The Impact of New Subway Line on House Prices in Shanghai China

Boston University
Freddie Guo, Weijie Nie, Anran Chen
April 28th, 2023

Abstract

The question that how the subway, as public transportation, affects the housing units is hotly debated. In this paper, we examine the relationship between the opening of the new subway line and the house prices around. We focus on Shanghai China out of the reason that Shanghai is a cosmopolitan city that embraces the highest house prices in China. We examine the spillover effect of the subway on the price and area of surrounding housing using a staggered DID approach based on microdata of all 600,000 new housing transactions in Shanghai from 2012-2015. The econometric study finds that the new subway increases the price of new houses within 1 km of the station by 26.49% and reduces the average housing area by 3.25 m^2, both spillover effects diminish as the distance increases: the spatial siphon effect is manifested by a 35.56% decrease in the price of new houses beyond 3 km and an average increase in the average housing area by 3.40 m^2. The study has important implications for the capitalization of public services and the fair and reasonable distribution of land appreciation benefits.

I. Introduction

In recent years, China's rapid economic growth has been accompanied by rapid urbanization, with an average annual growth rate of 1.31 percentage points from 2005 to 2015, which means that 20.904 million people will be added to the urban population each year. On the one hand, the gathering of a large number of people in the city enhances the vitality of the city and improves the efficiency of capital and labor allocation: on the other hand, it also generates the well-known "urban diseases", the most typical of which is traffic congestion. According to the latest data. The average congestion time in first-tier cities such as Beijing and Shanghai is as long as 57.3 minutes. In addition, the spatial layout of the population in large cities also shows a serious separation of employment and residence, with the central areas of cities absorbing a large number of industries and related employment due to the agglomeration effect. However, the land premium in these areas is so high that people employed in urban centers have to choose more remote places to live due to the cost of living. This has led to a spatial separation of jobs and residences, with "work in the city and live in the suburbs" (Zheng, S. Q. and Cao, Y., 2009).

Public transportation is an effective means to solve the "urban disease" and the separation of work and residence, and the subway is one of the most important public transportation modes. Compared with other public transportation, the subway has the advantages of large passenger capacity, long distance and high punctuality. The first subway in China was the Beijing subway line 1, which was opened in January 1971. By the end of 2005, 26 cities in mainland China had opened urban rail transit, with 116 lines and a total mileage of 3618 km, and an average daily passenger flow of 38.19 million. Due to the important role of the metro in urban development, many cities in China are actively promoting the construction of the metro, according to statistics,44 cities are planning and building a metro, covering almost all provincial capitals and some developed prefecture-level cities.

This paper is concerned with how the metro affects housing prices in the surrounding area. It involves many important economic issues such as capitalization of public services, benefit distribution of urban land appreciation and urban spatial changes, which are of great theoretical and practical significance, but this paper notes that the existing related studies only focus on the impact of subways on housing prices, but ignore that the opening or planning of subways may also affect another important choice variable in homebuyers' decision making-one of housing area, which leads to the existing literature on the This leads to an incomplete understanding of the link between public transportation and the housing market. At the same time, even with respect to the impact of subways on housing prices.

In terms of the specific research scheme, this paper uses a large sample of primary housing transactions in Shanghai from January 2012 to August 215 as the research sample, and uses the staggared DID approach to examine the impact of the announcement of each metro line plan on the surrounding housing market during the sample period, including not only the price but also the impact on the area. The results show that within 1 km of a subway station, the price of primary housing increases by 26.5% while the average unit size decreases by an average of 3.2 m2. The spillover effect of the subway is strongest around the station and decreases with distance, showing a spatial distribution of 27% decrease in price and 0.35 m^2 increase in average unit size for every 100 meters away from the station. The explanation of this paper is. The increase of house price around the subway is brought by the convenience of the subway. The decrease in area is a collateral effect of the price increase: since houses closer to the subway are more expensive, those who have higher demand for convenience will prefer to buy smaller area houses close to the subway in exchange for better convenience at the expense of some living comfort, i.e., the spatial distribution trend of area is brought about by the separation of different preference groups in living space. In this paper, we confirm the above mechanism by testing the price of the whole house and find that the total price still increases after the subway plan, but less than the unit price.

The paper also finds that the tendency for the spillover effect to diminish with distance does not cut off at the point where the effect becomes zero, but rather there is a negative spillover in the housing market further away. Specifically, the price of housing 3 km away from the subway station decreases by 35.6% and the size increases by 3.4 m^2. This negative spillover is similar to the siphon effect of regional economics in which large cities absorb investment from neighboring areas. From the theoretical model in this paper, the siphoning effect of the subway is due to the contraction of the demand for housing from the periphery to the periphery of the station, which causes the supply of housing in the periphery to exceed the demand and thus the price to decrease, because the siphoned demand is mainly for small-sized housing. Therefore, the price reduction is accompanied by an increase in the area. It is worth noting that the part of the housing stock where the siphon effect occurs has been used in many papers as a control group in the double-difference approach to remove the overall trend in the housing market, whereas the double-difference approach requires that the control group be completely unaffected by the shock, either directly or indirectly through the experimental group (violating the assumption of individual treatment effect stability).

The contribution of this paper is twofold: firstly, it is the first time to find that the appearance of subway makes the spatial change of new housing in the surrounding area from far to near from shrinking to enlarging, thus proving the spatial separation of people with different preferences in living space; secondly, it proves that the appearance of subway has a siphoning effect on the housing in the peripheral area, which leads to the overestimation of the double difference method, thus advancing the research on this issue methodologically. The rest of the paper is organized as follows. Part II is the literature review; Part III presents the data and descriptive statistics; Part IV presents the hypotheses and research design; Part V is the estimation results; and finally, the conclusions and policy implications of the paper.

II. Literature Review

The emergence of the subway has had a dramatic impact on the spatial structure and economic activities of cities. The effects of subways on cities include redevelopment of urban space (Cheape,1976), decentralization of residential locations (Zheng and Kahn,2013), optimization of industrial layout (Bollinger and Ihlanfeldt, 1997), the centralization of commerce (Barnes, 2005;

Cervero et al, 2004), and the re-planning of the location pattern of various public services (Zheng and Kahn, 2013), among others. As the metro changes the spatial structure of the city, it has a direct impact on the housing market, which is closely linked to the spatial structure of the city.

The research reveals that the impact of better accessibility on home values is influenced by the socioeconomic level of the area. Hess and Almeida (2007) evaluate the effect of proximity to light rail transportation stations on residential property values in a research for Buffalo, New York. They see that in high-income station areas and low-income station regions, proximity effects are favorable and negative respectively. In Taipei, Taiwan, Lin and Cheng (2016) discover several outcomes. According to their research, the effect of employment accessibility on apartment rent is strongly favorable in submarkets with median or lower rent levels, but only marginally negative in those with higher rent levels. In this essay, we present data from Shanghai. Shanghai is exceptional in its recent rapid population expansion when compared to Buffalo and Taipei.

Most studies take transit station gradients into account when analyzing the unequal distribution of home price growth brought on by a new transit line (e.g. McMillen and McDonald, 2004; Agostini and Palmucci, 2008). There are numerous studies that show how the effects of rail transport expansions vary between cities (such as Kahn, 2007). Few articles, however, look into how the influence changes with the distance between a housing site and the CBD. According to McMillen and McDonald (2004), the new transit line in Chicago had little to no impact on housing costs around the two transit stops that were closest to the city center. The scarcity of parking spaces close to the two stations is blamed for this insignificance.

However, the existing literature draws inconsistent conclusions about the possible changes in the housing market around a subway or rail transit. On the one hand. There are a large number of empirical studies, both domestic and foreign, that argue that the opening or planning of a subway or rail transit will lead to housing appreciation along the line. For example, Almosaind et al1993) found that rail transit in Portland brought a 10.6% premium to housing within 500 meters, McDonald and Osuji1995) examined land prices in Chicago before and after the announcement of light rail plans and found a 17% increase within 1.5 miles of the station, and Benjamin and Sirmans(1996) for Washington, D.C., showed that a 0.1-mile increase in distance to a subway station decreased apartment rents by 2.5 percent. In addition, studies by Agostini and Palmucci (2008) for Santiago, Chile, Bae et al. (2003) for Seoul, Korea, Hao, Qianjin, and Chen, Jie (2007) Chen and Hao (2010) for Shanghai, Gao, Xiaohui, and Liu, Fang (2011) for Shanghai, Gu, Yizhen, and Zheng, Siqi (2010) and Feng, Changchun, et al. (2011) in Beijing all concluded that rail transit has a positive impact on the surrounding property prices. On the other hand, there are also a number of foreign studies that suggest that metro has little impact on neighborhood housing prices. For example, Gatzlaff and Smith (1993) found that the Miami metro system brought a very small premium to surrounding residential properties. Both Bowes and Ihlanfeldt (2001) for Atlanta and Du and Mullev (2006) for the United Kingdom show that housing prices are lower in the immediate vicinity (within a quarter mile) of a metro station.

III. Econometric Model

As an important accessory property of housing, the convenience of travel will largely affect the price of housing. After the emergence of subway, the convenience of the area along the subway will be enhanced in a gradient, and the real estate developers will adjust the price accordingly. After this gradient increase in prices, real estate developers will adjust prices accordingly. On the one hand, the group with strong travel demand would like to live near the subway station, but the budget constraint is not enough to support the high price of subway housing, so the most optimal choice is to sacrifice part of the living comfort in exchange for a lower total price to buy housing closer to the subway, and the typical practice of this sacrifice of comfort is to buy small. On the other hand, for those who need to travel less, the effect of the convenience of the subway is not enough to compensate for the cost of high housing prices. Not to mention the compromise of living comfort, so this group will choose to buy housing far from the subway. This group tends to prefer larger housing areas than those closer to the subway. For a real estate developer in a competitive market, it is important to build the housing that the buyer prefers in order to win the competition. With the subway separating the different preferences, real estate developers can more clearly identify the housing size preferences of the audience in the project's location and build housing with a smaller size closer to the subway. Therefore, we propose two hypotheses.

> **Hypothesis 1**: With the convenience of the opening of the subway, the unit price of housing will increase significantly, while the size will decrease accordingly.
>
> **Hypothesis 2**: There will be a phenomenon of rising house prices along the line and falling house prices in the peripheral areas (siphon effect).

In this paper, we adopt a progressive DID approach to test our hypothesis, which means that we do not explicitly set a control group, but place shocks to site emergence at different points in the same model, with each site being a control group before the plan is released and becoming an experimental group after the plan is released. In this way, when estimating the effect of a given site presence, the housing market in other areas where sites have not yet appeared can be used as a background to remove common trends over time. The model used to test the overall effect of subway presence on house prices is as follows.

$$\ln(price_{i,s,t}) = \alpha_0 + \alpha_1 dplan_{i,s} + \alpha_2 distance_{i,s} + \gamma X + \delta_s + \gamma_t + t \times \delta_s + \varepsilon_{i,t} \quad (1)$$

Where, i represents a housing unit, s represents the nearest metro station, and $t$represents the time of the transaction. $ln(price)$ is the natural logarithm of the price per square meter of the housing unit, and $dplan$ is a dummy variable that takes 0 if the nearest metro station is not yet planned at the time of the transaction, and 1 if it is planned. α_1 can be used to estimate the size of the price premium effect. X is the housing characteristics and location variables, including housing type, floor, area, distance from the city center and its squared term, and the presence of parks, schools, and hospitals within two kilometers. $\delta_s$and γ_t are the fixed effects and month fixed effects of the subway station, so that the coefficients obtained will reflect the differences of housing around the same station before and after planning. In addition, the product of the

$month*station$ is added to further exclude the effect of heterogeneous trends in housing prices near different stations.

In model (1), the focus is on the coefficient α_1, which reflects the overall premium brought by the subway plan to the surrounding housing market by screening the samples of different distance ranges. After that, the interaction term between $dplan$ and $distance$ is added to model (1) to form model (2), which is used to study the heterogeneity in distance of housing price changes brought by the plan. The focus of this paper is on the coefficient α_3 which will reflect the gradient effect brought by the subway plan, i.e., the change of the distribution of different price housing due to the subway plan.

$$\ln(price_{i,s,t}) = \alpha_0 + \alpha_1 dplan_{i,s} + \alpha_2 distance_{i,s} + \alpha_3 dplan_{i,s} \times Distance_{i,s} + \gamma X + \delta_s + \gamma_t + t \times \delta_s + \varepsilon_{i,t} \quad (2)$$

Similarly, models (3) and (4) are used to estimate the effect of the subway station on the surrounding housing area, where $area$ is the housing area and Y is a housing characteristic variable other than area, and the coefficient β_1 in model (3), reflects the overall effect of the plan on the housing area, and the coefficient β_3 in model (4) reflects the trend of this effect in space.

$$Area_{i,s,t} = \beta_0 + \beta_1 dplan_{i,s} + \beta_2 distance_{i,s} + \gamma Y + \delta_s + \gamma_t + t \times \delta_s + \varepsilon_{i,t} \quad (3)$$

$$Area_{i,s,t} = \beta_0 + \beta_1 dplan_{i,s} + \beta_2 distance_{i,s} + \beta_3 dplan_{i,s} \times distance_{i,s} + \gamma Y + \delta_s + \gamma_t + t \times \delta_s + \varepsilon_{i,t} \quad (4)$$

IV. Data and Descriptive Statistics

The housing data used in this paper are all from the new housing transaction data provided by Shanghai Real Estate Transaction Center, including 845,614 primary housing units sold in Shanghai from January 2012 to August 2015, of which 602,263 units of ordinary apartments basically cover more than 90% of the new commercial housing units sold in Shanghai during this period. The statistical scope is all residential units including apartments, villas, and townhouses. The main housing information of the sample data obtained in this paper also includes the transaction date, unit price, total price, neighborhood name, neighborhood address, property type, floor, area and room type of each house.

In addition, this paper collected information on all identified metro stations in Shanghai before the end of the sample period, covering a total of 404 stations from Line 1 to Line 18. Specifically, the coordinates of each station, the subway line to which it belongs, the date of announcement of the plan, the date of construction, and the date of opening for operation are included. The date of announcement of the plan is adopted from the website of Shanghai Municipal Bureau of Planning and Land Resources, which published the "Public Notice of Line Selection Special Plan". The date of construction is collected from News 2. The date of opening operation is the date of the first day of trial operation. Of the 404 stations, 242 were already in operation before the start of the sample period and are referred to as "old stations". 199 of these 242 old stations had no new lines planned by the end of the sample period and remained stable throughout the sample period, while the remaining 43 old stations had new lines. The remaining 162 stations are referred to as "new stations". 44 stations were opened before the beginning of the sample period, but 35 stations were not opened before the end of the sample period. 14 new stations were used as interchange stations and involved the planning or opening of two new lines. In order to avoid the interference of extreme transaction behavior in the market, the highest and lowest 5% of the total price in the sample were excluded, leaving 148,673 housing units.

After these treatments, the final sample size used in this paper is 148,673 housing units, and the main variables include $lnprice$(the natural logarithm of house price), $transactionmonth$, $area$(the area of the house), $floor$(the floor of the house), $room$(number of the rooms in the house), $distance$(distance to the nearest station) and dcc(distance to the center of the city). The descriptive statistics of these variables are shown in Table 2. The variance of this variable is large, with the largest housing unit being 289.04 m^2 and the smallest being only 33.74 m^2; in terms of other characteristics of the housing units, two rooms and two bathrooms are the main types, the average distance from the city center is 33.54 km, and the average distance from the nearest metro station is 55.96 km, indicating that a large part of the housing units are not fully covered by the metro. housing is not yet fully covered by the metro.

V. Estimation Results

1. The impact of subway on average house price

Models (1) and (2) are first used to examine the impact of the subway plan on the surrounding housing prices. The first regression in Table 3 shows that within 2 km of the subway station, housing prices did not increase overall after the announcement of the plan, suggesting that there may be spatial heterogeneity in the increase in convenience brought by the subway. From column 2 to column 5 of Table 3, we can see that the coefficient becomes significant from 15 km onwards and rises in a stepwise manner, with a price increase of 8.28% within 1.5 km and 26.49% within 1 km and 54.45% within 750 m. The price increase within 500 m is 110.25%. This increase in price the closer you are to the station is very much in line with the expectation that the convenience of the metro decreases with distance. In order to further estimate the change in the spatial layout of the surrounding house prices brought by the subway plan, this paper next regresses model (2) with a sample of 2 km range, i.e., the interaction term of distance to the station and $dplan$ is added to model (1), and the coefficient of this interaction term will reflect how the spatial layout of house prices changes due to the presence of the subway. In the results in column 6 of Table 3. The coefficient of the horizontal term of distance to the subway station represents the price gradient before the plan, and the significant but very small coefficient indicates that before the subway plan, house prices in the surrounding area did not show a significant trend in geographic distribution: while the coefficient of the interaction term is a significant -0.0268. It indicates that the announcement of the plan has led to a geospatial ranking of house prices within 2 km of the station, and for every 100 m closer to the station, house prices will The coefficient of -0.0268 indicates that the announcement of the plan has led to a geospatial ranking of house prices within 2 km of the site, with house prices increasing by 2.68%

for every 100 m of proximity to the site, indicating that the added value of convenience gradually disappears with increasing distance, which is fully consistent with the previous expectations of this paper. Thus, Table 3 fully reveals the spillover effect of the subway on the neighboring house prices, i.e., an upward movement centered on the station.

2. The impact of subway on average house area

Next, the effect of the subway on housing area is analyzed. As can be seen in column 1 of Table 4, the overall housing size within 2 km of the station plan decreases significantly by 6.69 m^2 after its announcement. Again taking into account the radiation range of the subway, the sample is then gradually reduced from 2 km and it is found that except for the smallest 500 m range. The overall decrease in area is significant, with the largest decrease being within 750 meters, down 6.96 square meters, and the smallest being within 1 kilometer, down 3.25 square meters, indicating that the subway plan has indeed made smaller housing areas more popular. In addition, if the reduction of housing area is to balance the total price of housing after the increase of unit price, it is understandable that the area within 500 meters has not been reduced because the unit price has increased too fast and the significance of balancing the total price by reducing the area is compensated by convenience.

However, the spatial trend in size reduction cannot be seen from this series of regressions, and thus the hypothesis of spatial separation of different preferences cannot be fully tested. Therefore, in column 6 of Table 4, we regress model (4) with an interaction term on the sample within 2 km to examine the difference in the spatial distribution of housing area before and after the subway plan. The results show that the coefficient of the interaction term is significantly positive, indicating that the housing units sold in the area after the announcement of the plan show a tendency to decrease in size the closer they are to the station, specifically by 0.39 m^2 per 100 m of proximity to the station, indicating that the curve in Figure 1 of the theoretical hypothesis does exist after the subway plan in which people with different preferences for comfort and convenience are sorted in terms of living space. In addition, since housing size requires a certain period of adjustment by developers to be completed, the migration of heterogeneous residents in the short term should logically be reflected in the market as a larger increase in the unit price of small-sized housing than large-sized housing. At the end of Table 4, the interaction between area and subway planning is tested by adding the area to model (1), and it is found that the subway planning causes a significant negative relationship between area and price of surrounding housing. This further confirms the previous research assumptions of this paper, that the unit price of housing decreases by 0.28% for every 1 m^2 increase in area.

From the above regression, we can see the whole story: the emergence of the subway dramatically increases the convenience of the area along the line and thus increases the price of the area: the increase in price increases the budgetary pressure on potential home buyers in the area and forces them to make the most optimal choice according to their preferences, sacrificing one for the other in terms of convenience and comfort: thus, those who need to travel more So those with greater travel needs choose smaller homes near the subway. Those with greater housing needs buy larger homes away from the subway which is supportive of our hypotheses.

3. The siphon effect of subway on housing market

In Table 3, housing prices within 2 km of the site do not increase significantly overall, but do increase significantly in the small sample. Given that the small sample is a subsample of the 2-km sample, it is likely that the increase in prices near the site was accompanied by a decrease in prices in the periphery, thus leveling out the overall fluctuation in prices within the 2-km range. In order to test this conjecture, we examine the housing sample far from the site separately. Columns 1-3 in Table 5 show that the subway plan reduced housing prices by 20.74% in the 1-2 km distance range, and by 12.32% and 35.56% in the 2-3 km and 3 km ranges, respectively. This result shows that. The rationale for this is that the subway draws the demand for housing from the area around the station, which leads to a shrinkage of demand in the peripheral market and ultimately lowers housing prices. Of course, the common trend of house price fluctuations has been removed using the double difference method in this paper. Therefore, the siphon effect reflects a decline in house prices not in terms of a ringgit decline compared to the previous price decline in the same area, but rather a decline compared to the counterfactual situation without a new subway.

Since the subway attracts buyers of smaller homes, would this heterogeneity of preference be reflected in the siphon effect, if the buyers attracted to the subway are the same type of buyers who prefer smaller homes? Then the empirical evidence would show an increase in the size of the housing stock in the periphery. This is tested in columns 4-6 of Table 5 using model (3), which shows that while the area of housing 1-2 km away is still decreasing, the area of housing 3 km away is increasing by 3.36 m^2. This indicates that the siphon effect of the subway attracts a relatively large share of demand for housing of small size, but the area that increases in size as a result of the siphon effect is further away than the area that decreases in price, and the magnitude is not as large as the decrease in price, indicating that the demand displaced by the siphon effect is not purely for housing of small size.

4. The impact of old station new line on house price

While the above studies have focused on the case of a subway station from scratch, this paper also focuses on the impact of adding a new line to an existing station on the surrounding housing. Therefore, a total of 21 stations that were opened before the start of the sample period and had a new planned line passing through them during the sample period were selected. This paper regresses these 21 stations as the "nearest stations" with a total of 7622 housing samples, and uses model (1) and (3) to see what impact the new line will have on the price and area of the surrounding housing. The first six regressions in Table 6 examine the price and area effects of the new line at the old station in three distance ranges: 2 km, 1 km, and 750 m. It can be seen that the price effect is not significant in any of the three regressions. This means that the planning of new lines on top of the already opened stations does not bring a significant premium to the local housing market. In contrast, the size effect remains, with the size of housing sold after planning decreasing by 13.74 m^2, 10.60 m2 and 3.08 m^2 compared to pre-planning in the three range regressions than the results in Table 6. This indicates that although the overall housing demand did not increase significantly, the announcement of the new route plan still made smaller units more desirable. This may be due to the fact that the housing prices near the old stations are already at a high level and it is difficult to break through the overall housing market environment. The demand for housing brought about by the new line plan is in favor of smaller units in the face of high prices. Columns 7 and 8 examine the gradient effect of price and area respectively, and the interaction term shows that the price of housing per 100 meters closer to the station increases by 21% after the new line. This gradient is steeper than when the new station was planned, probably because the change of a station from a regular station to an interchange station often implies a concentration of businesses, and people are significantly more sensitive to distance in anticipation of this.

VI. Conclusion

The congestion and expansion of the boundaries of large cities bring huge travel costs to their residents, which largely dissolves the meaning of living in large cities, hinders urban development and reduces the welfare level of urban residents. As a public facility that can significantly reduce the cost of travel, the subway brings enormous travel convenience to the residents along its route, which in turn releases a spillover effect on the housing market within a certain distance along the route. However, this spillover effect has only been observed in the literature in terms of the increase in housing prices, but the possible impact on the area of new housing has been neglected. The theoretical and empirical studies in this paper fill this gap in the research perspective and provide methodological improvements in measuring the impact of the metro on the housing market.

This paper examines the changes in price and housing area in the surrounding housing market brought about by the presence of a station, using the announcement of all metro lines in Shanghai from January 2012 to August 2015 as a natural experiment. The results show that the spillover effect of the metro increases by 26.49% within 1 km of the station, and the average area shrinks by 3.25 m^2 , while the edge areas show different degrees of siphon effect, i.e., the price decreases and the area increases; the spillover effect of the metro also shows a significant gradient as the distance to the station increases, with a 2.68% increase in price and a 0.39 m^2 decrease in area for every 100 m closer to the station within 2 km. 0.39 square meters; when the new line at the opened site, the effect of area decline still exists, but the price did not change significantly: the total price of a single suite still rose significantly. But the magnitude is smaller than the single price. The price and area effects are robust. These findings contribute to the comprehensive understanding of the relationship between metro and real estate market in this paper. This paper also demonstrates the problems in the previous literature at the methodological level. and proposes a more suitable research model.

Boundary expansion and population agglomeration are inevitable trends in the development of large cities, however, with the construction land targets approaching the upper limit, how to rationally plan housing land and public transportation routes geospatially becomes a major problem in urban planning. From the empirical results of this paper, the price increase and area reduction of the housing market along the subway lines indicate that the effect of public transportation convenience on residents is huge. The siphoning effect of the subway at long distances proves that people are attracted to subway housing. This study has several important policy implications. First, in real estate market regulation and stabilization, we should pay closer attention to the spillover effect of the subway on housing prices along the subway line, both to prevent the impact of rising housing prices around the subway brought by the announcement of the subway plan and to pay close attention to the possible price suppression effect of the subway plan on housing at a distance through the siphon effect. Do a good plan for a rainy day. Secondly, in future urban planning, more attention should be paid to the spatial correspondence between public transportation site selection and housing land approval, so as to increase the supply of residential land or housing stock renewal in the vicinity of subway lines and balance the structural distortion of the housing market in space caused by the emergence of public transportation from the level of housing supply, thus maximizing the benefits of public transportation convenience while not bringing excessive fluctuations in the real estate market. Thirdly, those who focus on the convenience of travel are mostly the ones who are interested in the public transportation. The findings of this paper make it possible to rationalize the distribution of public services and improve the efficiency of fiscal spending, and also provide a basis for adjusting the layout of market consumption.

References

Agostini, C. A., & Palmucci, G. A. (2008). The Anticipated Capitalisation Effect of a New Metro Line on Housing Prices*. *Fiscal Studies*, *29*(2), 233–256. https://doi.org/10.1111/j.1475-5890.2008.00074.x

Bae, C.-H. C., Jun, M.-J., & Park, H. (2003). The impact of Seoul's subway Line 5 on residential property values. *Transport Policy*, *10*(2), 85–94. https://doi.org/10.1016/S0967-070X(02)00048-3

Bajic, V. (1983). The Effects of a New Subway Line on Housing Prices in Metropolitan Toronto. *Urban Studies*, *20*(2), 147–158. https://doi.org/10.1080/00420988320080291

Barnes, G. (2005). The Importance of Trip Destination in Determining Transit Share. *Journal of Public Transportation*, *8*(2), 1–15. https://doi.org/10.5038/2375-0901.8.2.1

Benjamin, J., & Sirmans, G. S. (1996). Mass Transportation, Apartment Rent and Property Values. *Journal of Real Estate Research*, *12*(1), 1–8. https://doi.org/10.1080/10835547.1996.12090830

Billings, S. B. (2011). Estimating the value of a new transit option. *Regional Science and Urban Economics*, *41*(6), 525–536. https://doi.org/10.1016/j.regsciurbeco.2011.03.013

Bollinger, C. R., & Ihlanfeldt, K. R. (1997). The Impact of Rapid Rail Transit on Economic Development: The Case of Atlanta's MARTA. *Journal of Urban Economics*, *42*(2), 179–204. https://doi.org/10.1006/juec.1996.2020

Bowes, D. R., & Ihlanfeldt, K. R. (2001). Identifying the Impacts of Rail Transit Stations on Residential Property Values. *Journal of Urban Economics*, *50*(1), 1–25. https://doi.org/10.1006/juec.2001.2214

Cervero, R., & Landis, J. (1993a). Assessing the impacts of urban rail transit on local real estate markets using quasi-experimental comparisons. *Transportation Research Part A: Policy and Practice*, *27*(1), 13–22. https://doi.org/10.1016/0965-8564(93)90013-B

Cervero, R., & Landis, J. (1993b). Assessing the impacts of urban rail transit on local real estate markets using quasi-experimental comparisons. *Transportation Research Part A: Policy and Practice*, *27*(1), 13–22. https://doi.org/10.1016/0965-8564(93)90013-B

Du, H., & Mulley, C. (2006). Relationship between Transport Accessibility and Land Value: Local Model Approach with Geographically Weighted Regression. *Transportation Research Record*, *1977*(1), 197–205. https://doi.org/10.1177/0361198106197700123

Ke, S. (2010). Determinants of Economic Growth and Spread–backwash Effects in Western and Eastern China. *Asian Economic Journal*, *24*(2), 179–202. https://doi.org/10.1111/j.1467-8381.2010.02032.x

Ma, X., & Huang, T. (2021). The Impact of Subway Network Expansion on Housing Rents: An Empirical Study in Beijing, China. *Chinese Journal of Urban and Environmental Studies*, *09*(04), 2150025. https://doi.org/10.1142/S2345748121500251

McMillen, D. P., & McDonald, J. (2004). Reaction of House Prices to a New Rapid Transit Line: Chicago's Midway Line, 1983–1999. *Real Estate Economics*, *32*(3), 463–486. https://doi.org/10.1111/j.1080-8620.2004.00099.x

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy*, *82*(1), 34–55. https://doi.org/10.1086/260169

Zhang, X., Zheng, Y., Sun, L., & Dai, Q. (2019). Urban Structure, Subway Systemand Housing Price: Evidence from Beijing and Hangzhou, China. *Sustainability*, *11*(3), Article 3. https://doi.org/10.3390/su11030669

Zhou, Z., Chen, H., Han, L., & Zhang, A. (2019). *The Effect of a Subway on House Prices: Evidence from Shanghai* (SSRN Scholarly Paper No. 3239760). https://doi.org/10.2139/ssrn.3239760

Appendices

Table 1: Variable Descriptions

Variable Name	**Variable Description**
lnprice	the natural logarithm of the house price
area	the area of the house
dplan	a dummy, equals to 1 if there is a subway station within a specified distance from the house, otherwise 0
distance	distance to the nearest station

d_cc	distance to the center of the city
floor	The floor of the house
room	number of the rooms in the house

Table 2: Summary Statistics of the Variables

VARIABLES	N	mean	sd	min	p25	p50	p75	max
area	148,673	92.68	24.98	33.74	77.65	88.53	103.7	289.0
floor	148,673	7.607	5.102	1	3	6	11	33
room	148,673	2.181	0.697	1	2	2	3	5
distance	148,673	55.96	73.86	0.389	13.22	20.91	57.63	313.4
lnprice	148,673	9.043	0.640	7.731	8.825	9.155	9.517	10.01
d_cc	148,673	33.54	12.59	11.84	22.01	32.38	43.60	58.91

Table 3: The impact of subway on house price

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**2km ln(price)**	**1.5km ln(price)**	**1km ln(price)**	**750m ln(price)**	**500m ln(price)**	**2km ln(price)**
dplan	0.007	0.083***	0.265***	0.545***	1.103***	0.307***
	(0.47)	(5.29)	(11.34)	(11.94)	(15.29)	(13.00)
distance	-0.034***	-0.014***	-0.035***	-0.044***	0.092***	-0.013***
	(-42.37)	(-14.14)	(-17.68)	(-7.14)	(6.04)	(-8.41)
dplan*distance						-0.027***
						(-16.64)
Constant	18.193***	11.441***	14.236***	55.488***	67.034***	17.675***
	(88.17)	(31.36)	(-15.06)	(-11.39)	(-6.02)	(85.25)

Observations	70,359	52,056	24,070	12,892	7,181	70,359
R-squared	0.620	0.717	0.844	0.868	0.931	0.624
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Station FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Station*Month	Yes	Yes	Yes	Yes	Yes	Yes
Observations	70,359	52,056	24,070	12,892	7,181	70,359
R-squared	0.620	0.717	0.844	0.868	0.931	0.624

Table 4: The impact of subway on house area

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	**2km area**	**1.5km area**	**1km area**	**750m area**	**500m area**	**2km area**	**2km ln(price)**
dplan	6.686***	6.069***	3.246***	6.959***	-1.846	11.052***	0.269***
	(-14.17)	(-9.85)	(-3.89)	(-5.86)	(-0.85)	(-15.87)	(12.53)
distance	0.194***	0.204***	1.008***	0.464***	2.498***	0.114***	0.034***
	(9.86)	(-5.98)	(-17.90)	(2.94)	(4.52)	(-2.85)	(-42.39)
area							0.002***
							(9.71)
area*distance							0.003***
							(-15.48)
dplan*distance						0.389***	
						(9.13)	
Constant	17.678***	216.663***	123.867***	545.907***	649.344***	25.188***	18.156***

	(3.23)	(18.28)	(4.90)	(-4.22)	(-3.00)	(4.62)	(87.82)
Observations	70,359	52,056	24,070	12,892	7,181	70,359	70,359
R-squared	0.807	0.821	0.871	0.868	0.878	0.807	0.622
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Station*Month	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	70,359	52,056	24,070	12,892	7,181	70,359	70,359
R-squared	0.807	0.821	0.871	0.868	0.878	0.807	0.622

Table 5: The siphon effect of subway on housing market

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	1-2km ln(price)	2-3km ln(price)	>3km ln(price)	1-2km area	2-3km area	>3km area
dplan	-0.207***	-0.123***	-0.356***	-9.772***	-1.542	3.359***
	(-13.20)	(-4.34)	(-11.38)	(-18.14)	(-1.09)	(3.26)
Constant	19.885***	0.564	13.804***	113.433***	315.141***	122.692***
	(87.49)	(0.83)	(92.54)	(17.92)	(-11.90)	(17.79)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Station FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Station*Month	Yes	Yes	Yes	Yes	Yes	Yes
Observations	46,289	23,405	54,909	46,289	23,405	54,909

R-squared	0.759	0.823	0.595	0.844	0.834	0.707

Table 6: The impact of old station new line on house price

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	**2km ln(price)**	**2km area**	**1km ln(price)**	**1km area**	**750m ln(price)**	**750m area**	**2km ln(price)**	**2km area**
dplan	0.037	13.740***	0.032	10.603***	0.032	13.080***	2.539***	26.582***
	(0.77)	(-6.80)	(-0.65)	(-3.13)	(-0.55)	(-3.30)	(19.14)	(-7.77)
distance	0.097***	1.237***	0.005	10.397***	0.005	10.965***	0.009*	0.682***
	(-23.12)	(9.89)	(-0.40)	(14.75)	(0.48)	(15.68)	(1.79)	(3.90)
dplan_distance							0.208***	1.076***
							(-20.99)	(5.33)
Constant	21.905***	97.348**	3.533***	563.651***	0.379	1,063.639***	12.571***	145.013***
	(-12.95)	(-2.18)	(2.83)	(-8.32)	(-0.15)	(-5.32)	(-9.52)	(-2.94)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Station* Month	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,696	6,696	3,310	3,310	3,178	3,178	6,696	6,696
R-squared	0.806	0.873	0.968	0.920	0.971	0.922	0.872	0.874