us from conducting the over-identification test, we construct more instrumental variables using the straight-line strategy similar to those previously mentioned. Specifically, following Gao et al. (2018), we construct another potential HSR connection variable by drawing straight lines between two ends of each HSR line segmentation rather than by drawing previously-used straight lines between two end provincial capitals, and assign the HSR opening time of those cities on these lines as the earliest HSR opening year of cities in that segmentation. We then use the potential HSR connection variables constructed here and previously to interact with the distance from each city to its provincial capital. The argument is that cities close to a provincial capital are more likely to be connected by HSR while the location of a city is also somewhat exogenous. Because the distance is time-invariant, we use its interactions with two potential HSR connection variables as the IVs of actual HSR connection. In other words, we have four instrumental variables, two potential HSR connection variables and their interactions with the distance to the provincial capital. The rest of the columns in Table 8 report the IV results with four IVs, from which we see that HSR connection boosts tourist arrivals in peripheral cities by 17% and its effect on tourism revenue is also positive at 5% significance level. The first-stage F values indicate that the IVs are not weak, but the over-identification tests show that the IVs are not valid enough when estimating tourist arrivals.

6. Discussion

We provide robust empirical results indicating that China's HSR indeed boosts domestic tourist arrivals but fails to promote domestic tourism revenue. Consequently, the tourism revenue generated by each arrival is reduced with the HSR connection. There might be some explanations for these results. The most important reason for HSR's failure to boost tourist arrivals in Europe has been found to be a substitution role of HSR for airlines (Albalate et al., 2017; Albalate & Fageda, 2016). However, this might be not the case in China, where airlines play a limited role in short-distance transportation but an increasing role in long-distance transportation by connecting large central cities. Thus, HSR in China facilitates people's access to peripheral cities; rather than acting as a substitute for airlines, it complements them. This is the reason for HSR boosting tourist arrivals.

An unintended consequence of HSR connection might be its substitution for the hospitality in peripheral areas. Due to the remarkable improvement in accessibility, tourists travel easily to peripheral cities by HSR but need not stay there overnight, since peripheral cities have limited tourism resources and central cities can provide much better hospitality services. Previous studies have confirmed such a consequence. For example, Harman (2006) showed that people travel daily

Table 6
Robustness checks with subsamples.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Peripheral cities		Non-tourist cities		Cities without World Heritage Sites		After 2005		After 2006	
	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals
HSR (t-1)	−0.011	0.083**	−0.002	0.097**	−0.022	0.101**	−0.013	0.062*	−0.006	0.066**
	(0.025)	(0.039)	(0.026)	(0.042)	(0.024)	(0.047)	(0.024)	(0.032)	(0.025)	(0.033)
Observations	2601	2493	2419	2323	1718	1636	2644	2520	2391	2260
R-squared	0.781	0.838	0.783	0.836	0.865	0.811	0.746	0.830	0.704	0.799
Number of cities	257	257	241	241	167	167	288	288	288	288

Notes: Robust standard errors clustered at the city level are in parentheses; ** denotes the significance level of 5%; all the results are estimated using the DID method embedded in the fixed-effects panel data model; both year and city fixed effects are controlled in all the columns. Other controls include the one-year lag of the dependent variable, the GDP per capita, the number of 5A scenic spots, passenger road ridership, and having an airport.

Table 7
Falsification test.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Tourism revenue			Tourist arrivals		
HSR (t+4)	−0.023			−0.012		
	(0.031)			(0.022)		
HSR (t+3)		0.003			0.036	
		(0.038)			(0.031)	
HSR (t+2)			−0.001			−0.025
			(0.037)			(0.027)
Observations	1039	1039	1039	1055	1055	1055
R-squared	0.646	0.646	0.646	0.652	0.653	0.652
Number of cities	274	274	274	274	274	274

Notes: Robust standard errors clustered at the city level are in parentheses; all the results are estimated using the DID method embedded in the fixed-effects panel data model; both year and city fixed effects are controlled in all columns. Other controls include the one-year lag of the dependent variable, the GDP per capita, the number of 5A scenic spots, passenger road ridership and having an airport.

rather than weekly to surrounding cities within 1-h travel time after they are connected to Paris by HSR, and thus overnight stays reduce as HSR connection. Similarly, Givoni (2006) argued in a review that HSR connection, on the one hand, reduces travel time and increases the time for site seeing; on the other hand, it reduces expenditures on accommodations and thus stays at connected cities. Similar effects happen in China. Zhang, Liu, Yang, Lyu, and Hou (2013) observed that people reduce their stays in HSR-connected cities, although HSR expands tourism destinations, shortens travel time, and increases tourist arrivals. Thus, by improving accessibility, HSR connection causes a reduction in overnight stays while increasing tourist arrivals.

Moreover, HSR intensifies competition in two ways when it expands the market size, confirming the observations from Wang et al. (2018) and Wang et al. (2012), and complementing to those from Behrens and Pels (2012). First, HRS enables tourists in peripheral areas to visit central cities. As we previously argued, almost all kinds of advanced resources, including those related to tourism industries, have been concentrated in China's central cities. They are more abundant in historical scenic spots, which are better preserved and professionally developed than those in peripheral cities, and thus attract more tourists from peripheral areas after being connected by HSR. Thus, local tourism industries compete with their peers in central cities for local tourists as a result of HSR connection. Second, the increase in the market size with more visitors may also attract more entries and thus intensify the competition in the local tourism market. Besides, from a dynamic perspective, HSR can produce long-lasting effects on tourism industries in central cities but only one-shot effects in peripheral areas. Poorer tourism management and amenities and less developed tourism markets in peripheral areas cause tourists to have no inclination to revisit them, despite the convenience brought by HSR connection.

Thus, given China's regional development pattern as well as the spatial distribution of tourism resources, both of which favour central cities, our findings on the effects of HSR connection on tourism growth are not strange but complement the extant studies (Albalate et al., 2015; Chen & Haynes, 2012, 2015a; Dobruszkes, 2011; Dobruszkes et al., 2014; Wang et al., 2012) by providing new evidence on that transportation–tourism nexus. Furthermore, from the perspective of regional tourism development, this paper mirrors the core–periphery tourism development prediction inferred from new economic geography (Fujita et al., 2001; Helpman & Krugman, 1985; Krugman,

Table 8
Robustness of the IV results by regions.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Peripheral cities		Central cities		Peripheral cities	
	Tourism revenue	Tourist arrivals	Tourism revenue	Tourist arrivals	Tourist revenue	Tourist arrivals
HSR (t-1)	−0.095 (0.091)	0.274** (0.120)	0.069 (0.124)	−0.141 (0.101)	0.087** (0.039)	0.170*** (0.059)
Observations	2601	2493	288	1718	2561	2493
Number of cities	257	257	31	167	257	257
First-stage F value	16.16***	13.27***	35.66***	40.06***	692.56***	624.28***
Over-identification test					2.548	7.835**

Notes: Robust standard errors clustered at the city level are in parentheses; ** and *** denote the significance levels of 5%, and 1%, respectively; all the results are estimated using the DID method embedded in the fixed-effects panel data model; both year and city fixed effects are controlled in all the columns. Other controls include the one-year lag of the dependent variable, the GDP per capita, the number of 5A scenic spots, passenger road ridership, and having an airport. The IV in columns (1)–(4) is the potential HSR connection introduced in section 3, while in columns (5) and (6) they are two potential HSR connections and their interactions with the distance to the provincial capital; the over-identification test reports the Sargan–Hansen statistics with the null hypothesis that the IVs are valid.

1991; Masson & Petiot, 2009) that transportation improvement strengthens economic polarization, and thus it also complements the literature on the HSR and growth relationship (Banister & Berechman, 2001; Gao et al., 2018; Qin, 2017; Vickerman, 2015) by adding a new channel through which HSR impedes peripheral economic growth.

7. Conclusion

In this paper, we use high-speed rail rollout as a natural experiment to examine the effects of transportation improvement on domestic tourism growth. The empirical results obtained through the DID method and IV method show that HSR connection does not promote tourism revenue growth but indeed attracts tourist arrivals. As a result, the average tourism revenue generated per arrival following connection to HSR decreases. We also find that cities in central and western regions attract more tourist arrivals by connecting to HSR, while again such a tourist boost does not bring about an increase in tourism revenue. Central cities, however, although they suffer a little in terms of tourist arrivals, do not lose revenues. Some robustness checks provide consistent evidence on the impacts of HSR connection on tourism growth.

It should be noted that the increased frequency of visiting friends and relatives (VFR) due to the ease of making those visits can also account for the fall of tourism revenue per arrival. That VFR business usually does not increase tourism revenues very much while it indeed increases tourist arrivals. However, to extend our paper to discover such aspect of HSR connection, it remains needing future research incorporating into the data on HSR users' trip motives.

Our findings have strong policy implications. Local officials, as well as residents, often expect HSR connection to boost local tourism industries, which is especially the case for those cities with unique tourism resources. Our findings imply that it is just a good expectation, since HSR can only attract tourist arrivals and cannot increase tourism revenue. Given China's contrasting urban–rural divide, to gain long-lasting tourism benefits from connecting to HSR, local tourism firms need to improve their capacity to provide professional tourism services and develop their unique tourism products, and local governments need to provide comfortable amenities as well as improving their tourism governance ability.

Contribution

Yanyan Gao organized the research, conducted formal estimation and wrote the paper. Wei Su provided materials and insights on China tourism industries and also wrote the paper. Kaini Wang collected the data and provided some primary estimation results.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tourman.2018.12.003.

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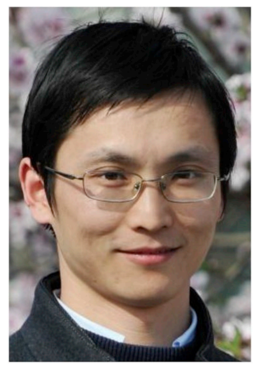

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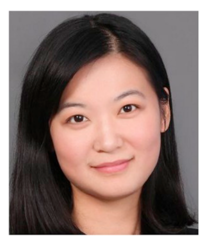

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