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Research Article

Housing Price Appreciation Effects of Elevator Installation in Old Residential Areas: Empirical Evidence Based on a Multiperiod DID Model

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Scientific measurement of the appreciation effect of house prices after the installation of elevators in old residential areas would help build a reasonable urban renewal investment mechanism. Based on the transaction data of second-hand houses in old residential areas with elevators installed in Beijing from 2016 to 2021, a multiperiod DID model is constructed to measure the appreciation effect, dynamic effect, and heterogeneity effect brought by the installation of elevators and to explore the mechanism of the appreciation effect. The research results show that, overall, the installation of elevators boosts the house prices of the entire community, and the appreciation effect appears in advance due to good market expectations. However, the effect of house prices varies by floor. The higher the floor, the greater the appreciation of house prices, while low-rise residential buildings are depreciated by the installation of elevators. Mechanistic research shows that the appreciation of house prices on high floors is mainly due to the improvement in the living environment, and factors such as noise and poor lighting lead to depreciation on lower floors. The results of quantile regression analysis show that the appreciation effect brought by the installation of elevators increases with the increase in the residential value.

1. Introduction

As the core content of urban renewal and a major livelihood project following the renovation of shantytowns, the renovation of old residential areas has received strong policy support in recent years, and renovation work has been continuously promoted in China. The renovation of old communities promotes the transformation of China's land use model from incremental development to stock renovation, and popular land use methods will have a positive impact on the prices of surrounding housing [1, 2]. Especially with the acceleration of the aging process, as an upgrade project in the renovation of old residential areas, elevator installation has been eagerly expected by residents in recent years, and governments at all levels have attached great importance to it. The State Council has included "elevator installation" in the annual Government Work Report for four consecutive years. Statistics from the Ministry of Housing and Urban-Rural Development of the People's Republic of China show that between 1980 and 2000, the area of urban residential houses built in China exceeded 8 billion square meters, but more than 70% of the old buildings inhabited by the urban elderly do not have elevators installed. The total demand for elevators exceeds 2 million units. However, the rate at which elevators are being installed is far from meeting the needs of society. Taking 2021 as an example, only approximately 51,000 elevators were installed during the renovation of old residential areas in China in 2021, and the contradiction between the supply and demand of elevators is prominent.

There are many factors that restrict the installation of elevators in old communities. Liu and Sun noted that the issue of cost allocation and loss compensation is the core of the conflict between stakeholders in the elevator installation project [3]. In fact, the Chinese Party Central Committee and governments at all levels have clearly stipulated the investment mechanism for the renovation of old residential areas, that is, "whoever benefits will contribute the capital," as clearly stated in the "Guiding Opinions on Comprehensively Promoting the Reconstruction of Old Urban Districts" and "In terms of renovation funds, first of all, according to the principle of who benefits and who contributes, we should actively promote residents' participation in renovation." Policy documents such as the "Notice on Strengthening the Construction of Supporting Facilities for Renovation of Old Urban Residential Areas" also have explicit provisions on "who benefits and who contributes." Therefore, the basis for constructing a reasonable investment mechanism for the installation of elevators is to scientifically and rationally measure the comprehensive benefits, especially the economic benefits, of projects renovating old residential areas, such as the installation of elevators. Evans [4] and Lee and Chan [5] showed that urban renewal has significant spillover effects in terms of environmental, social, and economic benefits for communities. A breakthrough in measuring the economic benefits of installing elevators is that doing so in old communities can increase the convenience of community travel, improve the quality of public services in the community, and improve the living environment of the community. Shi and Chen and other scholars have conducted qualitative analysis on the installation of elevators in old residential areas and found that the installation will increase house prices in the residential area to a certain extent [6], but this effect has not been tested quantitatively nor has the contribution of the installation of elevators to the house price rise been accurately measured.

This paper takes the installation of elevators in old residential areas as a quasinatural experiment. Taking some old residential areas with elevators installed in Beijing as samples, a multiphase DID model is constructed to study the appreciation effect, dynamic effect, and heterogeneity of elevator installation on residential prices. Measuring the impact of the installation of elevators on the overall house price, the house price of each floor and the house prices of old houses of different values, and exploring its mechanism of action provide a theoretical reference for scientifically measuring the economic benefits of elevator installation, improving the mechanism of cost sharing and loss compensation for elevator installation, and promoting steady and long-term urban renewal.

2. Research Hypothesis

2.1. The Appreciation Effect of House Prices and the Dynamic Effect of Elevator Installation. At present, a small number of scholars have found that urban renewal projects have a negative or nonsignificant impact on surrounding house prices [7, 8], and most scholars have paid attention to the improvement in housing itself or whether the surrounding environment has a positive impact on house prices. Malpezzi [9], Immergluck [10], and Collins and Shester [11] summarized the practical experiences of Western countries and found that urban renewal projects increase the number of amenities, improve the overall environment of surrounding communities and the living conditions of residents, and have a positive spillover effect on house prices. Ahlfeldt et al. [12] and Jayantha and Yung [13] found that urban renewal not only has a positive impact on the price of surrounding houses but also has a certain effect on house rental. Zhang et al. (2016) proved that urban village renovation projects increase the value of houses within 1,000 meters by 3%-4% [14]. Wang et al. examined the spillover effect of shantytown renovation on surrounding house prices [15]. Liu and Chen used urban village renovation as a natural experiment to measure the external spillover effect of urban renewal on the commercial housing market [16]. Liu et al. empirically studied the spatiotemporal heterogeneity of urban renewal in Shenzhen on surrounding house prices [17]. Residents benefit from the use of elevators as a public good in the community. It is in the interests of most people to install elevators in old communities, and the convenience of travel will be capitalized into house prices. Therefore, in terms of theoretical analysis, the installation of elevators leads to an increase in the overall price of housing. Based on this, this study proposes the first research hypothesis:

(H1): installing elevators leads to overall house price appreciation

From the announcement to the start of construction to the completion, the implementation of an elevator installation project is a continuous and observable process. Positive or negative market expectations can cause house prices to rise or fall before a project is completed. It is also possible that after the completion of the project, the relevant uncertainties are eliminated, the owners perceive an improvement in the living environment, and the house price shows a trend of appreciation; that is, there is a time lag. This kind of early or delayed reflection of house prices is a dynamic effect. Ooi and Le suggested that in the stage of land acquisition for new projects, market uncertainty causes people to have negative expectations, so house prices fall at this stage; however, in the presale and completion stages, house prices responded positively [18]. The research results of Hyun and Milcheva showed that the surrounding house prices decline during the announcement stage of new projects [19]. Wang et al. also verified the existence of this dynamic effect when examining the impact of shantytown renovation on surrounding house prices [15]. Based on the above research, this paper proposes the second research hypothesis:

(H2): there is a dynamic effect of the installation of elevators on house prices.

2.2. Heterogeneous Effect of House Price Appreciation by Floor. Residents' demand for elevators varies by floor. Ning considered the installation of elevators to have less value for low-rise residents than for high-rise residents; the lower the floor is, the greater the possibility of harm and damage, and the higher the floor is, the greater the benefits and profits [20]. Liu and Sun further established a cost allocation model and a loss compensation model, and the research results indicated that with a certain number of voting rights, owners of houses on a higher floor have a higher proportion of cost allocation [3]. Bai et al. established a cost-sharing compensation model based on the life cycle cost theory and the time value of capital theory and concluded that residents on the ground floor should be compensated, and that residents on other floors should pay fees, and the higher the floor is, the higher the fees is [21]. In terms of theoretical analysis, middle and high-rise owners have the strongest demand for elevators. The installation of elevators brings great travel convenience for residents, thereby indirectly increasing the price of high-rise housing, while low-rise owners, especially those on the ground floor, have little demand for elevators. In addition, the installation of elevators will affect the quality of the house, lighting, ventilation, privacy, and safety and can result in feeling crowded. Based on the above analysis, this paper proposes a third research hypothesis:

(H3): the higher the floor is, the greater the house price appreciation is, and low-rise housing will depreciate due to the installation of elevators.

2.3. The Mechanism by Which Elevator Installation Affects House Prices. Since most homeowners in old communities are elderly, travel convenience, which directly affects house prices, is the primary factor they consider. The installation of elevators in old buildings can enable some elderly people who cannot travel freely all year round to go downstairs, greatly improving their living environment and enhancing their sense of well-being. Some scholars have noted that urban renewal projects can provide better public services and improve the living environment, which will have a positive spillover effect on housing [18, 22–24]. However, there are indeed some problems in the installation of elevators in old residential areas, especially the installation of peripheral elevators, which greatly affects the lighting of low-rise residents and even leads to infiltration of rainwater, which seriously reduces the price of houses. As confirmed by scholars' studies, the installation of elevators has obvious negative externalities for low-rise residents, such as affected ventilation and lighting, noise pollution, and deteriorated staircase quality, thus negatively affecting house prices [3, 20, 21, 25, 26]. Based on this, this study proposes the following two research hypotheses:

(H4): the installation of elevators increases house prices by improving the living environment

(H5): the installation of elevators decreases house prices due to noise, impacts on lighting, and the deterioration of building quality

2.4. The Appreciation Effect of Elevator Installation on Residential Buildings of Different Values. The house price spillover effects of urban renewal projects also depend on housing type; that is, the spillover effects of renovation projects on high-priced and low-priced houses differ, but scholars have not reached consensus on this research conclusion. Using quantile regression, Liu et al. found that the spillover effect of urban renewal projects on house prices decreases as the house price increases. This is because the public facilities and living environment of low-priced housing are more backward than those of high-priced housing, and the social and economic benefits brought by the update are more sensitive, resulting in a greater price increase [17]. However, Liu and Chen found that the transformation of urban villages has a more obvious impact on house prices in surrounding areas with good location conditions, such as access to transportation and commercial services [16]. For the old communities in Beijing, the old buildings with high values are usually located in the core areas of Beijing. On the one hand, house prices in the core areas are more differentiated; on the other hand, owners in the core areas have greater economic strength. Therefore, the demand for the installation of elevators is stronger, and this demand is capitalized into the house price, which will bring about a greater price appreciation. Based on this, this paper proposes the sixth research hypothesis:

(H6): the appreciation effect of elevator installation on second-hand house prices increases with the house value

3. Study Design

Most of the previous studies on the factors influencing house prices used the hedonic price model; however, this model can identify the contribution of only existing features around the house to the house price but cannot reflect the differences in house prices caused by specific factors [27], and this model cannot solve the problems of endogeneity and missing variables well. In recent years, the double-difference model has been widely used [28, 29], and considering the inherent defects of the hedonic price model to study such problems, this paper regards the installation of elevators as a quasinatural experiment and uses the DID model to test and measure the impact of the installation of elevators on house prices.

3.1. Variable Selection

3.1.1. Explained Variable. The second-hand housing unit price is used as the explained variable because the second-hand housing transaction market in China is relatively mature. At the same time, to make the data more stable, this paper conducts logarithmic processing of the transaction prices of second-hand housing units.

3.1.2. Core Explanatory Variable. The multiplication term of the group dummy variable and the time dummy variable represents the average effect of elevator installation on house price increases.

3.1.3. Control Variables. Referring to the studies of Freeman [30] and Gillard [31], this paper divides the control variables into three dimensions: macro, meso, and micro. The macrodimensional control variables include the Beijing second-hand housing price index, GDP, and CPI; the mesodimensional control variables and their quantification are shown in Table 1; and the microdimensional control variables and their quantification are presented in Table 2.

3.1.4. Metavariables. Improving the living environment enhances the happiness of the owners, which in turn affects the happiness index of the entire community. Therefore, the happiness index of the residents of the community (happiness) is selected as the measurement index of the metavariable "improvement in the living environment," and the number of complaints received by the street office (complaint) was used to measure the mediating variable "noise, reduced lighting, and poor building quality."

3.2. Model Setting. Since the time at which elevators are installed in each community varies, this paper builds a double-fixed effect of location and time multiperiod DID model. The DID model required two dummy variables: the group dummy variable "treat" and the time dummy variable "time." If the second-hand house in the transaction is equipped with an elevator, treat = 1, and otherwise, treat = 0. If the transaction time of second-hand housing is earlier than elevator installation in the community in which it is located, post = 1, and otherwise, post = 0. The model setting is as follows:

$$\begin{aligned} \ln Y_{\mathrm{it}} &= \alpha_0 + \theta \mathrm{did}_{\mathrm{it}} + \beta X_{\mathrm{it}} + u_i + \lambda_t + \varepsilon_{\mathrm{it}}, \\ i &= 1, 2, \ldots, n, \\ t &= 1, 2, \ldots, T. \end{aligned} \tag{1}$$

In the above formula, i represents the second-hand residence traded, t represents the time, Y_{it} is the explained variable, and did is the core explanatory variable, which is the product of treat and post. X_{it} is the set of all control variables, λ_t is the time fixed effect, and u_i is the location fixed effect, that is, the administrative district to which the sample cell belongs. ε_{it} is the random error term. θ is the most important coefficient, which represents the average effect of elevator installation on house price increases. When θ is significantly positive, the installation of elevators has a positive effect on the increase in house prices; otherwise, the installation of elevators has no effect on house prices.

3.3. Data Source and Preprocessing. This paper selects old residential areas with elevators installed in Beijing from 2016 to 2021 as the data sample collection. To form an experimental group and a control group in the same community, only communities with elevators installed in some buildings and some buildings without elevators can enter the sample set. There are a total of 34 old communities in Beijing that meet this condition.

To ensure the accuracy of the research, this study retains only the data for buildings with a total of 6 floors and excludes the transaction data for the basement, and a total of 2875 samples are obtained.

In terms of data sources, the aggregated data of old residential areas with elevators come from the statistics of Beijing Municipal Commission of the Housing and Urban-Rural Development and the elevator company. Second-hand housing prices and microdimensional control variables come from websites such as Fangtianxia and Lianjia. The macrodimensional control variables are from the official website of the National Bureau of Statistics. The "first-class primary school" in the mesodimensional control variables comes from the network definition, and the rest come from AMAP and Baidu Maps. Information such as the time taken to install elevators is collected manually. The happiness index of community residents comes from data collection agencies, and the number of calls received related to complaints comes from on-the-spot interviews.

Before conducting empirical research, it is necessary to preprocess the data, which mainly include the following: for the processing of missing values, this paper uses interpolation, and for individual data that cannot be filled with interpolation, data from adjacent years are used. All index data, such as the second-hand housing price index in Beijing, are uniformly converted to be based on January 2016. The initial regression eliminates insignificant control variables and then conducts empirical analysis.

4. Empirical Analysis

4.1. Inspection of the Appreciation Effect of Elevator Installation. After preliminary regression, when the location and time effects are fixed and no control variables are added, the coefficient of the core explanatory variable (did) is 12.45%, which is significant at the 1% level, indicating that the installation of elevators led to increase in house prices. When the location and time effects are fixed and control variables are added for regression, some control variables are not significant. Excluding variables that are not significant and economically significant, the regression result is shown in Table 3.

The DID coefficient is 0.0574525, which has a positive correlation with house price, indicating that the installation of elevators in the old community can bring a 5.75% appreciation to house prices (logarithm) as a whole, and the first research hypothesis has been verified.

4.2. Dynamic Effect Test of House Price Appreciation. A previous article verified that the installation of elevators has an overall lifting effect on house prices, but this lifting effect is an average effect and has not been determined to be a dynamic effect. To test whether the second research

Table 1: The mesodimensional control variables and their quantification.

Variable names	Variable descriptions	Variable quantifications
Subway	Distance to the nearest subway station (straight-line distance)	Within 500 m is assigned 5, 500–1000 m is assigned 4, 1-2 km is assigned 3, 2-3 km is assigned 2, and over 3 km is assigned 1
Bus	Distance to the nearest bus stop (straight-line distance)	Within 200 m is assigned 3, 200–500 m is assigned 2, and above 500 m is assigned 1
Hospital	Distance to the nearest tertiary hospital (distance through vehicle)	Within 1 km is assigned 4, 1–3 km is assigned 3, 3–5 km is assigned 2, and above 5 km is assigned 1
Park	Distance to the nearest park (straight-line distance)	Within 1 km is assigned 4, 1-2 km is assigned 3, 2-3 km is assigned 2, and above 5 km is assigned 1
Market	Distance to the nearest market (straight-line distance)	Within 500 m is assigned 4, 500 m–1 km is assigned 3, 1-2 km is assigned 2, and above 2 km is assigned 1
Supermarket	Distance to the nearest supermarket (straight-line distance)	Within 200 m is assigned 3, 200–500 m is assigned 2, and above 500 m is assigned 1
School	Number of first-class primary schools in the administrative area	Number of first-class primary schools
Tiananmen	Distance to Tiananmen square (straight-line distance, kilometers)	—
Government	Distance to city hall (straight-line distance, kilometers)	—
CBD	Distance to the nearest CBD (straight-line distance, kilometers)	—

Table 2: The microdimensional control variables and their quantification.

Variable names	Variable quantifications
Room	—
Floor	The lower layer (1st and 2nd layer) is assigned 0, the middle layer (3rd and 4th layer) is assigned 1, and the upper layer (5th and 6th layer) is assigned 2
Orientation	1 for south orientation, and 0 for nonsouth orientation
Age	—
Decoration	1 for rough, 2 for simple, 3 for hardcover, and 0 for other
Property fee	—
Plot	—
Green	—
Parking	The ratio of the number of parking spaces to the total number of houses in the community

Table 3: Benchmark regression result.

Variables	Regression coefficients	t value	P value
did	0.0574525	6.19	0.000
Floor	−0.0314137	−7.72	0.000
Room	−0.0658706	−12.02	0.000
Property fee	0.0946122	9.23	0.000
Plot	−0.0204142	−3.36	0.001
Subway	0.0732853	11.89	0.000
Market	0.1369714	14.43	0.000
School	0.3864729	19.67	0.000
INDEX	0.0146738	24.43	0.000
Constant	8.204143	88.15	0.000
Adj R-squared	0.8550		
Number of obs	2875		

hypothesis holds, this paper constructs a new model by adding the dummy variable of the year in which the elevator was installed into the baseline model:

$$\begin{aligned} \ln Y_{it} &= \alpha_0 + \theta did_{\mathrm{it}} + \phi_m \mathrm{pred}_{\mathrm{im}} + \varphi_n \mathrm{postd}_{\mathrm{in}} \\ &\quad + \beta X_{it} + u_i + \lambda_t + \varepsilon_{it}, \\ i &= 1, 2, \ldots, n, \\ t &= 1, 2, \ldots, T, \\ m &= 1, 2, 3, \\ n &= 1, 2, 3. \end{aligned} \tag{2}$$

Here, $\mathrm{did}_{\mathrm{it}}$ is the product of treat and post. At the same time, the number of days between the transaction time and the installation of the elevator is indicated by "date," each period is 90 days, pre_{im} are the three periods before date, and $pred_{im}$ is the product of treat and pre_{im}. Similarly, $post_{in}$ are the three periods after date, and $postd_{in}$ is the product of treat and $post_{in}$. Due to the difficulty of data collection, this paper does not divide the process of elevator installation into the three stages of announcement, start-up, and completion but does take 90 days as the period to study the impact of the installation of elevators on house prices in three phases before and after the completion of the elevator.

The empirical analysis result shows that all the regression coefficients of $post_{in}$ are insignificant, and the regression results of pre_{im} are shown in Table 4.

The research results suggest that there is no time lag in the effect of elevator installation on house prices, but housing prices will reflect positively in the first two or three phases before the completion of elevator installation due to good market expectations, and the second research hypothesis is validated.

Table 4: Dynamic effect regression results.

Variables	Regression coefficients	t value	P value
did	0.0042191	0.20	0.045
pre_{i3}	−0.0768575	−3.09	0.002
pre_{i2}	0.0985562	3.46	0.001
pre_{i1}	0.0394703	1.45	0.147
Adj R-squared	0.8553		
Number of obs	2875		

4.3. Heterogeneity Test of the Appreciation Effect of Elevator Installation on Residential Buildings by Floor. The effects of elevator installation on the house prices may vary by floor. To confirm the third research hypothesis of this paper, this paper uses the benchmark regression model to regress the second-hand residential buildings of high rise, middle rise, and low rise, respectively. The regression results are shown in Table 5.

The regression results show that the installation of elevators increases the house price by 10.73% for the upper floors (5th and 6th floors), 9.44% for the middle floors (3rd and 4th floors), and 6.78% for the lower floors (1st and 2nd floors), and the impact of elevator installation on different floors is heterogeneous. The third hypothesis is verified. The results of this study can provide a quantitative reference for related departments to determine the mechanism of cost allocation and loss compensation: compared with middle-level owners, high-level owners should share more costs. Lower-level owners not only do not need to share the cost but also should receive appropriate compensation for the depreciation of their house prices.

4.4. Analysis of the Mechanism by Which the Installation of Elevators Affects House Prices. The analysis of the mechanism of action in this paper is divided into the following two steps: first, the regression of a single mediator variable on did, as shown in (1) and (3) in Table 6, and then, the regression of explanatory variables on did and the mediator variable, as shown in (2) and (4) in Table 6. The analysis results of the mechanism of action are as follows (Table 6).

According to the regression result, it can be seen that (1) in the first row, did is significant at the 0.1 level, indicating that the installation of elevators improves the living environment; (2) in the second row, the did coefficient dropped from 5.75% to 5.57%, indicating that "improvement in the living environment" is the mediating variable. The coefficient of happiness is significantly positive, indicating that improving the living environment promotes house prices; (3) in the third row, did is significant at the 0.05 level, indicating that the installation of elevators brings about problems such as noise, weak lighting, and poor building quality; (4) in the fourth row, the did coefficient is reduced from 5.75% to 5.60%, indicating that "noise, less lighting, worse building quality, etc." is a metavariable. The coefficient of complaint is significantly negative, indicating that problems such as weak lighting have a negative impact on house prices. Therefore, both the fourth and fifth research hypotheses were validated.

The appreciation effect of the installation of elevators on house prices is transmitted in two ways: through "improving the living environment" and "generating noise and other problems." Combined with the result of the benchmark regression analysis, it can be seen that the positive effect is still obtained after the positive and negative effects of the two ways are canceled out; that is, from the overall effect, the installation of elevators plays a role in increasing the house price.

4.5. Quantile Regression Analysis of the Appreciation Effect of Elevator Installation on Houses of Different Values. The benchmark regression used to measure the house price appreciation effect of installing elevators is a mean regression, and what is obtained is the conditional expected effect of installing elevators on house price appreciation. The benchmark regression model does not take into account that there may be significant differences in the impact of installing elevators on house prices for house in different price ranges, which reduces the accuracy of the model estimation and the explanatory power of the explanatory variables on the explained variables. In addition, the benchmark regression result is inevitably affected by extreme values and residual sums of squares.

Based on this, Koenker's quantile regression model is used here to depict the impact of installing elevators at different quantiles on the appreciation of house prices, which can improve the robustness of the results and the accuracy of data characterization. In this paper, the bootstrap dense algorithm technique is used to estimate the quantile regression coefficient, and the confidence interval is determined by sampling with replacement. The regression results of house prices at the 25%, 50%, 75%, and 90% quantiles are shown in Table 7. The did coefficients are 0.0807959, 0.1081383, 0.0896266, and 0.119905, respectively, indicating that houses of different values respond differently to the installation of elevators. The quantile regression trend

Table 5: Heterogeneity analysis results for residential buildings by floor.

Floor	did regression coefficients	t value	P value	Adj R-squared	Number of obs
High floor	0.107278	7.44	0.000	0.8653	1116
Middle floor	0.0944266	6.82	0.000	0.8668	976
Low floor	−0.0678726	−2.92	0.004	0.8322	783

Table 6: Mechanism of action analysis results.

Variables	(1) Happiness	(2) Ln (price)	(3) Complaint	(4) Ln (price)
did	0.0722465* (0.0533637)	0.0556829*** (0.0091159)	0.0433083** (0.0521586)	0.0559616*** (0.0091376)
Happiness		0.0244942*** (0.0036067)		
Complaint				−0.0144262*** (0.0031475)
Control variable	Yes	Yes	Yes	Yes
Adj R-squared	0.5494	0.8593	0.6365	0.8612
Number of obs	2,875	2,875	2,875	2,875

Standard errors in parentheses, $^{*}P < 0.1$, $^{**}P < 0.05$, and $^{***}P < 0.01$.

Table 7: Quantile regression results of different value dwellings.

Variable	Second-hand home price natural logarithm			
	$\Theta = 0.25$	$\Theta = 0.50$	$\Theta = 0.75$	$\Theta = 0.90$
DID	0.0807959*** (0.0155159)	0.1081383*** (0.0106782)	0.0896266*** (0.0114748)	0.119905*** (0.0192153)
Floor	−0.0507751*** (0.0100571)	−0.0373477*** (0.0072419)	−0.0351411*** (0.0063951)	−0.0454045*** (0.0074183)
Room	−0.0890057*** (0.0107251)	−0.0464848 (0.0096143)	−0.0409412*** (0.0064855)	−0.0477666*** (0.006567)
Property fee	0.1577307*** (0.0179914)	0.015922 (0.0099816)	0.0484947* (0.0191919)	0.110648*** (0.017752)
Plot	−0.0138215 (0.0120328)	0.0076585 (0.0101805)	−0.0125724 (0.0154403)	-0.0467431*** (0.0086376)
Subway	0.0657575*** (0.0080883)	0.148784*** (0.0073774)	0.1750115*** (0.0093856)	0.1905539*** (0.0072173)
Market	0.0294006** (0.0144838)	0.0117484 (0.0116799)	0.0027454 (0.0202591)	−0.0373311*** (0.0078028)
School	0.5373062*** (0.0175748)	0.5814613*** (0.0157113)	0.5478679*** (0.0192262)	0.5959256*** (0.0135145)
INDEX	0.0169642*** (0.0010379)	0.0177948*** (0.0006355)	0.0155064*** (0.0007246)	0.0136821*** (0.000922)
Constant	7.858499 (0.1387806)	7.760422*** (0.0829116)	8.148983*** (0.1365699)	8.569518*** (0.1341247)
Adj R-squared	0.4183	0.4646	0.5180	0.5168
Number of obs	2,875	2,875	2,875	2,875

Standard errors in parentheses, $^{*}P < 0.1$, $^{**}P < 0.05$, and $^{***}P < 0.01$.

chart of the appreciation effect is shown in Figure 1. The appreciation effect of house prices increases gradually with house prices in general, and the sixth hypothesis has been verified. For the installation of elevators in low-value houses, the appreciation benefit of the house price attributable to the owners is relatively small. Therefore, compared with the owners of high-value houses, the government should give them greater subsidies.

4.6. Robustness Check

4.6.1. The Fixed Effects of the Treatment Group and Treatment Period Multiperiod DID Model. The benchmark model in this study adopts the double fixed effect of location and time multiperiod DID model and uses the reghdfe command. The fixed effects of the treatment group and treatment period multiperiod DID model are now used, and the diff command is used. If the two conclusions are consistent, it proves that the conclusions drawn by the benchmark regression model are reliable. The fixed effects of the treatment group and treatment period multiperiod DID model are as follows:

$$\begin{aligned} \ln Y_{\text{it}} &= \gamma_0 + \varphi \text{treat}_i * \text{post}_t + \delta X_{it} \\ &\quad + \phi_1 \text{treat}_i + \phi_2 \text{post}_t + \nu_{it}, \\ i &= 1, 2, \ldots, n, \\ t &= 1, 2, \ldots, T. \end{aligned} \tag{3}$$

The regression result shows that the regression coefficient of DID is 0.008, which is significant at the 5% level, and the hypothesis is confirmed again.

4.6.2. PSM-DID Model. When using the DID model to analyze the problem, it is difficult to keep the basic characteristics of the experimental group and the control group highly similar, which affects the scientificity of the research. To reduce the sample selection bias and the error caused by nonrandom selection, the propensity score matching (PSM)

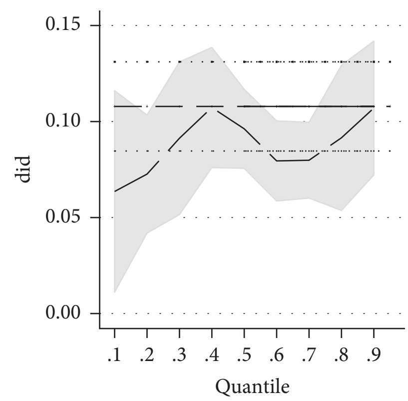

Figure 1: Quantile regression change trend chart.

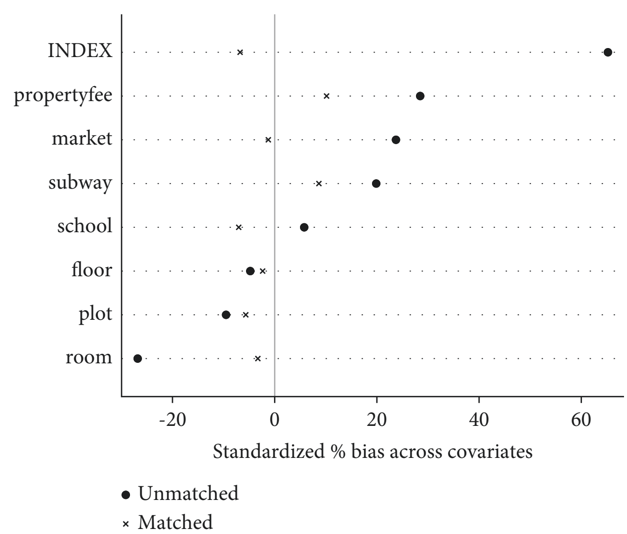

Figure 2: Standard deviation before and after matching the experimental and control groups (%).

Table 8: PSM matching validity test.

Variable name		Mean: Experimental group	Mean: Control group	Standard deviation (%)	t-statistic	*t*-test, $P > \|t\|$
Floor	Unmatched	1.087	1.1243	−4.8	−1.01	0.313
	Matched	1.087	1.1054	−2.4	−0.40	0.686
Room	Unmatched	1.9047	2.0817	−26.8	−5.70	0.000
	Matched	1.9047	1.9264	−3.3	−0.61	0.542
Property fee	Unmatched	0.93303	0.79664	28.5	5.99	0.000
	Matched	0.93303	0.8844	10.2	1.89	0.059
Plot	Unmatched	1.988	2.0614	−9.5	−2.07	0.039
	Matched	1.988	2.0316	−5.7	−0.99	0.321
Subway	Unmatched	4.0334	3.8867	19.9	4.27	0.000
	Matched	4.0334	3.9699	8.7	1.48	0.139
Market	Unmatched	3.5602	3.4004	23.7	5.14	0.000
	Matched	3.5602	3.5686	−1.2	−0.23	0.822
School	Unmatched	0.48161	0.45279	5.8	1.26	0.208
	Matched	0.48161	0.51672	−7.0	−1.21	0.225
INDEX	Unmatched	132.24	127.73	65.2	11.73	0.000
	Matched	132.24	132.71	−6.8	−2.47	0.014

model is combined with DID to analyze the house price appreciation effect of installing elevators. The main steps are as follows: first, we select the control variables according to the benchmark regression result, then use the logit regression model to estimate the propensity score, then use the nearest neighbor matching method to match the experimental groups one-to-one according to the scores, and finally, on the basis of the matching, carry out the DID analysis.

Before conducting the empirical analysis of PSM-DID, this paper first verifies the matching balance hypothesis. The matching effect is shown in Figure 2. Compared with before matching, most variables are close to the vertical line with a standard error of 0 after matching, and there is no significant difference between covariates, indicating that the PSM-DID model used in this paper is reasonable. The results in Table 8 show that the standard deviations after matching are all less than 20%, indicating that there is no systematic difference between the experimental group and the control group after matching, the matching method is feasible, and the matching balance hypothesis is satisfied, again proving that the use of PSM-DID for empirical analysis is justified. The PSM-DID regression result shows that the coefficient of the core explanatory variable is 0.0523388, which is significant at the 1% level, indicating that the installation of elevators has a significant effect on the appreciation of house prices.

5. Conclusions and Recommendations

This paper focuses on the impact of installing elevators on house prices. The research results show that (1) on the whole, installing elevators can increase house prices by 5.75%, which shows that installing elevators in old communities not only improves people's well-being but also has significant economic benefits and external effects; and (2) the appreciation rates of house prices vary by floor, with the rates for high, medium, and low floors being 10.73%, 9.44%, and −6.78%, respectively. The government should formulate a reasonable cost sharing and loss compensation plan for the installation of elevators according to the calculation result. (3) The higher the residential value is, the greater the effect of house price appreciation brought about by the installation of elevators. The research result suggests that the government should adopt different subsidy policies in light of the appreciation of houses of various values when appropriating subsidies for the installation of elevators.

In the past, when the subdistrict office communicated with homeowners about financing the installation of elevators, it was often difficult to persuade the residents due to the lack of quantitative research evidence. Therefore, there have been great difficulties in raising funds for the installation of elevators. The research results of this paper could provide scientific theoretical support for the communication and publicity work between subdistrict offices and residents, contribute to the construction of a benign investment mechanism for the installation of elevators in old communities, and have certain reference significance for the construction of long-term mechanisms of other urban renewal projects.

Data Availability

The data used to support this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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References

[1] C. Y. Jim and W. Y. Chen, "Impacts of urban environmental elements on residential housing prices in guangzhou(China)," *Landscape and Urban Planning*, vol. 78, no. 4, pp. 422–434, 2006.

[2] T. E. Panduro and K. L. Veie, "Classification and valuation of urban green spaces — a hedonic house price valuation," *Landscape and Urban Planning*, vol. 120, pp. 119–128, 2013.

[3] X. J. Liu and Y. K. Sun, "Research on the cost-sharing compensation of old residential buildings with elevator," *Mathematics in Practice and Theory*, vol. 49, no. 10, pp. 114–121, 2019.

[4] G. Evans, "Measure for measure: evaluating the evidence of culture's contribution to regeneration," *Urban Studies*, vol. 42, no. 5-6, pp. 959–983, 2005.

[5] G. K. L. Lee and E. H. W. Chan, "The analytic hierarchy process (AHP) approach for assessment of urban renewal proposals," *Social Indicators Research*, vol. 89, no. 1, pp. 155–168, 2008.

[6] S. X. Shi and H. . Chen, "The multiple streams approach to understand policy agenda setting in community: a case study of elevators retrofitting on old communities in H district of fuzhou," *Urban Development Studies*, vol. 28, no. 12, pp. 11–15, 2021.

[7] K. W. Chau and S. K. Wong, "Externalities of urban renewal: a real option perspective," *The Journal of Real Estate Finance and Economics*, vol. 48, no. 3, pp. 546–560, 2014.

[8] J. Uitermark and M. Loopmans, "Urban renewal without displacement? Belgium's 'housing contract experiment' and the risks of gentrification," *Journal of Housing and the Built Environment*, vol. 28, no. 1, pp. 157–166, 2013.

[9] S. Malpezzi, "Housing prices, externalities, and regulation in U.S. metropolitan areas," *Journal of Housing Research*, vol. 7, no. 2, pp. 209–241, 1996.

[10] D. Immergluck, "Large-scale redevelopment initiatives, housing values, and gentrification: the case of the Atlanta Beltline," *Urban Studies*, vol. 46, no. 8, pp. 1725–1747, 2009.

[11] W. J. Collins and K. L. Shester, "Slum clearance and urban renewal in the United States," *American Economic Journal: Applied Economics*, vol. 5, no. 1, pp. 239–273, 2013.

[12] G. M. Ahlfeldt, W. Maennig, and F. J. Richter, "Urban renewal after the Berlin Wall: a place-based policy evaluation," *Journal of Economic Geography*, vol. 17, no. 1, pp. 129–156, 2017.

[13] W. M. Jayantha and E. H. K. Yung, "Effect of revitalisation of historic buildings on retail shop values in urban renewal: an empirical analysis," *Sustainability*, vol. 10, no. 5, p. 1418, 2018.

[14] Y. Zhang, S. Zheng, Y. Song, and Y. Zhong, "The spillover effect of urban village removal on nearby home values in Beijing," *Growth and Change*, vol. 47, no. 1, pp. 9–31, 2016.

[15] Y. R. Wang, Z. Y. Wang, C. D. Yi, H. Wang, and R. Gao, "The spillover effects of urban renewal projects on local housing prices: empirical evidences based on Shanty Town reconstruction in Beijing," *Urban Development Studies*, vol. 27, no. 12, pp. 106–113+131, 2020.

[16] C. X. Liu and A. P. Chen, "Urban renewal's premium: evidence from a quasi-natural experiment of urban village redevelopment," *China Economic Studies*, vol. 4, pp. 78–90, 2021.

[17] G. W. Liu, Q. Z. Zhou, and J. Huang, "Research on the spatio-temporal heterogeneous effects of urban renewal on housing prices: empirical evidences based on Shenzhen," *Construction Economics*, vol. 42, no. 9, pp. 72–77, 2021.

[18] J. T. L. Ooi and T. T. T. Le, "The spillover effects of infill developments on local housing prices," *Regional Science and Urban Economics*, vol. 43, no. 6, pp. 850–861, 2013.

[19] D. Hyun and S. Milcheva, "Spatio-temporal effects of an urban development announcement and its cancellation on house prices: a quasi-natural experiment," *Journal of Housing Economics*, vol. 43, pp. 23–36, 2019.

[20] C. Q. Ning, "Theoretical analysis on the cost-sharing and compensation method for the installation of elevators in existing residences," *Urban Problems*, vol. 5, pp. 44–48, 2014.

[21] F. R. Bai, H. Shao, and T. H. Zeng, "Construction and application of elevator cost model in existing multi-storey residential buildings," *Construction Economics*, vol. 41, no. 12, pp. 36–40, 2020.

[22] S. S. Rosenthal, "Old homes, externalities, and poor neighborhoods: a model of urban decline and renewal," *Journal of Urban Economics*, vol. 63, no. 3, pp. 816–840, 2008.

[23] T. R. Samara, "Policing development: urban renewal as neoliberal security strategy," *Urban Studies*, vol. 47, no. 1, pp. 197–214, 2010.

[24] C. C. Lee, C. M. Liang, and C. Y. Chen, "The impact of urban renewal on neighborhood housing prices in Taipei: an application of the difference-in-difference method," *Journal of Housing and the Built Environment*, vol. 32, no. 3, pp. 407–428, 2017.

[25] Y. Y. Zhou and C. Tang, "The rationales of the supply of communal public goods——a case study of installing new elevators in the long-established condominium communities," *Chinese Public Administration*, vol. 9, pp. 62–66, 2019.

[26] D. Q. Li and Y. Wang, "Solution to the dilemma of collective action: a case study of the additional installation of elevators for old or old-styled residential areas in Guangzhou," *Journal of Beijing Administrative College*, vol. 1, pp. 28–35, 2021.

[27] Y. X. Zeng, Y. J. Zhang, and P. Liu, "Research on the spillover effect of newly-built urban parks on housing prices in Beijing," *Prices Monthly*, vol. 1, pp. 1–8, 2021.

[28] G. Kavetsos, "The impact of the London Olympics announcement on property prices," *Urban Studies*, vol. 49, no. 7, pp. 1453–1470, 2012.

[29] M. van Duijn, J. Rouwendal, and R. Boersema, "Redevelopment of industrial heritage: insights into external effects on house prices," *Regional Science and Urban Economics*, vol. 57, pp. 91–107, 2016.

[30] A. M. Freeman, "Hedonic prices, property values and measuring environmental benefits: a survey of the issues," *The Scandinavian Journal of Economics*, vol. 81, no. 2, pp. 154–171, 1979.

[31] Q. Gillard, "The effect of environmental amenities on house values: the example of a view lot," *The Professional Geographer*, vol. 33, pp. 216–220, 1981.