Spatial Changes of Urban Housing Prices: Analysis of Traffic Costs Based on Taiyuan

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Abstract: In the modern society, traffic costs have become a key factor for residents to choose housing with increasing congestion for urban areas. The interaction between housing prices and traffic costs is getting closer. The convenience of traffic and the distance from the schools, hospitals and commercial centres will affect the traffic costs of residents, which in turn will affect the housing prices in urban. In terms of traffic convenience, this paper not only uses the number of bus stations within 1km to measure the bus convenience of housing, but also uses the number of lanes adjacent to the main street to measure the accessibility of street frontage. In terms of medical facilities, while considering the number of surrounding hospitals, the quality of hospitals is distinguished, which makes the traffic convenience of housing and the level measurement of medical facilities more comprehensive and the research results more reasonable and reliable. Through the empirical study of Taiyuan, Shanxi Province, the results show that the traffic costs can explain the price level of 41.7%. For each additional bus station near the residential area, the housing price will increase by 2.1%. For every street number, the housing price will increase by 1.3%. The school will increase the housing price by 7.3%. The distance from the business circle will increase by 3.1% for 1km. For each third, second and first class hospital within 3km of the housing, the price will increase by 0.6%, 1% and 3.2%.

1. Introduction

With the development of the national economy and the improvement of living standards, the residents' demands for living facilities such as education, medical care and leisure shopping have increased. Especially for the choice of educational facilities, families will put quality education first and distance in the second place. Due to historical path dependence, particularity of the spatial structure and local public service supply system in China’s cities, the comprehensive hospitals and key schools with strong educational strengths have been established earlier and concentrated in urban centres. The most prosperous leisure shopping business circles are located in the centre of the urban. This phenomenon is more prominent in the development of inland cities that are relatively backward. Compared with the expansion speed of urban scale, education and medical strength are expanding slowly. The high-quality resources are not only concentrated in concentration but also limited in supply. As a result, residents enjoy high-quality resources and need to pay huge traffic costs.

In order to enjoy high-quality resources and improve the quality of life, residents choose to buy their house in the centre of the urban due to low traffic costs. But the housing supply in the centre is limited, and the shortage of supply will cause housing prices rise where closing to high-quality resources. Residents who have difficulty in paying relatively high prices for housings in urban centres can choose to buy houses that are far from the urban centre, which only increase traffic costs. No
matter the cost of traffic or the cost of housing, it is not conducive to the improvement of residents' quality of life and the development of the urban, which will reduce the efficiency of urban operation. Therefore, studying the impact of urban traffic costs on housing prices can provide a basis for regulating housing prices, and provide theoretical guidance for optimizing urban construction and planning.

The relationship between traffic costs and housing prices has attracted wide attention from scholars. Zheng et al. [1] took Beijing's housing market and traffic system as the research object, and it accurately measured the relationship between traffic costs and housing costs by designing a comprehensive payment index for housing and traffic. Zheng et al. [2] studied the impact of Beijing's "separation of occupation and housing" and over-concentration of public services on traffic congestion and has found that the uneven distribution of public service distribution is an important factor affecting urban traffic. Wang [3] used Tianjin as an example to construct a housing demand function, which showed a significant negative correlation between housing costs and commuting costs. Dong et al. [4] taking the residential market around Beijing Metro Line 5 as an example, showed that traffic costs have a significant impact on housing prices. The price of residential houses around rail transit appears with the subway to the city. The price of residential houses around rail transit decreases as the subway extends to the edge of the city. Taking the No.1 and No.2 lines of Nanjing Metro as an example, Liu [5] found that the price increase effect was 14.3%, 8.9% and 3.9%, respectively, from the 0.5km, 1km and 1.5km nodes of the subway. There is a significant negative correlation between accessibility and housing prices. Karlsson [6] used data from Iceland to study the relationship between traffic and housing prices in sparsely populated areas, and found that the improvement of traffic conditions to CBD had a significant marginal impact on local housing prices compared with the remote areas. Mayock [7] concluded that lower commuting costs and higher housing prices were equivalent by establishing an empirical model between wages, housing prices, and commuting. K.Turnbull [8] studied the influence of school quality on housing price in Florida of the United States and concluded that key schools would indeed increase the housing price around them.

In summary, there are many studies on the interaction between traffic costs and housing prices in the academic world. However, in terms of evidence, most of the researches are based on developed cities with large cities and small cities with relatively backward development. Urban traffic costs at different levels of development are sensitive to housing costs. The economic development level of small cities in the central and western regions is relatively low, and the size of cities is small. The housing or rental housing of most families is not far from the working place, and the separation of employment is not obvious. Therefore, the cost of commuting to and from work is not the primary factor in the purchase of housing by these urban families. As residents' incomes increase, urban key schools, quality medical conditions, and prosperous leisure shopping centres are the targets of residents' choice. In short, urban traffic costs at different levels of development are sensitive to housing costs. This paper chooses Shanxi Taiyuan as the research object, which is a typical representative of the capital city of the central and western regions. Studying the impact of traffic convenience on housing prices is important for urban development and planning.

The remainder of the paper is organized as follows: section 2 introduces the theoretical basis of the impact of traffic costs on housing prices. Section 3 briefly describes the model construction, and takes a developing urban as an example for empirical analysis. Section 4 draws conclusions.

2. The theoretical basis
Theories in urban economics show that the traffic costs and housing costs that residents bear are usually in a downward relationship. The theory of competitive rent can study the spatial structure of the urban and study the spatial structure of the urban. It can be used as a theoretical basis for studying the relationship between traffic costs and housing price. Bidding is a virtual concept of ‘willing to pay rent’, that is, the highest rent that a land user (resident or business) is willing to pay for a certain urban land (a certain location). Since the construction cost does not change substantially in the same urban space, and the land rent is closely related to the location, the rent and housing prices show a basically
uniform change in space. Aroso's theory of land rent shows that the better the soil conditions, the higher the land rent, and the higher the corresponding housing prices. When households choose their addresses, they weigh the wages, land costs, and traffic costs to maximize utility. Therefore, when the location traffic or basic service resources of the housing are improved, the residents can enjoy the high-quality service resources nearby, and the traffic costs of the residents is reduced, thereby attracting more residents to compete for the housing here. The farther away from high-quality public resources, the lower the housing price, the higher the traffic time cost and capital cost. The farther away from high-quality public resources, the lower the housing price, the higher the traffic time cost and capital cost. With the same utility, the price of housing that resident is willing to pay for this will decrease as the distance from these high-quality resources increases.

3. Empirical Analyses

3.1 Sample selection and variable description
Taiyuan is the capital city of Shanxi Province and belongs to the smaller cities and lower economic cities in the country. Taiyuan was selected as the research object of this paper, which has a good representativeness for exploring the impact of traffic costs on housing prices in smaller cities. This paper collects information on the housing prices of the six main urban residential quarters in Taiyuan and the surrounding living facilities. Excluding the obvious outliers and missing samples, 463 communities were selected. In order to control the impact of time on housing prices, prices are in January 2018. Rates and amenities are sourced from the “Anjuke” website.

This paper selects the housing price $P$ as the explanatory variable of the model. The data comes from the average price of the housing price of the “Anjuke” website. At this stage, the seller asks for the price. The last transaction price between the buyer and the seller is not much different from the seller's asking price. The two can be considered equal.

For the measurement of traffic costs, in recent years, the three-dimensional traffic in Taiyuan has developed rapidly, and the urban traffic congestion has been greatly alleviated. The traffic costs basically depend on the traffic distance. The farther the housing is from the commercial circle, hospitals, schools, etc, the more the time and capital cost of traffic are. This paper takes Taiyuan as the research object and measures the traffic costs by the distance.

See Table 1 for details.

| Variable         | Code | Unit        | Explain                              |
|------------------|------|-------------|--------------------------------------|
| Housing price    | $P$  | ¥/㎡        | Asking price for housing sale        |
| Traffic          | $X_1$| Number      | Number of bus stops within 1km of the house |
| Convenience      |      |             | Road accessibility is the number of lanes facing the main street. |
| Medical          | $X_2$| Number      | Number of tertiary hospitals reachable within 3km of the house |
| Facilities       |      |             | Number of secondary hospitals reachable within 3km of the house |
| Business         | $X_3$| Number      | Number of primary hospitals reachable within 3km of the house |
| centre           |      | Km          | Distance from the nearest commercial centre of the house |
| Educational      | $X_4$| 0-1 variable| The key primary and secondary schools within 2km of the house are recorded as 1 and the non-key schools are recorded as 0. |
| Facility         |      |             |                                      |

According to the analysis of the literature and the actual situation, the variables are detailed as follows:
Convenience of traffic is an important factor affecting traffic costs and thus affecting housing prices. Bus is the most important mode of transportation. The closer to the bus station, the more convenient it is for residents to go out. Therefore, the price is higher in theory. The number of bus stops ($X_1$) reachable within 1km from the community is selected as an explanatory variable for measuring traffic convenience.

Road accessibility is another important factor affecting the convenience of traffic. In this paper, the number of lanes ($X_2$) of the main street of the community is used as an indicator to measure road accessibility. This index data is obtained by Baidu map.

Medical facilities usually do not need to be very close to the community, and the effect on the value of the house within 3km is significant. The number of hospitals within 3km of the housing was selected as the explanatory variable, and the degree of influence on the housing price of the three ($X_3$), second ($X_4$) and first ($X_5$) hospitals near the housing was analyzed according to the hospital grade.

In the analysis of the influence degree of commercial centre distribution on housing price, three commercial centres in Taiyuan were selected as representatives of large-scale shopping malls, namely Wanda Commercial Centre (north business centre), Liuxiang Commercial Centre (central business centre) and Hexin Business Centre (southern business centre). Use $X_6$ to indicate the distance from the commercial centre, and use the distance to measure the traffic costs. This distance is the distance that can be measured according to the Baidu map.

The impact of the distribution of educational facilities on the choice of residential housing is mainly reflected in the high housing prices around key primary and secondary schools. Although enrolment is now by region, the imbalance in educational resources leads to inconsistent levels of school. Parents hope that their children will go to key schools, but the uneven distribution of educational resources will lead to differences in housing prices in different locations. Usually, the school within 2km of the housing is the range of residents’ choice of school. The traffic costs of this area are basically the same. Set dummy variable $X_7$, assign 1 to key schools around the house, and assign 0 to no key schools.

3.2 Model construction

The Hedonic Pricing Model is the most widely used model for studying the factors affecting housing prices. It can separate various factors and study their impact on housing prices. Based on the above indicators and data, this paper establishes a semi-logarithmic feature price regression model and uses SPSS software to perform regression analysis on the following models.

$$\ln P = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \mu$$  \hspace{1cm} (1)

In the above formula, $P$ represents the housing price of a single residential cell, $\alpha$ is a constant term, and $\mu$ is a random error term.

3.3 Empirical analysis and results

A stepwise regression analysis of the model was performed, and it was found that all of the seven explanatory variables selected entered the results. The final adjustment is 0.417, indicating that the explanatory variables can explain a total of 41.7% of the explanatory variables, that is, residents' daily traffic costs will affect 41.7% of housing price changes. Since this model is only used to explain the impact of urban traffic costs on housing price and housing prices, many other variables affecting housing prices (especially macroeconomic variables and physical characteristic variables) are not

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1 Peng X L(2015) used Changsha Metro Line 2 as an example to study the relationship between transportation cost and housing price. It shows that the value-added effect of residential buildings within 1km from subway stations is significant.

2 Zhang Z F (2016) found in the study of residential prices around key hospitals: between 0.85 and 2.35 km from key hospitals, housing prices increased significantly with distance.
introduced into the model, so the explanatory strength of the model is acceptable. The results of each variable entering the model are shown in Table 2 below.

| Model          | B     | Standard error | t     | Sig. |
|----------------|-------|----------------|-------|------|
| (constant)     | 8.932 | 0.049          | 183.144 | 0    |
| X6             | -0.031| 0.005          | -6.323 | 0    |
| X4             | 0.01  | 0.004          | 2.356  | 0.019|
| X1             | 0.021 | 0.004          | 5.495  | 0    |
| X2             | 0.013 | 0.003          | 4.467  | 0    |
| X7             | 0.073 | 0.02           | 3.565  | 0    |
| X5             | 0.032 | 0.009          | 3.682  | 0    |
| X3             | -0.006| 0.002          | -2.746 | 0.006|

a. Dependent variable: LNY

The final regression equation is:

$$\ln Y = 8.932 + 0.021X_1 - 0.013X_2 - 0.06X_3 + 0.010X_4 + 0.032X_5 - 0.031X_6 + 0.073X_7 + \mu$$  \(2\)

From the empirical results, the distance from the residential area to the housing has the strongest impact on housing prices. The distance from the business circle is close to 1km, and the housing price will increase by about 3.1%. The modern large-scale business district is a comprehensive shopping mall integrating shopping, leisure and entertainment. The improvement of residents’ living standards has led to a significant increase in the demand for entertainment facilities. Therefore, houses near the business circle are very attractive to the residents, and the housing prices will be high. In addition, according to the theory of urban rent in urban economics, the closer the business circle is, the higher the land price is. So the higher the cost of building a house is, the higher the housing price will be.

The number of primary hospitals around the housing and the number of tertiary hospitals have the weakest impact on housing prices, and the number of tertiary hospitals and housing prices are significantly negatively correlated. As a hospital affiliated to large hospitals and medical colleges in the whole province and even the whole country, residents are less likely to go to tertiary hospitals to see a doctor in daily situations. There are many patients nearby, and the flow of people is large, which will affect the surrounding living environment. The first-level hospitals belong to urban street hospitals, almost every mature neighborhood, and their traffic costs have little impact on residents. Therefore, the impact of the number of hospitals on housing prices is weaker than other factors. The secondary hospital refers to the district-level hospitals in the urban. It is medium-sized and is the most suitable medical institution for daily needs of residents. Therefore, the number of secondary hospitals near the housing has a higher impact on housing prices.

The number of bus stations that can be reached within 1km of the housing is positively correlated with the price of the house, that is, for every additional bus stop around the house, the housing price increases by 2%. It shows that the more convenient the traffic, the lower the time cost of traffic, and the higher the housing price. The convenient public traffic will greatly reduce the commuting time of residents and improve the efficiency, so the corresponding nearby housing prices will higher. At the same time, it can be seen that the use of public traffic in this developing city is very efficient and is an important means of traffic for residents. Road accessibility is also an important factor affecting traffic costs. The wider the main street of the community, the more convenient the traffic conditions, the lower the cost of traffic time, and the higher the housing price. The empirical results also show that the number of lanes around the community has increased by one, and the corresponding housing price will increase by 1.3%.

The existence of key schools also has a significant positive impact on housing prices, with key schools increasing the price by 7.3% within 2km of housing. Educational resources are important
supporting resources in the vicinity of housing, especially in key schools. Today's parents pay great attention to children's education, giving priority to buying houses near key schools and obtaining property rights instead of renting houses. Therefore, the supporting facilities of the key schools have a higher impact on the housing price.

4. Conclusions
The difference in housing prices in the urban is a reflection of the difference in rent. With the development of the urban, the convenience of traffic and the distribution of quality supporting facilities around the housing affect the costs of urban housing by affecting the traffic costs of the residents. The empirical results show that the convenience of traffic around the housing, the presence of nearby key primary and secondary schools and primary and secondary hospitals, and the distance from the business circle have significant effects on housing prices. The cost of housing for residents with comprehensive facilities and high-quality resources is high, but the traffic time and capital cost will be too high for residents who are relatively far away from these high-quality resources, both of which will lead to a lower living standard for urban residents. Taiyuan is in the period of rapid urban development, and traffic costs will become an important factor to consider. If the spatial layout of public infrastructure can be comprehensively coordinated during the period of urban expansion, and the allocation of high-quality resources will be improved, these will help alleviate the current traffic congestion problem in urban, effectively regulate the growth of housing prices, and improve the quality of life of urban residents and the development potential of urban economy.

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