Enhancing Real Estate Project Feasibility Through Real Option Analysis

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Abstract:
Real estate development projects are often influenced by market uncertainty, long timelines, and changing economic conditions. Traditional evaluation methods, such as Discounted Cash Flow (DCF) analysis, assume fixed future cash flows and may not fully capture the value of strategic flexibility. In this study, a residential real estate project was first evaluated using DCF, which showed that immediate investment was not financially favourable. To better understand the potential for flexibility, a Real Option Analysis (ROA) was applied using a binomial tree framework, focusing on the option to defer investment by one year. This approach helps to assess whether waiting can improve project outcomes under uncertain conditions. Additionally, a limited sensitivity analysis was conducted to observe how factors, such as rental income growth and construction cost changes, could affect the results. Overall, the study highlights how applying ROA offers a more flexible and responsive way to evaluate real estate investments compared to static models

Keywords - Real Estate, Real Option Analysis, Binomial Analysis, Project Feasibility.

1. Introduction

The real estate sector is deeply influenced by dynamic and unpredictable market conditions, making investment decisions highly challenging. Traditional financial evaluation tools, such as Discounted Cash Flow (DCF) analysis, although widely used, assume a fixed path of future cash flows and fail to adequately capture the value of managerial flexibility under uncertainty (Titman, 1985; Geltner, 2014). In response to this limitation, Real Option Analysis (ROA) has emerged as an advanced method that incorporates the value of strategic decision-making flexibility, offering a more realistic approach to project feasibility analysis. ROA has been successfully applied in industries such as oil and gas, pharmaceuticals, and infrastructure, where investment decisions often face significant uncertainty (Smit and Trigeorgis, 2012).

However, within the real estate sector, the practical adoption of ROA at the individual project level, particularly through the binomial tree modeling approach, remains relatively limited (Guma, 2021). While some studies have evaluated real estate projects under broader flexibility frameworks, very few have combined ROA with sensitivity analysis to systematically assess external risks, such as rental income variations, construction cost inflation, and operating expense volatility.

Accordingly, this study aims to address this gap by applying Real Option Analysis using a binomial tree framework along with DCF analysis to a real estate development project. It further integrates a sensitivity analysis to test the impact of key external variables on investment feasibility during a one-year deferment period. By combining these methods, this study seeks to provide a more strategic and resilient framework for evaluating real estate investments under uncertainty, ultimately supporting more informed and flexible decision making for developers.

2. NEED OF STUDY

Real estate development projects often deal with unexpected changes like rising construction costs, shifting rental rates, and market uncertainties. Traditional methods, such as Discounted Cash Flow (DCF) analysis, are useful but assume fixed conditions and do not provide flexible decisions when the market changes.

To handle real-world uncertainties better, Real Option Analysis (ROA) offers a helpful way for developers to adjust their investment plans by waiting, expanding, or exiting based on future market movements. Among the various ROA techniques, the binomial tree model allows for a step-by-step evaluation of choices at different times, making it easier to plan under uncertainty.

By combining ROA with sensitivity analysis, this study provides a more practical and flexible way to assess project feasibility than using DCF alone. It helps developers make smarter timing decisions and improves the chances of project success, even when market conditions are unpredictable.

3. AIM OF THE STUDY

This study aims to assess the flexibility of real estate investment using Real Option Analysis (ROA) and to evaluate the influence of external market risks through sensitivity analysis.

4. OBJECTIVE

- To assess real estate project feasibility using Real Option Analysis (ROA).
- To apply a binomial tree model for evaluating investment flexibility.
- To analyse the effects of external risks through sensitivity analysis.

5. RESEARCH METHODOLOGY

Step 1: Conduct Discounted Cash Flow (DCF) analysis to calculate the Net Present Value (NPV) and Internal Rate of Return (IRR) for initial project feasibility under static conditions.

Step 2: Apply Real Option Analysis (ROA) to introduce strategic flexibility and identify deferment in response to uncertain market conditions.

Step 3: Develop a 10-step Binomial Tree model to simulate possible project value changes over time and determine the option value of deferring investment.

Step 4: Calculate the expanded Net Present Value (ENPV) by integrating DCF outcomes with the option value obtained through the binomial model.

Step 5: Perform Sensitivity Analysis of rental income, construction costs, and operating expenses to evaluate how external risks impact the deferred investment decision.

6. LITERATURE REVIEW

- **Ashima, Rastogi, and Sidana (2022)** emphasized that incorporating Real Option Analysis (ROA) into traditional financial feasibility strengthens decision-making under uncertainty in real estate development. Their study highlighted how ROA helps manage risks like fluctuating construction costs and rental incomes.

- **Guma (2021)** explored the role of real options in enhancing the value of real estate projects, particularly through deferment strategies. The research concluded that ROA, combined with flexible decision-making frameworks like binomial models, improves project adaptability in volatile markets.
- **Čirjevskis and Tatevosjans (2015)** applied real option models empirically in real estate, demonstrating that binomial frameworks outperform static DCF when accounting for market uncertainty. Their findings support the use of ROA for more resilient investment evaluations.
- **Bravi (2013)** combined Highest and Best Use (HBU) concepts with Real Option Analysis for better real estate development planning. The study showed that ROA adds value by embedding flexibility into the development decision-making process.
- **Zhang and Zhu (2020)** investigated the application of binomial tree models to real estate investments, concluding that flexibility captured through real options better reflects the project's evolving risk profile over time.

7. REAL OPTION ANALYSIS: CONCEPTS, VALUATION METHODS, AND APPLICATIONS

Real Option Analysis (ROA) is a strategic method that assesses investment prospects by identifying the flexibility decision-makers face in the face of uncertainty. Compared with traditional Discounted Cash Flow (DCF) techniques, which presume constant cash flows and unchanging investment directions, ROA takes into account the fact that investors may delay, modify, scale, and even abandon projects in response to shifting market conditions. This is similar to financial options, where the right to make a decision but not the obligation adds measurable value. ROA is especially essential in sectors such as technology, energy, real estate, and infrastructure, which are known for their high levels of volatility and irreversible investments. Unlike traditional methodologies, ROA values flexibility, resulting in more robust and well-informed investment decisions**.**

7.1 Types of Real Options

In real investment projects, flexibility can arise in several ways, giving rise to different types of real options.

Types of Real Options are:

- Defer Option
- Expand Option
- Abandon Option

Each type reflects a distinct managerial action that can help optimize project value depending on evolving market conditions.

7.1.1 Defer Option

The defer option provides the right to postpone an investment decision rather than committing immediately. When the condition of the market is unknown and waiting can yield better knowledge or opportunities, this flexibility is useful. By deferring, investors retain the option to start later without losing the chance to invest. In the mining, oil, and real estate industries, where significant capital expenditures are required and market timing is crucial, defer options are frequently used. Defer options are not just useful in real estate; they are also useful in technology implementations and telecom infrastructure projects, where it is unclear whether the market will be ready. One way to measure the benefits of postponing is to use

$$\text{Payoff}_{\text{Defer}} = \max(V_t - I, 0)$$

where Vt is the project value at time t, and I is the investment cost.
Overall, deferment helps firms avoid investing under unfavorable conditions and capitalize on future upside opportunities.

7.1.2 Expand Option

The expand option grants the right to increase the scale or scope of a project if the initial results are favorable. Enabling businesses to respond quickly to increasing consumer demand or advantageous business circumstances provides them with a competitive edge. Pharmaceutical manufacturing, industrial manufacturing facilities, renewable energy initiatives, and real estate development commonly incorporate expandable alternatives. A project usually starts in a modest phase with the possibility of expansion if the results are favorable. Similar to the call option, the expansion choice is priced by using:

$$\text{Payoff}_{\text{Expand}} = \max(V_{\text{expanded}} - \text{Expansion Cost}, 0)$$

The expand option allows firms to control risk during uncertain periods and exploit growth opportunities without committing full capital upfront.

7.1.3 Abandon Option

The abandon option gives the right to exit a project partially or completely if the market outlook deteriorates. By using this option, businesses can limit additional losses and recover the residual value. In industries where project outcomes are extremely uncertain, such as real estate, mining, manufacturing, and research and development, abandonment options are typical. The ability to drop out guarantees that resources are not committed to initiatives that fail. This option can be priced using the following formula, which is typically described as the put option:

$$\text{Payoff}_{\text{Abandon}} = \max(SV - V_t, 0)$$

Where SV represents the salvage value, and V_t is the project value at time t.
Incorporating the abandon option into project evaluation protects firms from significant downside risks and ensures better resource reallocation under changing conditions.

7.2 Models for Real Option Valuation

Real options are valued using mathematical models. Each model differs according to a project's complexity, flexibility, and level of market uncertainty.

7.2.1 Binomial Tree Model

The binomial tree model is a discrete-time approach that visualizes the evolution of project value across multiple stages. Depending on specific probabilities, the value may move upward or downward at each time step. Investors can use this framework to see potential future directions and make decisions at various points in time.
The core parameters of the binomial tree are calculated as follows:
Up Factor (u): $u = e^{(\sigma\sqrt{\Delta t})}$
Down Factor (d): $d = 1 / u$
Risk-Neutral Probability (p): $p = (e^{(r\Delta t)} - d) / (u - d)$

where:

- σ = volatility of project value,
- r = risk-free interest rate,
- Δt= time interval per step.

The binomial model involves backward induction in which the values are rolled back stage by stage to the starting point after the payout at the end nodes is determined. Both European options, which can only be exercised at maturity, and American options, which can be exercised at any point prior to expiration, can be valued using a binomial model. The binomial model provides exceptional flexibility and accuracy for real estate projects with several stages or potential early termination.

7.2.2 Black-Scholes Model

The Black-Scholes model provides a closed-form solution for valuing European-style real options, assuming constant volatility and continuous trading of the underlying asset. It is particularly suited for simpler projects with a single critical decision point.

The Black-Scholes formula for a call option is:

$$C = S_0 N(d_1) - X e^{-rT} N(d_2)$$

Where,

$$d_1 = \frac{\ln(S_0/X) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

In this formula:

- $\mathbf{S_0}$ is the present value of expected project cash flows,
- **X** is the investment cost (exercise price),
- **T** is the time to expiry,
- **N** represents the cumulative normal distribution function.

In simple terms, the Black-Scholes model calculates the project's current value ($\mathbf{S_0}$) multiplied by the probability of success (linked to $\mathbf{d_1}$), then subtracts the investment cost (**X**) adjusted for time value and the probability of success (linked to $\mathbf{d_2}$). Although the Black-Scholes model is elegant and computationally fast, its limitations arise in projects involving multiple exercise dates or highly fluctuating parameters, where binomial or simulation models become preferable.

7.2.3 Monte Carlo Simulation Model

Monte Carlo Simulation is a probabilistic method used to model the future uncertainty of project values by generating a large number of random scenarios. It is particularly effective in situations in which the number of variables is unpredictable and changes over time, including costs, revenues, interest rates, and market demand. Black-Scholes and binomial models assume a simplified market behaviour, whereas Monte Carlo models capture more intricate, path-dependent outcomes.

The basic process of Monte Carlo Simulation involves simulating n random future paths for the project value using random modeling, calculating cash flows and option payoffs for each path, and discounting them back to present value. The discounted payoffs from each simulation are combined to determine the actual option value.

$$\text{Option Value} = \frac{1}{n}\sum_{i=1}^{n} e^{-rT} \times \text{Payoff}_i$$

By averaging the discounted payoffs across thousands of random scenarios, Monte Carlo Simulation provides an effective estimate of the option's value, making it highly useful in projects involving various types of risk and complex managerial flexibility.
Understanding Real Option Analysis's theoretical foundations is followed by a part that focuses on using these ideas in practice. In order to find out how deferment techniques can affect investment choices, we examine a real estate development project under uncertainty.

8. PROJECT DEVELOPMENT OVERVIEW

On a location of around 10 acres, XYZ Developers is developing a residential development project in Louisiana, USA, with an emphasis on building 100 multifamily residential units. Approximately $32.5 million USD is the expected first investment. Following an analysis of the U.S. real estate market, including secondary market data, development patterns, and comparable rental prices in the area, a project proposal was developed. The developers hope to determine if it is financially feasible to start construction right now or to take a flexible timing strategy based on changing market conditions by examining these market-driven indications.
This study uses a comprehensive Real Option Analysis (ROA) methodology to assess strategic decision-making in the face of uncertainty and identify the most advantageous course of action.
This study employs a detailed Real Option Analysis (ROA) framework to evaluate strategic decision-making under uncertainty and determine the most advantageous course of actionFor academic consistency and confidentiality, the developer entity is referred to as XYZ Developers throughout this study.

Table 8.1: Expenditure breakup of the project

Category	**Amount (USD)**
Land Acquisition Cost	165,000
Hard Costs (Construction)	22,750,000
Soft Costs	4,225,000
Contingency Reserve	1,625,000
Financing Costs (Interest, Fees)	2,275,000
Developer Fee	1,460,000
Total Project Cost	**32,500,000**

8.1 Rental Comparable Analysis

Rents are calculated by collecting nearby rental comparables. Rental rates were gathered from reliable property listing websites such as Zillow, Crexi, and Costar for the project analysis.

Table 8.2 Unit-wise Rent Distribution and Rental Income

Number of Bedrooms	Total Units	Gross Rent($)	Monthly Gross Rent($)	SF (Size in sq.ft)	Rent per sq ft/month	Total Monthly Rent($)
1BHK	22	1,478	1,378	650	2.12	30,316
2BHK – A1	28	1,627	1,527	800	1.91	42,756
2BHK – A2	20	2,149	2,029	1,053	1.93	40,580

3BHK	30	2,270	2,130	1,036	2.06	63,900
Total	100	—	—	—	—	1,77,552
					Annual	21,30,624.00

8.2 DCF Modeling

Step 1: The step involved conducting a DCF analysis based on rental comparables (Table 2), other income sources (Table 4), and projected operating expenses (Table 5), applying a 7% vacancy rate. Using these inputs, the net operating income (NOI) and terminal value were estimated, and all future cash flows were discounted at a WACC of 8.1% to determine the project's Net Present Value (Table 6)

8.2.1 Weightage average cost of capital

The Weighted Average Cost of Capital (WACC) was determined using market-based inputs, including the risk-free rate, equity volatility, expected market return, cost of debt, and tax adjustments covering both federal and state levels.

Table 8.2.1: WACC Calculation Results

WACC Calculation	
Equity value	35
Debt value	65
Cost of Debt	6.5%
Tax rate	26%
10y Treasury (Rf)	4.32%
Beta (β) ·	1.3
Market Return(Rm)	12%
Cost of Equity	14%
E / D +E	35%
D / D+E	65%
WACC	**8.1%**

WACC Calculation: $RE = Rf + \beta \cdot (Rm - Rf)$

$RE = 4.32\% + 1.3 \cdot (12\% - 4.32\%) = 14.30\% \approx 14\%$

$WACC = (E / (E + D)) \times RE + (D / (E + D)) \times RD \times (1 - T)$

$= (35 / 100) \times 14\% + (65 / 100) \times 6.5\% \times (1 - 0.26) = 14\%$

Table 8.3: Other Income Sources

Other Income Source	**Monthly Fee ($)**	**Total Annual Income (for all units in $)**
Parking + Garage	75	90,000
Storage	50	60,000
Laundry/Common Area	25	30,000
WIFI	35	42,000
Trash/Utility Recovery	30	36,000
Pet Rent	25	12,000

Total	**240**	**$ 2,70,000**

Table 8.4: Annual Operating Expense

Operating Expense Category	**Total ($)**
Administrative	154,141
Operating and Maintenance	130,736
Utilities	77,840
Real Estate Taxes	40,600
Replacement Reserve & others	35,000
Total	$ 438,517

Table 8.5: Projected Rental and Operating Income for DCF Modeling

SOURCES	YOY	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Income												
Rental home	2.5%	2,130,624	2,183,890	2,238,487	2,294,449	2,351,810	2,410,605	2,470,871	2,532,642	2,595,958	2,660,857	2,727,379
Less: Vacancy	-7.0%	-149,144	-152,872	-156,694	-160,611	-164,627	-168,742	-172,961	-177,285	-181,717	-186,260	-190,917
Other income	2.0%	270,000	275,400	280,908	286,526	292,257	298,102	304,064	310,145	316,348	322,675	329,128
One-Time Move-In Fees												
Application Fee		144,000										
Application Fee		84,000										
Less : Vacancy	-15.0%	-40,500	-41,310	-42,136	-42,979	-43,839	-44,715	-45,610	-46,522	-47,452	-48,401	-49,369
Effective Gross Income		2,438,980	2,265,107	2,320,565	2,377,385	2,435,602	2,495,250	2,556,364	2,618,981	2,683,137	2,748,871	2,819,677
Expenses												
Adminstrative	2.5%	154,141	157,995	161,944	165,993	170,143	174,397	178,756	183,225	187,806	192,501	197,314
Operating & Maintenance Expenses		130,736	134,004	137,355	140,788	144,308	147,916	151,614	155,404	159,289	163,271	167,353
Utilities		77,840	79,786	81,781	83,825	85,921	88,069	90,271	92,527	94,840	97,211	99,642
Real Estate Taxes		40,800	41,820	42,866	43,937	45,036	46,161	47,315	48,498	49,711	50,954	52,227
Reserves & others		35,000	35,875	36,772	37,691	38,633	39,599	40,589	41,604	42,644	43,710	44,803
Total Operating Expenses		438,517	449,480	460,717	472,235	484,041	496,142	508,545	521,259	534,291	547,648	561,339
Net Operating Income		2,000,463	1,815,627	1,859,848	1,905,150	1,951,561	1,999,108	2,047,819	2,097,722	2,148,847	2,201,223	2,258,338
CAPEX	2.0%	40,009	36,313	37,197	38,103	39,031	39,982	40,956	41,954	42,977	44,024	45,167
NET NOI		1,960,454	1,779,315	1,822,651	1,867,047	1,912,530	1,959,126	2,006,862	2,055,767	2,105,870	2,157,199	2,213,172
Discounted NOI	8.1%	1,813,556	1,522,655	1,442,867	1,367,264	1,295,626	1,227,745	1,163,423	1,102,474	1,044,721	989,996	939,577
Sum of Discounted NOI		13,909,904										
Year 11 NOI (2% Growth)		2,245,248										
Terminal Value (cap-7%)		32,074,969										
Discount Terminal Value		17,910,495										
Initial project cost		32,500,000										

*All figures are presented in USD

Rental income growth is assumed at 2.5%, reflecting lower-end U.S. rental trends. The estimated vacancy rate is considered at 7%, comparable to the national average of 7.1%. A 15% adjustment is applied as an assumption, recognizing that not all tenants may utilize amenities such as WiFi, parking, or pet facilities. Other income growth is maintained at 2% for a safer projection. A terminal cap rate of 7% is adopted, based on prevailing market trends in Louisiana

Table 8.5 Calculation: 1)Discounted NOI = Net NOI / (1 + WACC)^n

$=1,960,454 / (1 + 8.1\%)^1 + 1,779,315 / (1 + 8.1\%)^2 + 1,822,651 / (1 + 8.1\%)^3$…………….

2)Terminal Value = Year 11 Net Operating Income / Cap Rate

= 2,245,248 / 7% =32,074,969

3) Discounted Terminal Value = Terminal Value / (1 + WACC)^n

$= 32,074,969 / (1 + 8.1\%)^{10} = 17,910,495$

8.2.2 Net Present Value (NPV) Calculation

NPV = Sum of Discounted NOI + Discounted Terminal Value – Initial Project Cost
13,909,904 + 17,910,495 – 32,500,000
NPV = (679,601)
The NPV of the project was calculated as –$679,601, based on discounted cash flows using a WACC of 8.1%.
A negative NPV indicates that the project's expected returns are insufficient to recover the initial investment.
Therefore, starting the project immediately would not be financially advisable, as it would result in a net loss rather than
value creation.

8.2.3 Internal Rate of Return (IRR) Calculation

$$CF_0 + \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + \ldots + \frac{CF_n}{(1+IRR)^n}$$

Or

$$0 = NPV = \sum_{n=0}^{N} \frac{CF_n}{(1+IRR)^n}$$

IRR = rate where NPV = 0 = (Initial Investment) + (Cash Flow in Year 1) / (1 + IRR)^1 + (Cash Flow in Year 2) / (1 + IRR)^2 + … + (Cash Flow in Year 10 + Terminal Value) / (1 + IRR)^10
IRR = (−32,500,000) + (1,960,454 / (1 + r)^1) + (1,779,315 / (1 + r)^2) + (1,822,651 / (1 + r)^3)………..
IRR = 5.94%
The IRR of the project was found to be 5.04%, which is lower than the WACC of 8.1%. Since the IRR does not exceed the cost of capital, the project fails to meet minimum return expectations if started immediately.
However, through strategic flexibility such as deferment, the project's financial viability could potentially improve based on future market conditions.

8.3 Strategic Investment Flexibility through Real Option Analysis

According to the DCF analysis, the project's Weighted Average Cost of Capital (WACC) is more than the Net Present Value (NPV), which is negative, and the Internal Rate of Return (IRR). These findings suggest that it would not be wise to begin the project right away because it would not generate enough revenue.
In order to determine whether the project still has value under changing conditions, Real Option Analysis (ROA) is applied. By taking into account several potential future choices based on risks or market improvements, ROA enables us to analyze the project's adaptability. Defer, expand, or abandon are the three main options in ROA.
In the present case, a one year project delay was decided in order to allow for the observation of market trends, including rental rates, building costs, and financing circumstances.
Waiting might enhance the project's financial outcomes compared to starting immediately in an uncertain environment.

8.3.1 Determine ROA input variables

Step 2: Important input variables needed to conduct the Real Option Analysis (ROA) are collected in this step. Project value, investment cost, volatility, and risk-free rate are some examples of these values that aid in creating a practical framework for examining the flexibility of postponing the investment choice.

Table 8.6: Variables Used for Real Option Analysis – Defer Option

Variable	Value	Source
Underlying asset value (S_0)	\$31.82 M	Present value from DCF before deducting the initial investment
Cost of exercising the option (X)	\$32.50 M	Initial project cost
Volatility (σ)	10%	Based on CBRE & Damodaran estimates for stabilized U.S. real estate
Risk-free interest rate (r)	4.32%	U.S. 10-Year Treasury bond rate (2024)
Duration of the option (T)	1 year	Time period the investor waits before committing
Number of binomial steps (n)	10	Monthly decision nodes within 1 year

Calculation of the Underlying asset value (S_0)

S_0 = Sum of Discounted NOI + Discounted Terminal Value

S_0 = \$13,909,904 + \$17,910,495 = \$31,820,399

8.3.2 Determine Variables for Binomial Analysis

The binomial decision tree for evaluating the project's deferral option is constructed using the up and down factors and risk-neutral probabilities.

Table8.7: Input for Binomial Analysis

Variable	Expression	Value
Up factor (u)	$u = e^{(\sigma\sqrt{\Delta t})}$	1.0321
Down factor (d)	$d = 1 / u$	0.9690
Risk-neutral up-side probability (p)	$p = (e^{(r\Delta t)} - d) / (u - d)$	0.560
Risk-neutral down-side probability (1-p)	1 - p	0.440
Time interval (Δt)	1 year / 10 steps = 0.1	0.1

Calculations:

Up Factor (u): $u = e^{(\sigma\sqrt{\Delta t})} = e^{(0.10 \times \sqrt{0.1})} = 1.0321$

Down Factor (d): $d = 1 / u = 1 / 1.0321 = 0.9690$

Risk-Neutral Probability (p): $p = (e^{(r\Delta t)} - d) / (u - d) = (e^{(0.0432 \times 0.1)} - 0.9690) / (1.0321 - 0.9690) = 0.560$

8.4 Construction of Binomial Lattice for Deferment Option

Step3: In this step, the volatility, risk-free rate, up factor and down factor etc.. derived from previous analyses are used to develop the binomial tree (Ref Table8.6 and8.7). Using these inputs, a 10-step binomial lattice is constructed to show the potential changes in project value over time. Each node is linked to a calculated option value based on the risk-neutral probabilities. This approach enables the analysis of a project's adaptability and determines the advantages of delaying investment in a volatile market.

One year is broken up into ten equal steps in this model, with each time interval denoting 0.1 years. Every node represents roughly 36–37 days of the project's development. This finer division emphasizes the importance of managerial flexibility in the face of uncertainty and increases the accuracy of project value change modelling.

10 step binomial tree

0	1	2	3	4	5	6	7	8	9	10
										43.6552
									42.2963	0.0000
								40.9797	0.0000	40.9797
							39.7041	0.0000	39.7041	0.0000
						38.4682	0.0000	38.4682	0.0000	38.4682
Stock price					37.2708	0.0000	37.2708	0.0000	37.2708	0.0000
Option price				36.1106	0.0109	36.1106	0.0000	36.1106	0.0000	36.1106
			34.9865	0.0550	34.9865	0.0249	34.9865	0.0000	34.9865	0.0000
		33.8975	0.1572	33.8975	0.1118	33.8975	0.0570	33.8975	0.0000	33.8975
	32.8423	0.3367	32.8423	0.2891	32.8423	0.2236	32.8423	0.1302	32.8423	0.0000
31.8200	0.6029	31.8200	0.5690	31.8200	0.5181	31.8200	0.4384	31.8200	0.2975	31.8200
0.9552	30.8295	0.9484	30.8295	0.9316	30.8295	0.8988	30.8295	0.8357	30.8295	0.6800
	1.4141	29.8698	1.4416	29.8698	1.4682	29.8698	1.4950	29.8698	1.5304	29.8698
		2.0220	28.9401	2.1064	28.9401	2.2090	28.9401	2.3506	28.9401	2.6302
			2.7821	28.0392	2.9412	28.0392	3.1415	28.0392	3.4198	28.0392
				3.6715	27.1664	3.9040	27.1664	4.1812	27.1664	4.4608
					4.6391	26.3208	4.9151	26.3208	5.1935	26.3208
						5.6225	25.5015	5.8996	25.5015	6.1792

6.5801	24.7076	6.8584	24.7076
	7.5128	23.9385	7.7924
		8.4214	23.1934
			9.3066

Calculation of Option Value (Backward Induction)

C = Max { e^(-rΔt) × [p × Cup + (1 - p) × Cdown] , S - X , 0 }

Step 0 value (today) is found **after rolling back all the way to the beginning**.

C Step 0 = $ 9.31 million

The 10-step binomial tree was constructed by applying risk-neutral valuation, considering the project's volatility, risk-free rate, and flexibility assumptions. Every node represents the project's possible future worth based on changes in the market over time. It was determined that the option value at Step 0 (today) was 9.31 million USD by employing backward induction across the lattice. This number emphasizes the advantage of delaying commitment for a year in order to take advantage of positive market developments and lower downside risks. Thus, by raising the anticipated project value under uncertainty, exercising the deferment option provides a strategic advantage over moving forward right away.

8.5 Extended Net Present Value (ENPV) Calculation

Step 4:After the option value has been calculated at Step 0, the Expanded Net Present Value (ENPV) is calculated by combining the option value from ROA with the traditional NPV from DCF analysis. This method supports a more calculated investment choice and adds project flexibility to valuation.

ENPV=NPV+Option ValueENPV = NPV + Option\ ValueENPV=NPV+Option Value

NPV = (–679,601 USD) *(from earlier DCF)*

Option Value = 9.31 million USD *(from binomial tree Step 0)*

ENPV=(–0.679 million)+9.31 million

ENPV=8.63 million USD

The positive ENPV of **8.63 million USD** indicates that by deferring the project for one year, the investment becomes financially effective. Thus, applying strategic flexibility improves project feasibility, even though the initial DCF analysis suggested a loss.

8.6 Sensitivity Analysis of External Market Risks

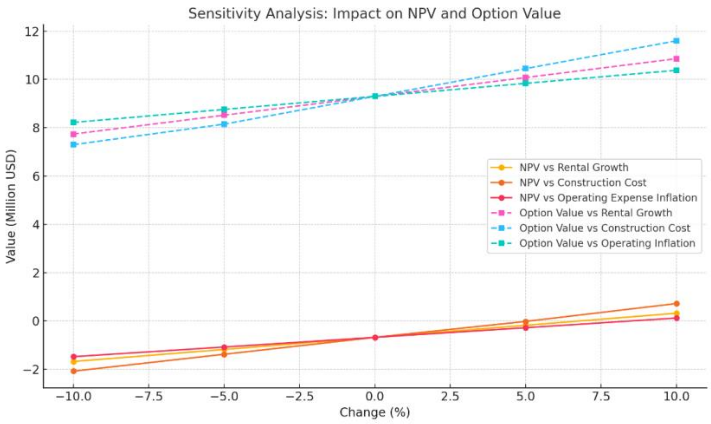
Step 5: The sensitivity analysis demonstrates that the project's NPV and option value are affected by modest variations in building and operating costs. On the other hand, growth in rental income has a stronger positive impact, indicating that even modest increases in market rent could significantly boost project returns. The decision to postpone investment for a year to wait for better circumstances is supported by the deferment strategy's overall appearance of resilience under reasonable market fluctuations.

Table8.8 Sensitivity Analysis of NPV and Option Value

Change (%)	NPV vs Rental Income Growth (Million USD)	NPV vs Construction Cost (Million USD)	NPV vs Operating Expense Inflation (Million USD)	Option Value vs Rental Growth (Million USD)	Option Value vs Construction Cost (Million USD)	Option Value vs Operating Inflation (Million USD)
–10%	–1.68	–2.08	–1.48	7.74	7.30	8.22
–5%	–1.18	–1.38	–1.08	8.52	8.15	8.76
0%	**–0.68**	**–0.68**	**–0.68**	**9.30**	**9.30**	**9.30**
+5%	–0.18	–0.02	–0.28	10.08	10.45	9.84
+10%	+0.32	+0.72	+0.12	10.86	11.60	10.38

The sensitivity analysis variables were chosen based on a mix of real market data and standard thumb rules used in industry practice. Construction costs have historically increased by 5%–7% per year (CBRE, 2024), while rental incomes typically grow by 3%–5% annually (NMHC, 2024). Operating expenses, such as utilities and maintenance, rise by about 2%–3% each year (U.S. Bureau of Labor Statistics, 2024). These inputs were varied by ±5% and ±10% to test the project's resilience under different market scenarios.

Fig-8.6 Sensitivity Analysis chart : Impact on NPV and Option Value



The sensitivity analysis shows that the project's NPV and option value are manageably impacted by relatively small variations in construction and operation costs. However, the growth of rental income has a greater positive impact, indicating that even modest increases in market rents could significantly increase project returns. The decision to postpone investment for a year in order to wait for more favorable circumstances is supported by the deferment strategy's overall strength under reasonable market fluctuations.

IX. CONCLUSION

According to the first DCF analysis, an immediate investment would be financially detrimental, as evidenced by the negative Net Present Value (NPV) of -679,601. Given the drawbacks of static analysis, Real Option Analysis (ROA) was carried out to examine strategic adaptability in unpredictable market circumstances. According to the ROA results, a one-year delay in the project would result in an option value of $9.31 million, raising the project's total Expanded Net Present Value (ENPV) to $8.63 million. The impact of significant external risks, including inflation in construction costs, growth in rental income, and volatility in operating expenses, was assessed through a sensitivity analysis. The analysis revealed that the project's financial viability would not be greatly impacted by adequate market movements, with the most important positive driver being growth in rental income. These findings suggest that waiting for a year presents an opportunity to profit from upward market trends while minimizing the risk of decline. Consequently, waiting a year turns out to be a reasonable and well-balanced approach, enhancing the project's financial viability and enabling better-informed investment choices.

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