Economic Research-Ekonomska Istraživanja

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rero20

Highways, railways and entrepreneurship in peripheral cities: evidence from China

Jun Chen & Xiaowen Zeng

To cite this article: Jun Chen & Xiaowen Zeng (2023) Highways, railways and entrepreneurship in peripheral cities: evidence from China, Economic Research-Ekonomska Istraživanja, 36:2, 2106505, DOI: 10.1080/1331677X.2022.2106505

To link to this article: https://doi.org/10.1080/1331677X.2022.2106505

Published online: 05 Aug 2022.

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA
2023, VOL. 36, NO. 2, 2106505
https://doi.org/10.1080/1331677X.2022.2106505

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Highways, railways and entrepreneurship in peripheral cities: evidence from China

Jun Chen[a,b] and Xiaowen Zeng[a]

[a]School of Economics, Guangdong University of Finance & Economics, Guangzhou, China; [b]National Economics Research Center, Guangdong University of Finance & Economics, Guangzhou, China

ABSTRACT
Peripheral cities are more susceptible to transportation infrastructure than core cities in terms of entrepreneurial activities. We use market access approach to estimate the impacts of highways and high-speed railways on entrepreneurship in the small and medium-sized cities in China under knowledge spillover entrepreneurship framework. The results show that the increased market potential caused by highways and high-speed railways significantly improves the entrepreneurial performance of peripheral cities. The entrepreneurship effects of highways are stronger than high-speed railways, especially for these cities that are relatively closer to core cities. On the contrary, the entrepreneurship effects of high-speed railways are stronger in these cities that are far from core cities. This study suggests that transportation infrastructure plays an important role in entrepreneurship, and there is a complementary effect between highways and high-speed railways.

ARTICLE HISTORY
Received 31 August 2021
Accepted 21 July 2022

KEYWORDS
Transportation infrastructure; market access; small and medium-sized cities; knowledge spillover entrepreneurship; entrepreneurial performance

JEL CLASSIFICATIONS
L26; M13; O32; R40

1. Introduction

Entrepreneurial activities have obvious large city bias (Fritsch & Storey, 2014; Sternberg, 2009; Tavassoli et al., 2021). Take China as an example, among 292 prefecture-level cities[1], about 90% investment events of venture capital (VC) and private equity (PE) occur in large cities (urban permanent population over 1 million), only less than 10% of investment events of VC and PE occur in the remaining 208 small and medium-sized cities[2]. We naturally ask why entrepreneurial activities are concentrated in large cities, but small and medium-sized cities have few entrepreneurial activities? This implies that spatial context might be an important role in determining entrepreneurial activities. Actually, cities not only provide the necessary space for entrepreneurial activities, but also provide entrepreneurs for talent supply, financial services, industrial clusters, knowledge capital and entrepreneurial opportunities, etc. (Audretsch et al., 2015; Audretsch & Keilbach, 2007; Ghani et al., 2013; Ghio et al.,

CONTACT Jun Chen tcj@gdufe.edu.cn

2015). In these respects, small and medium-sized cities are clearly unable to compare with large cities.

The construction of transportation infrastructure is conducive to knowledge flow between people and it enhances entrepreneurs to identify and use entrepreneurial opportunities (Audretsch et al., 2015). As transportation linkages with core cities established, small and medium-sized cities are embedded in a larger transportation network, which will increase their market potential. On the one hand, the increase of market potential can have an economic incentive effect on entrepreneurial investment. On the other hand, as the increase of market potential, entrepreneurs can get more users' information, and thus reduce the uncertainty of entrepreneurial investment (Chen & Liu, 2021; Fontana & Guerzoni, 2008; Verheul et al., 2002). Therefore, transportation infrastructure theoretically is conductive to the entrepreneurial activities of small and medium-sized cities.

Incredibly, there is very little literature linking transportation infrastructure to entrepreneurial activities. One partial exception is Audretsch et al. (2015), which studies the overall impacts of infrastructure (highways, railways, knowledge and broadband) on startup activity and the heterogeneous impacts on startup activity in different industries using German county-level data. Another similar work is Bennett (2019), which further studies the impacts of public and private infrastructure investment on entry and exit of establishment using US state-level data. The only previous works show that further corroboration is still required. The role of infrastructure level (Audretsch et al., 2015) and infrastructure investment (Bennett, 2019) played in entrepreneurship have been discussed, but the simultaneous determination is the common identification challenge that have not been solved in their works.

The objectives of this paper are three. First, we estimate the impact of exogenous market demand changes caused by transportation infrastructure on entrepreneurship, in which a market access approach widely used by recent works (Chen, 2021; Donaldson, 2018; Donaldson & Hornbeck, 2016; Dong et al., 2020; Gibbons & Wu, 2020; Zheng & Kahn, 2013) is employed to address the identification issues. Second, we turn our focus to the peripheral cities, which are dominant in number (e.g., in China), but have not been paid close attentions by researchers. In particular, the peripheral cities seem to be more susceptible to transportation constraints than core cities in terms of entrepreneurial activities because of the poor conditions in transportation infrastructure. Third, we further study the heterogeneity by entrepreneurial types and relative geographic locations of cities. To be specific, whether there is a complementary effect between highways and high-speed railways on entrepreneurship will be discussed in the paper.

In order to achieve these goals, we construct an econometric model under the knowledge spillover entrepreneurship framework, in which endogenous structural variables (knowledge capital, market barriers and commercialization capabilities) and exogenous increased market potential caused by highways and high-speed railways are introduced. Using Chinese city-level panel data, we estimate the impacts of increased market demand caused by highways and high-speed railways on entrepreneurship performance of small and medium-sized cities. Moreover, we discuss the heterogeneity by dividing the entrepreneurial performance into different parts (new firm startup, foreign investment and venture investment) and grouping cities by distance from core cities.

This study confirms that the increased market potential caused by highways and high-speed railways plays an important role in entrepreneurial performance in peripheral cities. For different types of entrepreneurial performance, the effects of transportation infrastructure are heterogenous. The complementary effect of highways and high-speed railways is also confirmed, that is, the entrepreneurship effects of highways are stronger in these cities that are relatively closer to core cities, but the entrepreneurship effects of high-speed railways are stronger in these cities that are far from core cities. This evidence indicates that the construction of fast and convenient transportation infrastructure is an important incentive for entrepreneurship in peripheral cities, but the complementary role of highways and high-speed railways needs to be paid attentions to by traffic planners.

Remainder of this paper is organized as follows. Section 2 introduces the background of Chinese highways and high-speed railways construction. Section 3 introduces the determination of entrepreneurship under knowledge spillover entrepreneurship framework and puts forward the theoretical hypotheses. Section 4 introduces the econometric model, variables and data sources. Section 5 reports the empirical results. The conclusions and discussions will be in section 6.

2. Background

The peripheral cities in this paper are the small and medium-sized cities. According to the *Notice on Adjusting the Standards for City Size Division* issued by the State Council of China in 2014, cities are divided into three types by urban permanent population: (1) a city with a permanent population of less than 500,000 in the urban area is a small city; (2) a city with a permanent population of more than 500,000 and less than 1 million in the urban area is a medium city; (3) a city with a permanent population of more than 1 million in the urban area is a large city. Therefore, small and medium-sized cities refer to cities with a permanent population of less than 1 million in urban areas.

The core cities refer to provincial capital, sub-provincial and provincial municipalities. The cities in this paper refer to prefecture-level cities. According to official statistics, there are 292 prefecture-level cities in China in 2014, of which 208 are small and medium-sized cities, 36 are core cities, and the remaining 48 are non-core large cities.

There is a 'core-periphery' structure between the core cities and small and medium-sized cities. The number of permanent populations in small and medium-sized cities is about twice that of core cities[3], but the GDP of the two groups of cities is almost the same. According to the China City Statistical Yearbook, the total GDP of small and medium-sized cities was about 25390.523 billion Yuan, and the total GDP of core cities was about 25895.513 billion Yuan in 2014. The total GDP of small and medium-sized cities accounted for 37.4% of all prefecture-level cities, of which 152 small and medium-sized cities were located in the central and western China. The total GDP of these 152 cities accounted for 63.3% of small and medium-sized cities and 23.7% of all prefecture-level cities. The total GDP of core cities accounted for 38.2% of all prefecture-level cities, of which the total GDP of 15 sub-provincial and 4 provincial municipalities accounted for 78.0% of core cities and 29.8% of prefecture-level cities.

All core cities in China have opened highways by 2003. A highways network between core cities had been completed since then. The newly built highways mainly occurred in small and medium-sized cities. In our sample, there were 118 small and medium-sized cities that opened highways before 2003, and 72 small and medium-sized cities that opened highways between 2004 and 2016.

The Qinhuangdao-Shenyang Passenger Dedicated Line was completed in 2003, but this line was only used for experiment at that time. The large-scale construction of China's high-speed railway began in 2008, and has since gradually extended from core cities to small and medium-sized cities. 33 core cities and 114 small and medium-sized cities have opened high-speed rail stations by 2016[4].

The improvement of the highways and high-speed railways network has made the economic welfare (such as employment opportunities, industrial transfer, high-quality products and services, etc.) of core cities gradually spread to small and medium-sized cities. Although core cities may have backwash effects (such as the loss of talents and capital) on small and medium-sized cities, the backwash effects mainly occur around the super mega cities (such as Beijing, Shanghai, and Guangzhou) (Chen & Partridge, 2013). Because the strong spread effects from core cities, small and medium-sized cities have a strong incentive for the construction of transportation infrastructure. Therefore, core cities can be regarded as the core market of peripheral cities, and transportation infrastructure is the tie between peripheral cities and core cities.

3. Theoretical framework and hypotheses

3.1. Theoretical framework: the spatial factors of entrepreneurship

An important feature of entrepreneurial activity is its dependence on the diffusion and use of knowledge (Acs et al., 2013). Knowledge spillover entrepreneurship theory (KSET) suggests that regions rich in knowledge capital reflect more extensive entrepreneurial opportunities, and then more entrepreneurship will be generated in these context (Audretsch & Keilbach, 2007). In addition to knowledge capital, the commercialization capabilities and market barriers of incumbent companies are also crucial to the identification and utilization of entrepreneurial opportunities (Acs et al., 2009). This is because entrepreneurship requires not only good entrepreneurial opportunities, but also the accurate identification and commercialization of entrepreneurial opportunities by entrepreneurs. For instance, government regulations and commercialization of entrepreneurial opportunities by incumbent companies are not conducive to startup activities. Under the framework of knowledge spillover entrepreneurship, the determination of entrepreneurship can be simplified as equation (1).

$$ENT = f(KC, BA, INC) \tag{1}$$

where KC represents knowledge capital, BA represents market barriers, and INC represents the commercialization capabilities of incumbent companies, $f(\cdot)$ represents the function of determinants of entrepreneurship.

Transportation infrastructure construction requires large-scale capital investment and private capital is difficult to enter, therefore transportation infrastructure is usually provided by governments as public service. Audretsch et al. (2015) have shown that railways and broadband infrastructure play significant roles in startup activities, especially in technology-oriented services, consumer-related services and retail trade. The explanation is that the improvement of infrastructure can promote interpersonal knowledge flow, and knowledge flow is conductive to identifying and utilizing entrepreneurial opportunities by entrepreneurs. The knowledge spillover entrepreneurship model that introduces transportation infrastructure can be re-written as equation (2).

$$ENT = f(INF, KC, BA, INC, X) \tag{2}$$

where INF represents transportation infrastructure, and X represents all other factors that may affect entrepreneurial activities.

According to previous works, these potential factors (X) include at least: (1) economic growth, the increase of economic scale means the increase of market demand, which is conducive to generating more entrepreneurial opportunities (Audretsch et al., 2015; Audretsch & Keilbach, 2008; Bennett, 2019; Comporek et al., 2021); (2) agglomeration, which facilitates the sharing of intermediate products, matching of labor force, and knowledge learning (Duranton & Puga, 2004), and many studies have shown that agglomeration has positive effects on entrepreneurial activities (Brunello & Langella, 2016; Glaeser, Kerr, et al., 2010; Glaeser, Rosenthal, et al., 2010); (3) market competition, intense market competition will reduce the operating profits of new firm startup, which will reduce the economic incentive on entrepreneurial activities and have negative impacts on entrepreneurship (Casson, 2005; Plummer & Acs, 2014); (4) financial development, entrepreneurship needs financing, and the development of financial market is conducive to entrepreneurs to conduct entrepreneurship financing, as well as alleviate the financing constraints of new firm startup, so financial development has positive effects on entrepreneurial activities (Bianchi, 2012; Dutta & Sobel, 2018; Rogers, 2012); (5) in addition, a large amount of empirical evidence shows that regional policies, institutions, culture and geography will also have profound impacts on entrepreneurial activities (Alesina & Giuliano, 2015; Audretsch et al., 2021; Audretsch & Belitski, 2017; Fritsch & Storey, 2014; Verheul et al., 2002).

3.2. Theoretical hypotheses

The questions that need to be answered theoretically in this paper are as follows: first, whether highways and high-speed railways can promote the entrepreneurial performance of peripheral cities; second, whether there are heterogeneous impacts on different types of entrepreneurial activities; third, whether there is a complementary effect between highways and high-speed railways in terms of entrepreneurship.

From the perspective of KSET, knowledge flow is the mechanism of transportation infrastructure spurs entrepreneurial activities. It is clear that, highways and high-speed railways which is faster than ordinary roads could save the time costs of face-to-face communications. Moreover, the construction of highways and high-speed railways could strengthen the connection between peripheral cities and core cities, and thereby increase the market potential of peripheral cities. From the demand-pull perspective, the increase of market demand can increase the expected return on entrepreneurial investment, which will have an economic incentive for entrepreneurs (Schmookler, 1966, 1962). At the same time, the increase of market demand is also conductive to entrepreneurs getting more information about users' needs and reducing the uncertainty of entrepreneurial investment (Chen & Liu, 2021; Fontana & Guerzoni, 2008; Myers & Marquis, 1969). Therefore, this leads to.

Hypothesis 1: The increased market potential caused by highways and high-speed railways will promote the entrepreneurship of peripheral cities.

Entrepreneurship activities are not only represented by new firm startup, but also include the entry of foreign investment and venture investment, because all of them are the results of identification and utilization of entrepreneurial opportunities by entrepreneurs. The difference is that the entry of foreign investment and the entry of venture investment are mainly the identification and utilization of entrepreneurial opportunities within the city by entrepreneurs outside the city, but the new firm startup is mainly the identification and utilization of local entrepreneurial opportunities by entrepreneurs within the city. Compared with external entrepreneurs, the ability of internal entrepreneurs in small and medium-sized cities to identify and use entrepreneurial opportunities is weaker than that in large cities or foreign countries. Therefore, the construction of transportation infrastructure has heterogeneous impacts on new firm startup, entry of foreign investment and entry of venture investment. This leads to.

Hypothesis 2: The increased market potential caused by highways and high-speed railways plays a greater role in promoting the entry of foreign investment and the entry of venture investment than new firm startup in peripheral cities.

High-speed railways have the advantages of faster speed and lower marginal transportation cost than highways, so they have absolute advantages in long-distance transportation. But if the transportation distance is short, the transportation by high-speed railways still needs to rely on road transportation between the station and the starting point of the goods because of the high-speed rail station is immovable. At this time, the advantage of high-speed railways is difficult to play. It is clear that highways have advantages for short-distance transportation, while high-speed railways have advantages for long-distance transportation. This means that, for peripheral cities that are close to core cities, the role of high-speed railways will be replaced by highways to a greater extent. By contrast, for peripheral cities that are far from core cities, the highways lack advantages, and the role of high-speed railways can be exerted to a greater extent. This leads to.

Hypothesis 3: Highways have a greater effect on promoting the entrepreneurship of peripheral cities that are close to core cities, while high-speed railways have a greater effect on promoting the entrepreneurship of peripheral cities that are far from core cities.

Figure 1 can briefly illustrate the relationship among the above three theoretical hypotheses.

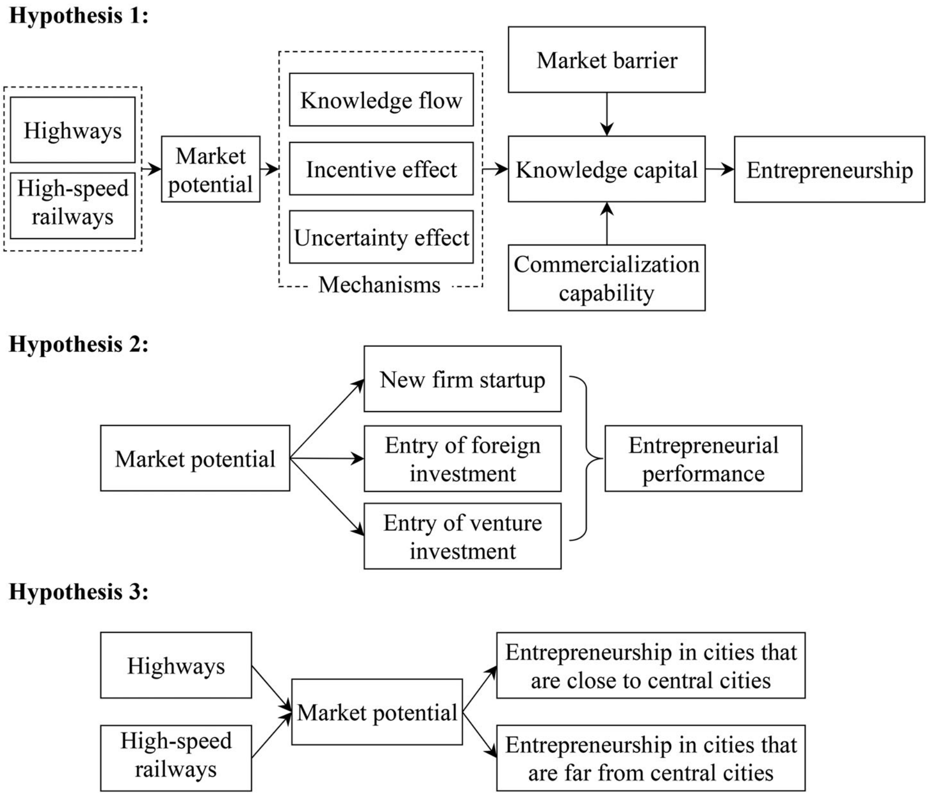

Figure 1. Theoretical hypotheses.
Source: Drawn by the authors.

4. Research design

Based on equation (2), the following econometric model is constructed to examine the impacts of highways and high-speed railways on entrepreneurial performance in small and medium-sized cities.

$$ENT_{it} = \beta_0 + \beta_1 \Delta \ln MP_{it} + \beta_2 KC_{it} + \beta_3 BA_{it-1} + \beta_4 INC_{it-1} + \gamma Z_{it-1} + \mu_t + \lambda_i + D_{r(i)t} + \epsilon_{it} \quad (3)$$

where the subscripts i and t represent small and medium-sized cities and years respectively, and $r(i)$ represents the region to which city i belongs[5]. β and γ are the coefficients of the corresponding variables. ϵ is the random error term. ENT_{it} represents the entrepreneurial performance of small and medium-sized cities. $\Delta \ln MP_{it}$ is the variable we are interested in, which represents the increased market potential caused by highways and high-speed railways. KC_{it} represents the stock of knowledge capital. In order to reduce the impact of the contemporaneous correlation on the regression results, we lag the following variables for one year. BA_{it-1} represents the market barriers, which is measured by the ratio of the number of employees in public management and social organizations to the total number of employees. INC_{it-1}

represents the commercialization capability of incumbent companies, which is measure by relative specialization index[6].

The control variables Z_{it-1} represents the factors might affect the entrepreneurial performance, which includes: (1) economic growth ($\ln Y_{it-1}$), measured by city's real GDP in log form; (2) agglomeration (POP_{it-1}), measured by the number of registered population per square kilometer of land area; (3) market competition (HHI_{it-1}), measured by the Hirschman-Herfindahl Index; (4) financial development (FD_{it-1}), measured by the ratio of total credit to GDP.

In order to minimize the impacts of omitted variables, we introduce three sets of dummy variables in regression model: first, year dummy variables (μ_t), which are used to control the influence of time-varying factors such as macroeconomic policies; second, city dummy variables (λ_i), which are used to control time-invariant factors at the city level, such as local culture, institutions, geography, and other factors those are not likely to change in the short term; third, the interactive terms of regional dummy variables and year dummy variables ($D_{r(i)t}$), which are used to control the impacts of regional policies.

The entrepreneurial performance indicators for small and medium-sized cities come from the database of China Innovation and Entrepreneurship Index[7]. The index includes 7 sub-indicators: the number of new firm startup registrations (weighted by 20%), the number of new foreign investment (weighted by 15%), the number of companies newly got venture investment (weighted by 25%), the number of newly granted invention patents (weighted by 12.5%), the number of newly granted utility model patents (weighted by 7.5%), the number of newly granted design patents (weighted by 5%), and the number of new trademark registrations (weighted by 15%). As we can see, the first three sub-indicators represent the performance of entrepreneurship, while the last three sub-indicators represent the performance of innovation. Therefore, we use the average of first three sub-indicators to measure the entrepreneurial performance of small and medium-sized cities. We also use the three sub-indicators alone when testing Hypothesis 2. The new firm startup performance ($STARTUP_{it}$) is measured by the score of the number of new firm startup registrations. Foreign investment performance ($FOREIGN_{it}$) is measured by the score of the number of new foreign investment. Venture investment performance ($VCPE_{it}$) is measured by the score of the number of companies newly got venture investment.

Highways and high-speed railways are two more advanced kinds of transportation infrastructure than ordinary roads[8]. The construction of highways and high-speed railways can significantly save commuting time between cities, thereby increase the market potential of small and medium-sized cities. Drawing on Zheng and Kahn (2013), the market potential is calculated by equation (4).

$$MP_{it} = \sum_{j \neq i} GDP_{jt-1} \times \exp\left(-\tau T_{ijt}\right) \tag{4}$$

where MP_{it} represents the market potential of small and medium-sized city i in year t, GDP_{jt-1} represents the GDP of core city j in the last year, T_{ijt} represents the commuting time between small and medium city i and core city j in year t, and τ is the spatial decay parameter, which equals 0.02. In the part of robustness check, we will recalculate the market potential of small and medium-sized cities by taking different values for τ and adopting the registered (*huji*) population instead of GDP.

We set the maximum speed for different kinds of transportation infrastructure as following: the maximum speed of ordinary roads is 60 km/h, the maximum speed of highways is 120 km/h, and the maximum speed of high-speed railways is 250 km/h. Unlike Zheng and Kahn (2013), who uses 1.2 times the straight-line distance between cities to estimate the railway distance, we use the train information provided by Chinese Innovation Research Database (CIRD) to calculate the actual railway distance[9]. The inter-city highway distance is obtained from Baidu Map API. Accordingly, we calculated the market potential caused by ordinary roads (MP_{it}^{O}), the market potential caused by highways (MP_{it}^{S}), and the market potential caused by high-speed railways (MP_{it}^{R}). The formula for calculating the increased market potential caused by highways and high-speed railways is shown in equation (5).

$$\Delta \ln MP_{it} = \begin{cases} 0, \text{no highway and no high-speed railway;} \\ \ln MP_{it}^{S} - \ln MP_{it}^{O}, \text{after the highway opened;} \\ \ln MP_{it}^{R} - \ln MP_{it}^{O}, \text{after the high-speed railway opened.} \end{cases} \tag{5}$$

Knowledge capital (KC_{it}) is calculated by the formula: $X_{it}^{N} = P_{it} + (1 - \delta_N)X_{it-1}^{N}$, where X_{it} represents knowledge capital, P_{it} represents the number of patent granted, δ_N represents the depreciation rate of knowledge capital, and N represents the types of patent. Although China's Patent Law carried out in 1985, the first patent authorization occurred in 1989, so the initial knowledge capital was the amount of patent granted in 1989. According to China's Patent Law, patents are divided into three types: inventions, utility models and designs. In terms of technical ingredient, inventions are the most intensive among them and utility models are more intensive than designs. The protection period of inventions is 20 years, while the protection periods of utility models and designs are 10 years. Therefore, the three kinds of patents should be separately accounted for when we calculate knowledge capital. The annual depreciation rate of inventions knowledge capital (X_{it}^{1}) is calculated at 5%, and the annual depreciation rate of utility models knowledge capital (X_{it}^{2}) and designs knowledge capital (X_{it}^{3}) are calculated by 10%. The total amount of local knowledge capital in each prefecture-level city is equal to the weighted sum of the three terms. The formula is: $X_{it} = X_{it}^{1} + 0.5X_{it}^{2} + 0.3X_{it}^{3}$.

The opening data of highways is collected manually from the Internet. The opening data of high-speed rail stations comes from CIRD. The patent data comes from State Intellectual Property Office of China. The raw data of other statistics come from China City Statistical Yearbook and China Statistical Yearbook. Due to the lack of important indicators in some cities, we dropped 18 cities, and finally kept 190 small and medium-sized cities, which is about 91.35% of the total number of small and medium-sized cities. The time span of the sample is from 2004 to 2016. The descriptive statistics of variables mentioned above are shown in Table 1.

Table 1. Statistic description.

Variable	Measure	Mean	SD	Min	Max
ENT_{it}	Average entrepreneurial performance, provided by Zhang (2019).	41.996	19.229	1.934	92.264
$STARTUP_{it}$	Index of new firm startup, provided by Zhang (2019).	42.074	22.811	2.048	98.976
$FOREIGN_{it}$	Index of foreign investment, provided by Zhang (2019).	41.824	23.824	0.341	97.952
$VCPE_{it}$	Index of venture investment, provided by Zhang (2019).	42.091	24.341	0.341	95.904
$\Delta lnMP_{it}$ ($\tau = 0.01$)	Market potential caused by highways and high-speed railways, $\tau = 0.01$.	0.103	0.048	0	0.302
$\Delta lnMP_{it}$ ($\tau = 0.02$)	Market potential caused by highways and high-speed railways, $\tau = 0.02$.	0.200	0.093	0	0.594
$\Delta lnMP_{it}$ ($\tau = 0.03$)	Market potential caused by highways and high-speed railways, $\tau = 0.03$.	0.289	0.135	0	0.874
$\Delta lnMP_{it}$ ($\tau = 0.05$)	Market potential caused by highways and high-speed railways, $\tau = 0.05$.	0.449	0.209	0	1.380
$\Delta lnMP_{it}$ (pop.)	Market potential caused by highways and high-speed railways, $\tau = 0.02$, registered population.	0.199	0.091	0	0.565
KC_{it}	Knowledge capital calculated by patent data.	0.103	0.048	0	0.302
BA_{it-1}	The ratio of the number of employees in public management and social organizations to the total number of employees, lagged by one year.	0.289	0.135	0	0.874
INC_{it-1}	Relative Specialization Index calculated by the number of employees in 2-digit industry, lagged by one year.	0.449	0.209	0	1.380
lnY_{it-1}	The logarithm of real GDP, lagged by one year.	0.199	0.091	0	0.565
HHI_{it-1}	Hirschman-Herfindahl Index calculated by the number of employees in 2-digit industry, lagged by one year.	5.384	1.416	0.199	9.758
POP_{it-1}	The number of registered populations per square kilometer of land area, lagged by one year.	0.141	0.050	0.007	0.390
FD_{it-1}	The ratio of total credit on GDP, lagged by one year.	3.617	3.498	1.260	35.893

Source: Authors' computations.

5. Empirical analyses

5.1. Baseline regressions

Table 2 reports the various regression results of the econometric model (3). Column (1) is the result when the control variables Z_{it-1} and the dummy variables $D_{r(i)t}$ are not added. The adjusted R^2 in this column is 0.782. The coefficients of $\Delta \ln MP_{it}$ and KC_{it} are significantly positive. The coefficient of BA_{it-1} is significantly negative. The coefficient of INC_{it-1} is negative, but it is not statistically significant. The result indicates that the goodness of fit is high, and changes in transportation infrastructure and knowledge capital are positively correlated with changes in entrepreneurial performance in small and medium-sized cities, and changes in market barriers and incumbent commercialization capabilities are negatively correlated with changes in the explained variables.

Considering the potential impacts of omitted variables on the regression result, we added the control variables Z_{it-1} and the dummy variables $D_{r(i)t}$ in columns (2)-(4). The results show that: (1) when the control variables Z_{it-1} are added, the coefficients of $\Delta \ln MP_{it}$, KC_{it}, $\ln Y_{it-1}$, and POP_{it-1} are statistically significant, and the adjusted R^2 rises to 0.785; (2) when the dummy variables $D_{r(i)t}$ are added, the coefficients of $\Delta \ln MP_{it}$ and KC_{it} are still statistically significant, and the adjusted R^2 rises to 0.786; (3) when both the control variables Z_{it-1} and the dummy variables $D_{r(i)t}$ are added, the coefficients and standard errors of all variables are not much different from the results in column (2), and the adjusted R^2 rises to 0.789, which is higher than that in column (2) and column (3).

Table 2. Main regression results.

	(1) OLS	(2) OLS	(3) OLS	(4) OLS
$\Delta \ln MP_{it}$ ($\tau = 0.02$)	9.719**	10.906**	13.586***	13.902***
	(4.153)	(4.250)	(4.216)	(4.228)
1 SD effect size	[0.905]	[1.015]	[1.265]	[1.294]
KC_{it}	3.340***	3.174***	2.254***	2.244***
	(0.735)	(0.717)	(0.740)	(0.745)
BA_{it-1}	−28.534**	−19.567	−16.473	−12.223
	(14.038)	(14.057)	(14.360)	(14.143)
INC_{it-1}	−0.246	−0.164	−0.168	−0.124
	(0.159)	(0.152)	(0.153)	(0.150)
$\ln Y_{it-1}$		8.058***		8.582***
		(2.365)		(2.444)
HHI_{it-1}		−0.836		−3.043
		(8.542)		(8.118)
POP_{it-1}		0.066***		0.051**
		(0.021)		(0.020)
FD_{it-1}		0.900		1.219*
		(0.651)		(0.705)
Constant	26.978***	−47.451***	30.069***	−42.058**
	(4.873)	(17.432)	(4.735)	(17.306)
Year FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Regional policies	No	No	Yes	Yes
Adjusted R^2	0.782	0.785	0.786	0.789
Observations	2470	2470	2470	2470

Note: robust clustered standard error in parentheses. 1 SD effect size in bracket is calculated by the coefficient of $\Delta \ln MP$ multiply its standard error. *, ** and *** indicate that the coefficient is significant at 10%, 5% and 1% respectively.
Source: Authors' computations.

Based on the goodness of fit and the change of coefficients, we mainly focus on the results of column (4). As shown that the coefficient of $\Delta \ln MP_{it}$ is 13.902, which is significant at the 1% level. Because the variable of increased market potential is not convenient to directly explain the economic effects, we used the method provided by Gibbons and Wu (2020) to further calculate the effect of a standard deviation change of $\Delta \ln MP_{it}$ on entrepreneurial performance in small and medium-sized cities. The result shows that an increase of $\Delta \ln MP_{it}$ by one standard deviation will cause the entrepreneurial performance index of small and medium-sized cities to increase by about 1.294. As with Audretsch et al. (2015), we get a similar conclusion that transportation infrastructure has a significantly positive effect on entrepreneurial activities.

The coefficient of KC_{it} is significantly positive in all columns. These results confirm the relationship between knowledge capital and entrepreneurial activity in the theory of knowledge spillover entrepreneurship. In line with Acs et al. (2009) and Audretsch and Keilbach (2007), cities with more knowledge capital can provide more entrepreneurial opportunities and therefore have higher entrepreneurial performance. The coefficients of $\ln Y_{it-1}$, POP_{it-1} and FD_{it-1} are significantly positive, which mean that economic growth, population agglomeration, and financial development can enhance the entrepreneurial performance of small and medium-sized cities. We also find that the coefficients of BA_{it-1}, INC_{it-1}, and HHI_{it-1} are not statistically significant, but the negative coefficients indicate that market barriers, incumbent commercialization capabilities and market competition are not conducive to the identification and utilization of entrepreneurial opportunities by entrepreneurs. For these factors, Acs et al. (2009)and Plummer and Acs (2014) have made in-depth discussions, and got a conclusion similar to this article.

5.2. Sensitivity

Table 3 reports sensitivity testing results for the market potential measurement. According to Zheng and Kahn (2013), the spatial decay parameter τ is generally between 0.01 and 0.05. Therefore, we take the value of τ as 0.01, 0.03, and 0.05 for sensitivity tests. The testing results are shown in columns (1)-(3). Regardless of which value τ is taken, the increase of entrepreneurial performance caused by a standard deviation increase of $\Delta \ln MP_{it}$ is between 1.29 and 1.30, which is almost consistent with the result when $\tau = 0.02$.

In the measurement of market potential, the population size is also often used in the literature, such as Gibbons and Wu (2020). Due to the lack of permanent population data at the city level in China, we use the end-of-year registered population instead of GDP to recalculate the increased market potential. The regression result is shown in column (4). The increase of entrepreneurial performance caused by a standard deviation increase of $\Delta \ln MP_{it}$ is 1.355, which is very close to the result when market potential is calculated by GDP.

We can also observe that the coefficients and standard errors of other variables don't change significantly in columns (1)-(4) in Table 3. They are almost consistent with the results in column (4) in Table 2. These sensitivity testing results suggest that the impact of the increased market potential caused by highways and high-speed

Table 3. Sensitivity testing results.

	(1) $\tau = 0.01$	(2) $\tau = 0.03$	(3)$\tau = 0.05$	(4) pop.
$\Delta lnMP_{it}$ (marked above)	26.897***	9.594***	6.191***	14.910***
	(8.210)	(2.906)	(1.862)	(4.393)
1 SD effect size	[1.297]	[1.292]	[1.292]	[1.355]
KC_{it}	2.244***	2.243***	2.240***	2.217***
	(0.745)	(0.745)	(0.745)	(0.745)
BA_{it-1}	−12.256	−12.192	−12.134	−12.540
	(14.140)	(14.147)	(14.156)	(14.119)
INC_{it-1}	−0.125	−0.123	−0.122	−0.130
	(0.150)	(0.150)	(0.150)	(0.150)
lnY_{it-1}	8.568***	8.595***	8.616***	8.558***
	(2.444)	(2.443)	(2.444)	(2.440)
HHI_{it-1}	−3.034	−3.054	−3.085	−3.081
	(8.120)	(8.115)	(8.110)	(8.112)
POP_{it-1}	0.051**	0.051**	0.051**	0.050**
	(0.020)	(0.020)	(0.020)	(0.020)
FD_{it-1}	1.221*	1.217*	1.213*	1.219*
	(0.705)	(0.705)	(0.705)	(0.705)
Constant	−41.971**	−42.141**	−42.268**	−41.754**
	(17.310)	(17.303)	(17.302)	(17.272)
Year FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Regional policies	Yes	Yes	Yes	Yes
Adjusted R^2	0.789	0.789	0.789	0.789
Observations	2470	2470	2470	2470

Note: robust clustered standard error in parentheses. 1 SD effect size in bracket is calculated by the coefficient of $\Delta \ln MP$ multiply its standard error. *, ** and *** indicate that the coefficient is significant at 10%, 5% and 1% respectively.
Source: Authors' computations.

railways on the entrepreneurial performance of small and medium-sized cities don't change obviously because of the different values of the spatial decay parameter and the calculation using GDP rather than population size.

5.3. Heterogeneity

Two sets of heterogeneity testing results are included in this subsection. First, according to hypothesis 2, we examine the heterogeneous impacts of transportation infrastructure on the new firm startup performance, foreign investment performance and venture investment performance of small and medium-sized cities. Second, according to hypothesis 3, we examine the heterogeneous impacts of highways and high-speed railways on the entrepreneurial performance of small and medium-sized cities with different relative geographic locations.

Table 4 reports the heterogeneous impacts of the increased market potential caused by highways and high-speed railways on different kinds of entrepreneurial performance in small and medium-sized cities. The results show that the regression coefficients of changes in $STARTUP_{it}$, $FOREIGN_{it}$, and $VCPE_{it}$ on change in $\Delta \ln MP_{it}$ are different and all statistically significant, which suggest that there are heterogeneous effects of transportation infrastructure on different kinds of entrepreneurial performance. An increase of $\Delta \ln MP_{it}$ by one standard deviation cause the index of new firm startup, the index of foreign investment and the index of venture investment in small and medium-sized cities increased by 0.869, 1.270 and 1.742, respectively.

Table 4. Heterogeneity testing by entrepreneurship types.

	(1) STARTUP	(2) FOREIGN	(3) VCPE
$\Delta lnMP_{it}$ ($\tau = 0.02$)	9.339**	13.648**	18.720**
	(4.649)	(5.775)	(9.097)
1 SD effect size	[0.869]	[1.270]	[1.742]
KC_{it}	1.208	2.175**	3.349**
	(0.733)	(1.086)	(1.466)
BA_{it-1}	−13.258	−19.399	−4.012
	(12.142)	(23.214)	(28.168)
INC_{it-1}	−0.048	−0.328	0.003
	(0.126)	(0.230)	(0.289)
lnY_{it-1}	6.806***	11.060***	7.879
	(2.432)	(3.480)	(5.089)
HHI_{it-1}	−14.837	5.144	0.563
	(9.332)	(10.951)	(17.017)
POP_{it-1}	0.078***	0.072**	0.002
	(0.021)	(0.028)	(0.039)
FD_{it-1}	1.142	1.424	1.091
	(0.973)	(1.101)	(1.476)
Constant	−32.511*	−64.212**	−29.452
	(17.839)	(25.711)	(36.528)
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Regional policies	Yes	Yes	Yes
Adjusted R^2	0.897	0.755	0.325
Observations	2470	2470	2470

Note: robust clustered standard error in parentheses. 1 SD effect size in bracket is calculated by the coefficient of $\Delta \ln MP$ multiply its standard error. *, ** and *** indicate that the coefficient is significant at 10%, 5% and 1% respectively.
Source: Authors' computations.

Table 5 reports the heterogeneous impacts of highways and high-speed railways on entrepreneurial performance in small and medium-sized cities with different relative geographic locations. Column (1) is the result under whole samples. The result shows that the coefficient of $\Delta \ln MP_{it}(HW)$ is significantly positive, while the coefficient of $\Delta \ln MP_{it}(HSR)$ is not statistically significant. The result suggests that highways roughly have a greater impact on improving the entrepreneurial performance of small and medium-sized cities than high-speed railways.

Considering the geographic distance may be matter, we further carry out the grouping tests according to the average distance between small and medium-sized cities and core cities. The results are shown in columns (2)-(6). We can see that the effects of highways on the entrepreneurial performance of small and medium-sized cities decreases with relative geographic distance increases, but the effects of high-speed railways on entrepreneurial performance increases with distance increases. For the small and medium-sized cities with average distance less than 1800 km, the impact of high-speed railways on their entrepreneurial performance is not statistically significant, while for small and medium-sized cities with average distance greater than 1800 km, high-speed railways have a significant effect on their entrepreneurial performance. $\Delta \ln MP_{it}(HSR)$ increase by one standard deviation cause the entrepreneurial performance to increase by 0.708-0.768 in the small and medium-sized cities with average distance greater than 1800 km. Nonetheless, the effects of highways on the entrepreneurial performance of small and medium-sized cities are always greater than that of high-speed railways: $\Delta \ln MP_{it}(HW)$ increased by one standard deviation cause the entrepreneurial performance to increase by

Table 5. Heterogeneity testing by relative geographic locations.

	(1) Full sample	(2) >1200km	(3) >1400km	(4) >1600km	(5) >1800km	(6) >2000km
$\Delta \ln MP_{it}(HW)$	14.305***	14.087***	10.714**	10.751**	8.847*	8.416*
	(4.309)	(4.386)	(4.434)	(4.649)	(4.818)	(4.965)
1 SD effect size	[1.224]	[1.265]	[1.032]	[1.100]	[0.964]	[0.921]
$\Delta \ln MP_{it}(HSR)$	9.220	4.854	−5.064	21.641	37.345*	46.391**
	(13.072)	(13.732)	(15.771)	(17.824)	(20.636)	(20.237)
1 SD effect size	[0.268]	[0.140]	[-0.143]	[0.556]	[0.708]	[0.768]
KC_{it}	2.230***	1.683**	0.999	1.116	0.463	0.351
	(0.741)	(0.817)	(0.926)	(0.951)	(1.035)	(1.065)
BA_{it-1}	−12.565	−9.092	−9.586	−18.318	−25.598	−26.300
	(14.148)	(15.224)	(15.370)	(16.749)	(17.289)	(17.696)
INC_{it-1}	−0.131	−0.232	−0.060	−0.160	−0.284	−0.288
	(0.152)	(0.182)	(0.173)	(0.181)	(0.191)	(0.192)
$\ln Y_{it-1}$	8.562***	9.178***	8.373***	7.580***	7.435**	7.399**
	(2.439)	(2.512)	(2.622)	(2.645)	(2.947)	(2.986)
HHI_{it-1}	−2.726	0.441	−6.994	−15.030	−11.281	−8.755
	(8.096)	(8.590)	(9.099)	(10.682)	(10.523)	(10.284)
POP_{it-1}	0.051**	0.063**	0.065**	0.052*	0.052*	0.059*
	(0.021)	(0.026)	(0.027)	(0.029)	(0.031)	(0.032)
FD_{it-1}	1.207*	1.007	1.915**	1.808*	2.143**	1.883*
	(0.703)	(0.707)	(0.881)	(0.915)	(0.973)	(0.976)
Constant	−42.010**	−45.341**	−38.910**	−28.363	−22.088	−22.920
	(17.288)	(18.264)	(18.860)	(18.940)	(20.359)	(20.672)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional policies	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.789	0.801	0.767	0.764	0.770	0.778
Observations	2470	2158	1729	1469	1209	1131

Note: robust clustered standard error in parentheses. 1 SD effect size in bracket is calculated by the coefficient of $\Delta \ln MP$ multiply its standard error. *, ** and *** indicate that the coefficient is significant at 10%, 5% and 1% respectively.
Source: Authors' computations.

0.921-1.265, which are always greater than the maximum effect size of high-speed railways.

6. Conclusions and discussions

With the completion of transportation network between core cities, the infrastructure investment of highways and high-speed railways in small and medium-sized cities in China has increased dramatically in the past decade. The importance of transportation infrastructure for economic growth has been widely proven(e.g. Baum-Snow et al., 2017; Chen, 2021; Fang et al., 2020; Gao & Zheng, 2020; Jia et al., 2017; Wu et al., 2022; Zhang & Qi, 2021). However, the relationship between transportation infrastructure and entrepreneurial activities has received little attention from researchers. This paper uses the market access approach to study the impacts of highways and high-speed railways on entrepreneurial performance in small and medium-sized cities in China. Based on the theory of knowledge spillover entrepreneurship, this paper analyzes the theoretical mechanism of transportation infrastructure affecting entrepreneurial activities, and further constructs an econometric model of transportation infrastructure affecting entrepreneurial activities. Using China's city-level panel data, we find that the construction of highways and high-speed railways increases the market potential of small and medium-sized cities, thereby improve their entrepreneurial performance.

We further analyzed the heterogeneous impacts of transportation infrastructure on different kinds of entrepreneurial performance and the complementary effect between highways and high-speed railways in terms of entrepreneurial performance in small and medium-size cities. The results confirm that the impacts of increased market potential caused by highways and high-speed railways on the entry of foreign investment and the entry of venture investment are greater than new firm startup in small and medium-sized cities. The complementary effect between highways and high-speed railways is also confirmed by our results. As shown above, the entrepreneurship effect of highways weaken as the average distance between small and medium-sized cities and core cities increases, but the entrepreneurship effect of high-speed railways increase as the average distance increases.

This study has policy implications for peripheral cities to improve entrepreneurial performance, but not limited to China. According to knowledge spillover entrepreneurship theory, entrepreneurial activities are the process of identifying and utilizing entrepreneurial opportunities, and the knowledge capital in a city is the source of entrepreneurial opportunities. Our study further suggests that, in an economic space of core-peripheral structure, the construction of trans-region transportation infrastructure is conductive to increasing the market potential of peripheral cities, which thus promotes the identification and utilization of entrepreneurial opportunities. Therefore, in order to improve the entrepreneurial performance of peripheral cities, the governments should increase investment in the transportation infrastructure of peripheral cities and improve the transportation network between peripheral cities and core cities. Besides, the construction of transportation infrastructure is not only conducive to the identification and utilization of entrepreneurial opportunities by internal entrepreneurs, but also play a greater role in attracting the entry of foreign investment and the entry of venture investment. Furthermore, the complementary effect of different types of transportation infrastructure is also an important issue that should to be considered by policymakers in the construction plan.

Nevertheless, further corroboration is also required. The mechanisms of highways and high-speed railways promoting entrepreneurship is analyzed theoretically in this paper, but no further empirical evidence is provided to verify these theoretical propositions. What is the impact of market potential caused by highways and high-speed railways on knowledge flow? What is the role of economic incentives and uncertainty reduction in entrepreneurial activities? All these mechanisms need to be further evaluated in the future. Moreover, the index of entrepreneurship represents the relative performance of cities, but it can't reflect the absolute level of entrepreneurship. Further studies can try to use other indicators such as entrepreneurship rate for empirical analysis.

Notes

1. According to the China City Statistical Yearbook, there were 292 cities at or above prefecture level in China in 2014.
2. Venture capital data during 2004 to 2016 comes from VCPE database of CNRDS.
3. According to the *China Regional Statistical Yearbook*, the number of permanent populations in small and medium-sized cities was approximately 680 million, and the number of permanent populations in core cities was approximately 310 million in 2013.

4. The opening time of each city's high-speed railway station comes from CRAD.
5. China is generally divided into four regions: the eastern, the central, the western and the northeastern. Due to the large disparity between regions, the central government has implemented different regional development strategies, which are called the eastern first development strategy, the central rise strategy, the western development strategy, and the northeast revitalization strategy.
6. See Duranton and Puga (2000). We use the number of employees in the two-digit industry for calculation.
7. This index is provided by Zhang (2019), which is available on https://doi.org/10.18170/DVN/PEFDAS.
8. The ordinary roads include national roads, provincial roads, county roads etc. in China, which speed is usually less than 80km/h.
9. Different trains have different travel routes. We use the mode value to measure the average railway distance between cities.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was funded by China National Office for Philosophy and Social Sciences (21CJY007).

ORCID

Jun Chen http://orcid.org/0000-0002-6796-271X

References

Acs, Z. J., Audretsch, D. B., & Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, *41*(4), 757–774. https://doi.org/10.1007/s11187-013-9505-9

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., & Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, *32*(1), 15–30. https://doi.org/10.1007/s11187-008-9157-3

Alesina, A., & Giuliano, P. (2015). Culture and institutions. *Journal of Economic Literature*, *53*(4), 898–944. https://doi.org/10.1257/jel.53.4.898

Audretsch, D. B., & Belitski, M. (2017). Entrepreneurial ecosystems in cities: Establishing the framework conditions. *The Journal of Technology Transfer*, *42*(5), 1030–1051. https://doi.org/10.1007/s10961-016-9473-8

Audretsch, D. B., Belitski, M., & Korosteleva, J. (2021). Cultural diversity and knowledge in explaining entrepreneurship in European cities. *Small Business Economics*, *56*(2), 593–611. https://doi.org/10.1007/s11187-019-00191-4

Audretsch, D. B., Heger, D., & Veith, T. (2015). Infrastructure and entrepreneurship. *Small Business Economics*, *44*(2), 219–230. https://doi.org/10.1007/s11187-014-9600-6

Audretsch, D. B., & Keilbach, M. (2007). The theory of knowledge spillover entrepreneurship. *Journal of Management Studies*, *44*(7), 1242–1254. https://doi.org/10.1111/j.1467-6486.2007.00722.x

Audretsch, D. B., & Keilbach, M. (2008). Resolving the knowledge paradox: Knowledge-spillover entrepreneurship and economic growth. *Research Policy*, *37*(10), 1697–1705. https://doi.org/10.1016/j.respol.2008.08.008

Baum-Snow, N., Brandt, L., Henderson, J. V., Turner, M. A., & Zhang, Q. (2017). Roads, railroads, and decentralization of Chinese cities. *The Review of Economics and Statistics*, *99*(3), 435–448. https://doi.org/10.1162/REST_a_00660

Bennett, D. L. (2019). Infrastructure investments and entrepreneurial dynamism in the U.S. *Journal of Business Venturing*, *34*(5), 105907. https://doi.org/10.1016/j.jbusvent.2018.10.005

Bianchi, M. (2012). Financial development, entrepreneurship, and job satisfaction. *Review of Economics and Statistics*, *94*(1), 273–286. https://doi.org/10.1162/REST_a_00156

Brunello, G., & Langella, M. (2016). Local agglomeration, entrepreneurship and the 2008 recession: Evidence from Italian industrial districts. *Regional Science and Urban Economics*, *58*, 104–114. https://doi.org/10.1016/j.regsciurbeco.2016.03.004

Casson, M. (2005). Entrepreneurship and the theory of the firm. *Journal of Economic Behavior & Organization*, *58*(2), 327–348. https://doi.org/10.1016/j.jebo.2004.05.007

Chen, J. (2021, September). High-speed rail and energy consumption in China: The intermediary roles of industry and technology. *Energy*, *230*, 120816. https://doi.org/10.1016/j.energy.2021.120816

Chen, J., & Liu, J. (2021). Incentive and uncertainty: The simultaneous effects of demand on innovation. *Scientometrics*, *126*(9), 7743–7757. https://doi.org/10.1007/s11192-021-04093-9

Chen, A., & Partridge, M. D. (2013). When are cities engines of growth in China? Spread and backwash effects across the urban hierarchy. *Regional Studies*, *47*(8), 1313–1331. https://doi.org/10.1080/00343404.2011.589831

Comporek, M., Kowalska, M., & Misztal, A. (2021). The sustainable development of transport enterprises in the context of macroeconomic conditions. The case of Central and Eastern European Countries. *Entrepreneurship and Sustainability Issues*, *8*(3), 226–247. https://doi.org/10.9770/jesi.2021.8.3(13)

Donaldson, D. (2018). Railroads of the Raj: Estimating the impact of transportation infrastructure. *American Economic Review*, *108*(4–5), 899–934. https://doi.org/10.1257/aer.20101199

Donaldson, D., & Hornbeck, R. (2016). Railroads and American economic growth: A 'market access' approach. *The Quarterly Journal of Economics*, *131*(2), 799–858. https://doi.org/10.1093/qje/qjw002

Dong, X., Zheng, S., & Kahn, M. E. (2020). The role of transportation speed in facilitating high skilled teamwork across cities. *Journal of Urban Economics*, *115*, 103212. (January): https://doi.org/10.1016/j.jue.2019.103212

Duranton, G., & Puga, D. (2000). Diversity and specialisation in cities: Why, where and when does it matter? *Urban Studies*, *37*(3), 533–555. https://doi.org/10.1080/0042098002104

Duranton, G., & Puga, D. (2004). Micro-foundations of urban agglomeration economies. In J. Vernon Henderson & Jacques-François Thisse (eds.), *Handbook of regional and urban economics* (Vol. 4, pp. 2063–2117). Elsevier. https://doi.org/10.1016/S1574-0080(04)80005-1.

Dutta, N., & Sobel, R. S. (2018). Entrepreneurship and human capital: The role of financial development. *International Review of Economics & Finance*, *57*, 319–332. https://doi.org/10.1016/j.iref.2018.01.020

Fang, L., Zhang, X., Feng, Z., & Cao, C. (2020). Effects of high-speed rail construction on the evolution of industrial agglomeration: Evidence from three great bay areas in China. *E + M Ekonomie a Management*, *23*(2), 17–32. https://doi.org/10.15240/tul/001/2020-2-002

Fontana, R., & Guerzoni, M. (2008). Incentives and uncertainty: An empirical analysis of the impact of demand on innovation. *Cambridge Journal of Economics*, *32*(6), 927–946. https://doi.org/10.1093/cje/ben021

Fritsch, M., & Storey, D. J. (2014). Entrepreneurship in a regional context: Historical roots, recent developments and future challenges. *Regional Studies*, *48*(6), 939–954. https://doi.org/10.1080/00343404.2014.892574

Gao, Y., & Zheng, J. (2020, March). The impact of high-speed rail on innovation: An empirical test of the companion innovation hypothesis of transportation improvement with China's manufacturing firms. *World Development*, *127*, 104838. https://doi.org/10.1016/j.worlddev.2019.104838

Ghani, E., Kerr, W. R., & O'Connell, S. D. (2013). Local industrial structures and female entrepreneurship in India. *Journal of Economic Geography*, *13*(6), 929–964. https://doi.org/10.1093/jeg/lbt004

Ghio, N., Guerini, M., Lehmann, E. E., & Rossi-Lamastra, C. (2015). The emergence of the knowledge spillover theory of entrepreneurship. *Small Business Economics*, *44*(1), 1–18. https://doi.org/10.1007/s11187-014-9588-y

Gibbons, S., & Wu, W. (2020). Airports, access and local economic performance: Evidence from China. *Journal of Economic Geography*, *20*(4), 903–937. https://doi.org/10.1093/jeg/lbz021

Glaeser, E. L., Kerr, W. R., & Ponzetto, G. A. (2010). Clusters of entrepreneurship. *Journal of Urban Economics*, *67*(1), 150–168. https://doi.org/10.1016/j.jue.2009.09.008

Glaeser, E. L., Rosenthal, S. S., & Strange, W. C. (2010). Urban economics and entrepreneurship. *Journal of Urban Economics*, *67*(1), 1–14. https://doi.org/10.1016/j.jue.2009.10.005

Jia, S., Zhou, C., & Qin, C. (2017). No difference in effect of high-speed rail on regional economic growth based on match effect perspective? *Transportation Research Part A: Policy and Practice*, *106*, 144–157. https://doi.org/10.1016/j.tra.2017.08.011

Myers, S., & Marquis, D. G. (1969). *Successful industrial innovations: A study of factors underlying innovation in selected firms* (Vol. 69). National Science Foundation.

Plummer, L. A., & Acs, Z. J. (2014). Localized competition in the knowledge spillover theory of entrepreneurship. *Journal of Business Venturing*, *29*(1), 121–136. https://doi.org/10.1016/j.jbusvent.2012.10.003

Rogers, T. M. (2012). Bank market structure and entrepreneurship. *Small Business Economics*, *39*(4), 909–920. https://doi.org/10.1007/s11187-011-9320-0

Schmookler, J. (1962). Economic sources of inventive activity. *The Journal of Economic History*, *22*(1), 1–20. https://doi.org/10.1017/S0022050700102311

Schmookler, J. (1966). *Invention and economic growth*. Harvard University Press.

Sternberg, R. (2009). Regional dimensions of entrepreneurship. *Foundations and Trends® in Entrepreneurship*, *5*(4), 211–340. https://doi.org/10.1561/0300000024

Tavassoli, S., Obschonka, M., & Audretsch, D. B. (2021). Entrepreneurship in cities. *Research Policy*, *50*(7), 104255. https://doi.org/10.1016/j.respol.2021.104255

Verheul, I., Wennekers, S., Audretsch, D., & Thurik, R. (2002). An eclectic theory of entrepreneurship: Policies, institutions and culture. In S. Wennekers, D. Audretsch, R. Thurik, & I. Verheul (Eds.), *Entrepreneurship: Determinants and policy in a European-US comparison* (pp. 11–81). Springer. https://doi.org/10.1007/0-306-47556-1_2

Wu, M., Hanley, D., & Li, J. (2022). High-speed railways and collaborative innovation. *Regional Science and Urban Economics*, *93*, 103717. August https://doi.org/10.1016/j.regsciurbeco.2021.103717

Zhang, X. (2019). *China innovation and entrepreneurship index*. Peking University Open Research Data Platform. https://doi.org/10.18170/DVN/PEFDAS

Zhang, B., & Qi, R. (2021). Transportation infrastructure, innovation capability, and urban economic development. *Transformations in Business and Economics*, *20*(3), 526–545.

Zheng, S., & Kahn, M. E. (2013). China's bullet trains facilitate market integration and mitigate the cost of megacity growth. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(14), E1248–53. https://doi.org/10.1073/pnas.1209247110