
PRICING STRATEGIES OF LAND AND BUILDINGS AFTER URBAN RENEWAL WITH REAL OPTION-BASED VALUATION MODEL : A CASE STUDY OF TAICHUNG CITY, TAIWAN

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Abstract

The main purpose of urban renewal is to promote the planned redevelopment and utilization of urban land, improve the overall urban space environment and revive urban functions, and improve the public interests of residents.

In Taiwan, urban renewal can be implemented by government agencies (institutions), specialized legal persons or organizations, urban renewal associations, and urban renewal institutions.

Real options theory (ROT) originated in 1977, Real option valuation model (ROV) has been utilized in a variety of real estate development decision, from planning to operations and from operations to abandonment.

This study takes a case of urban renewal based on the change of rights in Taichung City as an example, using the net present value (NPV) and ROV methods to evaluate the benefits of investing in real estate. Through the embedded real options adopted at decision making stage and the Black-Scholes model modified with value leakage, this study using the geometric Brownian motion to calculate the corresponding option premium (OP). Adding OP and passive NPV together, the expanded net present value (ENPV) is obtained as the investment value of the discounted price of the land and buildings.

Both the development model and valuation model proposed in this study have been verified in the aforementioned case. The net present value of these four places is negative, and the ENPV will be positive after a one-year deferral of development. Finally, through sensitivity analysis, it is found that the average sales price of residential buildings of the discounted price of the land and buildings is the most influential indicator affecting the fluctuation of the ENPV. When the average sales price of residential buildings drops by less than 3%, the ENPV will become negative. The second largest influencing indicator is the building area of the shops. When it decreases by about 23%, the ENPV will become negative.

The proposed valuation model can objectively and comprehensively value the discounted price of the land and buildings of the urban renewal association.

Keywords: Urban renewal, Urban renewal association, Net present value, Real option valuation model, Sensitivity analysis, Geometric Brownian motion

1. Introduction

The main purpose of urban renewal is to promote the planned redevelopment and utilization of urban land, improve the overall urban space environment and revive urban functions, and improve the public interests of residents. Urban renewal has a key impact on urban transformation and improvement of urban disaster prevention functions and improvement of the quality of life. Therefore, under the fierce urban competition of globalization, urban renewal has always been the ruler of each city to actively make the city win at the starting point. Important governance direction. (Urban Regeneration Portal Site, 2021.). With reference to an aging society, urban renewal is an important planning strategy that can help retrofit a city's existing conditions according to the needs of different people (Yung et al., 2016). Urban renewal also provides an opportunity to prepare an infrastructure for smart cities, which is nowadays an important concept especially for crowded and polluted cities and which will inevitably find a more broad application area in the future (Yıldız et al., 2020).

Refer to Article 3 of "Urban Renewal Act", the implementer, which begins the urban renewal business in accordance with Urban Renewal Act, is a government agency (institution), designated juristic person or institution, urban renewal association or urban renewal business institution. Refer to Article 43 of "Urban Renewal Act", the rights transformation method can be used to reconstruct the area within urban renewal business plan area; however, the authorities or relevant authorities can conduct land compulsory collecting, sectional expropriation or urban land re-plotting methods to implement it. Those are governed by the regulations in other laws or as agreed by all the owners of the lands and legal buildings can use the method of joint construction agreement or other methods to implement it.

Take the Jianguo Second Village and Fuxing Xincun area in Chiayi City, Taiwan as an example. This area is located in the Jianguo Second Village and Fuxing New Village on the east edge of Chiayi City's city center and the adjacent old and old dependent villages left after the completion of the rebuilding of the dependent village and the relocation of the residents. The current land use rate is not high, and it has the characteristics of simple land ownership. This area was approved by the Chiayi City Government on January 10, 2010 to be handled in the form of urban renewal. The "Drafted Chiayi City (Jianguo Second Village and Fuxing New Village Area) Urban Renewal Plan" was also released and implemented on October 2, 2013. This area adopted the "sale with styles" method of urban renewal for development from 2013 to 2014. However, after three announcements on the Internet, no vendors bid. After investigation, the reasons include strict overall development restriction conditions, excessively large street profile (amount), urban renewal development is not marketable, the implementer's profit is not clear, and the implementer's risk is too high. Nowadays, in addition to urban renewal methods, the area has now increased the use of general bidding methods, such as land compulsory collecting, sectional expropriation, urban land readjustment methods, etc., which are all alternative development methods. After evaluating various development methods, the urban land readjustment by government was the most suitable, so the development method of the plan was revised to the

urban land readjustment by government.

The model of the land and buildings after urban renewal which are provided by the implementer, urban renewal association, will be created in this study, where the urban renewal association has full ownership and flexible decision rights of the discounted price of the land and buildings during the period of sale, complying with all relative regulations and enjoying all incentive policies related to urban renewal simultaneously. Then, utilizing real options theory (ROT), real options of this new model at decision making stage will be identified by the urban renewal association. In addition, a real option valuation model (ROV) for this new model will be proposed, followed by a case study of the urban renewal based on the rights transfer in Taichung City to conduct relevant research.

2. Literature review

The term "Urban Renewal" first appeared in the United States around the 1960s and 1970s. It refers to the wide range and large-scale urban redevelopment projects carried out at that time. The main purpose is to eliminate the transformation of slums and urban spaces (Sun, 2009), and the main content is the transformation of the actual environment. But in fact, in Europe, a wave of urban revival movement emerged as early as the 1930s, mainly to solve the decline of European cities after World War I, and hope to revive urban functions through urban overall planning (Wu, 2015).

The development process of urban renewal in Taiwan can be roughly divided into two stages in accordance with the Urban Renewal Regulations, which are the old urban renewal stage and the Urban Renewal Act stage. During the redevelopment of the old urban area, during the Japanese colonial period, it had already started a series of modern urban constructions, called urban corrections in Taiwan. After the ten major constructions began in the late 1960s, this period focused on the country's political and economic development. Incorporate the relevant provisions of the old urban renewal chapter into the urban planning law revised in 1973. The local government formulates a renewal plan in accordance with the urban planning procedure, acquires land and buildings through expropriation or sectional expropriation, and takes the lead in promoting the renewal. At the stage of Urban Renewal Act, in the late 1990s, under the influence of the economic bubble, the government could no longer maintain the state-led approach alone. Urban renewal was regarded as an urgent way to improve the current economic environment (Wu, 2015).

The key to affecting people's housing rights is the quality and safety of the overall living environment. Therefore, the Ministry of the Interior prudently promotes the 3 Laws of Urban Renewal. First of all, the Legislative Yuan passed the "Statute for Expediting Reconstruction of Urban Unsafe and Old Buildings" on April 25, 2017, to accelerated the improvement of the potential threats of dangerous buildings through policy incentives such as tax reductions and exemptions, financial guarantees, bulk reward and building coverage ratio reward. Next, the "Act for the Establishment of the National Housing and Urban Regeneration Center" were formulated, and a special administrative corporation was established to strengthen the promotion of social housing and improve the performance of public offices. Finally, amend the " Urban Renewal

Act" to improve practical problems and accelerate the implementation of urban renewal (CPAMI, 2016).

A real option is the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined period of time – the life of the option (K, 2014). Like their financial cousins, the value of real options depends on five basic variables (although others may come into the picture), plus an important sixth. The six are: (i) The value of the underlying risky asset. (ii) The exercise price. (iii) The time to expiration of the option. (iv) The standard deviation of the value of the underlying risky asset. (v) The risk-free rate of interest over the life of the option. (vi) The dividends that may be paid out by the (Copeland, 2002).

Real options theory originated in 1977 with the ground-breaking idea of Stewart Myers that Black-Scholes financial option pricing model developed in 1973 can be applied to capital-budgeting, later it was proved by Folta & O'Brien (2004) and Borison (2005). Myers (1977) originally defined "real options" as: "opportunities to purchase real assets on possibly favourable terms" (Čirjevskis & Tatevosjans, 2015). From the research of Merton (1998), the future is uncertain (if it were not, there would be no need to create options because we know now what we will do later) and in an uncertain environment, having the flexibility to decide what to do after some of that uncertainty is resolved definitely has value. Option-pricing theory provides the means for assessing that value.

Refer to Li et al. (2014) and this study, Real option valuation model (ROV) has been utilized in a variety of real estate development decision, from planning to operations and from operations to abandonment (Hui et al., 2010). Some studies apply ROV to predict land prices (Grovenstein et al., 2011; Shen & Pretorius, 2013) or rent of soil (Hsieh & Lin, 2016), and some scholars utilize ROV to value certain types of real estate development, such as recreational facilities (Leung & Hui, 2002), public housing upgrading (Ho et al., 2009), office construction (Fu & Jennen, 2009) and farm (Stokes, 2012).

At the same time, as an efficient valuation model, ROV has been broadly applied in decision making of different types of real estate development. However, the application of ROV in valuing the discounted price of the land and buildings held by the urban renewal association at decision making stage is rarely found so far. This study aims at filling the knowledge gap by constructing a valuation model for the discounted price of the land and buildings at decision making stage, based on the identification of imbedded options in such projects.

3. Scope and methodology

3.1 NPV at decision making stage of the discounted price of the land and buildings held by the urban renewal association at decision making stage

Traditionally, discounted cash flow (DCF) analysis is used to value projects, companies or assets, and the time value of money is calculated at the discount rate. The sum of all discounted cash flows each year is the net present value (NPV), can be calculated as:

$$NPV = \sum_{t=0}^n \frac{(CI_t - CO_t)}{(1+q)^t}$$

(1)

where t means time in unit of year; n means the life-span of the discounted price of the land and buildings held by the urban renewal association; CI_t and CO_t means the cash inflow and cash outflow of the discounted price of the land and buildings held by the urban renewal association at year t separately; q means the discount rate.

From Equation (1), it is evident that three elements are crucial to estimate the NPV of the discounted price of the land and buildings held by the urban renewal association, namely CI_t, CO_t and q. As for CI_t, its principal source is the sale income of the discounted price of the land and buildings held by the urban renewal association, including the sale income of the shops and residential buildings (Assuming that it is planned as a residential building after the urban renewal, and the ground floor is planned as shops, parking spaces sale income, which equals to the product of its total building area, average selling price and average sales rate. The total building area can be determined by the calculation results of the preliminary plan of the case. With regard to the average selling price and average sales rate, it can be estimated from the demand and supply situation of local residential buildings.

As for CO_t, there are five main sources of the discounted price of the land and buildings held by the urban renewal association, namely the construction cost (mainly the construction cost of buildings), rights transfer fees, loan interest, taxes, and management expenses.

As for q, with reference to Article 43 of the “Regulations on Real Estate Appraisal”, the discount rate should be determined from a comprehensive review of the methods, including risk premium method, market extraction method, weighted average capital cost method, debt coverage ratio method, and effective gross income multiplier method. Internationally, in addition to the aforementioned methods, q can still be calculated by several quantitative methods, including Capital Asset-Pricing Model (CAPM), Multifactor Asset-Pricing Model (MAPT) and Arbitrage Pricing Theory (APT), or qualitatively set by management as a requirement for the firm, or as hurdle rate for specific projects (Mun, 2005).

In terms of financial feasibility assessment, the financial feasibility and balance mechanism need to be considered at the same time. As for financial feasibility, it must meet the following four conditions: (i) NPV is greater than zero (NPV > 0). (ii) Internal rate of return is greater than the weighted average cost of capital (IRR > WACC). (iii) Discounted payback period is less than concession period (DPB < Concession Period). (iv) Self-liquidating ratio is greater than 1 (SLR > 1) (Organization of Urban Re-s, R.O.C., 2015; Huang, 2019).

3.2 ENPV at decision making stage of the discounted price of the land and buildings held by the urban renewal association

Options are usually divided into European options and American options, and the sole difference between them is holders of one European option are only allowed to exercise the option on the maturity date, whereas one American option can be exercised at any time during the expiration period (Hui et al., 2010). Due to this additional flexibility the American options can be more valuable. In order to avoid arbitrage the price must be always at least the same as the available payoff. A put option gives the right to sell the underlying asset for a specified strike price while a call option gives the right to buy the asset for a strike price (Balajewicz & Toivanen, 2017).

As regards real options which are applicable to real estate development, they may be summarized as a deferral option, an abandonment option, an option to expand/ contract, a switching option, a growth option and a compound option (Trigeorgis, 2005 : Guma, 2008). In the international literature on land development and public construction, there are three common options: a deferral option, an option to expand and an abandonment option (Chen et al., 2004).

Considering characters and management flexibilities of the proposed model of the discounted price of the land and buildings held by the urban renewal association, the urban renewal association generally has two real options at decision making stage, which are a deferral option and an abandonment option separately. As for the abandonment option, it is the last choice and will not be exercised in general conditions because of the irreversible investments, e.g. construction costs. So, the only considered real option is the deferral option (Li et al., 2014). The deferral option of the discounted price of the land and buildings held by the urban renewal association is an American option, which can be exercised at any time without affecting the progress of the construction, since the urban renewal association gets the ownership of the land and buildings.

Multiple models and approaches are available for valuing option premium (OP), whilst Black-Scholes model is most widely used, because of its simplicity in process and accuracy in results. As explained before, deferral option is the principal real option of the discounted price of the land and buildings held by the urban renewal association at decision making stage, and it should be exercised at any time without affecting the progress of the construction, which is so short that the deferral option of the discounted price of the land and buildings held by the urban renewal association can be simplified as European style. As a result, the Black-Scholes model is applicable to the discounted price of the land and buildings held by the urban renewal association. Furthermore, this basic model is modified by considering the value leakage, which derives from several reasons (e.g. possible construction accompanied cost increase as a result of inflation) in the deferral period (Shieh & Su, 2021).

Like Hui et al. (2011) demonstrated, before constructing the assessment model of option premium of the discounted price of the land and buildings held by the urban renewal association, three assumptions should be made: ①the value of the discounted price of the land and buildings held by the urban renewal association follows geometric Brownian motion, and its rate of return is normally distributed; ②the risk-free interest rate and property's price volatility are known and constant throughout the period of development; ③the option is priced in a frictionless market.

Then, if the value leakage is δ , the value S at time t (i.e. S_t) of the discounted price of the land and buildings held by the urban renewal association varies according to a stochastic differential equation in the form of:

$$dS_t = (r_f - \delta)S_t dt + \sigma_s S_t dB_t \quad (2)$$

where r_f means risk-free interest rate; σ_s is the average volatility of the discounted price of the land and buildings held by the urban renewal association; δ means capitalization rate of holding the redeveloped project; B_t is one-dimensional Brownian motion. Then, based on the risk-neutral assumption and Ito's lemma (Chen, 2007), the stochastic differential equation of the discounted price of the land and buildings held by the urban renewal association's OP and its boundary condition can be written as:

$$\frac{\partial OP}{\partial t} = r_f OP - (r_f - \delta)S_t \frac{\partial OP}{\partial S_t} - \frac{1}{2} \sigma_s^2 S_t^2 \frac{\partial^2 OP}{\partial S_t^2} \quad (3-1)$$

$$OP(S_t, T) = \text{Max}[(S_t - C_t), 0] \quad (3-2)$$

where C_t is the investment cost of the discounted price of the land and buildings held by the urban renewal association at time t . Solving the stochastic differential equation of Equation (3-1) & (3-2), it is found that:

$$OP_t = S_t e^{-\delta(T-t)} N(d_1) - C_t e^{-r_f(T-t)} N(d_2) \quad (4-1)$$

$$d_1 = \frac{[\ln(S_t/C_t) + (r_f - \delta + \sigma_s^2/2)(T-t)]}{\sigma_s \sqrt{T-t}} \quad (4-2)$$

$$d_2 = \frac{[\ln(S_t/C_t) - (r_f - \delta + \sigma_s^2/2)(T-t)]}{\sigma_s \sqrt{T-t}} = d_1 - \sigma_s \sqrt{T-t} \quad (4-3)$$

where T is the maturity time of the discounted price of the land and buildings held by the urban renewal association's deferral option; $N(d_1)$ and $N(d_2)$ are cumulative probabilities of the variable smaller than d_1 and d_2 separately.

The conventional NPV method has been repeatedly criticized for its disabilities in dealing with uncertainty, irreversibility and management flexibility, while these disabilities can be cured by

ROV. However, as a broadly utilized decision making approach, the NPV method has many undeniable advantages (Chen, 2007). Trigeorgis (2005) put forward a new expanded NPV criterion to capture the additional value of managerial operating flexibility and other strategic interactions:

Expanded (or strategic) NPV (ENPV) = passive NPV + Option Premium (OP) (ROV, Flexibility value and Strategic value).

Based on such a model, it may now be justified to accept projects with negative NPV of expected cash flows (if this is offset by a larger option premium as a result of additional flexibility and strategic value), or delay investment with positive NPV until a later time when expanded NPV would be maximized under uncertainty (Trigeorgis, 2005). This model is adopted, optimized and exemplified in this study to value the discounted price of the land and buildings held by the urban renewal association.

Since this study aims to value the discounted price of the land and buildings held by the urban renewal association at decision making stage, t becomes 0 in Equation (4-1) ~ (4-3) combining Equation (1), the real option-based valuation model for the discounted price of the land and buildings held by the urban renewal association at decision making stage can be written as:

$$ENPV = \sum_{t=0}^n \frac{(CI_t - CO_t)}{(1+i_c)^t} + S_0 e^{-\delta T} N(d_1) - C_0 e^{-r_f T} N(d_2) \quad (5-1)$$

$$d_1 = \frac{[\ln(S_0/C_0) + (r_f - \delta + \sigma_s^2/2)]}{\sigma_s \sqrt{T}} \quad (5-2)$$

$$d_2 = \frac{[\ln(S_0/C_0) - (r_f - \delta + \sigma_s^2/2)]}{\sigma_s \sqrt{T}} = d_1 - \sigma \sqrt{T} \quad (5-3)$$

4. Case study

4.1 Basic information

To exemplify above proposed model, this study takes a case of urban renewal based on the change of rights in Taichung City as an example. This case is that the landlords implement the urban renewal business by means of forming an urban renewal association by themselves. The updated main indices related to the discounted price of the land and buildings held by the urban renewal association are taken from the information published on the website by the urban renewal association. Among these indices, the common sharing is 52.67%. The main indices of the discounted price of the land and buildings held by the urban renewal association in this study are illustrated in Table 1.

Table 1. Main indices of the discounted price of the land and buildings held by the urban renewal association

Index name	Index value	Index name	Index value
Land area (10 ⁴ m ²)	0.0629	Building area of housing buildings (10 ⁴ m ²)	0.5602
Housing uites	65	Building area of commercial buildings (10 ⁴ m ²)	0.0345
Parking spaces for motor vehicles	42	floors above ground	15
Motorcycle Parking	65	floors underground	4

4.2 Model parameters

4.2.1 NPV-relative parameters

According to the proposed valuation model, a lot of parameters should be determined in advance to calculate the NPV of the discounted price of the land and buildings held by the urban renewal association, primarily including CIt, COt, and q.

The first parameter about CIt is the average sales rate of the discounted price of the land and buildings held by the urban renewal association. After investigation the supply and demand of the surrounding market in this case, the local demand of the shops and residential buildings is significantly greater than the supply, the final average sales rate is evaluated at 100%. The second parameter about CIt is the average selling price of residential buildings of the discounted price of the land and buildings. According to market research and comparative analysis, the average selling price of similar residential buildings nearby is NT\$74,000 /m². This study uses these data directly.

The third parameter about CIt is the average selling price of shops of the discounted price of the land and buildings. According to market research and comparative analysis, the average selling price of similar shops nearby is NT\$148,000 /m². This study uses these data directly.

The fourth parameter related to CIt is the sales revenue of parking spaces for motor vehicles. The revenue is determined by its number, average sales rate and price per unit. According to the market supply and demand situation, the local demand for parking spaces for motor vehicles is obviously greater than the supply. Therefore, the final average sales rate is evaluated at 100%. According to market research and comparative analysis, it is estimated that the price for each parking spaces for motor vehicles in this case is NT\$825,000 / unit.

Taking the stores as an example, the calculation process of the average selling price of the stores in this case is shown in Table 2.

Table 2. Calculation table of the average selling price of shops of the discounted price of the land and buildings

Item	Code of the allocation unit	Floor	Building area (m ²)	Base unit price (NT\$/m ²)	Utility ratio for individual floor (%)	Horizontal Utility ratio (%)	Evaluated price (NT\$/m ²)	Unit Evaluated price(NT\$)	total
1	Store A	1F	70.25	154,000	100%	100%	154,000	10,818,182	
2	Store B	1F	69.85	154,000	100%	100%	154,000	10,757,091	
3	Store C	1F	69.85	154,000	100%	100%	154,000	10,757,091	
4	Store D	1F	69.85	154,000	100%	100%	154,000	10,757,091	
5	Store E	1F	101.45	154,000	100%	98%	151,000	15,319,636	
6	Store F	1F	62.58	154,000	100%	90%	139,000	8,698,413	
7	Store G	1F	62.58	154,000	100%	90%	139,000	8,698,413	
8	Store H	1F	79.70	154,000	100%	92%	142,000	11,317,752	
9	Store I	1F	69.19	154,000	100%	92%	142,000	9,824,992	
Grand total			655.31					96,948,661	
The average selling price of the stores in this case							148,000		

As for COt, there are five main sources of the discounted price of the land and buildings held by the urban renewal association, namely the construction cost (mainly the construction cost of buildings), rights transfer fees, loan interest, taxes, and management expenses. After referring to the information published on the website by the urban renewal association, the first parameter, the construction cost (mainly the construction cost of buildings), is NT\$378.20 million. The second parameter, rights transfer fees, is NT\$22.94 million. The third parameter, loan interest, is NT\$21.34 million. The fourth parameter, taxes, is NT\$2.05 million. The fifth parameter, management expenses, is NT\$79.35 million.

As for q, refer to the preliminary planning research report of relevant social housing in Taichung City, it is evaluated at 3.26%.

4.2.2 OP-relative parameters

In order to calculate OP part in Equation (5-1) ~ (5-3), six parameters are necessary in total. The first parameter is the maturity time T. According to the aforementioned urban renewal association, after obtaining land development rights, they can exercise the delayed option of urban renewal at any time without affecting the construction progress (is an American option). In this case, with reference to the surrounding real estate price changes, the maturity time is estimated as 1 year. That is to say, one year deferral option is considered in valuing this studied discounted price of the land and buildings held by the urban renewal association.

The second parameter is the current value S₀, which is the discounted value at decision making stage and can be estimated on the basis of q (i.e. 3.26%) and income cash flow at sales period (assumed to be three years). Considering parameters in previous section, during the three years of sales period, the annual sales revenue of residential buildings, shops, and parking spaces for motor vehicles is NT\$ 166.75 million. After deducting the related COt, S₀ can be calculated as NT\$ 351.56 million.

The third necessary parameter is the investment cost C_0 , which is also a discounted value at decision making stage and can be estimated on the basis of q and the irreversible investment. The costs that occur in operation stage should not be included. (Chen, 2007). Because the operation cost would only occur when the shops are sold, and it is not irreversible. The investment cost should only include the irreversible investment part. Based on the construction cost (mainly the construction cost of buildings) of this case and q (i.e. 3.26%), C_0 can be calculated as NT \$ 354.83 million.

The fourth necessary parameter is δ . From the perspective of data availability, only δ induced by cost increase is considered. In this case, it is obvious that the direct construction cost is the main component of building cost, approximately 84.50% of the construction cost. In addition, according to the survey, housing construction cost is the main component of the direct construction cost, accounting for about 66.5% of direct engineering cost. Therefore, the growth rate of total cost can be represented according to the average growth rate of material cost and labor cost, and their proportions are about 60%, 30% respectively. This study selected the local consumer price index (CPI) and per capita salary are selected as their tokens respectively. According to the “National Statistics, R.O.C. (Taiwan)”, the annual increases of CPI and per capita salary from 2014 to 2019 are 0.80% and 0.89% separately. Therefore, the value leakage δ of the studied social housing project is about 0.75% (=60% * 0.80% + 30% * 0.89%).

The fifth parameter is the risk-free interest rate r_f , which is usually based on the yield of the government’s debt (Chen, 2007). On November 08, 2019, the Central Bank of the Republic of China (Taiwan) announced to sell a thirty-year period national debt with an annual interest of 0.95%, which is adopted as the risk-free interest rate. That is to say, r_f of the studied discounted price of the land and buildings is 0.95%.

The sixth parameter is the average volatility of the discounted price of the land and buildings. From the official real estate information platform in Taiwan, from the third quarter of 2014 to the third quarter of 2019, the average fluctuation of the Taichung City residential price index was 3.68%, as shown in Table 3.

Table 3. Taichung City Residential Price Index and its volatility from the 3rd quarter of 2014 to the 3rd quarter of 2019

Point in time	Residential price index	Residential price index rate of change to the same quarter last
Q3 2014	95.5	12.82%
Q3 2015	100.63	5.37%
Q3 2016	101.65	1.01%
Q3 2017	101.81	0.16%
Q3 2018	102.43	0.61%
Q3 2019	104.59	2.11%
Average value		3.68%

In Table 4, a summary of the relative parameters and values of NPV of this study is listed.

Table 4. a summary of the relative parameters and values of NPV of this study

Variable	Symbol	Description	Value
NPV-relative parameters	q	Discount rate	3.26%
	CI _t	Cash inflow of the discounted price of the land and buildings at year t	Shown below
	CO _t	Cash outflow of the discounted price of the land and buildings at year t	Shown below
Determination of CI _t		Sales period for the discounted price of the land and buildings	3 years
		The average sales rate of the discounted price of the land and buildings	100%
		The average selling price of residential buildings	74,000 NTD/m ²
		The average selling price of shops	148,000 NTD/m ²
Determination of CO _t		The average selling price of a parking space	825,000 NTD/unit
		The construction cost (mainly the construction cost of buildings)	378.20 million NTD
		The rights transfer fees	22.94 million NTD
		The loan interest	21.34 million NTD
		The taxes	2.05 million NTD
		The management expenses	79.35 million NTD
		The rate of return on self-owned funds	4.20%
	The interest rate of loan funds	2.63%	

5. Results and discussions

Putting above NPV-relative parameters into Equation (1), the NPV of the discounted price of the land and buildings in this case can be calculated as NT\$-3.28 million. Since the NPV is negative, the studied discounted price of the land and buildings in this case seem financially unacceptable, and thus the urban renewal association should not undertake such the real estate. Then, putting above OP relative parameters into Equation (5-2) and (5-3), d₁ and d₂ can be calculated as 0.06 and -0.08 in this case. Further, N(d₁) and N(d₂) can be dug out from the value table of the standard normal distribution function as 0.5239 and 0.4681 respectively in this case.

Then, putting N(d₁) and N(d₂) in this case, as well as other parameters obtained in section OP-relative parameters into Equation (5-1), the OP values of this case can be calculated as NT\$18.28 million. Then, adding OP generated by one-year deferral option and passive NPV together, the ENPV of this studied the discounted price of the land and buildings held by the urban renewal association in this case can be calculated to be NT\$15.00 million. In Table 5, a summary of the relative parameters and values of OP of this study is listed.

Table 5. a summary of the relative parameters and values of OP of this study

Variable	Symbol	Description	Value
OP-relative parameters	T	The maturity tim	1 year
	S ₀	The current value	NT\$351.56 million
	C ₀	The investment cost	NT\$354.83 million
	δ	The value leakage of the discounted price of the land and buildings	0.75%
	r _f	The risk-free interest rate	0.95%
	σ _s	The average volatility of the discounted price of the land and buildings	3.68%
	d ₁	$\frac{[\ln(S_0/C_0) + (r_f - \delta + \sigma^2/2)]}{\sigma\sqrt{T}}$	0.06
	d ₂	$\frac{[\ln(S_0/C_0) - (r_f - \delta + \sigma^2/2)]}{\sigma\sqrt{T}}$	-0.08
	N(d ₁)	The cumulative probabilities of the variable smaller than d ₁	0.5239
	N(d ₂)	The cumulative probabilities of the variable smaller than d ₂	0.4681
OP	The option premium, $S_0 e^{-\delta T} N(d_1) - C_0 e^{-r_f T} N(d_2)$	NT\$18.28 million	
ENPV	Real option valuation model at decision making s The expanded net present value of the discounted price of the land and buildings held by the urban renewal association	NT\$15.00 million	

Consequently, the studied discounted price of the land and buildings in this case become financially acceptable, if taking OP generated by one-year deferral option into consideration.. In other words, the urban renewal association should build the discounted price of the land and buildings, and waiting one year is a better choice than building it immediately.

Regarding the case of this study, there are five potential influencing factors that will affect ENPV. As for income part, the sale income from the residential buildings of the discounted price of the land and buildings is the biggest contributor, and thus the average selling price of the discounted price of the land and buildings is a potential factor. As for the cost part, most cost items (except financial expenses) cannot be changed. Another potential factor is the building area of the shops, whilst it will affect the cost and income part simultaneously. Among OP-relative parameters, S₀ and C₀ are both affected by above-mentioned NPV relative parameters, while δ, r_f and S are all beyond the control of the urban renewal association. Among the OP-relative parameters, T is also a potential factor. After the urban renewal association obtaining the development rights, they can exercise the delayed option of the discounted price of the land and buildings at any time without affecting the construction progress. In addition, the rate of return on self-owned funds and interest rate of loan funds are also potential factors.

The influences of these five potential influencing factors on the ENPV of this studied discounted price of the land and buildings are calculated and demonstrated in Fig. 1. Through sensitivity

analysis, it is found that the average sales price of residential buildings of the discounted price of the land and buildings is the most influential indicator affecting the fluctuation of the ENPV. When the average sales price of residential buildings drops by less than 3%, the ENPV will become negative. The second largest influencing indicator is the building area of the shops. When it decreases by about 23%, the ENPV will become negative. As regards the maturity time, the rate of return on self-owned funds and the interest rate of loan funds, their influences are too small to be negligible.

6. Conclusions

Urban renewal has a key impact on urban transformation and improvement of urban disaster prevention functions and improvement of the quality of life. The competent authority has made great efforts to establish a special organization for management and implementation. The Taiwanese government has announced many incentive policies to promote urban renewal associations to participate in urban renewal. When urban renewal is carried out, the urban renewal association is rarely the implementer due to the lack of funds and professional capabilities in the initial stage.

The model of the land and buildings after urban renewal which are provided by the implementer, urban renewal association, is created in this study, where the urban renewal association has full ownership and flexible decision rights of the discounted price of the land and buildings during the period of sale, complying with all relative regulations and enjoying all incentive policies related to urban renewal simultaneously. Based on related management flexibilities of this mode at decision making stage, only the deferral option is considered in this study. Then, a real option-based valuation model is constructed, where expanded (or strategic) NPV(ENPV) is equal to the sum of passive (NPV) and option premium (OP).

A case of urban renewal in Taichung City based on the change of rights in this study illustrates the proposed mode of discounted price of the land and buildings held by the urban renewal association and related valuation models, which seems financially unacceptable because of a negative NPV indicator. Then, adding OP generated by one-year deferral option and passive NPV together, the ENPV indicator becomes positive in this case and thus the discounted price of the land and buildings turn to financially acceptable. Finally, through sensitivity analysis, it is found that the average selling price of residential buildings of the discounted price of the land and buildings is the most influential indicator affecting the fluctuation of the ENPV.

Although the deferral option is merely considered in the proposed valuation model, the OP is big enough to offset the negative NPV of studied discounted price of the land and buildings. Therefore, under the proposed model, the urban renewal association will have more management flexibilities and corresponding real options in the life cycle of the discounted price of the land and buildings project. As a result, the proposed discounted price of the land and buildings provision mode is a feasible way to attract the landlords implement the urban renewal business by means of forming an urban renewal association by themselves. The valuation model needs to be intensively studied and applied in more projects. Besides, identifying other real options (such

as option to switch) of the discounted price of the land and buildings held by the urban renewal association will be future works of this study.

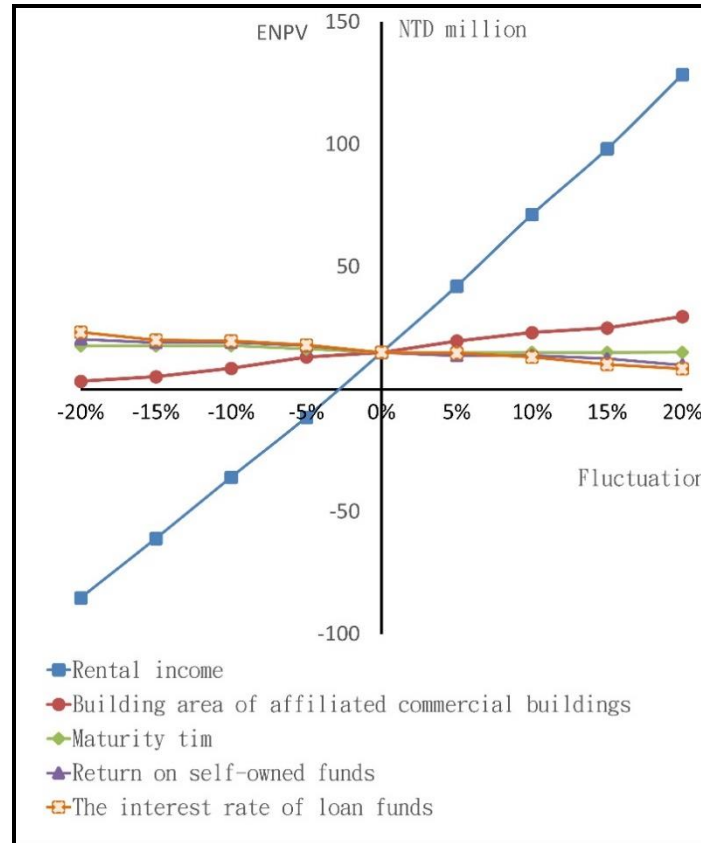


Fig. 5. Results of the sensitivity analysis in this case

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