Southward Premium: The Case of Chongqing, China

Panyi Li, Aochen Cao* and Dan Hu
School of Economics and Finance, Chongqing University of Technology, Chongqing, 400054, China

*Corresponding author. Email: 942957423@qq.com

Abstract. This paper focused on the relationship between the orientation of an apartment and its property value. Firstly, we used Hedonic model to decompose the characteristic prices of an apartment, and adopted FGLS to estimate the regression parameters to avoid the adverse consequences caused by heteroscedasticity phenomenon. The empirical result shows that the orientation is not the key factor in the demander’s purchase process. Secondly, in the same community, we selected samples facing south and non-south as a test group and a control group. Through paired regression analysis, we find that in Chongqing’s second-hand housing market, compared to the apartment having no south-facing orientation, those with it on average are valued only 1.42%. It is suggested that the evaluation practice should pay more attention to the orientation characteristics and measure orientation value according to local conditions.

Keywords: second-hand apartment, apartment orientation, hedonic price model, paired regression.

1. Introduction
For a long time, the influencing factors of housing price have been a hot topic discussed by civil and academia. Such as buyer's demand, developer's supply (Krainer, 2015) [1] and government's financial support (Cui, 2011) [2], etc., the impact of these factors on housing price cannot be ignored. In addition to macro factors, there is also a strong correlation between housing price and its own characteristics (Galatidetal, 2011) [3]. In the field of real estate value evaluation, all kinds of residential properties can be divided into three categories, including location property, building property and neighborhood property. A large number of scholars have studied the influence of location and neighborhood factors on apartment price. For example, surrounding landscape (Zhong et al., 2009) [4], traffic accessibility (Wu et al., 2019) [5], education resources (Zhang, 2017) [6], park green space (Shi, Zhang, 2010) [7], etc. As a specific factor, the orientation reflects the building property of an apartment, which should be fully reflected in the pricing link of the residential transaction market (Chan, Yim Yiu, Baldwin and Lee, 2009) [8]. A large numbers of scholars hold positive views on the value of facing south. Mak and Ng (2015) qualitatively analyzed the benefits of facing south from the perspective of Feng-Shui [9]. Taking Shanghai as an example, Lu (2018)’s research shows that a south-facing orientation is associated on average with a 14% premium in property value. In addition, A view of one Shanghai's landmark increases property values by 6%, with this premium being boosted a further 4% by south-facing orientation[10]. However, in an empirical study of the second-hand housing market in downtown Tianjin, the influence of orientation factor on the price of ordinary housing is not significant[11]. Similarly, Chen etc. (2015) took the Beijing Olympic park as an
example, and found that the impact of large urban park green spaces on housing prices in all directions varies with distance. Within 1000 meters from the park, the value-added coefficient of residential buildings in south is higher than east, but within 500 meters, the west is the highest[12]. It can be found from the existing studies that there are regional differences in orientation preference. In addition, quantitative empirical studies on orientation attribute value are relatively scarce. This paper attempts to take Chongqing as an example to analyze the problem of orientation premium and quantitatively investigate whether orientation preference is reflected in the second-hand housing market of Chongqing.

Unlike other freely tradable conventional commodities, residential properties cannot be purchased directly due to the lack of a formal market (Tiebout, 1956)[13]. According to the consumer theory put forward by Lancaster (1966)[14], the attribute value of the commodity can be estimated with the help of hedonic pricing model. When applied to real estate price evaluation, traditional characteristic price models are difficult to consider and control all characteristic factors that affect the value of housing, which is inevitably there is the problem of missing variables bias. To alleviate this problem, Chin and Foong (2006) incorporated as many explanatory variables as possible into the model, including neighborhood factors, building factors and location factors of the community [15]. Clapp et al. (2008) used panel data from the United States for fixed effect analysis [16]. In addition to improving the model itself, we can also start from the research and design process. The main idea is to learn from the current ideas of simulating natural experiments in social sciences, such as the paired regression method. He (2006) applied it to education research [17] and Zhang (2017) used this method to study the school housing premium. The main advantage of the paired regression method is that the number of variables required in the empirical process is small, and the difference method can alleviate the problem of missing characteristic variables to some extent. This paper aims to apply the hedonic model and the paired regression method to the second-hand housing market in Chongqing, and to quantitatively investigate the premium phenomenon of the apartment orientation, so as to provide a reference for the utility value of the apartment orientation in the practice of domestic housing evaluation.

The rest of this paper is organized as follows. Section 2 and 3 respectively introduce the data and methods of this empirical study. Empirical strategies and results are contained in section 4. And the last part is the conclusion.

2. Data

2.1. Attributes data

This paper took the second-hand apartments that were sold in nine main urban areas of Chongqing on December 31, 2019 as the research samples, and focused on exploring the impact of apartment orientation in property value. In the study samples, the number of communities was 773, with a total of 1,546 apartments after removing some samples with serious lack of information. The data information was from the official website of FANG WORLD (https://www1.fang.com/) (for data retrieval).

The explanatory variables can be divided into three groups, including building attributes, neighborhood attributes and location attributes.

| Table 1. Description of main variables. |
|-------------------------------|-----------------|-----|-----|-----|-----|
| Variable                       | Variable description | N   | Mean | Max | Min | SD  |
| Price                          | Unit price(CNY/m²)  | 1546| 14069.30 | 50000.00 | 6186.00 | 3560.93 |
| Building                       | Apartment Orientation(ORI) | 1546| 0.50 | 1.00 | 0.00 | 0.50 |
| Floor Level(FIO)               | Floor level of apartment | 1546| 24.80 | 58.00 | 1.00 | 10.48 |
### Attributes

| Attributes          | Floor Area (AREA) | Floor Area of Apartment (m²) | 1546 | 9.643 | 500.00 | 22.00 | 39.07 |
|---------------------|-------------------|-------------------------------|------|-------|--------|-------|-------|
| Decoration Level (DEC) | 1=rough, 2=simple, 3=medium, 4=hardcover, 5=luxury | 1546 | 3.09 | 5.00 | 1.00 | 1.43 |
| Building Age (AGE) | Age of apartment | 1546 | 5.74 | 20.00 | 0.00 | 2.58 |
| House Structure (STR) | 1=leveling, 0=otherwise | 1546 | 0.95 | 1.00 | 0.00 | 0.22 |
| Property Right (PROR) | 1=Commercial housing, 0=otherwise | 1546 | 0.76 | 1.00 | 0.00 | 0.43 |
| Neighborhood attributes | Plot Ratio (PR) | Plot ratio of community | 1546 | 3.39 | 60.00 | 0.35 | 2.89 |
|                      | Greening Degree (GR) | Greening rate of community (%) | 1546 | 33.03 | 70.00 | 0.35 | 7.78 |
|                      | Property Cost (PF) | Standard of property fee of community (CNY/m²·month) | 1546 | 2.15 | 10.50 | 0.50 | 0.96 |
| Location attributes | Primary School (MID) | 1=within 500m, 2=1000-1500m, 3=1500-2000m, 4=2000-2500m, 5=above 2500m | 1546 | 1.80 | 6.00 | 1.00 | 0.91 |
|                      | Middle School (MED) | 1=within 500m, 2=500-1000m, 3=1000-1500m, 4=1500-2000m, 5=2000-2500m, 6=above 2500m | 1546 | 2.29 | 6.00 | 1.00 | 1.18 |
|                      | Medical (MED) | 3=1000-1500m, 4=1500-2000m, 5=2000-2500m, 6=above 2500m | 1546 | 2.12 | 6.00 | 1.00 | 1.28 |
|                      | Park (PARK) | 1=within 500m, 2=500-1000m, 3=1000-1500m, 4=1500-2000m, 5=2000-2500m, 6=above 2500m | 1546 | 2.06 | 6.00 | 1.00 | 1.10 |
|                      | Transport (TRA) | 1=within 500m, 2=500-1000m, 3=1000-1500m, 4=1500-2000m, 5=2000-2500m, 6=above 2500m | 1546 | 4.09 | 6.00 | 1.00 | 1.81 |
|                      | Commercial Facilities (COM) | 1=within 500m, 2=500-1000m, 3=1000-1500m, 4=1500-2000m, 5=2000-2500m, 6=above 2500m | 1546 | 2.76 | 6.00 | 1.00 | 1.61 |

### Summary statistics

Table 1 reports the descriptive statistical of three groups variables. Among them, the average unit price of each apartment was 14069.30 CNY/m² in the study period. Residential units have a wide range of floors, ranging from 1 to 58. The average plot ratio, greening rate and property cost are 3.39%, 33.03% and 2.15 CNY/m² respectively. Finally, from the mean value of location variables, we can see that the overall scarcity of supporting facilities is primary school, park, medical treatment, middle school, shop and subway supporting facilities from small to large.

### 3. Empirical strategies and result

#### 3.1. Hedonic pricing model

According to the hedonic pricing model proposed by Harrison and Rusindeld (1978)[18], the price of second-hand apartments is determined by the utility value provided by their own features, while the price difference is due to the number of residential features and their combination mode. In this study, the unit price and its logarithmic form were used as the explained variables, and the apartment orientations were divided into two categories, namely south-facing and non-south-facing orientation. According to China’s "residential design code", when the height of seven floors and above or residential floor exceeds 16m, elevators must be installed. In this study, the actual height was replaced by the number of floors, and the square term of floors was added to the regression equation to capture its potential nonlinear influence. The hedonic pricing model constructed is as follows:

\[
\text{Price}_i = h_0 \text{ORI}_i + h_1 \text{FIO}_i + h_2 \text{FIO}_i^2 + \sum h_i X_i + \epsilon_i \tag{1}
\]

\[
\ln(\text{Price}_i) = h_0 \text{ORI}_i + h_1 \text{FIO}_i + h_2 \text{FIO}_i^2 + \sum h_i X_i + \epsilon_i \tag{2}
\]
In Eq. (1) and Eq.(2), Price is the listing unit price in CNY/m². ORI represents the orientation of an apartment, in which the south value is 1 and the non-south value is 0. FIO refers to the number of floors of residential buildings, which is classified according to whether there is elevator or not, and study the relationship between floors and apartment prices separately. X represents other variables affecting apartment prices, ε is the random disturbance term.

In order to ensure the reliability of empirical results, this paper diagnosed collinearity among feature variables by Pearson correlation test before parameter estimation, and the results showed that the maximum correlation coefficient between feature variables was 0.3714, so there was no serious collinearity in each model. Secondly, heteroscedasticity test was carried out on the model after OLS estimation and the White test including square terms and cross terms of characteristic variables was used for analysis. The test results showed that heteroscedasticity phenomenon existed in the model. This paper used feasible generalized least squares (FGLS) to estimate the equation.

It can be seen from table 2 that there is no significant influence on the unit price of second-hand apartment. That we know, in the second-hand housing market in Chongqing's main urban area, the apartment orientation is not the key factor to be considered by the demander in the process of purchasing. In the apartment with elevators, floor height was positively correlated with the unit price, while the opposite was true in the apartments without elevators. By further introducing the square term to capture the nonlinear relationship between floor height and unit price, it is found that regardless of whether the apartment is equipped with elevator or not, floor height and price show a "positive u-shaped" relationship, that is, the price of high and low floors is high, while the price of middle floors is relatively low.

From the other building attributes, decoration level has a significant positive impact on the value of second-hand apartment, flat floor and commercial property has a negative effect on its value. As for neighborhood variables, the higher the plot ratio and property costs, the higher its value. Although the high floor area ratio is not conducive to residents' comfort, the high-density living population also reflects the potential commercial value of the area from one side. The higher the property cost, the better supporting facilities and service standards of the community can be reflected. From the perspective of location variables, the distance between middle schools, parks and commercial facilities has a significant negative effect on the value of second-hand apartment.

**Table 2. Regression results in hedonic model.**

| Variables | PRICE Eq.(1) | PRICE Eq.(2) | PRICE Eq.(3) | LN(PRICE) Eq.(4) | LN(PRICE) Eq.(5) | LN(PRICE) Eq.(6) |
|-----------|--------------|--------------|--------------|-----------------|-----------------|-----------------|
| C         | 11613.4000*** | 11567.6300**  | 17131.6000*   | 9.4360***       | 9.5228***       | 9.7124***       |
| ORI       | 91.2324      | 105.3550     | -194.0900     | 0.0116          | 0.0114          | -0.0134         |
| FIO       | -80.6616**   | -249.8740*** | -0.0089***    | 0.0002          | 0.0003          |
| FIO²      | 2.2134       | 5.6038       |              |                 |                 |
| Others    | Control      | Control      | Control       | Control         | Control         |
| Elevator  | All          | E            | N             | All             | E               | N               |
| N         | 1546         | 1286         | 260           | 1546            | 1286            | 260             |
| Adj.R²    | 0.3853       | 0.3893       | 0.4649        | 0.3542          | 0.3631          | 0.4924          |
| Prob.     | 0.0000       | 0.0000       | 0.0000        | 0.0000          | 0.0000          | 0.0000          |

Notes: Standard errors are clustered at the same level as locational fixed effect, ***p<0.01, **p<0.05, *p<0.1.

**3.2. Paired regression**

When performing pairwise regression analysis, because the test group and the control group were in the same neighborhood, there were a lot of crossovers in the characteristics of the neighborhood and location of the apartment. Therefore, only the price difference caused by the architectural characteristics are considered.

\[ \Delta \text{Price}_i = h_0 \text{ORI}_i + h_1 \Delta \text{FIO}_i + h_2 \Delta \text{FIO}^2_i + \sum h_i \Delta X_i + \epsilon_i \]  

(3)
\[ \Delta \ln(\text{Price}_i) = h_0 \Delta \text{ORI}_i + h_1 \Delta \text{FIO}_i + h_2 \Delta \text{FIO}_i^2 + \Sigma h_i \Delta X_i + \varepsilon_i, \] (4)

In Eq. (3) and Eq. (4), \( \Delta \text{Price} \) represents the price difference per unit area between the southward housing and the non-southward housing in the same community. \( \Delta \text{FIO} \) represents the floor difference, \( \Delta X \) represents the numerical difference of other building features, and \( \varepsilon \) is the random disturbance term. The specific estimates are shown in Table 3.

### Table 3. Results of paired regression.

| Variables | \( \Delta \text{ORI} \) | \( \Delta \text{FIO} \) | \( \Delta \text{FIO}^2 \) | Others | N | Adj.\( R^2 \) |
|-----------|----------------|----------------|----------------|-------|---|----------------|
| Eq.(1)    | 170.8470**    | -57.1243***   | 2.7437***      | Control | 773 | 0.0303         |
| Eq.(2)    | 152.6408*     | -176.9487***  |                  | Control | 773 | 0.0745         |
| Eq.(3)    | 150.2468*     | -0.0033***    |                  | Control | 773 | 0.0911         |
| Eq.(4)    | 0.0153***     | -0.0102***    |                  | Control | 773 | 0.0428         |
| Eq.(5)    | 0.0142***     |                  |                  | Control | 773 | 0.0744         |
| Eq.(6)    | 0.0141***     |                  |                  | Control | 773 | 0.0862         |

Notes: Standard errors are clustered at the same level as locational fixed effect, **p<0.01, *p<0.05, *p<0.1.

It can be seen that in the same community, there is a premium of about 1.41% for a south-facing orientation, which is significantly lower than the conclusion measured by Lu (2018) that the premium in Shanghai is about 14%. In the second-hand housing market of Chongqing, the low premium in the south-facing orientation may be related to the unique weather and geographical characteristics. First, in Chongqing, the sun's height angle changes with the four seasons, this has no significant influence on indoor lighting. In addition, the north-facing and south-facing apartments in the plain area with the southwest wind into the house, can basically avoid the west sun, but in Chongqing, because of the mountain barrier, the utility value of the south may be restrained to a certain extent. Second, due to the mountainous terrain, it is difficult to achieve unified coordination and uniformity in the construction process of residential communities. Therefore, the proportion of south-facing orientation apartments is not prominent, and people's preference is not obvious. To sum up, in the second-hand housing market in Chongqing's main urban area, compared to non-south-facing apartments, the south one premium is only 1.41%.

### 4. Conclusion

This paper used hedonic pricing model and paired regression analysis to explore the relationship between apartment orientation and its property value. The following two conclusions are drawn. First, the apartment orientation is not the key factor in the process of buying. Second, the orientation premium in the same community is only 1.41% in the main urban area of Chongqing, far lower than 14% in Shanghai (Lu, 2018). This paper mainly explains the reason why the orientation premium in Chongqing is lower than that in the plain cities from two aspects of weather characteristics and geographical characteristics. In the process of measuring the house value, the main evaluation methods adopted by asset appraisal practitioners include replacement cost method and market comparison method. Among them, the cost method mainly studies the reconstruction cost and depreciation of the appraisal target, but these two parts of the valuation data are difficult to include the housing orientation factor. Similarly, the market comparison method based on the principle of substitution focuses on the valuation interval and similarity of the comparable object in the specific selection process of the comparable instance, and gives priority to such factors as use, building structure and location in the similarity process, and orientation feature becomes a relatively neglected factor in the process of comparison and correction. Similarly, when the domestic academia makes the characteristic attribution on the utility value of housing based on the theory of characteristic price, there are few literatures to study the orientation of an apartment as the core characteristic variable. It can be seen that the orientation value of apartment has not been paid enough attention to in the evaluation field and academia. This paper measures the South premium of second-hand houses in the main urban area of Chongqing.
Chongqing, key report on the following two Suggestions for discussion: first, asset assessment practice in the process of housing value evaluation should improve the attention to apartment orientation. Such as: plain cities have higher southward premiums and that can affect the accuracy of the evaluation results. Second, according to the different weather characteristics and geographical characteristics of different regions, orientation characteristics should be considered in the evaluation practice as much as possible according to local conditions.

Reference

[1] Krainer. Housing markets and demographics [J]. FRBSF Economic Letter, 2005, (21):1-3.
[2] Cui chengying. An Empirical Analysis of the Factors Affecting Commercial Housing Price in Beijing [J]. Productivity research, 2011(09):86-88.
[3] Galati G, Teppa F, Alessie R. Macro and micro drivers of house price dynamics: An application to Dutch data [J]. DNB Working Papers, 2011, 7(1):121-148.
[4] Zhong haizheng, Zhang Anlu, Cai yining. Impact of Wuhan Nanhu Landscape on the Value of Surrounding Houses—an Empirical Study Based on Hedonic Model [J]. China Land Science, 2009 (12): 65-70.
[5] Wu xiaoyan, Zhou jingkui. Research on the influence of traffic accessibility on residents' willingness to pay—survey from six districts in Tianjin [J]. Economic and management review, 2009, 25(3):145-151.
[6] Zhang ji. Re-estimation of housing premium in school districts: a case study of Beijing [J]. Exploration of economic problems, 2017(08):62-68.
[7] Shi yishao, Zhang rui. Spatial and Temporal Effects of Large-scale Park Green Space on Housing Price: A Case Study of Huangxing Park Green Space in Shanghai [J]. Geographical Research, 2010 (03): 130-140.
[8] Chan, E., Yim Yiu, C., Baldwin, A., & Lee, G. Value of buildings with design features for healthy living: A contingent valuation approach [J]. Facilities, 2009, 27(5/6), 229-249.
[9] Mak, M. Y., & Ng, S. T. The art and science of feng shui: A study on architects' perception [J]. Building and Environment, 2005, 40(3), 427–434.
[10] Lu J. The value of a south-facing orientation: A hedonic pricing analysis of the Shanghai housing market [J]. Habitat International, 2018, 81:24-32.
[11] Chen geng, Zhu daolin, Su yayi, et al. Influence of large urban park green space on housing price—a case study of Beijing Olympic forest park [J]. Resources science, 2015, 37(11):2202-2210.
[12] Tiebout, C. M. A pure theory of local expenditures [J]. Journal of Political Economy, 1956, 64(5), 416-424.
[13] Harrison, D., & Rubinfeld, D. L. Hedonic housing prices and the demand for clean air [J]. Journal of Environment Economics and Management, 1978, 5(1),81-102.