

A Synthesis of Research on the Impact of Urban Rail Transit on the Price of Commercial Residences Along the Line

Ying Lyu

School of Nanjing Agricultural University, Nanjing 210000, China

kouk_ly@163.com

Abstract. While urban rail transit relieves traffic pressure and improves the urban transportation network, it also has a certain impact on the prices of commercial residential properties along the line, and more and more scholars have begun to pay attention to the relationship between rail transit and real estate prices. By sorting out the relevant domestic and foreign research, the existing research results are analyzed from three aspects: research objects, research methods, and research contents, and it is found that Hedonic Price Model is most commonly adopted, and the research in the fields of spatial effect, temporal effect and sub-market effect of rail transit on real estate prices is gradually becoming a hot spot.

Keywords: Urban rail transit; Commodity residential prices; Time effect; Spatial effect; Sub-market effect.

1. Introduction

As China's urbanization process continues to accelerate, more and more people are flowing into cities, causing increasing traffic pressure. As a kind of public transportation facility with fast, punctual, and large transportation capacity, the development of rail transit can effectively relieve traffic pressure, improve the urban transportation network and optimize the location conditions of real estate in the surrounding areas, thus driving the development of the surrounding areas. Since the 1990s, local governments in China have started to develop rail transit to ease traffic congestion. By the end of 2021, the National Development and Reform Commission had approved the construction of rail transit in more than 50 cities, with 269 metro and suburban railway lines, operating a whopping 8,708 kilometers and investing over ¥10 billion. With the dual support of policies and opportunities, it is foreseeable that China's urban rail transit has a broad development prospect.

The construction of urban rail transit not only has a significant role to play in the improvement of the transportation network, but also has a guiding and supporting role in the development of the city's regional economy, especially the value-added effect on real estate. From the perspective of urban residents, the construction of rail transit brings great convenience to the residents along the line, so home buyers will give priority to real estate along the metro line. From the perspective of real estate development enterprises, the construction of metro lines can stimulate the development and prosperity of the surrounding properties and businesses, which will lead to an increase in the expected value and purchase demand for commercial properties along the lines. Therefore, the construction and development of rail transit have a significant impact on the price of commercial properties in its surrounding areas.

In recent years, much attention has been paid to the impact of rail transit on real estate prices, and experts and scholars from all walks of life have conducted extensive quantitative and qualitative research. However, the impact of rail transit on real estate values varies from city to city due to geographical location, economic level, traffic level, and population density, and this area is still a hot spot for related research in China.

2. Review of relevant domestic and international studies

The reasons for the differences in findings on the impact of rail transport on residential prices can be summarized into three points: differences in research objects, differences in research methods, and

differences in research content. Research objects include differences in residential, commercial and office buildings, residential land development efficiency, etc.; research methods mostly adopt Hedonic Price Model, but also Transport Cost Model, Double Difference Method, Mean Comparison Method, Geographically Weighted Regression Model, etc.; research contents mainly include spatial effects, temporal effects, sub-market effects, etc., among which, there are more studies on spatial effects, and the differences are mainly reflected in the different radiation range of the impact of rail transit on real estate prices, the different types of selected rail transit stations, etc.

2.1 Research objects

Researchers abroad have selected a wide range of research objects, such as Robert Cervero and Michael Duncan (2001) who studied San Diego County, USA, selected different types of real estate as the focus, and studied the relationship between urban and suburban rail transit and real estate value. At the same time, Knaap G (2001) and others focused on land use and studied the impact of the Washington rail system on open space prices.

In terms of the selection of research objects, domestic researchers have focused not only on the impact of rail transit on housing prices, but also on issues such as the efficiency of land development around rail stations. In general, the selection of research objects is generally fixed between urban residential land and the price of commercial housing. The impact of rail transportation on urban residential land is primarily reflected in increased land development intensity and improved urban land distribution. The increased land development intensity is reflected in the expansion of land accessibility and the increased land value and land demand after the opening of rail transit (Tian Li, Haibo Zhuang, 1998). The improvement in the distribution of urban land is mainly reflected in the expansion of the circle around rail stations and the localized land changes within the city. The influence of rail transit on the price of commercial housing is mainly reflected in two aspects: location factors, including the supply and demand of regional real estate, relative location in the city and accessibility, and administrative factors, including land and housing systems and urban land planning. On the one hand, urban railways have obvious comprehensive transportation advantages, which will lead to an increase in real estate prices around the stations along the line; on the other hand, as railways can reduce the travel costs of residents, they can lead to an increase in demand for commercial and residential land along the line, which will lead to an increase in land prices and a significant increase in land development intensity and even development density (Zehan Li, 2016).

2.2 Research methods

In terms of research methods, foreign scholars have more often adopted the Hedonic Price Method (HPM). Robert Cervero and Michael Duncan (2001) used this model to study commercial real estate prices within a 400-meter radius along rail lines, concluding that the impact of downtown rail stations on house prices was greater than that of suburban areas. In some studies, the Repeat Sale Method has been adopted. Scholars Gatzlaff and Smith (1993) obtained consistent results by comparing the repeat sale index and applying the value regression method, and summarized the view that rail transit has a weak impact on housing value. In addition, the Transport Cost Model has also been adopted by some scholars, such as Bernard L. Weinstein and Terry L. Clover (2002), who used the model to study rail transit and surrounding house prices in Texas, USA, and concluded that rail stations could increase property prices by 53%. In the latest research exploring the spatial impact of urban rail transit on house prices, some scholars have innovatively used Geographically Weighted Regression (GWR), which helped to study the spatial variation of multiple influencing factors and integrate the consideration of residential spatial attributes, thus contributing to study the variation of residential prices in different areas. Dziauddin (2015) et al. used the GWR model to study residential values in the Greater Kuala Lumpur area of Malaysia and found that the impact of the rail system on residential values was spatially differentiated by geographic region, with positive and negative impacts existing in different areas.

In recent years, domestic scholars have made great progress and innovation in this area of research, using a diversity of research methods, including the Hedonic Price Model, Double Difference Method, Geographically Weighted Regression Model, etc. Among them, the Hedonic Price Model is the most commonly used, which means that the additional cost that each unit of a consumer is willing to pay for each additional unit of consumption of a certain attribute in the pursuit of utility maximization is the marginal willingness to pay for that attribute, which is also the characteristic price of that attribute. The model requires low difficulty in obtaining empirical data and integrates various factors in the research process, which has a strong ability to test the reality as well as explain the situation, but the results of the arithmetic analysis using the model may be missing in the face of the changing housing characteristics. Bo Wang and Jiming Cao (2017) used the Hedonic Price Model as the basis for their study of Chongqing rail transit line 3, combined with the use of Double Difference Method to construct an impact group and a reference group, as a way to avoid the disadvantages of incomplete selection of characteristic variables or omission of important characteristic variables in the Hedonic Price Model. On the selection of regression models based on the Hedonic Price Model, Shujing Zhang et al. (2021) found through comparison that Geographically Weighted Regression Model (GWR) with locally variable parameters fitted better than Multivariate Linear Regression (MLR) with global constant parameters, Spatial Lag Model (SLM), Spatial Error Model (SEM) and Spatial Durbin Model (SDM), and that GWR could better eliminate the spatial effects of residuals and portray the spatial heterogeneity of the relationship between rail transit and land values.

2.3 Research content

In the analysis of the impact of rail transit on the price of commodity residential properties along the line, the study mainly includes spatial effect, temporal effect, and sub-market effect.

2.3.1 Spatial effects

With regard to the spatial effect, scholars have focused on the quantitative assessment of the spatial effect of urban rail transit on residential prices, the influencing factors, and the influence radius. Scholars at home and abroad have shown through empirical studies that urban rail transit has a significant value-added effect on the price of commercial residential properties along the route, but its spatial effect has obvious regional differences. A study by Wei Wang et al. (2014) explains the source of the spatial effect, arguing that metro stations improve accessibility and surrounding construction-related factors, such as commercial development and improvement of the regional environment; metro stations can contribute to the rise in land prices of residential land by enhancing the profitability of the surrounding land. Jia Luo and Shuangning Mo's study also reached similar conclusions, suggesting that the value-added effect of metro stations on surrounding housing comes from improving the accessibility of surrounding residential residents and increasing the use value and utility of surrounding housing.

(1) Radiation of the effect of rail transit stations on residential prices

Dueker and Al-Mosaind (1993) found that the price of second homes within a 500m radius of a rail station in Portland, Oregon, USA, was 8% higher than the price of homes within a 1000m radius. Im J et al. (2017) studied the impact of new underground lines on homes in Daegu, South Korea, based on the Hedonic Difference Model, and showed that homes within 500 meters of the nearest new line station could earn a premium of 997,000 won (equivalent to about US\$96.3) per square meter. Clemens A. Pilgram et al. (2018) identified the radius within which a light rail station generates a premium for housing in the surrounding area as 500 meters, based on a case study of the city of Minneapolis, USA.

Chong Nie et al. (2010) empirically studied the construction and operation of the first phase of the Shenzhen Metro and concluded that the impact of rail transit on house prices ranged from the area within a 700-meter radius of the rail station, with the greatest appreciation in real estate within the 100-meter area of the station. Changchun Feng et al. (2011) found that Beijing Metro Line 5 had a significant impact on residential prices within 2000 m of the station, while the impact on residential prices decreases as the mileage from the rail station increases. Kang Liu and Qun Wu (2015) selected

the commercial residential properties around Nanjing Metro Line 1 and 2 stations as the research object and found that the average range of the impact of rail transit on commercial residential properties along the line was 1500 meters, and the degree of impact was in an inverted "U" shape relationship with the straight-line distance from the metro station, and the distance with the greatest impact was 320m. Chunchun Huang et al. (2021) also concluded that the average spatial impact of rail transit is 1500 m. And her further empirical research found that for every 1000 m reduction in distance from rail transit, residential prices increased by 5.1%. In a study by Shujing Zhang et al. (2021) around new lines of urban rail transit in Beijing, it was found that the range of influence on residential prices was 1,000 meters, within which the value-added effect on residential prices was basically stable at around 3%. Qianlong Tang and Wanxuan Hu (2022) also concluded that the metro factor had an impact on residential prices within a distance of 1000m in a study of residential properties around Changsha's rail line 1.

(2) Heterogeneity in the impact of different types of rail transit stations on residential prices

At present, studies at home and abroad have focused on the distance range of the impact of rail transit stations on housing prices, with less research on the impact of different types of metro stations on housing prices. Han Fang, Zhongwei Shen, et al. (2022) selected different types of stations (interchange, first and last stop, and conventional station) as research samples, and compared the impact of different stations on residential prices in the surrounding areas by constructing a two-layer random intercept Hedonic Price Method, and their research results were as follows: the adjacent transfer stations, the first and last stations are positively correlated and negatively correlated with the house price respectively; the value-added effect of the transfer stations on housing prices in the surrounding areas was greater than that of conventional stations, but the value-added effect of first and last stop was no different from that of conventional stations.

2.3.2 Time effect

The time effect of rail transit projects on real estate prices mainly refers to the impact of rail transit on surrounding real estate prices at different times, including the planning period, construction period, and operation period. Research focuses on two periods: one is between the announcement of the construction of rail transit and its opening. The second is the time period before and after the opening of rail transit.

From the research results of foreign scholars, the temporal impact of rail transit has obvious regional differences. Forouhar (2016) found that the slope of residential sales prices within 400 meters of stations located in affluent neighbourhoods decreased by 40% after the opening of the Tehran metro in Iran, while there was a significant value-added effect on residential prices around stations located in deprived areas. Jayantha et al. (2015) showed that property prices began to experience a premium effect after the official announcement of the Shatin to Central Link plan in Hong Kong SAR. Mathur (2013) et al. used the San Francisco Bay Area light rail as an example and found that house prices increased by 7.3% during the construction of the light rail and did not change significantly before the construction.

Studies by more domestic scholars have shown that urban rail transit has a positive impact on surrounding house prices during the planning and operation periods, with a degree of negative impact during the construction period. Zhixiong Mei and Songjun Xu (2011) used accessibility equivalence theory, comparative analysis, Hedonic Price model, and GIS spatial analysis techniques to empirically examine the heterogeneity of the impact of the planning period on house prices in different areas of the neighbourhood; the impact of the construction period on house prices in the neighbourhood is negative first and then becomes positive; the positive impact is more obvious during the operation period. Bo Wang and Jiming Cao (2017) selected Chongqing Metro Line 3 as a research sample and found that rail transit has a significant positive impact on residential prices along the line, but the value-added is much smaller than expected at the time of planning or construction. Xinxin Zhou et al. showed that the construction period of Xuzhou's rail transit failed to drive up house prices along the line, and had a significant impact on house prices near the opening, with house prices along the line rising by 610 yuan/m². Xinan Gao et al. (2020) studied the real estate transaction data of Nanjing

Metro Line 3 for nine years before and after its opening, and found that the different development periods of rail transit had different degrees of impact on the appreciation of residential properties along the line. The property prices along the line increased the most in the first two years from the announcement of the project to the start of construction, and then tapered off after the opening of operation. Wei Wang et al. (2015) looked at the impact of rail transit on residential property values from both positive and negative perspectives, finding that the vicinity of underground stations may have a negative impact on surrounding property values due to noise, pollution, and social security issues, resulting in a decrease in the appreciation of residential property values within close proximity to the stations (0-300m). Kang Liu et al. (2015) also argue that housing in the vicinity of rail stations is affected by noise, sanitation, and other "negative externalities" brought about by metro operations.

2.3.3 Sub-market effects

Different economic and social environments, stages of economic development, and the current state of urban transportation have led to different impacts of rail transit on housing prices in different cities. Existing studies on the impact of rail transit on housing prices along the line are basically based on general studies of the entire line, with less research on sub-market effects. The sub-market effect is thought to be one of the reasons for the inconsistent findings of existing studies, namely that rail transit has different effects on housing prices in different parts of the city.

Most existing studies have concluded that the opening of rail transit has a smaller or even negative impact on relatively economically developed markets and a more significant impact on relatively less developed or suburban markets. [22,28,30-31] Forouhar (2016) used DID method based on two light rail stations in southern and northern Tehran and found that metro stations had a negative effect on house prices around affluent neighbourhoods in the north, while they brought a significant positive effect on house prices around poor neighbourhoods in the south. Jing Li, Wenwen Zhou et al. (2020) based on data on housing information along Wuhan rail transit line 6, and analyzed based on the estimated coefficients that urban rail transit had instead a smaller impact on the relatively economically developed central area (main urban market) and a greater impact on the relatively economically backward distant urban area (suburban market). Xinan Gao et al. (2020) found that the sensitivity of proximity to a rail transit station on house prices was more significant in areas with poor transportation facilities. Jincal He (2022) empirically tested the impact of the establishment of rail transit stations on housing prices along the lines using 2019 primary housing transaction data in the main urban areas of Chongqing and found that there were regional differences in the impact of rail transit on housing prices along the lines, i.e. the higher the level of economic development, the more residential prices were affected by rail transit.

Some scholars have also argued that the sub-market effect of rail transit on housing prices is related to the distance between the two. [32-33] Jing Zhao and Qing Han (2020) meticulously analyzed the impact of the opening of Shanghai Metro Line 13 on residential prices along the line using one-to-one matching double and triple difference methods, and found that the impact of the opening of Metro Line 13 on high-priced housing was greater than that on low-priced housing areas within 2.5 km, but when the distance exceeded 2.5 km and the premium effect turned negative, the impact is greater. Ziyang Fan et al. (2018) studied the spillover and siphoning effects of the emergence of the Shanghai metro on the prices of newly developed housing in the surrounding area through an asymptotic multiplicative difference method model. The empirical results showed that a new metro station would increase the average price of new housing within 1 km of the station by 26.49%; while the average price of new housing 3 km away from the new metro station would decrease by 35.56%.

3. Conclusion

In summary, the relationship between rail transportation and real estate prices in the surrounding areas has received considerable attention both at home and abroad. A large number of empirical studies have adopted different research areas, research objects, research methods and research contents, and their research focuses differ, and the research conclusions are not the same.

(1) Most of the studies have adopted the prices of commercial residential properties along rail transit lines as their research objects, while some scholars have also taken into account factors such as site development, commercial real estate, office buildings, and properties. However, the current studies are less likely to explore the differences in the effects of different price levels of residential properties affected by rail transit, and this area needs to be explored by in-depth research.

(2) The use of Hedonic Price Model is universal, and scholars are gradually adopting Double Difference Method or Multiple Difference Method and Geographically Weighted Regression Model to improve their research.

(3) Most scholars have observed a positive impact of urban rail transit on real estate prices, while a small number of studies have come to the conclusion that the impact is insignificant or negative. Due to the locational differences between areas along metro lines and the distance of housing along the lines from metro stations, both positive and negative impacts may exist on the same metro line, and research in this area needs to continue to be improved.

(4) Research on the spatial and temporal effects of rail transit on real estate prices and the sub-market effects are the latest hotspots of attention in this field. In terms of spatial effects, the current research mainly focuses on the scope and extent of the impact of urban rail transit on residential property prices, with less research on the differences in the impact of different types of stations on neighbouring property prices; in terms of temporal effects, the different stages of the rail transit planning period, construction period and operation period, as well as the different years after the opening of the rail transit, are yet to be discussed in depth; in terms of sub-market effects, the relevant research is not yet sufficient, and there are few studies that have put. There are also few studies that consider the spatial, temporal and sub-market effects in a comprehensive manner.

(5) Due to the differences between different regions, the overall impact of rail transit on house prices, the spatio-temporal mixing effect, and the sub-market effect need to be analyzed in detail. Most of the existing studies focus on first-tier cities such as Beijing, Shanghai and Guangzhou, and less on new first-tier, second-tier and third-tier cities, which have seen rapid development of rail transport and housing markets in recent years and are somewhat representative. Therefore, the study of rail transport in these cities needs to be further improved.

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