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The Influence of Floor Type of Multi-Family Residential on the Transaction Price and the Estimation of Utility Ratio among Floors

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Authors' contributions

This work was carried out in collaboration among all authors. Authors HWY and HCH proposed the research framework of the study, managed the literature searches, carried out the analysis of hedonic price model and estimation of utility ratio among floors, managed the analyses of the study, wrote the protocol and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

In Taiwan's multi-family residential, there are some problems in the previous research on the utility ratio among floors, including the failure to consider the difference in total number of floors, the excessive research scope and the residential price without deducting the parking space price. This research hopes to improve the problems of previous research, select 1,172 data of multi-family residential with total number of floors of 12, 15 and 22, and use the hedonic price model to establish the utility ratio among floors of residential buildings, and then compare the difference between absolute floors and relative floors on the transaction price. The empirical results found that in the comparative analysis of absolute floors and relative floors, the variable of relative floors

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is significant, showing that the residential price is significantly different with different total number of floors, and the total number of floors is higher that the residential price is higher; the importance of absolute floors on the residential price isn't high. In the model of utility ratio among floors of different total number of floors, the utility curves are distributed in zigzag pattern. Taking floor 4 as the base floor, the floor price difference is higher on floor 1 and near the top floors, and the floor price difference of other floors is not significant.

Keywords: Multi-family residential; utility ratio among floors; absolute floors; relative floors.

1. INTRODUCTION

In Taiwan's multi-families residential, with the increasing land price and the improvement of construction technology, the total number of floors has also increased. When the builders sell residential buildings, they sell them at three-dimensional land prices, and then adjust them slightly according to the utility ratio among floors. But what is the basis for these adjustments?

Furthermore, previous studies haven't established the utility ratios among floors according to different total number of floors; the research scope is too large, making the utility ratio among floors too rough. Chiang [1] pointed out that the application of the overall utility ratio of floors should have certain applicable area limits; except for buildings with different land use types, they must be distinguished, and different overall utility ratios among floors must be calculated separately; finally, the parking space price and parking space area aren't deducted from the transaction price and transfer area. These factors will also cause the actual price of the house itself to be distorted and affect research judgment.

This research hopes to improve the problems of the previous research, using the actual entry data published by the Ministry of the Interior as an analysis sample. The data period is from April 2012 to March 2019, covering 22 multi-families residential on the block near Zhongke Shopping Plaza in Xitun District, Taichung City. A total of 1,172 data of multi-families residential with total number of floors of 12, 15, and 22 are selected for subsequent analysis.

2. LITERATURE REVIEW

The utility ratio among floors refers to the difference in the three-dimensional space utility of high-rise buildings due to different floors. The vertical price difference of high-rise buildings is adjusted by utility ratio among floors; the vertical land price difference of high-rise buildings is adjusted by the land price distribution rate. For the three-dimensional adjustment of land price, if the land contribution theory is used, the land price distribution rate should be adopted; if the joint contribution theory is used, the utility ratio among floors should be adopted. Residential buildings are traded at three-dimensional land prices, and vertical price differences are adjusted according to utility ratio among floors.

Regarding the literatures on the utility ratio among floors, Lin [2] pointed out that the basic factors affecting the utility ratio among floors can be divided into three categories: accessibility, visibility, and comfort. If these three factors are comprehensively measured, the total utility among floors can be regarded as the sum of the accessibility utility and the habitability utility. Chang [3] pointed out that the price of residential units on each floor is mainly determined by the sum of the vertical price difference and the flat price difference. Chiang [1] pointed out that generally the price of fourth floor is the lowest; usually the floor is higher and the price is higher, and the prices of similar floors are more the same; the top floor has the highest price because it has the right to use the roof terrace. Chang and Farr [4] discussed the main factors affecting real estate prices in the Taipei metropolitan area and their degree of influence. They pointed out that if location is regarded as an index of horizontal accessibility, the floor is regarded as an index of vertical accessibility and the type of use is regarded as space, and then it can understand that the urban spatial structure is a fundamental element that affects real estate prices deeply and greatly. Lin et al. [5] thought that the utility ratio of floor 1 is the highest utility ratio of the whole building, and the utility ratio of floor 4 is the lowest; the utility ratio of each floor increases as the number of floors above floor 5 increases. The utility ratio of the top floor is only lower than floor 1 and floor2. Tsai [6] pointed out that previous studies in Taiwan had established the table of utility ratio among floors. Cheng [7] mentioned that the average method and the curve fit method are most commonly used in the method of obtaining the utility among floors. The average method is to average the unit price of the same floor in the same area, and the unit price of each floor of each building, usually the middle floor is lower, and the unit price gradually increases upwards or downwards; the curve fit method uses a quadratic curve to match its changes. However, these two methods are not very successful. Therefore, in recent years, relevant studies have almost adopted the hedonic price method to evaluate the utility ratio among floors. Huang [8] pointed out that for the evaluation of high floors, the utility ratio among floors is an extremely important calculation basis, which is based on the selling price of a certain floor (generally set as 100% based on the fourth floor), and then calculate the percentage of the price of each floor relative to the price of a reference floor.

This study found that in the literature of the past research, there are still several issues that can be considered and discussed in depth for the analysis of the utility ratio among floors:

First, previous studies haven't established utility ratios among floors based on different total number of floors. Lin [9] pointed out that in practice, the utility ratio among floors should be established according to different total number of floors. Furthermore, Yu [10] only divides the sample into residential and commercial buildings on the building with 12 floors to 14 floors and above 15 floors. The data is not subdivided into whether the transaction price includes the parking space price, or the parking space type is mechanical and flat, or the transaction price includes objects with more than one parking space. These factors will also cause the actual price of the house itself to be high and affect research judgments. Finally, the research scope of previous studies is too large. The location is also an important factor affecting the utility ratio among floors. When calculating the overall utility ratios, if the homogeneous areas isn't divided first, the utility ratios will be too rough and lead to poor applicability. The research scope discussed by Hsiao [11], Huang [12], and Tsai [13] all includes the four capitals which are Taipei City, New Taipei City, Taichung City, and Kaohsiung City. The utility ratios among floors estimated by those studies are too rough.

3. RESEARCH DESIGN

3.1 Research Framework

This research first deducts the parking space price and parking space area from the total transaction price and transfer area data of multi-family residential, and then uses the hedonic price method to obtain the utility ratios among floors and compares the influence difference between absolute floors and relative floors on the residential transaction price. "Absolute floors" refers to the price comparison of each floor relative to a specific floor in the building, regardless of the total number of floors of the building. "Relative floors" refers to the same floor between buildings of different total number of floors, and discusses the relationship between floor prices. Fig. 1 shows the research framework based on the hedonic price model.

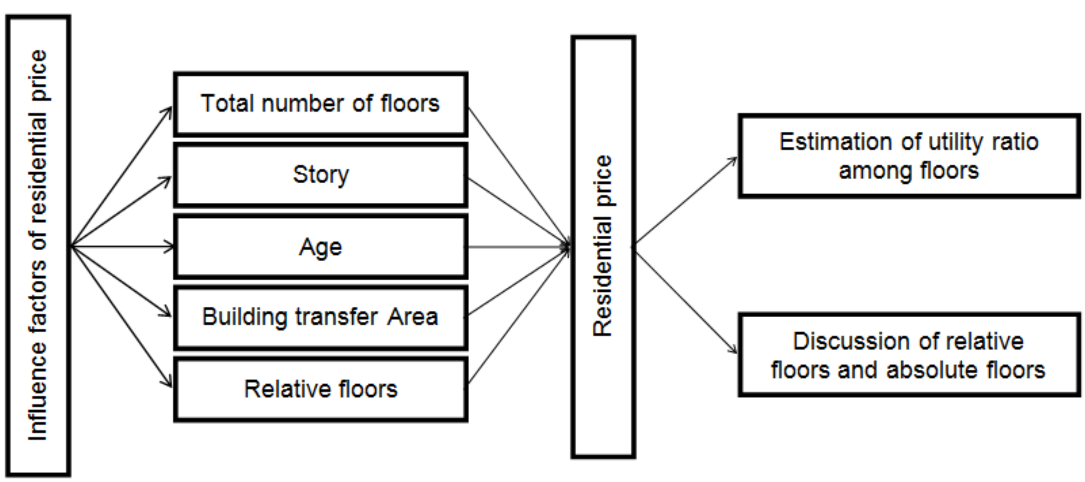

Fig. 1. Proposed Framework for Analysis

3.2 Data Collection

This research uses 22 multi-families residential on the block near Zhongke Shopping Plaza in Xitun District, Taichung City as the subject of discussion. After field visits, transcripts, inquiries about building licenses, use licenses, and reference to information registered at actual prices, there are a total of 2,500 transaction data. Deducting some sample data with missing floor data, a total of 1,172 data of multi-families residential with total number of floors of 12, 15, and 22 are selected. These data will be used as the relevant data of the hedonic price model and establish the utility ratio among floors of residential building, and compare the influence difference between absolute floors and relative floors for residential transaction prices to increase the empirical utility.

3.2.1 Dependent variable

This study intends to explore the relationship between the characteristics of multi-family residential and residential prices, and to further estimate the utility ratio among floors for buildings with different total number of floors. Huang and Chang [14] pointed out that in the past related studies, semi-logarithmic model is most widely used. Therefore, in the study, the total residential price (NT dollar, excluding parking space price) after natural logarithm transformation is used as the dependent variable.

3.2.2 Independent variable

In this study, total number of floors, story, age, and building transfer area (excluding parking space area) are used as independent variables.

3.2.2.1 Total number of floors

The total number of floors of the building actually has an impact on housing prices [15]. Therefore, in this study, the sample is divided into three data sets based on total number of floors: 12 floors, 15 floors, 22 floors, etc., so as to calculate the utility ratio among floors separately and compare the influence of relative floors and absolute floors on the residential price.

3.2.2.2 Story

Due to the product heterogeneity of real estate, when the floor is different, the ventilation and lighting, and the surrounding landscape are also different [16]. In addition, lower floors are prone to external noise and poor natural light, so the residential price is usually proportional to story. Therefore, this study expects that the story will have a positive and significant impact on the residential prices.

3.2.2.3 Age

Buildings are depreciated due to the age [16]. Liang [17] found that during the service life of buildings, the value of real estate displays an opposite depreciation phenomenon that first drops and then rises. Tsai [18] thought that as time changes, residential prices will produce depreciation. Thus, this study assumes that age will have a negative influence on the housing prices.

3.2.2.4 Building transfer area (excluding parking space area)

Lin et al. [19] proposed that building transfer area will significantly affect residential price. Building transfer area is directly proportional to the living space and comfort of the residents, so this study assumes that building transfer area will have a positive influence on the housing price.

3.2.2.5 Relative floors

As explained in the variable "Total Number of Floors", the total number of floors of residential building actually has an impact on residential prices. When two residential units are on the same floor, if the total number of floors of the residential building is different, the price of the residential unit may also be different.

3.3 Hedonic Price Model

Rosen [20] proposed the Hedonic Price Theory based on the new consumer theory. Its concept is that when the market's supply and demand reach equilibrium, under the principle of maximizing utility, consumers evaluate the extra cost that they are willing to pay for each additional unit of each feature [16]. This additional cost is the implied price formed by the marginal willingness of consumers to pay for each feature of the real estate, and then multiply the features of the subject property by the implicit price of each feature to obtain the price of the subject property. Compared with other goods, real estate has the characteristics of heterogeneity, and its price is affected by different composition characteristics. The utility of consumers comes from the characteristics (attributes) of real estate. Therefore, in the empirical research on real estate prices, this theory is generally widely used to establish regression models, that is, hedonic price models.

3.3.1 Models of absolute floors and relative floors

The hedonic price model is a form of multiple regression equation, and its concept is to explore the degree and direction of the influence of various independent variables on dependent variable. The total price of building is composed of the implicit price of the building's attributes [20]. Therefore, this study uses the logarithmic value of the total transaction price as the dependent variable, and the various characteristics of the building are independent variables, including a relative floors category variable. The main purpose is to explore the impact on the total transaction price of residential buildings with different total number of floors when the floor of residential unit is fixed. The hedonic price model established is as follows:

$$Ln(P_i) = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 LR_i + \gamma_i F_i + \varepsilon_i \quad (1)$$

3.3.2 Model of utility ratio among floors

The concept of utility ratio among floors is to set a certain floor as the base floor, and the difference between the prices of other floors and the base floor price is expressed as a percentage, which is the utility ratio among. From past research, it can be known that due to different total number of floors have an impact on the residential transaction prices. Therefore, in this study, the sample is divided into 12, 15, and 22 floors according to the total number of floors, and the model for estimating the utility ratio among floors are established respectively. In the model, the floor 4 is set as the reference floor, and the utility ratio floors are mainly calculated from the coefficients of floors. Since the utility ratio among floors model is established based on different total number of floors, the variable of relative floors is removed from equation (1), and the established hedonic price model is shown in equation (2):

$$Ln(P_i) = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \gamma_i F_i + \varepsilon_i \quad (2)$$

P_i: Residential Price
x_{1i}: Age
x_{2i}: Building Transfer Area (3.306 m^2)
β_1: Regression Coefficient of Age
β_2: Regression Coefficient of Building Transfer Area
F_i: Floor (If i=4, it is 0, otherwise it is 1.)
LR_i: Relative Floors (Comparison of two buildings with different total number of floors; the higher total number of floors is set to 0 (reference group), and the lower total number of floors is set to 1 (for example, when 12 floors is compared with 15 floors, 15 floors is set to 0 and 12 floors is set to 1))
β_3: Regression Coefficient of Relative Floors
γ_i: Regression Coefficient of Floor
ε_i: Error Terms

Based on the above-mentioned hedonic price model, establish the price prediction models for the i-floor and fourth-floor floors where the residential unit is located, and subtract the two models to obtain the following formula (3):

$$Ln(P_i) - Ln(P_4) = \gamma_i F_i \quad (3)$$

The floor is a dummy variable. When the floor is i-floor, F_i=1, if it is the fourth floor, F_i=0, so the formula (3) can be expressed as the formula (4):

$$Ln(P_i) - Ln(P_4) = \gamma_i \quad (4)$$

After further transformation, the formula (5) can be finally obtained. Through this equation, the utility ratio among floors can be calculated.

$$\frac{P_i}{P_4} = e^{\gamma_i} \quad (5)$$

4. RESEARCH FINDINGS AND DISCUSSION

4.1 Analysis Results of Absolute Floors and Relative Floors

The hedonic price model is used to explore the impact of relative floors variable and floor variable (absolute floors) on the transaction prices, so as to understand the extent of the influence of absolute floors and relative floors when consumers purchase a house. Since the sample is divided into 12 floors, 15 floors, and 22 floors based on total floors of building in the study, a pairwise comparison analysis will be made for different total number of floors. In each model, floor 4 is used as the reference group for the variable of floor, and the higher total number of floors is used as the reference group for the variable of relative floors.

4.1.1 Twelve floors and fifteen floors

Table 1 shows that the VIF values of the floor, relative floors, age and building transfer area are all less than 10, indicating that the model doesn't have the problem of collinearity. The adjusted R^2 is 74.2%, which means that this model can explain 74.2% of the variance in residential prices.

The variable of relative floors is significant and the coefficient is negative, it means that if the residential unit is located on the same floor, the price of 22 floors building and 12 floors building are significantly different. Moreover, if the residential unit is located on the same floor, the price of 22 floors building is higher than 12 floors building. Among the floors, only floor 1 has a significant difference in the transaction prices compared to floor 4, and there isn't difference in the other floors compared to floor 4.

Table 1. Examination of the relative floors between 12 floors and 15 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B estimation	Std. error	Beta			
Intercept	14.866	0.046		325.146	<.001	
L1	0.089	0.041	0.052	2.163	0.031	1.494
L2	0.007	0.035	0.006	0.208	0.836	1.844
L3	-0.009	0.036	-0.007	-0.264	0.792	1.754
L5	0.005	0.033	0.004	0.157	0.875	1.974
L6	0.074	0.037	0.053	2.036	0.042	1.725
L7	0.027	0.034	0.022	0.806	0.420	1.934
L8	0.006	0.036	0.004	0.166	0.868	1.729
L9	0.019	0.033	0.017	0.585	0.558	2.081
L10	0.045	0.035	0.035	1.290	0.197	1.880
L11	0.039	0.033	0.033	1.184	0.237	1.982
L12	0.078	0.034	0.063	2.299	0.022	1.921
Relative Floors (15 floors as the reference group)	-0.307	0.025	-0.426	-12.147	<.001	3.171
Age	-0.023	0.002	-0.368	-11.024	<.001	2.876
Building Transfer Area	0.037	0.001	0.980	41.353	<.001	1.447
Mean Square Error (MSE)	0.033					
R^2	0.747					
Adjust R^2	0.742					

Table 2. Examination of the relative floors between 12 floors and 22 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B estimation	Std. error	Beta			
Intercept	15.236	0.034		442.389	<.001	
L1	0.109	0.032	0.067	3.402	0.001	1.421
L2	-0.017	0.026	-0.015	-0.649	0.517	1.848
L3	-0.018	0.024	-0.018	-0.746	0.456	2.027
L5	0.021	0.023	0.022	0.914	0.361	2.170
L6	-0.009	0.026	-0.007	-0.330	0.741	1.781
L7	-0.004	0.026	-0.004	-0.170	0.865	1.754
L8	0.041	0.027	0.033	1.525	0.128	1.685
L9	0.030	0.024	0.029	1.242	0.215	2.035
L10	0.021	0.025	0.019	0.838	0.402	1.917
L11	0.033	0.024	0.034	1.420	0.156	2.096
L12	0.015	0.024	0.014	0.617	0.537	1.976
Relative Floors (22 floors as the reference group)	-0.218	0.031	-0.356	-7.009	<.001	9.449
Age	-0.030	0.002	-0.795	-16.367	<.001	8.627
Building Transfer Area	0.030	0.001	0.885	40.944	<.001	1.712
Mean Square Error (MSE)	0.014					
R^2	0.854					
Adjusted R^2	0.850					

4.1.2 Twelve floors and twenty-two floors

Table 2 shows that the VIF value of the floor, relative floors, age and building transfer area are all less than 10, indicating that the model doesn't have collinearity problems. The adjusted R2 is 85%, which means that this model can explain 85% of the variance in residential prices.

The variable of relative floors is significant and the coefficient is negative, it means that if the residential unit is located on the same floor, the price of 22 floors building and 12 floors building are significantly different. Moreover, if the residential unit is located on the same floor, the price of 22 floors building is higher than 12 floors building. Among the floors, only floor 1 has a significant difference in the transaction prices compared to floor 4, and there isn't difference in the other floors compared to floor 4.

4.1.3 Fifteen floors and twenty-two floors

Table 3 shows that the VIF values of the floor, relative floors, age, and building transfer area are all less than 10, indicating that the model doesn't have collinearity problems. The adjusted R^2 is 81.5%, which means that this model can explain 81.5% of the variance in residential prices.

The variable of relative floors is significant and the coefficient is negative, it means that if the residential unit is located on the same floor, the price of 22 floors building and 15 floors building are significantly different. Moreover, if the residential unit is located on the same floor, the price of 22 floors building is higher than 15 floors building. Among the floors, only floor 6, floor 10, floor 12 and floor 15 have significant differences in the transaction prices compared to floor 4, and there isn't difference in the other floors compared to floor 4.

4.2 Estimation of Utility Ratio among Floors

The aforementioned analysis shows that the variable of relative floors has significant on residential price, which means that the residential price will vary with different total number of floors. Therefore, when estimating the utility ratio among floors, the buildings with different total number of floors must be separated. The following will discuss the analysis results of the hedonic price model of each group.

Table 3. Examination of the relative floors between 15 floors and 22 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B estimation	Std. error	Beta			
Intercept	14.997	0.036		418.517	<.001	
L1	0.091	0.054	0.030	1.683	0.093	1.302
L2	-0.009	0.043	-0.004	-0.201	0.840	1.576
L3	-0.006	0.036	-0.004	-0.174	0.862	2.077
L5	0.035	0.035	0.023	1.004	0.316	2.170
L6	0.092	0.036	0.055	2.514	0.012	1.983
L7	0.040	0.036	0.025	1.117	0.264	2.086
L8	0.016	0.037	0.009	0.436	0.663	1.896
L9	0.031	0.034	0.021	0.911	0.363	2.298
L10	0.095	0.037	0.055	2.569	0.010	1.917
L11	0.083	0.035	0.055	2.384	0.017	2.185
L12	0.119	0.036	0.071	3.260	0.001	1.985
L13	0.059	0.036	0.036	1.621	0.105	2.021
L14	0.045	0.037	0.027	1.231	0.219	1.966
L15	0.077	0.036	0.048	2.150	0.032	2.038
Relative Floors (22 floors as the reference group)	-0.101	0.016	-0.117	-6.229	<.001	1.474
Age	-0.023	0.002	-0.283	-15.035	<.001	1.479
Building Transfer Area	0.035	0.001	0.845	53.829	<.001	1.030
Mean Square Error (MSE)	0.033					
R^2	0.819					
Adjusted R^2	0.815					

Table 4. Regression analysis of the buildings with 12 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B estimation	Std. error	Beta			
Intercept	17.355	0.239		72.560	<.001	
L1	0.134	0.036	0.195	3.725	<.001	1.659
L2	0.001	0.030	0.001	0.021	0.983	2.082
L3	0.015	0.033	0.024	0.452	0.651	1.714
L5	0.015	0.030	0.027	0.477	0.633	2.009
L6	-0.005	0.037	-0.007	-0.141	0.888	1.546
L7	0.024	0.034	0.036	0.684	0.495	1.673
L8	0.016	0.036	0.023	0.456	0.648	1.562
L9	0.024	0.031	0.043	0.770	0.442	1.894
L10	0.039	0.032	0.069	1.225	0.221	1.916
L11	0.011	0.031	0.021	0.371	0.711	1.946
L12	0.012	0.031	0.023	0.398	0.691	1.951
Age	-0.124	0.011	-0.517	-11.777	<.001	1.167
Building Transfer Area	0.028	0.002	0.691	15.696	<.001	1.177
Mean Square Error (MSE)	0.013					
R^2	0.527					
Adjusted R^2	0.505					

Table 5. Regression analysis of the buildings with 15 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B estimation	Std. error	Beta			
Intercept	14.828	0.058		254.586	<.001	
L1	0.065	0.074	0.024	0.880	0.380	1.415
L2	-0.001	0.063	0.000	-0.015	0.988	1.649
L3	-0.023	0.059	-0.012	-0.385	0.700	1.821
L5	-0.003	0.056	-0.002	-0.053	0.958	1.993
L6	0.127	0.058	0.068	2.197	0.029	1.917
L7	0.040	0.054	0.025	0.743	0.458	2.214
L8	-0.002	0.057	-0.001	-0.032	0.975	1.903
L9	0.013	0.053	0.008	0.247	0.805	2.309
L10	0.095	0.058	0.051	1.636	0.103	1.895
L11	0.081	0.055	0.048	1.471	0.142	2.066
L12	0.162	0.057	0.089	2.850	0.005	1.936
L13	0.023	0.057	0.013	0.410	0.682	1.980
L14	0.019	0.059	0.010	0.313	0.754	1.839
L15	0.081	0.055	0.047	1.467	0.143	2.044
Age	-0.021	0.002	-0.204	-8.840	<.001	1.052
Building Transfer Area	0.037	0.001	.859	37.260	<.001	1.051
Mean Square Error (MSE)	0.049					
R^2	0.777					
Adjusted R^2	0.769					

4.2.1 Twelve floors

From the analysis results in Table 4, it can be seen that the VIF values of all independent variables are less than 10, indicating that the model hasn't collinearity problem, and the overall adjusted R^2 is 50.5%. According to the floors, only the price of floor 1 is significantly higher than floor 4, and the other floors haven't significant difference.

4.2.2 Fifteen floors

From the analysis results in Table 5, it can be seen that the VIF values of all independent variables are less than 10, indicating that the model hasn't collinearity problem, and the overall adjusted R^2 is 76.9%. According to the floors, only the price of floor 6 and 12 are significantly higher than floor 4, and the other floors haven't significant difference.

4.2.3 Twenty-two floors

From the analysis results in Table 6, it can be seen that the VIF values of all independent variables are less than 10, indicating that the model hasn't collinearity problem, and the overall adjusted R^2 is 90.8%. According to the floors, the price of only floor 1, 11, 13, 16 and 18 are significantly higher than floor 4, while the other floors haven't significant difference.

Take the influence coefficients of floor from Table 4 to Table 6 into equation (5) to obtain the utility ratios among floors of 12, 15, and 22 floors respectively. The results are summarized as shown in Table 7. The comparison of the trend of utility ratio among floors is shown in Fig. 2. In the model of building with a total of 12 floors, floor 1 has the highest utility ratio, while other floors haven't significant differences. Therefore, except for floor 1, the utility ratio fluctuates very slowly. In the model of building with a total of 15 floors, the highest utility ratio is floor 12, followed by floor 6. As can be seen from Fig. 2, there are two peaks, and the top floor has a slight upward trend. In the model of building with a total of 22 floors, floor 1 has the highest utility ratio, and floor 2 has the lowest utility ratio. Except for floor 1, there isn't obvious peak in the trend.

The average value of the difference in utility ratio between two adjacent floors, and if the difference in utility ratio is greater, the fluctuation is more obvious. Comparing the difference in the utility ratio between floors, if the buildings have 12 floors, the average difference is the lowest that the value is 0.027; if the buildings have 15 floors, the average difference is the highest that the value is 0.059; if the buildings have 22 floors, the value of average difference is 0.045.

4.3 Summary

Based on the above analysis results, it can be seen that age has negative impact on the residential price, which shows that age is the higher and residential price is lower; besides, building transfer area has positive impact on residential, indicating that the area is the higher and the residential price is higher. From standardized regression coefficients, building transfer area has higher impact on the residential price than age. The following will comprehensively discuss the analysis results of the comparison of absolute floors and relative floors and the estimation of utility ratio among floors.

4.3.1 Comparison of absolute floors and relative floors

In the case of pairwise comparisons of different total number of floors, the relative floors variable of the three models are all significant and the coefficients are negative, which means that the total price of real estate on the same floor at different total number of floors is significantly different. Moreover, when the residential units are on the same floor, the total price of the high-rise building is higher than the low-rise building.

In addition, in terms of the floor, floor 4 is used as the reference floor. In comparing buildings with 12 floors and 15 floors, only floor 1, floor 6 and floor 12 have significant differences in the transaction prices compared to floor 4; in comparing buildings with 12 floors and 22 floors, only floor 1 has significant difference in the transaction prices compared to floor 4; in comparing buildings with 15 floors and 22 floors, only floor 6, floor 10, floor 12 and floor 15 have significant differences in the transaction prices compared to floor 4.

From this analysis, it can be seen that there are few significant differences between the transaction prices of each floor and the base floor, indicating that the importance of absolute floors isn't high.

4.3.2 Discussion of utility ratio among floors

In the analysis of buildings with 12 floors, taking floor 4 as the reference floor, only floor 1 has a significant difference in price; the utility ratio of floor 1 is obviously higher and the gap of utility ratio between other floors is small.

In the analysis of buildings with 15 floors, taking floor 4 as the reference floor, only floor 6 and floor 12 have significant difference in price, and the utility ratio of the top floor is not much different with floor 1. In addition, the utility ratio of floor 1 is not particularly high. It is possible that living on floor 1 is more severely affected by air and noise pollution. If resident want to open the windows to let air circulate, the privacy of life is not good. The utility ratio of floor 12 is the highest in the whole building, which may be due to the high habitability of floor 12, and the top floor has problems such as water leakage and sun exposure, so the utility ratio of floor 12 is the highest.

Table 6. Regression analysis of the buildings with 22 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B estimation	Std. error	Beta			
Intercept	15.227	0.031		493.321	<.001	
L1	0.201	0.075	0.042	2.672	0.008	1.107
L2	-0.070	0.041	-0.031	-1.686	0.093	1.473
L3	-0.029	0.030	-0.023	-0.971	0.332	2.552
L5	0.043	0.030	0.034	1.429	0.154	2.536
L6	0.009	0.032	0.007	0.296	0.767	2.180
L7	-0.012	0.034	-0.007	-0.343	0.732	1.938
L8	0.058	0.034	0.035	1.712	0.088	1.913
L9	0.038	0.031	0.028	1.233	0.218	2.344
L10	0.053	0.033	0.034	1.613	0.107	2.032
L11	0.075	0.030	0.058	2.480	0.014	2.436
L12	0.050	0.032	0.034	1.550	0.122	2.105
L13	0.076	0.032	0.052	2.382	0.018	2.169
L14	0.056	0.032	0.039	1.767	0.078	2.222
L15	0.038	0.033	0.025	1.154	0.249	2.074
L16	0.085	0.036	0.048	2.380	0.018	1.791
L17	0.059	0.032	0.040	1.838	0.067	2.121
L18	0.093	0.034	0.057	2.740	0.006	1.932
L19	0.043	0.037	0.023	1.163	0.246	1.695
L20	0.007	0.036	0.004	0.207	0.836	1.800
L21	0.036	0.044	0.015	0.816	0.415	1.460
L22	0.008	0.051	0.003	0.163	0.870	1.279
Age	-0.030	0.001	-0.371	-23.685	<.001	1.099
Building Transfer Area	0.030	0.001	0.915	57.048	<.001	1.153
Mean Square Error (MSE)	0.010					
R^2	0.913					
Adjusted R^2	0.908					

Table 7. The utility ratio among floors of different total number of floors

Floors	Utility Ratio		
	Twelve Floors	Fifteen Floors	Twenty-two Floors
1	114.34%	106.72%	122.26%
2	100.10%	99.90%	93.24%
3	101.51%	97.73%	97.14%
4	100%	100%	100%
5	101.51%	99.70%	104.39%
6	99.50%	113.54%	100.90%
7	102.43%	104.08%	98.81%
8	101.61%	99.80%	105.97%
9	102.43%	101.31%	103.87%
10	103.98%	109.97%	105.44%
11	101.11%	108.44%	107.79%
12	101.21%	117.59%	105.13%
13		102.33%	107.90%
14		101.92%	105.76%
15		108.44%	103.87%
16			108.87%
17			106.08%
18			109.75%
19			104.39%
20			100.70%
21			103.67%
22			100.80%

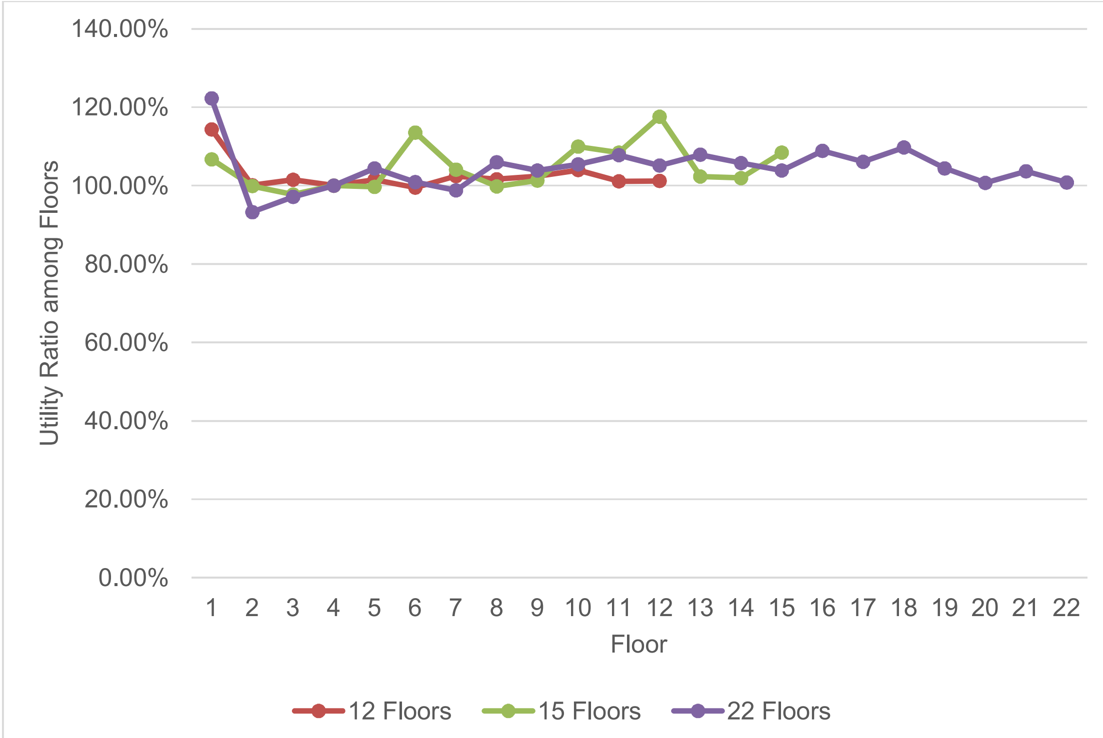

Fig. 2. Comparing the Utility Ratios among Floors Trends of Different Total Number of Floors

In the analysis of buildings with 22 floors, taking floor 4 as the reference floor, only floor 1, floor 11, floor 13, floor 16 and floor 18 have significant differences in prices. It can be seen that in addition to floor 1, the price of middle and high floors is higher. The utility ratio of each floor is that floor 1 is the highest, floor 18 is the second, and floor 12 is the lowest. The reason may be that there are problems such as blocked water pipes, water leakage, and location close to the ground without privacy, so floor 2 has the lowest utility. The top floor has problems such as water leakage and hot sun, so the utility of top floor isn't high.

5. CONCLUSION

The main purpose of this study is to explore the utility ratio among floors of buildings with different total number of floors, and to compare the difference between absolute floors and relative floors on residential prices for buildings with different total number of floors. The research results show that age and building transfer area have significant impact on the residential price in each analysis result, and the impact of building transfer area is greater than age. In each analysis model of the utility ratio among floors, the utility curve is distributed in a zigzag pattern. With floor 4 as the base floor, the floor price difference is higher on floor 1 and near the top floors; the floor price difference of other floors is not significant. In the model of building with a total of 12 floors, floor 1 has the highest utility ratio (114.34%), and floor 6 has the lowest utility ratio (99.50%). In the model of building with a total of 15 floors, floor 12 has the highest utility ratio (117.59%), and floor 3 has the lowest utility ratio (97.73%). In the model of building with a total of 22 floors, floor 1 has the highest utility ratio (122.26%), and floor 2 has the lowest utility ratio (93.24%).

In the comparative analysis of buildings with different total number of floors, when the residential units are located on the same floor, the transaction price of buildings with 22 floors is significantly higher than buildings with 15 floors and buildings with 12 floors; when the residential units are located on the same floor, the transaction price of buildings with 15 floors is significantly higher than buildings with 12 floors.

There aren't many residential prices on each floor with significant differences compared to the floor 4, and the relative floor variable in each model shows significant result, indicating that the effect of absolute floors on residential prices is slight; while the influence of relative floors variable is significant, it shows that the price of residential buildings with different total number of floors is significantly different; the total number of floors is higher and the price is higher.

CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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