

## City House Price Premium Brought by High-speed Rail

Yanfang Deng\*

Shanghai University, Jiading Town, Jiading District, Shanghai, China

dengyanfang116@163.com

**Keywords:** High-speed rail; House price; Population size; GDP

**Abstract.** As an important transportation infrastructure in China, high-speed railway construction has an important impact on housing price. Based on the housing price data of 31 new cities and cities from 2013 to 2015, the urban housing price decomposition model was built to analyze the impact of high-speed rail on the real estate price. Study found that: (1) the high-speed rail is significantly improved the city's real estate prices, mainly reflected in the urban population and GDP to house prices expected effect, the effect of the current period and late effect; (2) the changes in population and GDP caused by high-speed rail have significant heterogeneity on the impact of housing prices in cities of different sizes. Specifically, the population size brought by high-speed rail has a significant impact on housing prices in middle cities. In addition, the GDP change brought by high-speed rail has a significant impact on housing prices in small and medium-sized cities.

### Introduction and Literature Review

As an important carrier and core of China's "The Belt and Road" strategy promotion, the development of high-speed railway has been highly valued by the state. At present, there are many related studies in the academic world on the connection between transportation infrastructure construction and social economic development (Zhang Lixin and Qin Junwu, 2014).

In theoretical research, there are mainly land rent theory, consumer theory and market supply and demand theory. The theory of land rent was first proposed by Du Neng (1826). It is believed that land rent and transportation cost are important factors in determining land price. Haig (1926) based on this theory, studies the relationship between transportation infrastructure, land supply and housing prices, and provides a useful framework. Lancaster (1966) argues that consumers maximize their utility by choosing a range of characteristics of their homes, and the implied prices corresponding to these characteristics ultimately constitute the market price of the home.

In the empirical research, the existing empirical research conclusions on the impact of transportation facilities construction on housing prices have certain differences. There are mainly the following points: (1) Transportation infrastructure has significantly increased the prices of surrounding cities (Dueker and Bianco, 1999). (2) The impact of transportation infrastructure on house prices is not obvious (Gatzlaff and Smith, 1993). (3) Transportation infrastructure has a significant negative impact on house prices (Forrest, 1996).

In general, existing studies on the link between transport infrastructure and housing prices can be divided into two categories. The first category studies the impact of specific urban traffic lines on the housing prices of surrounding buildings from a micro perspective. Most data used are the housing prices of specific buildings (Liu guiwen and Hu guoqiao, 2007). The second category studies the impact of transportation infrastructure investment on the housing price in many cities from a macro perspective. The housing price data adopted are mainly panel data of prefecture-level cities (Gong weijin and Xu chunhua, 2017). However, neither of these studies focuses on what effects high-speed rail has had on cities, and how these effects are reflected. In other words, there are two important problems : (1) the effect of high-speed rail; The impact of high-speed railway construction on the housing price usually has three periods. The first is the construction period of high-speed railway, and there is a prophase effect. House prices are sensitive to the smell of the market, so they react quickly; Then there are the current effects brought by the opening period of high-speed railway and the later effects after the opening of high-speed railway. (2) urban heterogeneity. The first kind of research ignores the heterogeneity between cities, which leads to the

general conclusion. The second type of research ignores the heterogeneity between different buildings in the city, which leads to low accuracy of the results.

In this paper, 31 cities with newly opened high-speed railway stations and urban housing price data in 2014 are used to investigate the impact of changes in population size and GDP brought by high-speed railway construction on urban housing price by using the decomposition model of urban housing price, and discuss the difference of its impact on different types of cities. Specifically, the main contributions of this paper are as follows: first, based on micro data, this paper studies the impact of changes in population size and GDP brought by high-speed railway construction on housing prices in specific cities from macro and micro perspectives, and comprehensively considers the macro factors affecting housing prices in cities. Secondly, the heterogeneity of different cities is taken into the research framework to discuss the impact of high-speed railway construction on different types of cities.

### The Urban House Price Decomposition Model and Variable Description

**Model Building.** This paper refers to the model constructed by Zhang Minghong (2017) to investigate the linear relationship between the impact of high-speed rail on housing prices and population and GDP in different periods of high-speed rail construction, as follows:

$$\begin{aligned}
 price^k\_n &= f(population^k\_n, GDP^k\_n, dum^{period}\_n, CV) \\
 &= \alpha_{0n} + \alpha_{1n} \times population^k_n + \alpha_{2n} \times GDP^k_n + \gamma_{0n} \times dum^{period}_n + \gamma_{1n} \times dum^{period}_n \times \\
 &population^k_n + \gamma_{2n} \times dum^{period}_n \times GDP^k_n + \beta CV + \varepsilon_n^k. \quad (1)
 \end{aligned}$$

Where, subscript n represents the year, k represents the city,  $n=2013, 2014, 2015$ , Respectively represent expected effect, current effect and late effect.  $price^k\_n$  indicates the price of housing transactions in a specific city in a certain year;  $population^k\_n$  indicates the population size of a particular city in a certain year;  $GDP^k\_n$  represents the total GDP of a city in a year;  $CV$  represents the control variable. In the model, three periods of dummy variables are constructed based on the three periods of high-speed rail construction  $dum^{period}\_n$ , defined as:

$$dum_n^{period} = \begin{cases} 0, & \text{control period} \\ 1, & \text{current period} \end{cases} \quad (2)$$

Therefore: when in the control period,

$$f(dum_n^{period} = 0) = \alpha_{0n} + \alpha_{1n} \times population_n^k + \alpha_{2n} \times GDP_n^k + \beta CV + \varepsilon_n^k. \quad (3)$$

When in the processing period,

$$\begin{aligned}
 f(dum_n^{period} = 1) &= \alpha_{0n} + \gamma_{0n} + (\alpha_{1n} + \gamma_{1n}) \times population_n^k + (\alpha_{2n} + \gamma_{2n}) \times GDP_n^k \times \\
 dum_n^{period} &+ \beta CV + \varepsilon_n^k. \quad (4)
 \end{aligned}$$

Therefore, the effect of high-speed rail on house prices in different periods is:

$$\Delta_n = f(dum_n^{period} = 1) - f(dum_n^{period} = 0) = \gamma_{0n} + \gamma_{1n} \times population_n^k + \gamma_{2n} \times GDP_n^k. \quad (5)$$

The expression of  $\Delta_n$  shows that the effect of the expected effect, current effect and late effects of high-speed rail on house prices in different periods is linear and varies with variables. In this paper, the population size and GDP change between cities in 2013, 2014 and 2015 did not exceed 10%. Therefore, when examining the effects of specific cities, this paper focuses on the coefficient signs and their sizes of related variables. The settings are shown in Table 1.

Table 1 Specific effect table

	Expected effect		Current effect		Late effect	
Control period	—		2013		2014	
Processing period	2013		2014		2015	
Expression	$\Delta_{2013}$		$\Delta_{2014}$		$\Delta_{2015}$	
Specific values	Dhp between 2013 and previous		Dhp between 2014 and 2013		Dhp between 2015 and 2014	
Effect reference value	Rvcd between 2013 and previous		Rvcd between 2014 and 2013		Rvcd between 2015 and 2014	
	Pop vcd between 2013 and previous	GDP vcd between 2013 and previous	Pop vcd between 2014 and 2013	GDP vcd between 2014 and 2013	Pop vcd between 2015 and 2014	GDP vcd between 2015 and 2014

Comment: Dhp indicates the difference in house prices; vcd indicates variable coefficient difference; Rvcd indicates Related variable coefficient difference.

If the coefficient of  $dum^{period} _n$  is significantly positive, it means that the high-speed rail does have a lifting effect on house prices; if the coefficient of  $population^k _n$  is significantly positive, it means that the effect of high-speed rail on house prices gradually increases with the increase of population size; likewise, if the coefficient of  $GDP^k _n$  is significantly positive, It shows that the effect of high-speed rail on housing prices gradually increases with the increase of GDP; if there are significant differences in the coefficients of these three variables in the comparison of different stages, it means that the effect of high-speed rail on housing prices changes with time.

**Variable Selection.** (1) The variable being interpreted. The explanatory variables are the housing transaction prices for 2013, 2014 and 2015 for the newly opened high-speed rail cities in 2014.

(2) Explain the variables. This paper selects the population of population in 2013, 2014 and 2015 of 31 cities in the 2014 new high-speed rail station as the explanatory variables of the focus. In addition, gross domestic product (GDP) variables were added to study.

(3) Control variables. In addition to the main population and GDP variables, in order to more comprehensively control the role of other factors, the model introduces the average area (pccon) of each housing control variable, it is the quotient of the total area of housing and the number of housing units. The details are shown in Table 2:

Table 2 Variable Selection

	variable	Variable meaning	unit
Explained variable	<i>price</i>	City house price level	Yuan/square meter
Explanatory variable	<i>population</i>	Urban permanent population	Ten thousand
	<i>GDP</i>	City GDP	billion
Control variable	<i>pccon</i>	Average area per house	Household/square meter

### Statistical Description

**Statistical Description.** This paper selects 31 cities that opened new high-speed rail stations in 2014, and studied the impact of the high-speed rail opening on the urban population size and GDP in 2013, 2014 and 2015, and explored the population size and GDP before and after the opening of the high-speed rail. A mechanism for the impact of urban housing prices. The statistical results are shown in Table 3:

Table 3 Descriptive statistics

variable	sample	Mean	Standard deviation	minimum	maximum
Price_2013	30	4919.167	1773.518	3043	10692
Population_2013	31	343.3045	215.7448	23.55	928.521
GDP_2013	31	1522.163	1862.287	112.26	7650.8
Pccon_2013	30	106.7441	11.08255	84.98991	131.3582
Price_2014	30	4922.452	1745.742	2699	10239
Population_2014	31	341.508	214.817	24.13	954.21
GDP_2014	31	1623.965	1944.086	106.62	7655.6
Pccon_2014	30	105.6576	10.41518	86.41603	131.1519
Price_2015	30	4802.806	1709.564	2595	9788
Population_2015	31	344.8206	217.6357	24.39	960.63
GDP_2015	31	1704.387	2019.416	94.86	8003.92
Pccon_2015	30	107.3188	11.27705	88.43574	135.701

**Visual Evidence.** It can be observed from Figure 1 that the trend of urban real estate prices in the three periods following the construction of high-speed rail in 2013, the opening of high-speed rail in 2014 and the opening of high-speed rail in 2015, led to the following three trends:

(1) Most cities have higher house prices in 2013 than in 2013; the impact of high-speed rail construction on house prices may be due to the current effect of opening.

(2) Some cities have higher housing prices in 2013; the impact of high-speed rail construction on housing prices may be due to the expected effects of the construction period.

(3) Some cities have higher housing prices in 2015; the impact of high-speed rail construction on housing prices may be due to the later effects of the opening of the car.

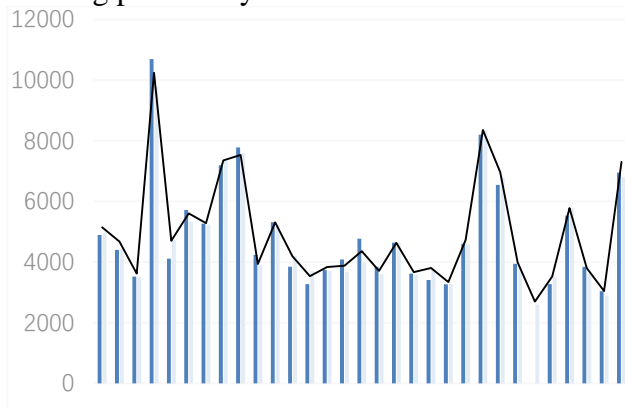


Fig. 1 Trends in housing prices

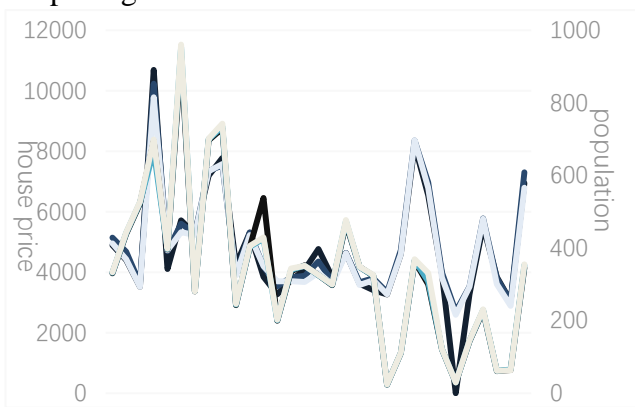


Fig. 2 Trends in house prices and population size

So, what is the impact between urban housing prices and population size? From Figure 2, we infer that:

- (1) Urban housing prices and population size have the same trend;
- (2) The urban population and housing prices are positively correlated.

In addition, what is the trend between urban housing prices and GDP? The following results can be derived from Figure 3:

- (1) Urban housing prices have the same trend as GDP;
- (2) GDP and housing prices are positively correlated.

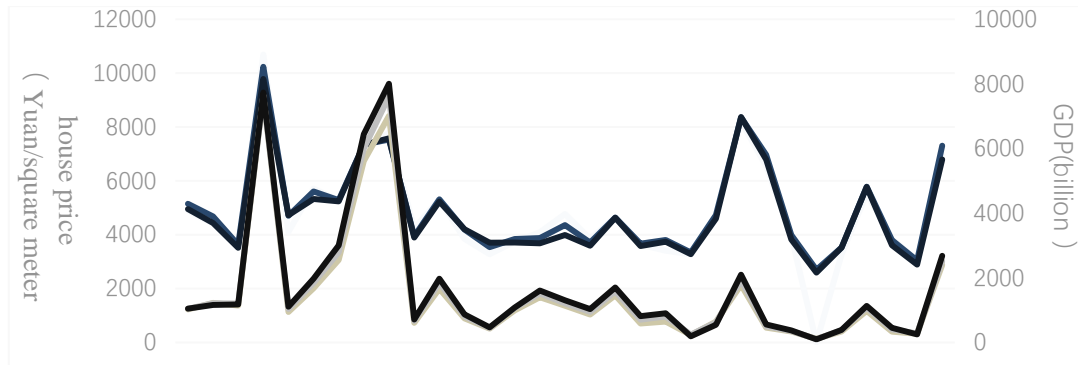


Fig. 3 House price and GDP trend chart

### Empirical Analysis

Table 4 shows the overall regression results, which can be clearly seen from the columns in Table 4 of (1)(2)(3):

(1) There is a significant positive correlation between population and house prices when controlling other variables.

(2) There is also a significant positive correlation between gross domestic product (GDP) and house prices when controlling other variables.

(3) From 2013 to 2014, the population's influence on housing prices gradually increased, and it slowed down in 2015. Assume that 2013 is the control period and 2014 is the treatment period. The current effect of the population after the opening of the high-speed railway is 0.723. If 2014 is the control period and 2015 is the treatment period, the post-effect of the population after the high-speed railway is opened is -0.231. In summary, the effect of the population brought by high-speed rail on housing prices is mainly in the current period.

(4) From 2013 to 2015, GDP has different effects on housing prices. It is also assumed that 2013 is the control period, and in 2014, the current effect of GDP after the opening of the high-speed rail is -0.109; assuming 2014 is the control period, and 2015 is the processing period, the later period of GDP after the high-speed rail is opened. The effect is 0.012. In summary, the effect of GDP caused by high-speed rail on housing prices is mainly reflected in expectations.

Table 4 Overall regression results

	(1) price_2013	(2) price_2014	(3) price_2015
population	2.475* (1.90)	3.198** (2.22)	2.967*** (2.10)
GDP	0.477*** (3.15)	0.368** (2.29)	0.380** (2.55)
pccon	-60.57*** (-3.12)	-65.18*** (-2.89)	-54.02** (-2.69)
_cons	9760.6*** (4.91)	10120.5*** (4.45)	8928.7*** (4.37)
<i>N</i>	30	31	31
<i>R</i> <sup>2</sup>	0.76	0.71	0.70
<i>Adj-R</i> <sup>2</sup>	0.74	0.67	0.67

*t* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

In Table 4, the paper initially analyzes the impact of population and GDP on housing prices. However, this article specifically considers the impact of high-speed rail opening on housing prices. The conclusions of (3)(4) obtained in Table 4 analyze the difference in the degree of influence of population and GDP on house prices each year. However, this paper considers the cities that opened

new high-speed rails in 2014. These cities have different degrees of development due to factors such as geographical location, business environment, and policy environment. Therefore, in order to make the paper more convincing, we performed the quantile regression of the selected 31 cities, and obtained the regression results of Table 5 and Table 6.

Table 5 shows the results of the quantile regression of population versus house price:

(1) In cities with a 90% grading, the population has little effect on house prices. The urban population size and GDP of the 90% grading have already had a relatively high scale. Before the city opened the high-speed rail, the house price has reached a certain height. Therefore, the impact of population and size on it is not large. It can be seen from the regression results that it is not significant.

(2) In cities with 10% grading, the impact of population on housing prices is even smaller or even negative. Cities with a 10% grading are relatively small in terms of population size and GDP. The opening of high-speed rail in cities is, to a large extent, not driven by economic development. The bigger possibility is the policy environment.

(3) For the cities with intermediate quintiles, the population has a greater impact on housing prices, especially 75% of the cities above. These cities are more under the economic development, and high-speed rail has become a necessity. Therefore, the increase in the population of the high-speed rail has directly affected the urban housing prices.

(4) In the cities with intermediate quintiles, the expected effects, current effects and late effects of the high-speed rail opening population on housing prices are different in each quintile. It can be seen that the 25% grading city, due to the opening of the high-speed rail, the population size has the greatest impact on housing prices, that is, the current effect is the most significant, and the regression results also demonstrate this point. For the 50% grading city, the expected effect is more significant. In addition, it is assumed that 2014 is the control period and 2015 is the processing period, and the difference between the two is the later effect. It can be seen from the regression results that the late effects of the cities on the 25% and 50% quintiles are negative. The urban late effect on the 75% grading is 2.76, indicating that the population with large population and high GDP has a lagging effect on the housing price caused by the high-speed rail.

Table 5 Quantile regression results of population versus house price

Explained variable: price					
	q10	q25	q50	q75	q90
population_2013	-0.185 (-0.18)	0.995 (1.13)	2.849* (1.76)	2.867 (1.16)	1.819 (0.51)
population_2014	0.0405 (0.02)	2.558** (2.52)	2.384** (2.46)	2.639 (0.65)	1.090 (0.19)
population_2015	-0.681 (-0.44)	2.241 (1.67)	2.014 (0.74)	5.399* (1.76)	0.613 (0.11)
N	31				

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 6 shows the quantile regression results of GDP versus house prices:

(1) In cities with 75% and 90% grading, GDP has less impact on house prices. By the same token, urban development on the 75% and 90% grading levels is relatively mature, so the impact is small.

(2) In cities with 10%, 25%, and 50% grading, GDP has a significant impact on house prices. Explain that after the opening of high-speed rail in small cities, GDP has a significant increase, which will promote the rise of housing prices.

(3) The impact of GDP on housing prices gradually decreases as the city's grading increases. The larger the city, the smaller the impact of GDP on house prices; conversely, the smaller the city, the greater the impact of GDP on house prices.

(4) In the low-divided cities, the expected effect, current effect and later effects of GDP on the

high-speed rail have the same trend. Similarly, assume that 2013 is the control period and 2014 is the processing period, and the subtraction yields the current effect. From the regression results, the current effects at the 10%, 25%, and 50% gradings can be calculated as -0.16, -0.203, and -0.072, respectively, indicating that the current effect has no expected effect. In addition, it is also assumed that 2014 is the control period and 2015 is the processing period, and the difference between the two is the later effect. The late effects under the three quintiles (10%, 25%, and 50% grading) were calculated to be 0.038, 0.021, and 0.029, indicating a certain late effect. But in general, the expected effect of high-speed rail opening GDP on housing prices is the biggest.

Table 6 Quantile regression results of GDP versus house prices

Explained variable: price					
	q10	q25	q50*	q75	q90
GDP_2013	0.693*** (4.89)	0.595*** (4.74)	0.438** (2.30)	0.351 (1.03)	0.342 (1.00)
GDP_2014	0.587** (2.45)	0.392** (2.23)	0.366** (2.17)	0.351 (0.72)	0.262 (0.66)
GDP_2015	0.625*** (3.32)	0.413** (2.19)	0.395 (1.44)	0.144 (0.34)	0.316 (0.76)
N	31				

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Conclusion

This paper uses the city and house price data of the newly opened high-speed rail station in 2014 to analyze the impact of the population and GDP of the high-speed rail opening on housing prices; and through the quantile regression, to study the impact of high-speed rail on cities of different scales. Through the empirical analysis of the fourth part, the following conclusions are drawn:

(1) Overall, the main performance of population-to-household prices brought about by the opening of high-speed rail is the current effect; the main performance of GDP on housing prices is the expected effect. The high-speed rail construction period will attract more enterprises to enter the city and promote urban economic development. GDP will increase to a certain extent during the construction period of high-speed rail. Therefore, the expected effect of GDP on housing prices is greater. Only the high-speed rail officially opened will increase the mobility of the population, so the current effect of the population on housing prices is more significant.

(2) For small cities, the main effect of population-to-household prices brought about by the opening of high-speed rail is the late effect; the main performance of GDP on housing prices is the expected effect. The economic development of small cities is often weaker than that of big cities, so the labor force generally migrates from small cities to big cities. Only when the economic development level of small cities is improved will there be more entrepreneurial opportunities to attract more people into small cities. Therefore, the impact of GDP on housing prices must be before the impact of population on housing prices.

(3) For the smaller cities, the main performance of the population brought by the high-speed rail to the housing price is the current effect; the main performance of GDP on housing prices is the expected effect and the later effect. The opening of high-speed rail in smaller cities will increase the mobility of the population in the current period, but only if the GDP rises steadily will retain the population. Therefore, the development of smaller cities still needs the support of GDP.

(4) For medium-sized cities, the main performance of population-to-household prices brought about by the opening of high-speed rail is the expected effect; the main performance of GDP on housing prices is the expected effect and the later effect. Medium-sized cities have a keen sense of economics, so both population and GDP will rise during the construction period of high-speed rail.

(5) For larger cities, the main effect of population-to-household prices brought about by the

opening of high-speed rail is the late effect; GDP has no significant impact on house prices. Larger cities have a relatively complete development model, so the opening of high-speed rail mainly increases the mobility of dolls in the later period, but has little impact on GDP.

(6) For large cities, the population and GDP brought by the opening of high-speed rail have no significant impact on housing prices. The transportation infrastructure of big cities is relatively perfect. Even if there is no high-speed rail, other transportation facilities are relatively developed. Therefore, whether or not the high-speed rail is opened has no obvious impact on its population flow and GDP growth.

According to the research conclusions of this paper, the following policy implications can be obtained:

(1) Vigorously strengthen the economic development of small cities

The improvement of the level of economic development is the source of vitality for the city. The short-term reliance on state support is equivalent to "giving the fish" and can only temporarily cover up the nature of the problem, rather than solving the problem from the root cause.

(2) Continuously improve the transportation infrastructure of medium-sized cities

The development of medium-sized cities is the main body to improve the overall social and economic level. The economic pattern that is developed in the eastern coastal areas and the backwardness of the central and western regions is similar to the "bigger and smaller" deformed babies, which are difficult to survive.

(3) Layout the economic development of big cities rather than economic points

The big cities themselves have a well-developed transportation infrastructure, so they should focus on how to use the transportation infrastructure to develop the economy, instead of blindly rebuilding the high-speed rail. Excessive public facilities will waste resources and fail to reach the optimal state of economic development.

## References

- [1] M.H. Zhang, Q.Y. Zhang and R.B. Liang: Contemporary Finance and Economics, (2017) No.9, p. 3. (In Chinese)
- [2] L.X. Zhang, J.W. Qin: Contemporary Finance and Economics, (2014) No.11, p. 10. (In Chinese)
- [3] J. V. Duoneng: *The relationship between isolated countries and agriculture and the national economy* (Trans The Commercial, China 1986). (In Chinese)
- [4] J. Ding, Z.F. Li: Contemporary Finance and Economics, (2014) No.9, p. 18. (In Chinese)
- [5] R.B. Liang, Y. Tang: World Economy, (2008) No.10, p.71. (In Chinese)
- [6] G.W. Liu, G.Q. Hu: Urban Development Research, (2007) No.2, p.83. (In Chinese)
- [7] W.J. Gong, C.H. Xu: International Trade Issues, (2017) No.2, p.50. (In Chinese)
- [8] Z. Li, S.L. Zhou, H.F. Zhang, X. Yao and W. Wu: China Land Science, (2009) No.10, p.20. (In Chinese)
- [9] Q.Y. Tang, W. Xu and W.L. Ai: Economic Geography, (2012) No.2, p. 52. (In Chinese)
- [10] R. M. Haig: Quarterly Journal of Economics, Vol. 40 (1926) No.2, p.179.
- [11] A.K. J. Lancaster: Journal of Political Economy, Vol.74 (1966), No.2, p.132.
- [12] S.H. Rosen: Journal of Political Economy, Vol. 82 (1974), No.1, p.34.
- [13] K. J. Dueker, M. J. Bianco: Transportation Research Record, Vol.1685(1999) No.1, p. 171.
- [14] D. H. Gatzlaff, M. T. Smith: Land Economics, Vol. 69(1993), No.1, p.54.
- [15] D. Forrest: Journal of Transport Economics and Policy, Vol. 30(1996), No.1, p. 15.
- [16] B. G. Ohlin: Journal of Political Economy, (1935).
- [17] A. Marshall: Political Science Quarterly, Vol.77(2004) No. 2, p.519.
- [18] P. Krugman: Journal of Political Economy, Vol. 99(1991) No.3, p.483.
- [19] D. J. Graham, A. Couto, W. E. Adeney and S. Glaister: Transportation Research Part E: Logistics and Transportation Review, Vol. 39(2003) No.6, p.443.
- [20] S. Gruber, L. Marattin and Taxation: Papers in Regional Science, Vol. 89(2010) No. 1, p.203.