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THE UTILITY MODEL OF INTEGRATING FLOOR INTERVAL AND TOTAL NUMBER OF FLOORS FOR MULTI-FAMILY RESIDENTIAL

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Abstract

In the past, there were many problems in the research on the utility ratio among floors of residential buildings, including the failure to consider the impact of total number of floors, the excessive research scope and the failure to remove the parking space price and parking space area from the total price and total area of residential units. Those problems resulting in the accuracy of the estimated floor-specific utility ratio is open to question. This study hopes to improve the problems of previous studies. Taking the multi-families residential on the block near Zhongke Shopping Plaza in Xitun District, Taichung City as the research subject, a total of 1,139 transaction information of residential unit for multi-families residential with 12 floors, 15 floors, and 22 floors were selected., and then used the hedonic price model to establish the utility ratio among floors of residential buildings. The concepts of absolute floors and relative floors are used to estimate the utility ratio of residential units in the multi-family residential. The empirical results show that the utility ratio of mid-high floors is the highest among the floor intervals; in the parts of different total building heights, as the number of floors increases, the utility ratio becomes higher. In the research, the utility ratios of floor interval and different total number of floors were used to construct a model of residential unit price adjustment, which can be used as the reference for establishing the models of residential unit transaction price in other regions.

Keywords: multi-family residential, utility ratio among floors, hedonic price theory

1. Introduction

In recent years, as construction technology has improved and land prices have increased year by year, the intensity of land use has become more intensive in Taiwan. Not only has the type of residential buildings evolved from the house to the multi-family building, the total number of floors of multi-family residential has also increased. When the construction companies sell the residential units of a residential building, they use the three-dimensional land price, that is, the construction floor as the unit price of sale, and make fine tuning through the utility among floors. In order to ensure the appropriateness and objectivity of the fine-tuning ratio, it is necessary to conduct a deeper discussion on the estimation of utility ratio among floors.

In the past research, when discussing the issue of utility ratio among floors, there are some problems which affect results judgment; for example, when estimating the utility ratio among floors, the influence of total number of floors was not considered, and the research scope was too large, which made the utility ratio among floors too rough and unclear, and the price of parking space and the area of parking space were deducted from the transaction price and the transfer area, causing distortion of the actual price of residential units, etc. Based on the above-mentioned issues, this study uses the multi-families residential on the block near Zhongke Shopping Plaza in Xitun District, Taichung City as the research subject, and select 1,139 data of residential unit for multi-families residential with total number of floors of 12, 15 and 22 to conduct an empirical study of utility ratio among floors estimation.

In the study, the concepts of absolute floors and relative floors are used to estimate the utility ratio of residential units in the multi-family residential. The "absolute floors" refers to the price comparison of each floor relative to a specific floor in the building (not limited to the same building), regardless of the total number of floors of the building, that is, a vertical comparison; the "relative floors" refers to the same floor between buildings with different total number of floors, and the relationship between the price of floors is discussed, that is, a horizontal comparison.

As stated before, the concept of "absolute floors" in this study is the comparison of the utility ratio of each floor interval; and the concept of "relative floors" is the comparison of the utility ratio of buildings with different total number of floors. The remnant of the paper is then organized as follows: the literature review on issues is discussed in section 2; section 3 is to describes the research framework, variables selection, and the concepts of hedonic price theory and estimation model of utility ratio among floors; section 4 presents the analysis and discussion of estimation results of utility ratio among floors, and the suggestions and conclusions of the study are presented in section 5.

2. Literature Review

Due to the increasing level of urbanization in Taiwan, the housing type is gradually dominated by buildings, and land prices have also changed from flat land prices to three-dimensional land prices. The utility ratio among floors refers to the difference in three-dimensional space utility between the residential units of the building due to the different floors; residential buildings are traded at three-dimensional land prices, and vertical price differences are adjusted according to utility ratio among floors. Huang (2005) mentioned that the utility ratio among floors is one of the most important calculation bases for the valuation of high floors, that is, take the selling price of a certain floor as a benchmark (usually set floor 4 as 100%), and then calculate the percentage of the price of each floor relative to the price of reference floor.

In the past, scholars have discussed the issues of concept, influencing factors and estimation methods of the utility ratio among floors. Lin (1982) pointed out that accessibility, visibility, and comfort are the basic factors that affect the utility ratio among floors. If these factors are comprehensively measured before the utility among floors is estimated, the total utility is the sum of the accessibility utility and the habitability utility. Chang and Farr (1993) pointed out that if the location and floor are regarded as horizontal and vertical accessibility indicators, and the usage pattern is regarded as the space profitability, it can be seen that the urban spatial structure is a very important factor in real estate prices. Chiang (2001) pointed out that when the construction company pre-sales and promotes the project, they usually price the floor 1 and the basement separately according to different planning purposes; and then set the price based on the floor of lowest price. The floor is higher and the price is higher, and the prices of adjacent floors are mostly similar. Finally, the top floor used to have the right to use the roof terrace, so the price is the highest. After the current law is amended, the price difference changes differently. Many studies have showed that floor level has a positive and significant impact on residential price (Chau et al., 2001; Tse, 2002; Chau et al., 2003; Chin et al., 2004; Sun et al., 2005; Conroy et al., 2013). Lin et al. (2010) pointed out that in a residential building, the utility ratio of floor 1 is the highest, and the utility ratio of floor 4 is the lowest; the utility ratio of floors 5 and above increases as the number of floors increases; in particular, the utility ratio of top floor is usually only lower than floor 1 and floor 2. Regarding the estimation method of utility ratio among floors, Tsai (1994) mentioned that in the past, domestic studies had established a utility ratio among floors table. Cheng (1991) mentioned that the average method and the curve fit method are the most commonly used estimation methods for utility among floors. The average method is that averages the unit prices of same floors in the same area, and the unit prices of each floor of each building are usually lower in the middle floor, and the unit price gradually increases upwards or downwards; the curve fit method uses a quadratic curve to match its changes. However, the aforementioned methods are not ideal in practical operation. Therefore, in recent years, the method of using the hedonic price method to evaluate the utility ratio among floors has gradually attracted attention and has been widely used.

From the above-mentioned literature discussion, understand the concept of utility ratio among floors and its importance in adjusting the transaction price of residential buildings. In addition, after an in-depth analysis of the literature on related issues related to estimation utility ratio among floors, this research found that there are still several topics that can be further discussed in this research:

First of all, previous studies did not consider the impact of the difference in total number of floors when establishing the utility ratio among floors. Chiang (2001) pointed out that the application of overall utility ratio among floors must be limited in its applicable area; buildings with different land use types must be distinguished, and the different overall utility ratios among floors must also be calculated separately; Lin (2010) also mentioned that in practice, when estimating the utility ratio among floors, the difference in total number of floors should be considered. Therefore, this study will divide the total number of floors into three types: 12, 15, 22, etc., and estimate the utility ratio among floors respectively.

On the other hand, Yu (2017) did not subdivide parking space prices and parking space types in the sample data. However, these factors will affect the actual prices of residential units and cause misjudgments in the research. Therefore, this study will split the parking space and price of the residential unit from the sample data, and then use the split data to estimate the utility ratio among floors.

Finally, the scope of the study is too large to produce inaccurate research results. Chiang (2001) pointed out that because location is also an important factor affecting the utility ratio among floors, the average unit price level of residential units in different locations varies greatly. Before calculating the overall utility ratio among floors, if the homogeneous areas are not divided first, and then calculate the overall utility ratio among floors in each homogeneous area, will get

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inaccurate utility ratio, which will lead to a situation of low applicability. In the past, some studies on the estimation of the utility ratio among floors (Hsiao, 2017; Huang, 2017; Tsai, 2017) have aforementioned problem. The analysis scope of these researches includes many counties and cities including Taipei City, New Taipei City, Taichung City, Kaohsiung City, however, the residential environment and market of each county and city are different, which reduces the reference value of the calculated utility ratio among floors.

Therefore, this study uses the block near Zhongke Shopping Plaza in Xitun District, Taichung City as the scope of empirical analysis to avoid the aforementioned problems, which will affect the applicability of utility ratio among floors.

3. Research Design and Method

3.1 Research Framework

Before estimating the utility ratio among floors, this study splits the parking space price and area from the data sample. After determining the influencing factors of residential price, the samples are grouped according to the total numbers of floors, and the utility ratio of each floor interval is calculated respectively. After comparing the utility ratios of buildings with different total number of floors, the total number of floors and the floor intervals are further integrated to establish a utility ratio estimation model. The research framework established in this study based on the hedonic price model is shown in Figure 1.

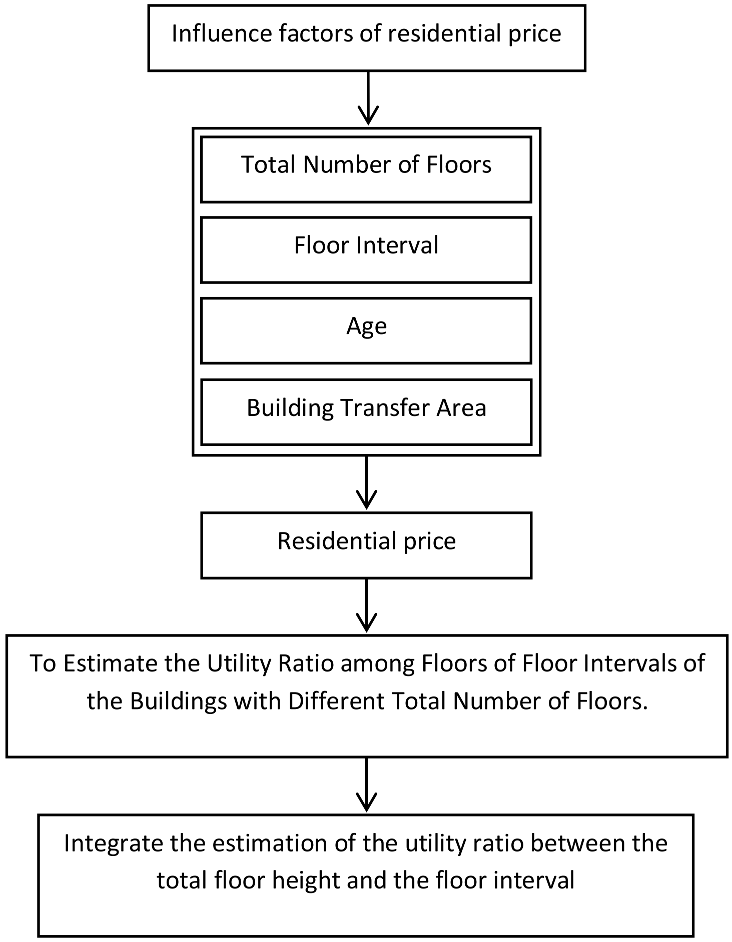

Figure 1. Research framework

3.2 Data Collection

This research conduct field visits, read transcripts, inquire about building licenses and use licenses, and search for real-value registration information to collecte 2,500 transaction data of residential units for 22 multi-families residential near Zhongke Shopping Plaza in Xitun District, Taichung City. Since the samples are mainly taken from the website of real-value registration of the Ministry of the Interior in Taiwan, the collection of information is limited, and information about construction materials cannot be obtained. Therefore, only the available data are analyzed in this research. Considering the influence of total number of floors on the estimation of utility ratio among floors, the sample data is grouped according to the total number of floors, and after deducting the samples with missing floor data, a total of 1,139 residential unit data of multi-families residential with 12 floors, 15 floors, and 22 floors were finally screened out for subsequent establishment of the utility ratio among floors estimation model.

3.2.1 Dependent Variable

This study uses residential prices as a dependent variable to explore the impact of characteristics of multi-family residential buildings on residential prices, and calculates the utility ratio of floor

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intervals and different total number of floors. In the analysis of hedonic price model, some scholars mentioned that the semi-logarithmic model is mostly used in real estate related research (Huang & Chang, 2005), because the empirical results of the semi-logarithmic model are usually better (Vanderford et al., 2005). Sirmans et al. (2005) mentioned that the distribution of prices after taking the natural logarithm is more normal. Allison (1999) pointed out that taking the natural logarithm of price can reduce the problem of heterogeneous variation. In this study, the total residential prices (excluding the parking space price) are converted by natural logarithm, and then the hedonic price model is established.

3.2.2 Independent Variable

The independent variables in the study include four building features: total number of floors, floor interval, age, and building transfer area (excluding parking space area).

1. Total Number of Floors

Lee (1999) mentioned in his research that the total number of floors will significantly affect the price of residential units. Therefore, in this study, all samples will be divided into three sets: 12 floors, 15 floors and 22 floors, and estimate the utility ratio among floors respectively.

2. Floor Interval

Real estate has product heterogeneity. Residential units are located on different floors and are affected by the surrounding environment to different degrees (Yang & Hsieh, 2020). For example, low-rise buildings are prone to insufficient lighting or noise interference compared to high-rise buildings. Many studies have showed that floor level has a positive and significant impact on residential price (Chau et al., 2001; Tse, 2002; Chau et al., 2003; Chin et al., 2004; Sun et al., 2005; Conroy et al., 2013).

Chiang (2001) has pointed out that there is little difference in the price of residential units on similar floors. Therefore, in this study, the floors are divided into 4 floor intervals: low floors, mid-low floors, mid-high floors, and high floors, and compare with floor 4 (reference floor) to estimate the utility ratio of each floor interval.

3. Age

Bokhari & Geltner (2014) found that the value of real estate will gradually decline over time. Buildings will have depreciation problems as the age increases (Tsai, 2009), Liang (2015) pointed out that the price of real estate exhibits reverse depreciation during the durability of building, that is, the trend of falling first and then rising. Lee et al., (2005) and Clapp & Salavei (2010) also interpreted this phenomenon from the perspective of real estate redevelopment value. Therefore, this study assumes that age will significantly negatively affect residential prices.

4. Building Transfer Area (excluding parking space area)

In real estate transactions, the living space of residents will increase as the area of the building transfer increases, and comfort will also be improved (Yang & Hsieh, 2020). The floor area of a building significantly affects the residential price (Rodriguez & Sirmans, 1994; Lin et al., 1996; Carroll et al., 1996; Martins-Filho & Bin, 2005). Therefore, this study assumes that the building transfer area will significantly positively affect residential prices.

3.3 The Estimation Model of Utility Ratio among floors

This research will establish a model for estimating the utility ratio among floors using a hedonic price model. The hedonic price theory is proposed by Rosen (1974) based on the new consumer theory. The main idea is that when supply and demand are balanced in the market, under the principle of maximizing the utility of consumers, evaluate the extra cost that each feature is willing to pay for each additional unit, and then multiply the features of the subject of investigation and valuation by the implicit price of each feature to obtain the price of the subject of investigation and valuation. The concept of hedonic price model is derived from the multiple regression model, which is exploring the influence degree and direction of various independent variables on dependent variables.

The concept of utility ratio among floors is that a certain floor is set as the base floor, and the difference between the price of other floors and the price of base floor is expressed as a percentage, which is the utility ratio among floors (Yang & Hsieh, 2020). It can be seen from past research that since different total number of floors has an influence on residential transaction prices, the estimation model of utility ratio among floors in the research is divided into two parts. The first is to establish the utility ratio estimation model of floor interval based on the buildings with different total number of floors, that is, for the buildings with 12 floors, 15 floors and 22 floors, respectively estimate the utility ratio of floor interval, and take floor 4 as the base floor in the model. Next, it incorporates the variable of total number of floors, and establishes an estimation model that integrates the utility ratio of floor interval and total number of floors. The total number of floors set 12 floors as the reference.

Through the coefficient of each floor interval and the coefficient of different total number of floors, the utility ratio is obtained after the exponential function conversion. The hedonic price model established by this research is shown in equation (1):

$$Ln(P_{ij})=\beta_0+\beta_1 x_{1ij}+\beta_2 x_{2ij}+\gamma_i F_i+k_j TL_j+\varepsilon_{ij} \quad (1)$$

P_{ij}: Residential Price

x_{1ij}: Age

x_{2ij}: Building Transfer Area ($3.306\ m^2$)

β_1: Regression Coefficient of age

β_2: Regression Coefficient of building transfer area

F_i: Floor Interval (If i=4, it is 0, otherwise it is 1)

TL_j: Total Number of Floors (If j=12, it is 0, otherwise it is 1)。

ε_{ij}: Error Term

Based on the above-mentioned hedonic price model, a hedonic price prediction model of the floor interval of residential unit is established as the i-floor and floor 4, and the two models are subtracted to obtain the following equation (2):

$$Ln(P_i)–Ln(P_4)=\gamma_i F_i \quad (2)$$

The floor interval is a dummy variable. When the floor is i-floor, Fi=1, and if it is floor 4, Fi=0. Therefore, equation (2) can be expressed as equation (3):

$Ln(Pi)–Ln(P_4)= \gamma_i$ (3)

After further transformation, the equation (4) can be finally obtained, through which the utility ratio of each floor interval can be calculated.

$P_i / P_4=e^{\gamma i}$ (4)

For the utility ratio estimation of buildings with different total number of floors, the above steps can be repeated to compare the 15 floors and 22 floors with the 12 floors. Finally, equation (5) can be obtained. Through this equation, the utility ratio of total number of floors can be calculated.

$P_j / P_{12}=e^{kj}$ (5)

4. Research Findings and Discussion

4.1 Estimating the Utility Ratio of Floor Interval with Different Total Number of Floors

Table 1 shows the analysis results of the utility ratio estimation model for the buildings with 12 floors. After the model is adjusted, the explanatory power is 60.7%, and the VIF values of the respective variables are all less than 10, indicating that there isn't collinearity problem among the variables. The age has a significant negative influence on the residential price, while the building transfer area has a significant positive influence on the residential price. The analysis result of floor interval shows that there isn't significant difference in the price of residential units in the four floor intervals compared to floor 4. However, in the study, the follow-up is to obtain the coefficient value of each floor interval to estimate the utility ratio. The coefficient value shows that the average price of residential units in the mid-high floors is higher.

Table 1. Regression analysis of the buildings with 12 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B	Std. error	Beta			
Intercept	17.903	0.210		85.233***	<0.001	
Low Floors (2~3)	0.004	0.022	0.010	0.164	0.870	2.560
Mid-Low Floors (5~7)	0.011	0.022	0.033	0.523	0.602	2.789
Mid-High Floors (8~10)	0.030	0.021	0.088	1.393	0.165	2.836
High Floors (11~12)	0.017	0.022	0.047	0.773	0.440	2.622
Age	-0.141	0.009	-0.602	-15.770***	<0.001	1.045
Building Transfer Area (3.306m^2)	0.024	0.002	0.618	15.949***	<0.001	1.076
R^2	0.615					
Adjusted R^2	0.607					
Note: *P< 0.05; **P < 0.01; ***P< 0.001						

Table 2 shows the analysis results of the utility ratio estimation model for the buildings with 15 floors. After the model is adjusted, the explanatory power is 76.9%, and the VIF values of the respective variables are all less than 10, indicating that there isn't collinearity problem among the variables. The age has a significant negative influence on the residential price, while the building transfer area has a significant positive influence on the residential price. The analysis result of floor interval shows that there isn't significant difference in the price of residential units in the four floor intervals compared to floor 4. However, in the study, the follow-up is to obtain the coefficient value of each floor interval to estimate the utility ratio. The coefficient value shows that the average price of residential units in the mid-high floors is higher and the average price of residential units in the low floors is lower than floor 4.

Table 2. Regression analysis of the buildings with 15 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B	Std. error	Beta			
Intercept	14.810	0.058		253.257***	<0.001	
Low Floors (2~3)	-0.014	0.052	-0.010	-0.276	0.783	2.374
Mid-Low Floors (5~8)	0.039	0.046	0.039	0.851	0.395	3.952
Mid-High Floors (9~12)	0.079	0.045	0.080	1.746	0.081	4.024
High Floors (13~15)	0.042	0.047	0.037	0.893	0.372	3.357
Age	-0.021	0.002	-0.203	-8.849***	<0.001	1.013
Building Transfer Area (3.306m^2)	0.037	0.001	0.866	37.824***	<0.001	1.009
R^2	0.772					
Adjusted R^2	0.769					
Note: *P< 0.05; **P < 0.01; ***P< 0.001						

Table 3 shows the analysis results of the utility ratio estimation model for the buildings with 22 floors. After the model is adjusted, the explanatory power is 90.8%, and the VIF values of the respective variables are all less than 10, indicating that there isn't collinearity problem among the variables. The age has a significant negative influence on the residential price, while the building transfer area has a significant positive influence on the residential price. The analysis results of the floor interval show that among the four floor intervals, only the price of mid-high floors is significantly higher than floor 4. The prices of residential units in the remaining floor intervals are not significantly different from those of floor 4. However, in the study, the follow-up is to obtain the coefficient value of each floor interval to estimate the utility ratio. The coefficient value shows that the average price of residential units in the mid-high floors is higher and the average price of residential units in the low floors is lower than floor 4.

Table 3. Regression analysis of the buildings with 22 floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B	Std. error	Beta			
Intercept	15.220	0.030		500.043***	<0.001	
Low Floors (2~3)	-0.037	0.029	-0.033	-1.283	0.200	2.941
Mid-Low Floors (5~10)	0.034	0.025	0.048	1.318	0.188	5.784
Mid-High Floors (11~16)	0.064	0.025	0.090	2.497*	0.013	5.728
High Floors (17~22)	0.049	0.027	0.059	1.856	0.064	4.493
Age	-0.029	0.001	-0.365	-24.008***	<0.001	1.030
Building Transfer Area (3.306m^2)	0.030	0.001	0.917	58.498***	<0.001	1.093
R^2	0.910					
Adjusted R^2	0.908					
Note: *P< 0.05; **P < 0.01; ***P< 0.001						

Incorporate the influence coefficients of each floor interval in Table 1 to Table 3 into equation (4) to obtain the utility ratios among floors with 12, 15, and 22 floors respectively. Table 4 shows the utility ratios of floor interval with different total number of floors, and Figure 2 shows the comparison of the utility ratios of floor interval in the buildings with different total number of floors. In the analysis of the three models with different total number of floors, the highest utility ratio of floor interval is the mid-high floors, and the lowest utility ratio is floor 4 in the buildings with 12 floors, and the lowest utility ratio is low-floors in the buildings with 15 floors and 22 floors.

Table 4. The utility ratio among floors of floor intervals with different total number of floors

Floor Interval	Utility Ratio		
	Twelve Floors	Fifteen Floors	Twenty-two Floors
Low Floors	100.4%	98.61%	96.37%
Floor 4	100%	100%	100%
Mid-Low Floors	101.11%	103.98%	103.46%
Mid-High Floors	103.05%	108.22%	106.61%
High Floors	101.71%	104.29%	105.02%

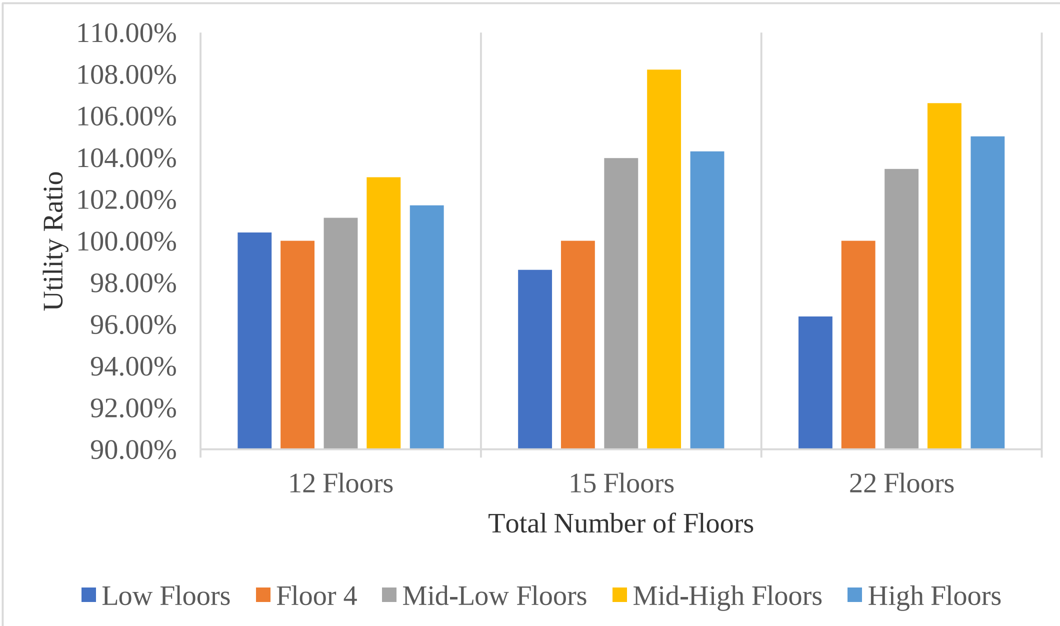

Figure 2. Comparison of the utility ratios of floor intervals with different total number of floors

4.2 Estimating the Utility Ratio of Integrating Floor Interval and Total Number of Floors

The above estimation of utility ratio among floors is to divide the sample and estimate the utility ratio of each floor interval according to different total number of floors. In this section, all samples are integrated, and the influence of floor interval (take floor 4 as the reference group) and total number of floors (take 12 floors as the reference group) are considered at same time to estimate their utility ratio respectively, and those utility ratios are used to establish a model of residential prices adjustment. From Table 5, the analysis results show that the VIF values of all independent variables are less than 10, indicating that the model hasn't collinearity problem and the overall adjusted explanatory power is 81.5%.

According to the floor interval, only the price of mid-high floors (11-16) is significantly higher than that of the floor 4, while the other floors haven't significant difference; in terms of total number of floors, the prices for the 15 floors and 22 floors are significantly higher than the 12 floors. Establish a model based on the analysis results in Table 5, as shown in equation (6), and use to estimate of the utility ratio by floor.

$$\ln(P)=14.755-0.004x_{(1)}+0.035x_{(2)}+0.055x_{(3)}+0.031x_{(4)}+0.245x_{(5)}+0.327x_{(6)} -0.025x_{(7)}+0.034x_{(8)}+\varepsilon \quad (6)$$

$x_{(1)}$: Low Floors

$x_{(2)}$: Mid-Low Floors

$x_{(3)}$: Mid-High Floors

$x_{(4)}$: High Floors

$x_{(5)}$: 15 Floors

$x_{(6)}$: 22 Floors

$x_{(7)}$: Age

$x_{(8)}$: Building Transfer Area

ε: Error Term

Table 5. Regression analysis of integrating the floor interval and total number of floors

Variable	Unstandardized coefficients		Standardized coefficients	t-value	p-value	VIF
	B	Std. error	Beta			
Intercept	14.755	0.043		345.923***	<0.001	
Low Floors (2~3)	-0.004	0.024	-0.003	-0.151	0.880	2.600
Mid-Low Floors (5~10)	0.035	0.021	0.044	1.660	0.097	4.397
Mid-High Floors (11~16)	0.055	0.022	0.065	2.542*	0.011	4.084
High Floors (17~22)	0.031	0.029	0.020	1.075	0.283	2.182
15 Floors	0.245	0.018	0.305	13.258***	<0.001	3.255
22 Floors	0.327	0.025	0.401	13.147***	<0.001	5.726
Age	-0.025	0.001	-0.453	-19.109***	<0.001	3.468
Building Transfer Area ($3.306m^2$)	0.034	0.001	0.874	60.998***	<0.001	1.267
R^2	0.817					
Adjusted R^2	0.815					
Note: *P< 0.05; **P < 0.01; ***P< 0.001						

Incorporate the influence coefficients of each floor interval and total number of floors of formula (6) into formulas (4) and (5) to obtain the utility ratio of each floor interval and buildings with different total number of floors respectively. The results are summarized, as shown in Table 6. As far as the floor interval is concerned, the utility ratio is the highest in the mid-high floors, and the lowest in the low floors; in terms of total number of floors, the total number of floors is higher and the utility ratio is higher. Based on the results in Table 6, this research establishes a model for estimating the price of residential units that integrates the total number of floors and the floor interval, as shown in equation (7).

$P_{ij}=P_{11}\times$Utility Ratio of Total Number of floors_i × Utility Ratio of Floor Interval_j (7)

(i=1,2,3 ; j=1,2,3,4,5)

i: 1=12 Floors; 2=15 Floors; 3=22 Floors

j: 1=Floor 4; 2=Low Floors; 3= Mid-Low Floors; 4= Mid-High Floors; 5= High Floors

P_{11}: The price of a residential unit on floor 4 where the building is12 floors.

P_{ij}: The price of a residential unit on floor j where the building is i floors, $i \neq 1$ and $j \neq 1$.

Table 6. The Utility Ratio of Floor Interval and Different Total Number of Floors

The Utility Ratio of Different Floor Interval	
Floor Interval	Utility Ratio
Low Floors (2~3)	99.60%
Floor 4	100%
Mid-Low Floors (5~10)	103.56%
Mid-High Floors (11~16)	105.65%
High Floors (17~22)	103.15%
The Utility Ratio of Different Total Number of Floors	
Total Number of Floors	Utility Ratio
12 Floors	100%
15 Floors	127.76%
22 Floors	138.68%

5. Conclusion

This research takes the multi-families residential on the block near Zhongke Shopping Plaza in Xitun District, Taichung City as the research subject. After screening, a total of 1,139 residential unit data of multi-family residential with total number of floors: 12 floors, 15 floors, and 22 floors are selected to estimate and analyze the utility ratios among floors. The main results of the study are divided into two parts. The first part is to calculate the utility ratios of floor intervals for residential buildings with 12 floors, 15 floors and 22 floors. The analysis results show that regardless of 12 floors, 15 floors, or 22 floors, all the highest utility ratios are the mid-high floors, but only the residential unit price with 22 floors in the mid-high floors is significantly higher than floor 4. In addition, the price of residential units with 12 floors in low floors is slightly higher than floor 4, and the price of residential units with 15 floors and 22 floors in low floors are slightly lower than floor 4.

The second part is the analysis results of utility ratio of the integrated total number of floors and floor interval. The empirical results show that in the part of the floor interval, only the residential unit prices of mid-high floors with the highest utility ratio are significantly higher than floor 4, and the lowest utility ratio is the low floors. It is speculated that the low floors are easily affected by the environment, such as insufficient lighting or noise interference, and are usually the turning points of the building's pipelines, which are more likely to be blocked. The high floors may have problems with sunlight or water leakage on the top floor. Therefore, the utility ratio of residential units in the mid-high floors is the highest; in terms of total number of floors, the trend is that as the total number of floors in the building increases, and the utility ratio of residential units also increases.

Finally, this study integrates the utility ratio between floor interval and buildings with different total number of floors to construct an adjustment model of residential unit price, which can be used as the reference for establishing a model of residential unit transaction price in other regions.

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