



The Role of Total Number of Floors under Age Influencing Residential Price Utilizing the Mediation Analysis

Ho-Wen Yang¹ and Hsien-Chi Hsieh^{2*}

¹Department of Land Management, Feng Chia University, No. 100, Wenhua Rd., Xitun Dist., Taichung City 407, Taiwan.

²Ph.D. Program for Civil Engineering, Water Resources Engineering, and Infrastructure Planning, Feng Chia University, No. 100, Wenhua Rd., Xitun Dist., Taichung City 407, Taiwan.

Authors' contributions

This work was carried out in collaboration between both authors. Authors HWY and HCH proposed the research framework of the study, managed the literature searches, carried out the regression analysis and mediation analysis, managed the analyses of the study, wrote the protocol and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

We examine here how does age and total number of floors affect residential prices in Taichung City Taiwan. In recent years, with the increase in land prices and the improvement of construction technology, number of floors in multi-family residential towers has also increased in Taiwan. There are many factors that affect the transaction price of multi-family residential towers. The research object of this study is 2,500 transaction data of 22 multi-families residential towers in the most densely populated area near Zhongke Shopping Plaza in Xitun District, Taichung City April 2012 to March 2019. First, this study uses the hedonic pricing model explore the significance of factors that affect the transaction price of multi-family residential towers with residential prices as the dependent variables, number of floors, age, land transfer area, building transfer area, story as independent variables. Then this study uses causal steps and bootstrapping to check the intermediary effect of number of floors between age and residential price. The statistical results

*Corresponding author: Email: aq3851653er@gmail.com;

found that number of floors, age, land transfer area, and building transfer area all significantly affect residential price. This study found that age affects residential price through number of floor height that represent number of floors playing the role of full mediation between age and residential price.

Keywords: Multi-family residential; hedonic price model; causal steps; bootstrapping; mediation.

1. INTRODUCTION

In recent years, with the development of industry and commerce in Taiwan, the population has concentrated in the city in order to work and go to school, the residential price has risen, the available land for urban construction has become scarce, and with the improvement of construction technology, the total number of floors of the building by reinforced concrete (RC) has also increased. In the research related to real estate prices, hedonic price method is generally widely used to establish regression models. Lin et al. [1] used the hedonic price method to measure the unit price of acquired residential properties by using total registered area, story, total number of floors, age, number of bathroom facilities, and neighborhood environmental characteristics (location).

There are many factors that affect the residential price of multi-family residential, but few discuss the difference between the influence of age and total number of floors on residential price. In this study, the natural logarithm of residential price (excluding the parking space price) is taken as the dependent variable; total number of floors, age, land transfer area, building transfer area (excluding the parking space area), and story are regarded as the dependent variables, to explore whether age and total number of floors will have significant impact on residential price. Further, this study uses the mediation analysis to examine how age and total number of floors interact to affect residential price, in order to clarify the difference in the influence of age and total number of floors on residential price. The main purpose is to explore the factors that affect the transaction price of the multi-family residential and examine how age and total number of floors affect residential price.

The first section introduces motivation and purpose. The second section is the literature review, reviewing and discussing the domestic and foreign researches related to this study. The third section is to propose the research framework and describe the concept of methodology; the research methods of this study include the hedonic price model, causal steps

method and bootstrapping method. The fourth section is the research findings, discussing the results of each model, and section five is the conclusion.

2. LITERATURE REVIEW

Regarding the factors that affect the residential price of multi-family residential, from the past literature, it is found that there are total number of floors [2], age [3,4,5], land transfer area [6], building transfer area [1], and story [1,7,8]. These factors have been confirmed to have significant impact on residential price.

Regarding the factors that affect the residential price of multi-family residential, it has been found in the past literature that buildings have depreciation problems due to the age of house. Lin [4] pointed out that as the age of the house increases, the price difference between floors will gradually decrease. This is because the building will be depreciated as the age of house increases, so the proportion of the building in the total price will gradually shrink. Liang [5] pointed out that the value of real estate exhibits a reverse depreciation phenomenon in which the value decreases first and then rises during the years of building durability. Liang [9] found that the reverse depreciation of real estate value was caused by the interaction between real estate use value and land redevelopment value, resulting in a phenomenon of descending first and then rising. Tsai [3] believes that residential price will depreciate over time.

Due to the increasing land prices, the building type of housing has changed from house to apartments and buildings. Many relevant studies have confirmed that total number of floors of the buildings certainly affect residential price [2]. Lin et al. [1] proposed that the floor area of a building has a significant influence on residential price.

The price of each floor of the residential building is different, because each floor has a different effect. Chang [7] discussed whether there is a price difference between each floor. The empirical results showed that there are significant differences in the residential prices of

different floors. Chiang [8] pointed out that the residential price on the fourth floor is generally the lowest, and the price is higher with higher floor. Lin et al. [1] pointed out that residential price on the first floor is the highest and on the third floor to the fifth floor is the lowest, and residential price will also increase as the floor rises. Lin and Evans [6] pointed out that the impact of unit land area on land prices is sometimes positive and sometimes negative, because the size of the area of the empirical data is different.

In the research of social sciences, the verification of interaction, mediation and moderating effect is often used. Baron and Kenny [10] introduced the concepts, strategies and statistical considerations of mediation and moderating effects. The independent variable influences the dependent variable through the intermediary variable. The mediation refers to the effect that the independent variable affects the dependent variable through the intermediary variable. There are three situations: no mediation, partial mediation, and full mediation.

It can be seen from the above literature review that the variables selected by this research: land transfer area, building transfer area, total numbers of floors, story and age have been confirmed to have an impact on the price of real estate, but what are the extent of the impact of those variables and how age and total number of floors affect residential price remains to be further verified by this study using mediation analysis.

3. METHODOLOGY

The scope of this study is the block near Zhongke Shopping Plaza in Xitun District, Taichung City. The multi-family residential with

elevator above 12 floors in this area was selected as the research object. The transaction cases in this area are more concentrated in location, the construction completion time is staged, and total number of floors is widely distributed. It is easy to observe the difference in total number of floors due to time changes and its impact on residential price.

In this study, the hedonic price model is used first, with residential prices as the dependent variable, total number of floors, age, land transfer area, building transfer area and story as independent variables, to explore the significant factors that affect the transaction price of multi-family residential. The research framework is presented as shown in Fig. 1. And then, the causal steps proposed by Baron and Kenny [10] are used to preliminarily discuss the mediation of total number of floors between age and residential price. Because the causal steps may be too subjective, then the more rigorous bootstrapping method is used to directly test the indirect effect of age on residential price through total number of floors, and the confidence interval is used to judge the result [11].

3.1 Data Collection

The scope of this study is originally 28 residential houses near Zhongke Shopping Plaza in Xitun District, Taichung City using the real-estate transaction real-estate registration data announced by the Ministry of the Interior, and working with the construction manager company to obtain a total of 3282 transaction data from April 2012 to March 2019. In this study, the database was organized. In addition to deleting the cases containing the remarks column, as well as the cases where the registration content was wrong or missing, the final database left 2500 valid data, distributed in 22 collective houses.

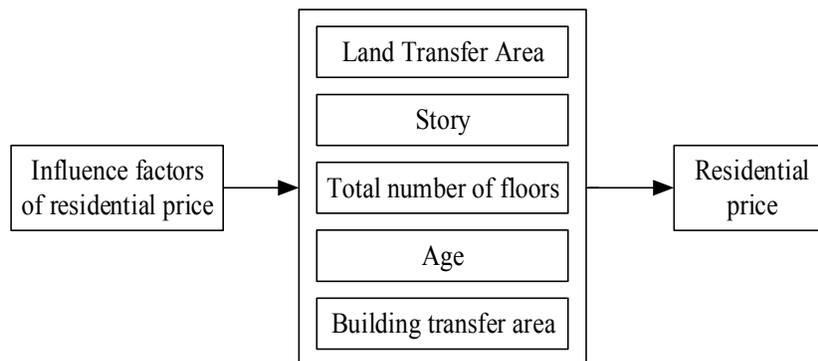


Fig. 1. Research framework of hedonic price model

3.2 Analysis Method

3.2.1 Hedonic price theory

Rosen [12] proposed hedonic price theory based on the new consumer theory. When the balance between supply and demand in the market is reached, under the principle of maximizing utility, consumers evaluate the additional cost that each feature is willing to pay for each additional unit. That is, the implicit price formed by the consumer's marginal willingness to pay for each characteristic of real estate. Multiply the characteristics of the evaluation target by the implied price of each feature to obtain the price of the evaluation target.

In empirical research related to real estate prices, this theory is generally widely used with regression model to establish hedonic price model. Tong [13] proposed a method for estimating housing prices in the market that the most commonly used method is to use housing characteristics to build a hedonic price model and use ordinary least-squares as parameter estimation method. The hedonic price method, which mainly builds models through regression analysis in statistical methods, attempts to explain dependent variables with one or more independent variables. It is one of the quantitative prediction methods, which predicts the future development trend of things based on the causal relationship of changes in internal factors. When the linear regression model has two or more independent variables, it is a multiple regression analysis, which explores the causal relationship between the dependent variable y and a group of independent variables x , and its equation can be expressed as Equation 1.

$$y = a + \sum_{i=1}^n b_i X_i + \varepsilon \quad (1)$$

In equation (1), $x_1 \dots x_n$ are independent variables, a is an intercept, $b_1 \dots b_n$ are regression coefficients, and ε is a residual term.

3.2.2 Causal steps method

The mediation model is a hypothesized causal chain that an independent variable (X) affects a dependent variable (Y) through a mediator (M). The diagram of mediation effect is shown as Fig. 2. In social science research, a mediator can be defined as a theoretical factor which influences the dependent variable and its effect

on the dependent variable must be deduced from the independent variable of the observed phenomenon.

Baron and Kenny [10] proposed a four-step approach that conducts several regression analyses and significance of the coefficients is examined at each step [14,15].

Step 1: Conduct a simple regression analysis with X predicting Y to examine if X has significant effect on Y,

$$Y = \beta_0 + \beta_a X + e \quad (2)$$

Step 2: Conduct a simple regression analysis with X predicting M to examine if M has significant effect on M,

$$M = \beta_0 + \beta_b X + e \quad (3)$$

Step 3: Conduct a simple regression analysis with M predicting Y to examine if M has significant effect on Y,

$$Y = \beta_0 + \beta_c M + e \quad (4)$$

Step 4: Conduct a multiple regression analysis with X and M predicting Y to examine if M has mediating effect,

$$Y = \beta_0 + \beta_{a'} X + \beta_c M + e \quad (5)$$

The diagram of mediating effect as show in Fig. 2, β_a is an effective index that X predicts Y; β_b is an effective index that X predicts M; similarly, β_c is an effective index that M predicts Y; $\beta_{a'}$ is an effective index that X affects Y when X and M predict Y simultaneously. β_a , β_b , β_c , and $\beta_{a'}$ are called 'Direct Effective Index'. On the other hand, the mediation effect in which X leads to Y through M is called the 'Indirect Effect Index' ($\beta_b \times \beta_c$). The indirect effect represents the part of the relationship between X and Y that is mediated by M [14,16].

The mediating effect means that X has an indirect effect on Y through M. The purpose of Steps 1 to 3 is to establish that "zero-order" relationships among the existing variables. If one or more of these relationships are non-significant, mediating effect is not likely. Assuming there are significant relationships from Steps 1 through 3, the Step 4 can then be preceded. In Step 4, some form of mediation is supported if the effect of M (β_c)

remains significant after controlling for X. If the effect of X (β_a) is no longer significant when M is controlled, the findings support "full mediation". If the effect of X (β_a) is still significant (i.e., both X and M have significant influence on Y), the finding supports "partial mediation" [14,16].

3.2.3 Bootstrapping

Although the causal steps proposed by Baron and Kenny [10] is simple and easy to understand, it is still one of the current mainstream methods of behavioral science to test the effect of intermediary, but the result judgment of this method is too subjective, therefore, this method has long been questioned [17,18,19]. In the light of this, in addition to using causal steps to test the intermediary effect of total number of floors, this study is also verified by the bootstrapping method proposed by Hayes and Preacher [11].

Among the many statistical methods that have been proposed to replace the causal steps [20, 21], the asymmetric confidence interval established by the repeated sampling method is increasingly popular. The advantage of the bootstrapping method is that there is an objective standard for the presence or absence of the intermediary effect, and it is directly estimated for the indirect effect.

3.3 Variables Selection

3.3.1 Dependent variable

The purpose of this study is to explore the relationship between the characteristics of multi-family residential and residential price. The dependent variable is the logarithmic value of the residential price (excluding the parking space price).

3.3.2 Independent variable

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

1. **Total number of floors:** The total number of floors of the building certainly affects residential price [2]. Therefore, this study anticipates that the total number of floors

will have a positive effect on residential price at the time of the transaction.

2. **Age:** Buildings have a problem of depreciation due to the age of house. Liang [5] found that the value of real estate showed a reverse depreciation phenomenon in which the value first decreased and then increased during the years of the building's durability. Tsai [3] believes that residential price will depreciate over time. Therefore, this study expects that age will have a negative impact on residential price at the time of the transaction.
3. **Land transfer area:** Lin and Evans [6] pointed out that when the land area exceeds a certain scale, the impact of unit land area on the total transaction price will show a negative relationship. Therefore, this study anticipates that the area of land transfer at the time of the transaction will affect the price of the residence.
4. **Building transfer area (excluding the parking space):** Lin et al. [1] proposed that the floor area of a building has a significant effect on the residential price. When real estate is bought and sold, if the building transfer area is larger, the living space of the residents will be larger and can improve the comfort of the households. Therefore, this study expects that the building transfer area will have a positive impact on residential price.
5. **Story:** In this research sample, the total number of floors is up to 25 floors, so the story is divided into four sections that 1-7th floor is "low floor", 8-13th floor is "middle and low floor", 14-20th floor is "middle and high floor", 21~25th floor is "high floor", and use the "high floor" as a reference group. Due to the heterogeneity of real estate products, different floors have different ventilation and lighting, and the surrounding landscape is also different, and the low floors are more susceptible to external noise and the building shielding light than the high floors, so the residential price of low floors is usually lower than the residential price of high floors. Therefore, this study anticipates that the residential price of low floors will be negatively affected relative to the residential price of high floors.

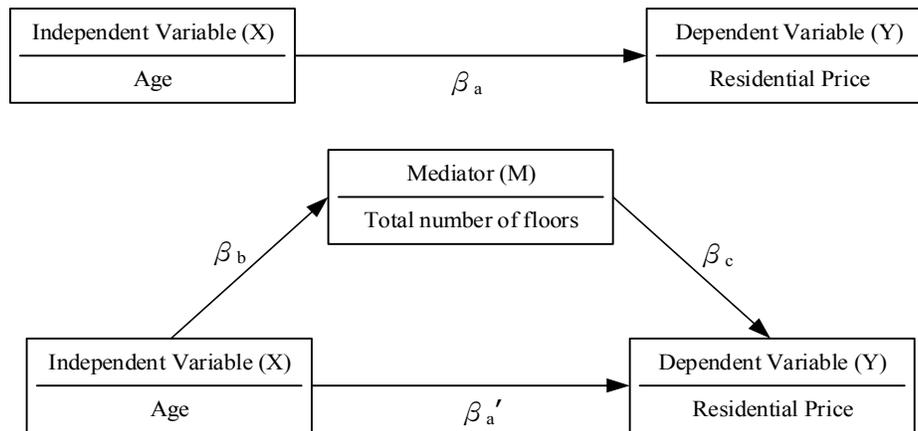


Fig. 2. The diagram of mediating effect

4. RESEARCH FINDING AND DISCUSSION

4.1 Results of Hedonic Price Model

The independent variables selected in this study include total number of floors, age, land transfer area, building transfer area (excluding parking area), and story. The results of hedonic price model are showed in Table 1. T-value of land transfer area is -11.363 and P-value less than 0.001, showing that land transfer area has a negative significant impact on. T value of total number floors is 2.492 and P-value is 0.013, showing that total number of floors has a positive significant effect on the residential price. T-value of age is -5.002 and P-value less than 0.001, indicating that age has a negative significant effect on residential price. T-value of building transfer area is 37.18 and P-value less than 0.001, indicating that building transfer area have a positive significant impact on residential price. It can be seen from those results that age and total number of floors have a significant influence on residential price. Low-floors and low-middle floors have a significant impact on residential price relative to high-floor floors.

4.2 Results of Causal Steps

In this study, the causal step method was used to test the intermediary effect of total number of floors.

Step 1: Assume that age has a significant relationship with residential price.

The linear regression is used to examine the impact of age on residential price and the result in Table 2 indicates

that age has a negative significant influence on residential price. T-value is -19.772, and P-value less than 0.001. Thus, this assume is supported.

Step 2: Assume that age has a significant relationship with total number of floors

The linear regression is used to examine the impact of age on total number of floors. The result showed in Table 3 indicates that age has a negative significant influence on total number of floors. T-value is -65.236 and P-value less than 0.001. Thus, this assume is also supported.

Step 3: Assume that total number of floors has a significant relationship with residential price

The linear regression is used to examine the impact of total number of floors on residential price and the result in Table 4 indicates that total number of floors has a positive significant influence on residential price. T-value is 26.024 and P-value less than 0.001. Thus, this assumption is true.

Step 4: Assume that total number of floors has an intermediary effect between age and residential price

In this hypothesis, it is to conduct a multiple linear regression analysis with age and total number of floors predicting residential price.

The result of the multiple linear regression in Table 5 revealed that total number of floors plays a full mediation role between age and residential. The total number of floors is found having a significant positive influence on residential price

and T value is 15.733, and P-value less than 0.001. but T-value and the P-value of age are -0.115 and 0.908 respectively, showing that age has no significant effect on residential price. Therefore, when considering the effect of total

number of floors and age on residential price at the same time, the direct effect of age on residential price disappears, indicating that total number of floors has a full mediation effect under the influence of age on residential price.

Table 1. Analysis results of hedonic price model

	Unstandardized coefficients		Standardized coefficients	T-value	P-value	VIF
	B	Std. error	Beta			
Intercept	15.212	0.052		290.725	<0.001	
Land Transfer area	-0.056	0.005	-0.318	-11.363	<0.001	7.819
Story 1 to 7	-0.074	0.02	-0.082	-3.814	<0.001	4.592
Story 8 to 13	-0.045	0.019	-0.05	-2.316	0.021	4.612
Story 14 to 20	-0.005	0.019	-0.005	-0.258	0.797	3.825
Total number of floors	0.005	0.002	0.05	2.492	0.013	3.977
Age	-0.005	0.001	-0.084	-5.002	<0.001	2.841
Building transfer area	0.024	0.001	1.041	37.18	<0.001	7.83
R square	0.751					
Adjusted R square	0.75					

Table 2. The result of regression analysis of age on residential price

	Unstandardized coefficients		Standardized coefficients	T-value	P-value
	B	Std. error	Beta		
Intercept	16.11	0.015		1051.854	<0.001
Age	-0.024	0.001	-0.368	-19.772	<0.001

Table 3. The result of regression analysis of age on total number of floors

	Unstandardized coefficients		Standardized coefficients	T-value	P-value
	B	Std. error	Beta		
Intercept	25.588	0.102		250.92	<0.001
Age	-0.525	0.008	-0.794	-65.236	<0.001

Table 4. The result of regression analysis of total number of floors on residential price

	Unstandardized Coefficients		Standardized Coefficients	T-value	P-value
	B	Std. Error	Beta		
Intercept	14.948	0.036		420.681	<0.001
Total number of floors	0.045	0.002	0.462	26.024	<0.001

Table 5. The effect of total number of floors between age and residential price

	Unstandardized Coefficients		Standardized Coefficients	T-value	P-value
	B	Std. Error	Beta		
Intercept	14.956	0.075		199.95	<0.001
Total number of floors	0.045	0.003	0.459	15.733	<0.001
Age	0.000	0.002	-0.003	-0.115	0.908

Table 6. The analysis results of bootstrapping

	Coeff.	S.E.	T-value	P-value	LLCI	ULCI
Intercept	14.956	0.0748	199.95	<0.001	14.809	15.103
Total number of floors	0.0451	0.0029	15.733	<0.001	0.0395	0.0507
Age	-0.0002	0.0019	-0.115	0.908	-0.0039	0.0035
Direct effect of X on Y						
	Effect	S.E.	T-value	P-value	LLCI	ULCI
Age	-0.0002	0.0019	-0.115	0.908	-0.0039	0.0035
Indirect effect of X on Y						
	Effect	Boot S.E.	Boot LLCI	Boot ULCI		
Total number of floors	-0.024	0.002	-0.027	-0.02		

4.3 Results of Bootstrapping

This study used repeated sampling 5000 times to examine the intermediary effect of total number of floors between age and residential price. The results of bootstrapping are showed in Table 6. In the direct effect of age on residential price, the confidence interval [LLCI, ULCI] = [-0.0039, 0.0035], it contains 0, so the direct effect of age on residential price is not significant; in the indirect effect of total number of floors on residential prices, the confidence interval [LLCI, ULCI] = [-0.027, -0.02], It does not contain 0, so the indirect effect of total number of floors on residential prices is significant.

5. CONCLUSION

This study explores the factors that affect the transaction price of residential buildings near Zhongke Shopping Plaza in Xitun District, Taichung City. First, the hedonic pricing model is used to analyze the data set that collect by this study, and it is concluded that total number of floors, age, land transfer area, and building transfer area (excluding parking area) all have a significant impact on residential price; When the effect of age and total number of floors on residential price is further tested using intermediary effect, the direct effect of age on residential price disappears, indicating that total number of floors has a "full mediation" effect under the influence of age on residential price. That is, the age affects residential price through total number of floors. This means that when the research object is locked in a multi-family residential built by reinforced concrete (RC), the lower age, the higher total number of floors and the higher residential price. It is also worth noting that the land transfer area has a negative significant impact on residential price. In addition to the situation where the land area exceeds a certain scale, it may also be that the research

object is multi-family residential. The total number of floors is higher and the household units are more, therefore, the smaller the land area it holds.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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