The Impact of Urban Rail Transit on Surrounding Residential Prices--Line 1 of Chengdu Metro as an Example

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Abstract

This article aims to build a hedonic price model of the research region by making a summary of relevant research in this field, and taking the running Line 1 of Chengdu Metro as an example. To be specific, the research discusses the influence of Line 1 of Chengdu Metro on surrounding residential prices taking samples of the estates within 2 km of Line 1 within a spatiotemporal perspective. The results shows that: after the operation of Line 1 (from July in 2010 to June in 2011), the growth rate of the residential prices has been increased by 5.89%, 9.44%, 12.45% and 11.03% from 1st ring to the third ring respectively, reaching at an average rising rate of 9.51%. Besides, the residential prices far away from the downtown area were more likely to be found ahead than those around the city center and represented a far more sensitivity to the metro operation. By quantitative calculating, it finds that: regions that are closer to subway stations per meter from 1st ring to the third, the residential prices increased 0.91 Yuan/m^2, 1.16 Yuan/m^2 and 1.21 Yuan/m^2, respectively. At the same time, Line 1 of Chengdu Metro has been increased a total number of 7.814 billion Yuan up to now of surrounding residential value.

Keywords: Rail Transport, Hedonic Pricing Model, Residential Value, Chengdu Metro

1. Introduction

As the main way of urban public transportation, urban rail transport represents sorts of benefits not only in saving energy, reducing noise and pollution, but also getting a great conveyance ability, high speed, and arriving on schedule. At the same time, it can promote life space and convenience, change land-use intensity and pattern, boost economic development, and improve the investment of the environment, so as to stimulate the surrounding residential value.

From the beginning of the 21st century, many attentions have been paid on the effect of rail transport to the residential value in this area. John Henneberry and Bae C-HC (2003) have found that the rail transport has appeared to be an advanced influence on the around estates, which means the value-added had been generated ahead of operation of rail transport. According to Xiafei Ye (2002) and Xiangyang Fang et al. (2004), the impacts of rail transport on surrounding residential value also appeared to be advanced and currently. It turned out a diverse influential mechanism from the planning period, initial operational stage to mature operational phase. Moreover, Ying Hui (2002) believed the residential market along the line had a good response to two iconic events. Hongxia Liu et al. (2007) divided the influence of rail transport into three stages and considered this influence to be weakened dramatically, which would finally tend to be stable with the development of the operation of rail transport. By literature overview, it is clearly seen that the research about the greatest influence of rail transport on residential prices is not sufficient today. Therefore, this article tries to discuss the value-added effect and value-added law etc by taking Line 1 of Chengdu Metro as an example.

2. Model and Data

2.1 Model Design

In the research area of property value and rail transport, Hedonic Pricing Model is a widely model used. As the Hedonic Price Model has strong explanatory power, it can quantify the different factors affecting the value of real estate. At present, the developed countries 40% of real estate valuation in case of the use of Hedonic Price Model. This article chooses a linear function model to make quantitative analysis about the influence of Line 1 on surrounding residential prices. The following formula shows the details:

$$p_i = \alpha_0 + \sum_{k=1}^{m} \alpha_k X_{ki} + \eta d_i + \varepsilon_i \tag{1}$$

Where, P_i is the price of the i^{th} estate, which is the value of reaction asset, (Yuan/m^2); X_{ki} is the k^{th} attribute of the i^{th} estate; d_i is distance to the most recent station, (m); ε_i is the stochastic error; α_0, α_k, η are coefficients estimated. The coefficient η represents the average increment of the estate between the rail transit station and the estate by each changing unit of the distance.

2.2 Identification of Influential Area

How to confirm the influential area of urban rail transport has not come to an agreement all over the world. Thus, the scholars tended to identify the influential radius according to the structure of a city. Some Japanese academics did these research mostly selecting "2 km" as the radius of the influence, so did Chinese scholars Xiaosong Zhang (2005), Xiafei Ye (2002), Guang Chen (2004), Youxiao Chen et al. (2005). By considering that, this article would select 2 km as the influential radius for the study areas.

2.3 Characteristic Variables Design

According to the report which prepared by Hick Lewis Bros Inc (2002), the characteristic variables of the estates are roughly divided into three categories which are: Location feature variable, Architectural feature variable and Neighborhood feature variable. According to the characters of the study region, this article chooses 16 feature variables (Table 1) as independent variables and the average price of each estate to be regarded as the dependent variables.

Where, some characteristic variables are presented by virtual variables (1, 0) for they are difficult to quantify. Furthermore, due to the availability of the sample data, many variables such as the directions of the estates are not included in this model.

2.4 Data Sources and Processing

The data of this article comes from Chengdu Real Estate Portal. The article selects 81 estates within 2 km of Line 1 from July in 2010 to June in 2011. In order to get rid of the influence of residential prices by other factors such as supply-demand relations, policy factor etc, and the article introduces residential price index to revise the data.

3. The Analysis of the Impacts on Surrounding Residential Prices from the Line 1 of Chengdu Metro

Line 1 of Chengdu Metro opened to the public on October 1, 2010. The overall length is 18.5 km spreading throughout the downtown from north to south. Seventeen underground sites were set up and the total investment reached at about 8 billion Yuan. The operation of Line 1 contributed to relieve the pressure of ground traffic dramatically and efficiently alleviate the contradiction causing by the short supply of the along regional transportation. Besides, the traveling conditions and environment were improved as well.

3.1 Analysis of the Time Benefit

This article makes a comparison of the sample data to get the result of Table 2. According to the unique regional loop of Chengdu, this article uses Ring 1, Ring 1-2, Ring 2-3, and Ring 3 to represent.

From Table 2, when it compares with Line 1 before three month of the running, the average price of the surrounding residences went up from 8092 Yuan/m^2 to 8862 Yuan/m^2 with an increasing of 770 Yuan/m^2 and a growth rate at 9.51%. The value-added benefit of Line 1 on surrounding residential prices is obviously, while it is unbalanced. By comparing, the value-added is 536 Yuan/m^2 in Ring 1 and the rest are 776 Yuan/m^2 in Ring 1-2, 939 Yuan/m^2 in Ring 2-3, and 827 Yuan/m^2 in Ring 3, reaching a growth rate of 5.89%, 9.44%, 12.45% and 11.03%, respectively. Within the influence range of Line 1, value-added subway benefit assumes to be more easily received with a stronger influence as the houses are far away from downtown area gradually. The factors are not only for the optimization degrees and accessibility of traffic structure, but also its adequacies in the city centre which prove to be better than that outside the city ring. As a result, the Line 1 drives up a high residential price on the latter areas for the advantages of improving regional accessibility, life space and convenience etc.

By summering the research achievements of Guoqiao Hu (2008), we can get two increment peaks from the data of urban rail and surrounding residential prices. The first wave came after the urban rail planning issues, and the second one could be found after the operation of the rail. We make a statistical analysis of the sample estates at the time point which achieves to maximum prices (Figure 1). Since a few number of samples in Ring 1-2, this article merges Ring 1 and Ring 1-2 into Ring 2 in the rest analysis.

Figure 1 shows that: in the sample estates of Ring 2, maximum prices concentrate in June 2011 mostly, so did in May 2011 of Ring 2-3 and in March 2011 of Ring 3 as well. The first step conclusion could be got: the maximum value-added timing point of Line 1 of Chengdu Metro on surrounding residential prices is not consistent. The further residences away from down-town, the earlier maximum value-added timing appears. The fluctuation of prices is more sensitive to the operation of Line 1. On the contrary, the maximum value-added timing appears later.

3.2 Analysis of Space Benefits

3.2.1 Model Analysis

We establish a multivariate linear equation between surrounding residential prices of Line 1 and related characteristic variables with step-by-step regression method by using SPSS Statistical Software. At last, four characteristic variables of Ring 2 are kept into the model, which are dStation-line, dBus, dAge and Volume rate (Table 3).

The effect of the regression model is as follows: R=0.858, R^2=0.737 and the revised R^2= 0.684. Besides, Std. Error of the estimation is 0.0634. It indicates that the significant influence of all the independent variables on the dependent variable in the model is 68.4%. Obviously, the effect of the model is fine. The t value of variable dStation-line is -1.784 and the significant test value is 0.050. Therefore, it can get a regression equation as follows:

$$P=1.230-0.091X_1-1.003X_2-0.015X_8-0.013X_7 \quad (2)$$

The coefficient of dStation-line is 0.091, which means when it gets closer to the subway stations per meter; the unit price of each estate raises 0.19 Yuan/m^2.

The same five characteristic variables of Ring 2-3 in this model are dStation-line, Property, Gre-rate, dmShop, dAge (Table 4).

The effect of the regression model is as follows: R=0.918, R^2=0.843 and the revised R^2= 0.822. The Std. Error of the estimation is 0.067; it indicates that the significant influence of all the independent variables on the dependent variable in the model is 82.2%. And, the effect of the model is fine either. The t value of variable dStation-line is -1.828 and the significant test value is 0.048. So it can get a regression equation as follows:

$$P=0.529-0.116X_1+0.100X_{16}+0.667X_{15}+0.092X_{12}-0.007X_7 \quad (3)$$

The coefficient of dStation-line is 0.116, which means when it gets closer to the subway stations per meter, unit price of each estate raises 1.16 Yuan/m^2.

The same five characteristic variables of Ring 3 in the model are dStation-line, dBus, dmPark, Gre-rate, Volume-rate (Table 5).

The effect of the regression model is as follows: R=0.967, R^2=0.935, the revised R^2= 0.907. The Std. Error of the estimation is 0.0299, which indicates that the significant influence of all the independent variables for the dependent variable in the model is 90.7%. And the effect of the model is fine. The t value of variable dStation-line is -3.250 and the significant test value is 0.007. So it can get a regression equation as follows:

$$P=0.770-0.121X_1+0.055X_{10}-0.281X_2+0.317X_{15}+0.010X_8 \quad (4)$$

The coefficient of dStation-line is 0.121, which means when it gets closer to the subway stations per meter, unit price of each estate raises 1.21 Yuan/m^2.

3.2.2 Value-added Estimation of the Residences

The 81 sample estates in this article are all located within 2 km of Line 1. There are 30 sample estates within the Ring 1 and Ring 2, the total construction area achieves 1125916 m^2. The shortest distance from the estate to the subway station is 100 meters while the longest gets 1450 meters. Another 31 sample estates with a total construction area of 3706508 m^2 located in Ring 2-3 get the shortest distance of 222 meters and the longest distance of 2000 meters. The rest of 21 sample estates are spread around Ring 3, and the total construction area reaches at the largest of 3712751 m^2. In the meanwhile, the shortest distance is 506 meters and the longest distance is 1975 meters. In order to calculate the result conveniently, this article makes an assumption that the biggest influence point of Line 1 on surrounding residential prices is closest to the subway station. Conversely, the value-added falls down to zero at the greatest distance point. Therefore, the value-added value in per building square meters of each ring could be remarked with interpolation method as follows:

$$\Delta P_2 = (1450-775)*0.91=614.3 \quad (\text{Yuan/m}^2) \tag{5}$$

$$\Delta P_{2\text{-}3} = (2000-1111)*1.16=1031.2 \ (\text{Yuan/m}^2) \tag{6}$$

$$\Delta P_3 = (1978-1240.5)*1.21=888.8 \ (\text{Yuan/m}^2) \tag{7}$$

The value-added value of each ring is as follows:

$$V_2=\triangle P_2 * S_2=614.3*1125916=691650198.8 \quad (\text{Yuan}) \tag{8}$$

$$V_{2\text{-}3}=\triangle P_{2\text{-}3} * S_{2\text{-}3}=1031.2*3706508=3822151049.6 \ (\text{Yuan}) \tag{9}$$

$$V_3=\triangle P_3 * S_3=888.8*3712751=3299893088.8 \quad (\text{Yuan}) \tag{10}$$

The total value-added of line 1 of Chengdu metro

$$V=V_2 +V_{2\text{-}3} +V_3 =7813694337.2 \ (\text{Yuan}) \approx 7.814 \text{ billion} \tag{11}$$

4. Conclusions and Enlightenments

4.1 Conclusions

4.1.1 The operation of Line 1 of Chengdu Metro produced significant influences on surrounding residential prices. By analyzing the surrounding residential prices, it turns out that the average price raises 770 Yuan/m^2 with a growth rate at 9.51%. However, the value-added effect is unbalanced, which can be found when the value-added effect becomes gradually stronger as far away from the center to outer ring.

4.1.2 The timeliness of Line 1 of Chengdu Metro influencing on surrounding residential prices has diversity. By researching the time point of peak residential prices, it turns out the residential prices, which are far away from the downtown, trigger the "subway benefits" earlier. The prices get highest peak earlier than those near the city center and would be more sensitive to the operation of Line 1.

4.1.3 Line 1 of Chengdu Metro produces a remarkable value-added benefit on surrounding residences. We make a quantitative calculation of the value-added value in each ring. It shows that from the center to outside of the city, when it is one meter closer to subway stations, the price of the houses raises 0.91 Yuan/m^2, 1.16 Yuan/m^2 and 1.21 Yuan/m^2, respectively. The total value-added is about 7.814 billion.

4.2 Enlightenments

4.2.1 Promote the Joint Planning and Development Associated with Land Resources and Rail Transport

It aims to stimulate spatial development by focusing on the station sites and give priority to develop the property, underground commercial streets and underground parking garages. On the ground, the government should layout industries and properties with proper intensity and density reasonably according to the distance between sites, and finally realizes the difference of the area function. By the joint development and planning, we try to establish rail transport oriented the city land utilization, improving the surrounding land resources and achieving the maximum benefit of the land development.

4.2.2 Implement the Policies on Phased Transfer of Land and Differential Pricing

Due to the value-added influence of rail transport on surrounding residences is unbalanced, it is reasonable to adopt the differential pricing. The area where rail transport affects weakly should have smaller amplitude to raise the land prices. On the contrary, the area under strong influences, it is also reasonable to improve the land prices. At the same time, the land price within 2 km along rail transport should be strictly controlled as the reserve. At last, it is necessary to achieve a goal that realizes the healthy development of the land market by adopting phased transfer of land and bidding and avoid the blind development of some land enterprises.

4.2.3 Set up Interests of Return Mechanism

The huge construction costs have become a cumbersome problem of urban rail transport. Hence, the stakeholders would likely to get direct or indirect return of the value-added construction by establishing a mechanism according to a certain proportion. It is a great support for the rail transport construction. At the same time, it contributes to spur the construction of people's livelihood and sustainable development for economy.

References

Bae, C. Hc., & Park, H. (2003). The impact of Seoul Subway on residential property values. *Transport Policy*, 10, 85-94.

Chen, G. (2004). Based on the land profit value-added, the financing method of subway construction in Nanjing. *Modern Urban Research*, 6, 70-72.

Chen, Y. X., & Lin, X. Y. (2005). The impact of rail transit on the land price— the rail transit of Beijing as an example. Journal of Beijing jiaotong University, 3, 7-13.

Fang, X. Y., & Chen, Zh. Y. (2004). The impact of foreign urban rail transit on residential value. *Tropical Geography*, 3, 70-74.

He, F., & Wang, X. L. (2004). The influence of rail transit on residential value. *China Real Estate*, 9, 13-15.

Henneberry, J. (1998). Transport investment and house prices. *Journal of property Valuation and Investment*, 2, 144-158. http://dx.doi.org/10.1108/14635789810212913

Hick, L. B. (2002). The impact of transit on commercial property values. *Federal Transit Administration*. [Online] Available: http://cd.soufun.com/

Hu, G. Q. (2008). Research on about impact of rail transit on value of property—base on case study of Chongqing rail transit. *Chongqing university, master's degree thesis*.

Hui, Y. (2002). The research on urban planning and construction of the rail transit sites. *Urban Planning Forum*, 2, 30-34.

Liu, H. X., & Yu, R. W. (2007). The prediction of impact of urban rail transit on real estate development in Wuhan. *Shanxi Architecture*, 29, 32-33.

Ye, F. X., & Cai, W. (2002). The basic research on urban rail traffic development with the interest reduction method. *Journal of Railway*, 1, 97-103.

Ye, X. F., & Cai, W. (2002). The calculation of the development interests of rail transit. *Journal of Tongji University,* 4, 431-436.

Zhang, X. S., & Hu, Zh. H. (2005). The research on interest of the affected area of rail transit development. *Journal of Tongji University*, 8, 1118-1121.

Table 1. Residential feature variables of Chengdu

Number	Category	Variable name	Significance of the variables
X_1	Location features	dStation-line	The distance to the nearest rail transit site. (Km)
X_2		dBus	The distance to the nearest bus stop. (Km)
X_3		dmRoad	The conditions of the nearby roads, if the condition is good is (1), otherwise is (0).
X_4	Architectural features	dmType	Estate types, high-rise residential is (1), otherwise is (0).
X_5		dmDeco	Decorate degree, exquisite decoration is (1), simple decoration is (0).
X_6		Area	the total construction area of the estate. (m^2)
X_7		dAge	The age of the estate.
X_8		Volume-rate	The volume rate of the residential quarters.
X_9	Neighborhood features	dmRiver	Whether there is a river within 0.5 Km, yes is (1), no is (0).
X_{10}		dmPark	Whether there is a park within 0.5 Km, yes is (1), no is (0).
X_{11}		dmUni	Whether there is a park within 1 Km, yes is (1), no is (0).
X_{12}		dmShop	Whether there is a mass merchants within 1 Km, yes is (1), no is (0).
X_{13}		dmSch	Whether there is middle and primary schools Walking for 10 min, yes is (1), no is (0).
X_{14}		dmHospt	Whether there is a hospital Walking for 10 min, yes is (1), no is (0).
X_{15}		Gre-rate	Residential areas green rates. (%)
X_{16}		Property	Property fee.(Yuan/m^2)

Table 2. The change of residential prices before and after operation of Line 1 Unit: ten thousand Yuan

Region	Before operation	After operation	D-value	Growth rate (%)
Ring 1	0.9102	0.9638	0.0536	5.89
Ring 1-2	0.8222	0.8998	0.0776	9.44
Ring 2-3	0.7544	0.8483	0.0939	12.45
Ring 3	0.7501	0.8328	0.0827	11.03
Line 1	0.8092	0.8862	0.0770	9.51

Table 3. The partial regression coefficients of residential prices in regression equation within Ring 1 and Ring 2

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (constant)	1.230	.051		24.172	.000
dStation-line	-.091	.051	-.250	-1.784	.050
dBus	-1.003	.403	-.406	-2.490	.022
Volume rate	-.015	.007	-.271	-2.300	.032
dAge	-.013	.004	-.396	-2.872	.009

Table 4. The partial regression coefficients of residential prices in regression equation within Ring 2-3

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (constant)	.529	.099		5.321	.000
dStation-line	-.116	.064	-.143	-1.828	.048
Property	.100	.008	.777	13.249	.000
Gre-rate	.667	.221	.188	3.015	.006
dmShop	.092	.037	.194	2.467	.022
dAge	-.007	.004	-.118	-1.868	.045

Table 5. Each feature variables partial regression coefficient of residential prices regression equation in Ring 3

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (constant)	.770	.074		10.443	.000
dStation-line	-.121	.037	-.373	-3.250	.007
dPark	.055	.020	.242	2.830	.015
dBus	-.281	.094	-.268	-3.004	.011
Gre-rate	.317	.110	.303	2.885	.014
Volume rate	.010	.005	.146	1.875	.045

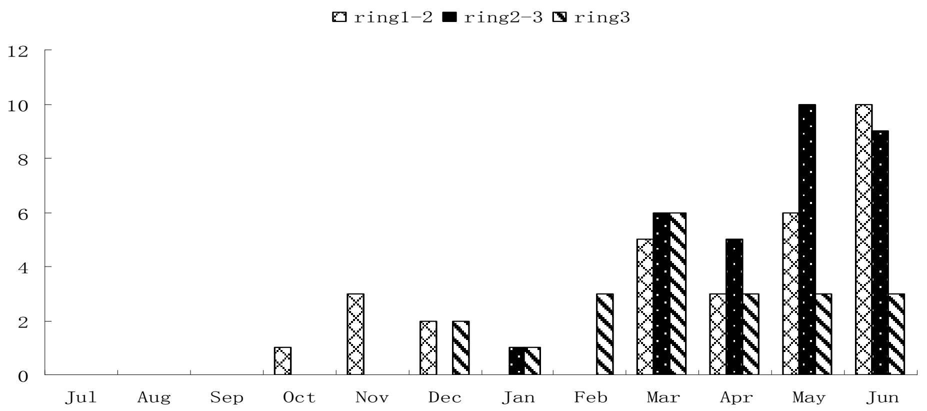

Figure 1. The time statistics of residential prices achieve maximum surrounding Line 1