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A study of the effect of a high-speed rail station on spatial variations in housing price based on the hedonic model

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A B S T R A C T

High-speed rail is a large-scale form of public infrastructure that delivers obvious public benefits and economic externalities. The effects of high-speed rail on housing prices are significant, generating positive effects such as increased accessibility between cities as well as negative impacts such as noise pollution. The development of housing projects and urban spaces that surround high-speed rail stations can be improved by scientifically examining the effects of high-speed rail stations on housing prices. In examining the Beijing high-speed rail station, this study develops a hedonic model to study the effects of a high-speed rail station on housing prices at varying geographical spatial ranges. Research shows that greater accessibility between cities, increased investment attractiveness, and an expansion of public service infrastructure results from the establishment of high-speed rail stations, which in turn positively affects housing prices. However, traffic congestion, electromagnetic radiation pollution, noise, and higher crime rates negatively affect housing prices. Spatial variations in housing prices result from the combined effects of positive and negative impacts. From the research result that housing price increases with an decline in distance between houses and high-speed rail stations within (0.891 km, 11.704 km) by the influence of high-speed rail station, and thus we recommend that residential land-transferring fee premiums resulting from high-speed rail station construction should be dedicated to the construction of affordable housing. In addition, housing price declines with an decline in distance between houses and high-speed rail stations within (0.475 km, 0.891 km), and thus regarding negative impacts of high-speed rail stations on housing prices, we recommend that compensation be made available to homeowners residing in affected regions. While land use intensities and urban space layouts should be considered during the planning of high-speed rail stations.

1. Introduction

Rail transit is the general term that is used to describe transportation methods such as rail, metro, light rail trams, suburban commuter trains, etc (Zhang, Meng, Wang, and Xu, 2014). High-speed rail generally refers to rail trains with a maximum operating speed of no less than 200 km/hour. As a fast, consistent, and low-polluting large-scale form of rail transit, high-speed rail infrastructure is popular because it reduces commuting periods, lowers commuting costs, and improves ease of transportation between cities in different regions. Thus, high-speed rail projects have been adopted by governments to improve living standards while promoting regional integration. High-speed rail station construction undoubtedly increases levels of effective investment in affected regions. At the same time, these projects also alter land use intensities in surrounding areas and even affect the structure and shape of urban space, consequently affecting real estate development. Therefore, important contributions can be made to housing and urban space development approaches in areas surrounding high-speed rail stations by scientifically examining the effects of high-speed rail stations on housing prices.

In recent years, numerous scholars in China and abroad have conducted empirical research on the positive effects of high-speed rail in different cities on real estate prices. Gutiérrez, Gonzalez, and Gomez (1996) analyzed the evolution of Madrid–Barcelona–France

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high-speed rail, and discovered that high-speed rail exerted a profound influence on strengthening the connection between the outskirt and downtown areas. Through the study on the Japanese Shinkansen high-speed rail system, Sasaki, Ohashi, and Ando (1997) discovered that high-speed rail could improve regional accessibility. Similar study has been conducted by Chang and Lee (2008) on the high-speed rail (KTX) in Korea. Research by Spiekermann and Wegener (1994) also shows that high-speed rail can reduce commuting periods and lowered commuting costs in Europe. Nakamura and Ueda (1989) discovered that increases in employment of the tertiary industry were particularly pronounced with the construction of high-speed rail. Sands (1993) found that high-speed rail could facilitate the development in business service, office building and real estate market. Makoto and Kiyoshi (1997), discovered that high-speed rail not only contributed greatly to the development in producer services but also to the urban capital accumulation and land rent structure. David, Oliver, and Johnson (2010) used the hedonic pricing model to examine the effects of the Kaohsiung high-speed rail station in Taiwan on housing prices in nearby areas. The research has been conducted by David, Oliver, and Angel (2012), who found the betterment of accessibility brought by high-speed rail in Taiwan which knitted seven metropolis played substantial influence on real estate price in at least four areas. In previous studies, few scholars have examined the effects of high-speed rail systems on housing prices through a combined quantitative analysis of both positive and negative impacts. While research on the effects of high-speed rail of other countries on real estate serve as a valid reference to research on the effects of high-speed rail on housing prices in China, there are certain differences with respect to speed levels, environmental pollution levels, accessibilities levels, etc. between high-speed rail systems of different countries. As well, while most scholars have focused on the effects of high-speed rail on housing prices in Western countries of North America and Europe, only a handful have examined the effects of high-speed rail on housing prices in cities of Eastern countries such as Korea, Taiwan and Japan. Because characteristics of economic development, urban planning and basic infrastructure vary across cities, the effects of high-speed rail stations on real estate prices must also vary between cities, including issues related to range and degrees of impact. The enormous success and rapid development of high-speed rail in China has significantly shaped social and economic development in China and worldwide. As the major hub of the Chinese high-speed railway network, the Beijing South Railway Station (as shown in Fig. 1) has had significant effects on the living and working styles of city residents while also affecting housing prices, spatial structures and land use patterns in surrounding areas. As a consequence, the effects of high-speed rail on housing prices have become a focal point of real estate market management departments, rail transit construction companies, and real estate developers. This study explores the effects of the Beijing South Railway Station on housing prices via the hedonic pricing model.

The structure of this paper is as follows. The following section provides an overview of previous research. The third section illustrates the mechanism used to examine the effects of this high-speed rail station on housing prices. The fourth section describes the data used, the research model, and the calculation process. The

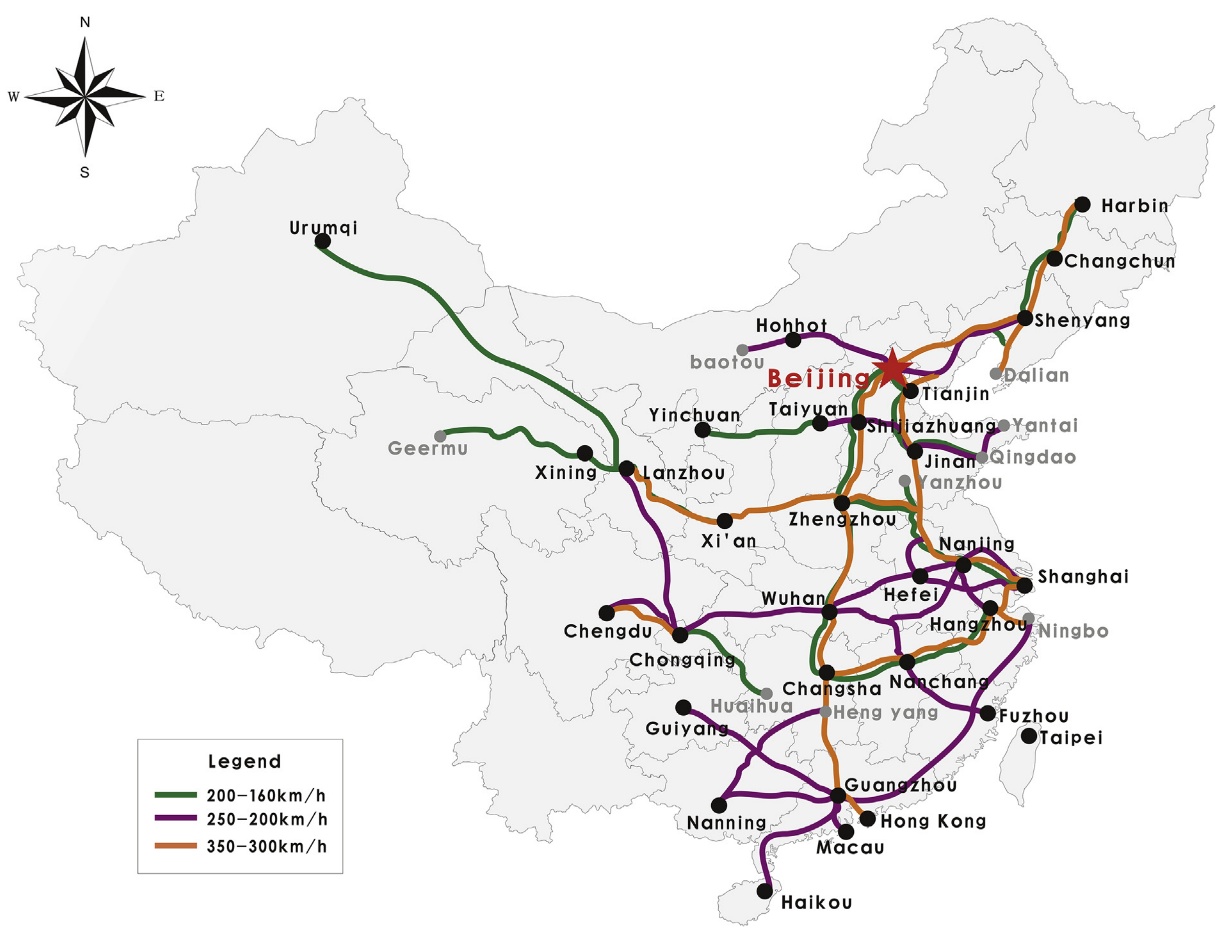

Fig. 1. Planning map of the Chinese high-speed railway system.

fifth section presents the research results, and the final section lists the study conclusions.

2. Literature review

High-speed rail construction to expand urban space while lowering commute costs has become one of the successful approaches to the promotion of coordinated development between cities within regions. The effects of high-speed rail on housing prices have been of particular interest among scholars. In previous studies, the effect to the housing price brought by high-speed rail bears distinct hierarchical characteristics:

First, high-speed rail directly changes spatiotemporal structure of regional accessibility. Gutiérrez et al. (1996) analyzed the evolution of Madrid–Barcelona–France high-speed rail. Their study results demonstrated that high-speed rail exerted a profound influence on strengthening the connection between the outskirt and downtown areas. Sasaki et al. (1997) applied the indicator system evaluation method to study the Japanese Shinkansen high-speed rail system. The authors discovered that high-speed rail could improve regional accessibility. A study on the Euro high-speed rail system discovered that high-speed rail greatly increased the accessibility of outskirt regions (Roger, Klaus, & Michael, 1999). Chang and Lee (2008) used ANOVA and GIS to examine the effects of the high-speed rail (KTX) in Korea on the accessibility. The results of the study demonstrated that the high-speed rail has increased accessibility to other cities from Seoul. Research by Blum, Haynes, and Karlsson (1997) also came to the conclusion that high-speed rail plays an important role in knitting cities and improving accessibility between cities.

Second, the change of accessibility between cities due to high-speed rail development influences the location preference of city dwellers. It triggers the movement of regional product factors, having a dominant effect on population, employment, economy, society, and urban system. Bonnafous (1987) applied enterprise interviews to study the effect of high-speed rail on the location preference of the different enterprises. The results of the study demonstrated that increased accessibility between cities by the high-speed rail had been regarded by most enterprises as the key factor in determining their location. Thus, most of them prioritized the location alongside high-speed rail station. Research by Spiekermann and Wegener (1994) also showed that high-speed rail could strengthen regional connection and the movement of product factors which in turn reduced commuting periods and lowered commuting costs in Europe. Sasaki et al. (1997) discovered that the Japanese Shinkansen high-speed rail construction made population and economic activity diffuse from the core to the peripheral area, thus changing urban system along the high-speed rail. Nakamura and Ueda (1989) used the metering method to examine the effect of the high-speed rail on the employment of different industries. The author discovered that increases in employment of the tertiary industry were particularly pronounced with the construction of high-speed rail, which manifested itself in the mushrooming in tourism and service industry (50% increase in employment). Kingsley and Haynes (1997) also have drawn the conclusion that the improvement of accessibility by the high-speed rail can spur the transformation of labor force structure, thereby, bettering labor market eventually. Tim (1998) discovered that high-speed rail in Florida can not only facilitate regional economy but also be conducive in cultural dissemination.

Third, it will exert positive influence on the peripheral land utilization and the real estate price along with the construction of high-speed rail station. The research has been conducted by Sands (1993) demonstrated that high-speed rail could shorten commute time, facilitating the development in business service, office building and real estate market. Francois (1998) discovered that rapid development of high-speed rail had significantly shaped economic development in Lyon. Around 72% of service companies had become the regular guest of high-speed rail. In the area surrounding the high-speed rail station, industrial structure has been optimized and tertiary industry has developed rapidly. The average annual growth rate of office building areas reached 5.2%. Makoto and Kiyoshi (1997), constructing dynamic system model for social economic factor of connected cities by high-speed rail, discovered that high-speed rail provided more chances of face-to-face communication for production departments of different cities, which not only contributed greatly to the development in producer services but also to the urban capital accumulation and land rent structure. David et al. (2010) used the hedonic pricing model to examine the effects of the Kaohsiung high-speed rail station in Taiwan on housing prices in nearby areas. The results of the study demonstrated that the high-speed rail station had increased accessibility to other cities from Kaohsiung, thus increasing housing prices in nearby areas. However, the authors only examined the positive effects of high-speed rail stations on housing prices, thus overlooking their negative effects on spatial variation in housing prices. The research has been conducted by David et al. (2012), who found the betterment of accessibility brought by high-speed rail in Taiwan which knitted seven metropolis played substantial influence on real estate price in at least four areas. Thus, commute time of high-speed rail has become the most determining factor for the formation of station-centered housing price gradient.

According to previous research, high-speed rail can increase regional accessibility and lower commuting costs, subsequently increasing real estate prices in nearby areas. However, with these positive impacts, negative factors such as noise, congestion, etc. can also decrease real estate prices in nearby areas. Therefore, the effects of high-speed rail stations on housing prices in nearby areas are the combined result of both positive and negative forces. This study examines the combined effects of a high-speed rail station on spatial variation in housing prices through empirical studies based on the hedonic pricing model.

3. Theory analysis

3.1. Analysis on dwellings' travel behavior pattern adjacent to high-speed rail station

With the accelerated pace of life and work, residents place more emphasis on transport convenience. Houses within the surrounding areas of high-speed rail station are attractive to many buyers. This phenomenon is attributable to the fact that the rapid development of high-speed rail in China has increased accessibility between cities, which in turn subverts stereotypical concept of life and work within same city. Take Beijing high-speed rail station as an example (as shown in Table 1). The high-speed rail pulls closer spatiotemporal distance of urban agglomeration industries in Beijing–Tianjin–Hebei metropolitan area with 2.3% of China's land areas and 7.23% of total population, because it reduces commuting period and lowers commuting cost. Thus, the preliminary realization of urban integration makes it possible for business elites to commute between cities daily by high-speed rail. While the surrounding facilities such as University Science Parks, CBD, high grade residential quarter, facilitate daily life and work for residents. In order to avoid traffic jam in the downtown of Beijing, real estate adjacent to high-speed rail station has become the first choice of a growing number of business elites. In China, the concept for “high-speed-rail district of real estate” makes debut accordingly.

Table 1
Commute time and Commute cost of Beijing South Railway Station in Beijing–Tianjin–Hebei metropolitan.

Departure station	Arrival station	Commute time (hour)	Commute cost (Yuan)
Beijing	Tianjin	0.35	55
	Shijiazhuang	1.07	129
	Qinhuangdao	1.49	175
	Tangshan	1.11	107
	Baoding	0.41	64
	Langfang	0.21	30
	Xingtai	1.51	186
	Cangzhou	0.51	95

Data from: http://www.12306.cn, 2015

3.2. The mechanism for the effect of a high-speed rail station on housing prices

According to the above mentioned research, it is evident that the effects of high-speed rail station on housing prices have a dual character. Therefore, in this study, we separate features of high-speed rail stations that affect housing prices into two categories: "positive" and "negative"; the change in housing prices due to high-speed rail stations in varying geographical spatial ranges is the combined result of the two categories, as shown in Fig. 2.

Based on this mechanism analysis on the effect of a high-speed rail station on housing prices, this study presents the following hypothesis:

Housing prices and distances between houses and high-speed rail stations might follow the pattern of spatial variation shown in Fig. 3. In other words, when the distance between a house and high-speed rail station falls between (a, b), the negative effect of negative factors will be greater than the positive effect of positive factors. Therefore, housing prices are positively correlated with the distance between a house and high-speed rail station, and the combined negative effects of housing prices would decline with an increase in distance. When the distance between a house and high-speed rail station ranges between (b, c), the positive effect of positive factors will be greater than the negative effect of negative factors. Therefore, housing prices are negatively correlated with the distance between a house and high-speed rail station, and the combined positive effect on housing prices would increase with an increase in distance. When the distance between a house and high-speed rail station falls between (c, d), the positive effect of positive factors will still be greater than the negative effects of negative factors, and housing prices are therefore negatively correlated with the distance between a house and high-speed rail station. However, due to the diminishing radiation effects of high-speed rail stations, the combined positive effects on housing prices also diminish. When the distance from a house to a high-speed rail station is larger than d, the effects of positive and negative factors will be minimal, as the radiation effects of high-speed rail stations diminish. The effects of a high-speed rail station on housing prices will be insignificant in this instance.

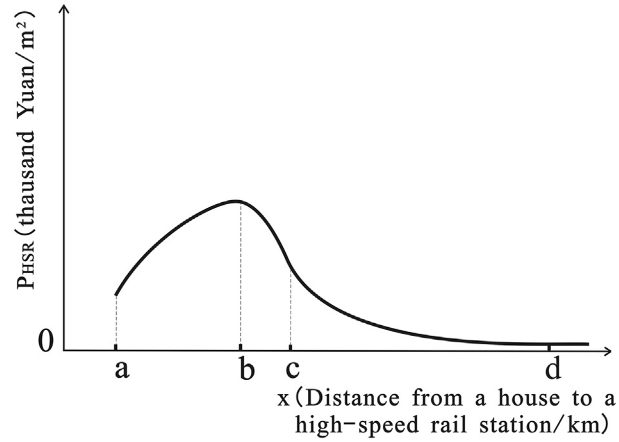

Fig. 3. Hypothesis of spatial variation in the effects of a high-speed rail station on housing prices.

4. Research data and model

4.1. Data source

The data used in this research were mainly collected from the National Real Estate Market Data Center, which is recognized by the Chinese society. In addition, data from websites such as SouFun (http://bj.fang.com) and Homelink Real Estate (http://bj.lianjia.com) were used as supplementary data. The data used include information on average unit prices, house ages, locations, plot ratios,

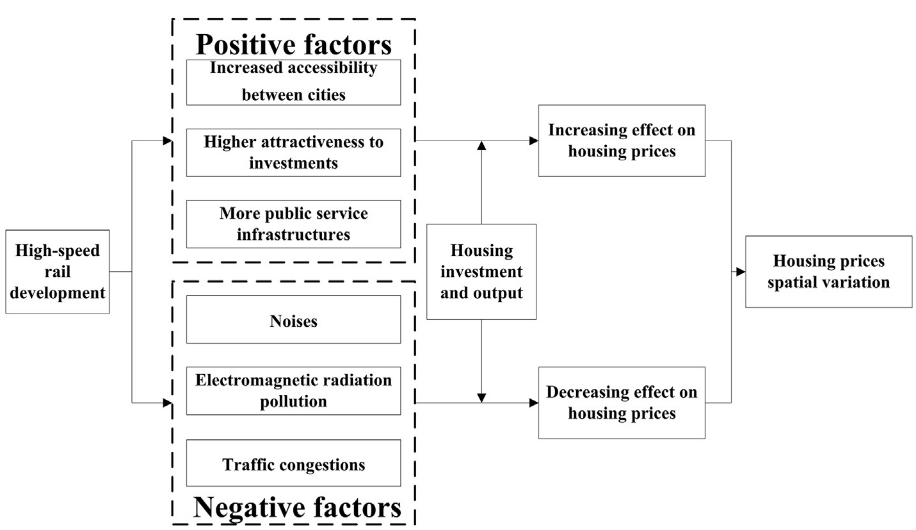

Fig. 2. The mechanism for the effect of a high-speed rail station on housing prices.

Table 2
Explanatory variables and definitions.

Variable	Symbol	Variable definition	Measurement	Minimum	Maximum	Average	Expected sign
Price	P	Average unit price of the residential district in May of 2013	1 thousand Yuan/m^2	6.091	165.402	28.625	
Neighborhood							
D_Hsr	x_1	Distance to the high-speed rail station	1 km	0.475	13.259	6.1	+ or −
D_PS	x_2	School district of major primary school	Yes = 1, No = 0	0	1	0.27	+ or −
D_MS	x_3	School district of major middle school	Yes = 1, No = 0	0	1	0.09	+ or −
D_University	x_4	Distance to the nearest university	1 km	0.413	6.142	3.2	+
D_Hospital	x_5	Distance to the nearest hospital (3C and above)	1 km	0.125	5	2.6	+
D_Supermarket	x_6	Distance to the nearest supermarket (large-scale supermarket, i.e., Merry Mart, CSF market, Wal-Mart, etc.)	1 km	0.135	3.9	1.9	−
D_Park	x_7	Distance to the nearest park (large-scale)	1 km	0.339	5.1	2.7	−
D_CBD	x_8	Distance to the nearest CBD business center (mid- to high-end business center, i.e., Sanlitun, Modern, Qianmen, etc.)	1 km	0.126	16.0	5.8	−
D_Government	x_9	Distance to the nearest government agency (i.e. Beijing municipal and county government, subordinate ministry of the State Council, municipal and provincial-level unit, and Beijing office)	1 km	0.3	9.7	5.1	−
D_TA	x_{10}	Distance to the nearest tourist destination (National 2A–5A level scenic location)	1 km	0.2	11.4	4.4	−
D_Metro	x_{11}	Distance to the nearest metro station	1 km	0.1	5.03	2.89	−
District characteristics							−
Ring12	x_{12}	Located within the second ring	Yes = 1, No = 0	0	1	0.12	+
Ring23	x_{13}	Located between the second and third ring	Yes = 1, No = 0	0	1	0.18	+
Ring34	x_{14}	Located between the third and forth ring	Yes = 1, No = 0	0	1	0.27	−
Ring45	x_{15}	Located between the fourth and fifth ring	Yes = 1, No = 0	0	1	0.41	−
Building structures							
S_Age	x_{16}	House age	One year	0	36	10	−
S_PR	x_{17}	Plot ratio	0.1	0.2	12	2.4	−
S_Gratio	x_{18}	Greening ratio	0.1	0.07	0.63	0.35	+
S_Deco	x_{19}	Upgraded decorations	Yes = 1, No = 0	0	1	0.26	+

greening rates, etc. for residential districts as of June of 2013. Government housing projects such as unit housing, capped-price housing, affordable housing, etc. were removed from the sample data. A total of 896 housing samples from near the Beijing South Railway Station and within the Fifth Ring Road in Beijing were selected. Information on three factors that affect housing prices was gathered. A total of 19 explanatory variables were examined (as shown in Table 2).

4.2. Model specification

Drawing from recommendations regarding the hedonic pricing model provided by previous scholars (Rosen, 1974; Freeman III, 1979), this study uses model 1 to build the housing hedonic pricing model. This study also uses SPSS17.0 to perform a multiple regression analysis, using the ordinary least squares (OLS) method to estimate unknown parameters and to obtain the regression model. We obtained the best model after performing statistical tests on regression coefficients.

$$P = \alpha + \beta_{1,1}x_1 + \beta_{1,2}/x_1 + \beta_{1,3}\Big/x_1^2 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \ldots + \beta_{19}x_{19} + \varepsilon \quad (1)$$

In model 1, P represents the housing price; x_i is the characteristic variable; α, β are the unknown parameters; ε is the error term.

5. Results and discussion

We performed hedonic pricing model calculations for data of 896 housing samples using SPSS17.0, and we obtained the regression coefficients (Table 3).

According to the results of the hedonic pricing model (Table 3), of the 19 characteristic variables examined, houses that are located in a school district that includes a major primary or middle school have the greatest absolute values. For example, housing located in major primary or middle school districts are 1.289 thousand Yuan/m^2 and 1.071 thousand Yuan/m^2 more expensive, respectively, than those that are not. Thus, school districts have the greatest impact on housing prices. This phenomenon is attributable to the fact that residents place more emphasis on children's education, and thus homebuyers are more concerned with the caliber of educational and cultural facilities in nearby areas when making purchase decisions. Houses within school districts that include major primary or middle schools are attractive to many buyers; this finding is largely consistent with existing research results (Wen, Bu and Qin, 2014; Wen, Zhang and Zhang, 2014). The next variable with the greatest impact is the distance to the nearest CBD business center. For example, as the distance to a CBD business center becomes 1 km shorter, housing prices increase by 1.758 Yuan/m^2. This is attributable to the fact that CBD business centers are hubs for many financial, informational and service-related facilities; employment opportunities are relatively centralized in CBD business centers, and income levels in these areas are also higher on average. To achieve job-housing balance, homebuyers are more willing to purchase houses closer to a business center to cut commuting costs. As a consequence, the impact of this characteristic variable on housing prices is relatively significant. The next variable with the greatest impact is the distance to the nearest metro station. This can be attributed to the fact that metro stations make daily travel more convenient. Especially given congestion problems in Beijing, the metro has become a convenient mode of city transportation, and business owners also tend to set up businesses close to metro stations; thus, metro stations have a considerable impact on housing prices. The variables with the lower impact are distances to the nearest hospital, supermarket, and government facility. This is attributable to the fact that individuals typically do not need to visit

Table 3
Housing hedonic pricing model calculation results.

Independent Variable	Unknown Parameters	B	t Value	Sig.	Tolerance	VIF
Constant Term		8.752	3.503	0.012		
D_Hsr	$\beta_{1,1}$	−0.011***	−2.795	0.001	0.722	1.385
	$\beta_{1,2}$	2.092***	4.684	0.003	0.713	1.403
	$\beta_{1,3}$	−0.951***	−2.893	0.002	0.784	1.276
D_PS	β_2	1.289***	4.427	0.003	0.721	1.387
D_MS	β_3	1.071***	3.698	0.007	0.719	1.391
D_University	β_4	−0.691*	−5.469	0.012	0.822	1.217
D_Hospital	β_5	−0.636***	−4.352	0.021	0.709	1.410
D_Supermarket	β_6	−0.617**	−5.183	0.018	0.727	1.376
D_Park	β_7	−0.731**	−3.282	0.017	0.673	1.486
D_CBD	β_8	−1.758***	−4.294	0.026	0.729	1.372
D_Government	β_9	−0.307*	−5.306	0.021	0.716	1.397
D_TA	β_{10}	−0.379*	−3.373	0.010	0.648	1.543
D_Metro	β_{11}	−1.681***	−4.189	0.009	0.715	1.399
Ring12	β_{12}	1.364*	7.185	0.013	0.858	1.166
Ring23	β_{13}	0.813*	6.284	0.002	0.671	1.490
Ring34	β_{14}	0.469*	3.472	0.014	0.726	1.377
Ring45	β_{15}	0.248*	4.293	0.012	0.714	1.401
S_Age	β_{16}	−0.719*	5.205	0.007	0.703	1.422
S_PR	β_{17}	−0.517**	3.375	0.005	0.651	1.536
S_Gratio	β_{18}	0.702*	6.241	0.009	0.785	1.274
S_Deco	β_{19}	0.385*	3.606	0.005	0.691	1.447

Note: The dependent variable is Price. ***, ** and * represent significance levels of 1%, 5% and 10%, respectively. The sample size is 896; the adjusted R-square = 0.8149; F = 73.95 (1% significance level); DW = 1.927; Obs*R-squared = 27.436, Probability = 0.109.

a hospital of level 3C and above, shop at a large-scale supermarket, or visit a government facility on a regular basis. The impact of these variables on housing prices is less significant because residents depend less on these features.

To further examine the effects of certain characteristic variable (D_Hsr) on housing prices, assuming that all other variables are held constant, we reorganized the function of the hedonic pricing model and acquired the following exponential form:

$$P_{\mathrm{HSR}} = -0.951\Big/x_1^2 + 2.092/x_1 - 0.011x_1 \tag{2}$$

In model 2, P_{HSR} represents housing hedonic price for high-speed rail station; the relationship between P_{HSR} and x_1 is indicated in Fig. 4.

In order to find out the effects of the Beijing South Railway Station on housing prices as the distance increases, we take the derivative of model 2 and get model 3.

$$P_{\mathrm{HSR}'} = 1.902\Big/x_1^3 - 2.092\Big/x_1^2 - 0.011 \tag{3}$$

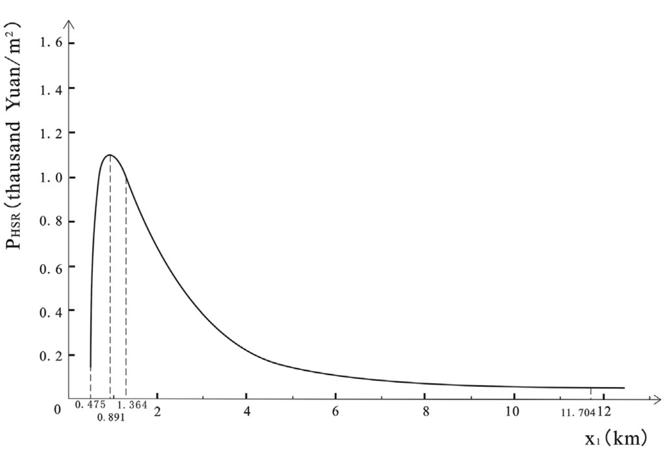

Fig. 4. Function curve for P_{HSR}–x_1

With the purpose of obtaining the effects of the Beijing South Railway Station on the rate of housing prices change as the distance increases, we take the derivative of model 3 and get model 4.

$$P_{\mathrm{HSR}}'' = -5.706\Big/x_1^4 + 4.184\Big/x_1^3 \tag{4}$$

From $P_{\mathrm{HSR}'} = 0$ in model 3, we can get $x_1 = 0.891$, that is, when $x_1 \in (0.475\ \mathrm{km},\ 0.891\ \mathrm{km})$, $P_{\mathrm{HSR}'} > 0$, indicating that within this distance range, housing price increases with an increase in distance. Besides, when $P_{\mathrm{HSR}}'' < 0$, the rising rate of housing prices therefore declines with an increase in distance.

From $P_{\mathrm{HSR}}'' = 0$ in model 4, we can get $x_1 = 1.364$. In other words, when $x_1 \in (0.891\ \mathrm{km},\ 1.364\ \mathrm{km})$, $P_{\mathrm{HSR}'} < 0$ and $P_{\mathrm{HSR}}'' < 0$. Thus, within this distance range, housing price declines with an increase in distance, and the descending rate of housing prices rises with an increase in distance.

When $P_{\mathrm{HSR}} = 0.043$, $x_1 = 11.704$ km, that is the hedonic price of high-speed rail station is only 0.043 thousand Yuan/m^2, which indicates that the effects of high-speed rail station on housing prices is insignificant in this instance. Therefore, when $x_1 \in (1.364\ \mathrm{km},\ 11.704\ \mathrm{km})$, $P_{\mathrm{HSR}'} < 0$ and $P_{\mathrm{HSR}}'' > 0$. It demonstrates that housing price declines with an increase in distance, and the descending rate of housing prices decreases with an increase in distance within this distance range.

6. Conclusions

The Beijing high-speed rail station has had certain effect on housing prices within a 11.704 km radius from the station, and the effects vary depending on geographical spatial ranges. Within distance ranges of (0.475 km, 0.891 km), (0.891 km, 1.364 km), and (1.364 km, 11.704 km) to a high-speed rail station, housing prices and the distance between a house and high-speed rail station are positively correlated, negatively correlated, and negatively correlated, respectively. This is attributable to the fact that spatial variation in housing prices results from the combined positive and negative effects of high-speed rail stations. Positive effects include increased accessibility between cities, higher investment attractiveness, and greater access to public service infrastructure. Negative effects include increased traffic congestion, electromagnetic radiation pollution, noise, and crime rates in areas close to a high-speed rail station. The effects of a high-speed rail station on housing prices discussed in this study suggest new ways of approaching regulations on housing price premiums or discounts related to high-speed rail station construction. Rather, the costs of high-speed rail development in addition to the combined effects of price increases or decreases in nearby real estate markets provide for a theoretical basis to determine real estate premium returns and disturbance compensation. On one hand, by the influence of high-speed rail station, housing price declines with an decline in distance between houses and high-speed rail stations within (0.475 km, 0.891 km), and thus we recommend that compensation by provided for homeowners in regions affected due to negative high-speed rail station impacts in nearby areas such as traffic congestion, noise, electromagnetic radiation pollution and increased crime rates. On the other hand, housing price increases with an decline in distance between houses and high-speed rail stations within (0.891 km, 11.704 km), and thus premiums obtained from residential land-transferring fees due to high-speed rail station construction should be used for the construction of affordable housing.

While a house's proximity to a CBD business center or metro station and whether a house is located in a desired school district also affects housing prices on a certain level, though proximity to the nearest hospital, supermarket or a government facility is less impactful. So, the following integrated and comprehensive approach should be applied when planning future high-speed rail station development projects: the high-speed rail station space and land use and urban city layouts should be integrated. For example, CBD business centers, metro stations, major primary and middle schools should be positioned within the radiation radius of a high-speed rail station in order to maximize the benefits of this form of infrastructure while facilitating real estate market development.

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