Valuation and Decision-Making in M&A: A Compound Real Options Approach

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Abstract: Mergers and acquisitions (M&A) play a vital role in enabling enterprises to achieve global expansion. However, it faces multi-layered uncertainties such as exchange rates, political shifts, market volatility, cultural gaps. To address this, the paper aims to develop a compound real options framework capturing interdependent flexibility options (delay/expansion/exit) inherent in M&A. Using a two-stage compound model, we dynamically assess the target company's value and M&A decision process. The results demonstrate the framework's effectiveness in optimizing decisions and enhancing returns for managers operating in complex international markets.

***Keywords*:** Real options, M&A, Valuation

INTRODUCTION

Global M&A activity is increasingly dynamic, marked by greater scale and complexity. However, the uncertainty and managerial flexibility of M&A transactions challenge the effectiveness of traditional valuation approaches such as discounted cash flow (DCF), which fail to adequately capture the strategic option value (Dixit and Pindyck, 1994). This highlights the need for real options theory, as it better captures the dynamic and uncertain nature of M&A decision-making.

In the field of M&A research, scholars have examined the implications of real options for target valuation (Bi and Gregory, 2011), deal timing (H. T. Nguyen et al., 2012), and risk management. However, existing literature focuses on the application of single-type real options. There remains a clear gap in the literature regarding the systematic development of compound real options models that capture the flexibility nature of decision-making in M&A. We find that the application of compound real options is more typical in mining (Chandra and Hartley, 2024), energy (Li and Cao, 2022), infrastructure investments (Polat and Battal, 2021).

To address this gap, the core objective of this study is to develop a two-stage compound real options binomial model. This model aims to dynamically evaluate the strategic value of the target firm under uncertainty and provide the acquirer with stage-specific decision rules throughout the M&A process.

This study examines an M&A case in the information technology sector by first assessing the target company's value using traditional valuation and real options methods. Then, a two-stage compound binomial tree framework incorporating delay, expansion, and abandonment options is constructed to evaluate the optimal M&A path. Results show that real options better quantify tech firms' future growth potential, while delay and expansion strategies effectively balance risk and flexibility, consistent with high-tech industry dynamics.

This study bridges the gap in applying compound real options to dynamic M&A valuation and decision-making, while giving firms a more realistic and flexible tool to evaluate acquisitions.

METHODOLOGY

- Compound real options framework

Mergers and acquisitions (M&A) involve a complex, ten-stage process. These stages cover pre-acquisition decisions (business plan, search, negotiation) and post-acquisition execution (integration, evaluation). (DePamphilis, 2019). Given the uncertainty and flexibility inherent in these stages, M&A embeds critical real options— such as timing (wait-and-see), expansion, and abandonment options. (Moles, 2003).

Building on this framework, we therefore attempt to construct a two-stage compound real options model to analyze the merger and acquisition case. The framework is illustrated in Table 1.

Table 1 Compound Real Options Framework

Stage	Time Horizon	Description	Option Type	Decision Rule
Stage 1	Year 0-2	pre-acquisition	Option to defer Option to abandon	If risks are too high *or* market conditions look bad
Stage 2	Year 2-5	post-acquisition	Option to expand	If integration is going well *and* new growth opportunities appear
Stage 2	Year 2-5	post-acquisition	continue	If results are steady *and* no major strategy changes are needed
Stage 2	Year 2-5	post-acquisition	Option to abandon	If integration fails *or* the strategic fit doesn't work

Source: Authors

- Binomial option pricing model

Real options valuation commonly uses closed-form solutions or binomial models. While closed-form solutions are efficient for standard European options under simplifying assumptions. By contrast, binomial lattices provide a discrete-time framework well-suited to modeling all types of options. It offers greater flexibility and better captures the multi-stage, decision-driven nature of M&A activities.

The binomial tree model (Cox, Ross and Rubinstein, 1979) discretizes the investment horizon into multiple time steps, simulating two possible movements (upward u or downward d) of the asset value S at each node, and employs risk-neutral probabilities p to recursively evaluate the option's value. The formula is as follows:

$$S_{up} = S \cdot u, \tag{1}$$

$$S_{down} = S \cdot d, \tag{2}$$

$$u = e^{\sigma\sqrt{\Delta t}}, \tag{3}$$

$$d = e^{-\sigma\sqrt{\Delta t}} = \frac{1}{u}, \tag{4}$$

$$p = \frac{e^{r\Delta t} - d}{u - d}, \tag{5}$$

$$\Delta t = \frac{T}{N}, \tag{6}$$

where S is the underlying asset, σ is the volatility of the underlying asset price, Δt is the length of time per step in the tree and is simply time to maturity T, divided by the number of time steps N.

At each terminal node of the tree, corresponding to the option's expiration, the option value is equal to its intrinsic (exercise) value:

$$\Psi^{call} = (S_T - K)^+ \tag{7}$$

$$\Psi^{put} = (K - S_T)^+ \tag{8}$$

where S_T is the underlying asset, K is the exercise price, $()^+ = \max(x; 0)$.

FINDINGS

- Case Background

In March 2025, Siemens acquired Altair for approximately USD 10 billion to enhance its position in industrial software and AI. By integrating Altair's simulation, HPC, and AI capabilities into the Siemens Xcelerator platform, the deal strengthens Siemens' digital twin and PLM solutions.

Financial data for this study were collected from the official website of Altair Engineering Inc., the Federal Reserve Bank of St. Louis, and NASDAQ, covering the period from 2019 to 2024.

- Target Company's Value

Altair Engineering Inc. is a U.S.-based information technology company, operating in a sector characterized by rapid innovation and high uncertainty. Following Myers (1977), we therefore decompose Altair's value into two components: the static "assets-in-place" value and the value of its future growth opportunities.

We first estimate the present value using the traditional discounted cash flow (DCF) approach. Based on Altair's strong revenue growth in recent years, we assume a two-stage projection: a high-growth phase (2025–2028) followed by a stable phase (2029 onward). Free cash flow to the firm (FCFF) is calculated using EBIT, tax rate, depreciation, capital expenditures, and changes in net working capital. The weighted average cost of capital (WACC) is derived using the CAPM, where the risk-free rate is proxied by the average 5-year U.S. Treasury yield (2019–2024), beta is estimated via linear regression against the NASDAQ-100 index, and the long-term U.S. GDP growth rate is used as the terminal growth rate (g). The results are presented in Table 2.

Table 2 DCF Results ($ in thousands)

	2025	2026	2027	2028	2029
Estimated FCFF	50,197	55,969	69,562	84,749	101,725
NPV	46,905	48,868	56,753	64,608	72,463
V1	217,134				
V2	626,617				
WACC in first stage	7.02%				
WACC in second stage	7.08%				
Growth rate g	2.42%				
V (enterprise value)	843,750				

Source: authors

Altair's intrinsic value is estimated at USD 843.75 million using the DCF model, yielding an equity value of USD 613.75 million and an implied stock price of USD 6.93, which is significantly lower than its market price of USD 109.1 at the end of 2024. As a technology-driven firm operating in simulation, AI, and high-performance computing, Altair holds substantial growth potential that is not fully captured by the DCF model.

We then captured Altair's future growth opportunities supported by its recent high R&D investment and accumulated goodwill. Growth opportunities are treated as underlying assets, and investment costs as the exercise price. Volatility is estimated from the historical log returns of the stock, and the risk-free rate is proxied by the 5-year U.S. Treasury yield. For simplicity, a 5-step binomial tree over a 5-year horizon is constructed. Using equations (1)– (5), we build the lattice and apply backward induction to calculate the real options value, with terminal payoffs defined by equation (7). Results are presented in Figure 1.

Figure 1 Real Options Value

Growth Opportunities Lattice

9,047,927	14,130,502	22,068,157	34,464,704	53,824,875	84,060,411
	5,793,495	9,047,927	14,130,502	22,068,157	34,464,704
		3,709,643	5,793,495	9,047,927	14,130,502
			2,375,328	3,709,643	5,793,495
				1,520,951	2,375,328
					973,883

Real Option Valuation Lattice

7,954,880	12,973,982	20,864,439	33,211,860	52,520,902	82,703,222
	4,670,342	7,844,209	12,877,659	20,764,184	33,107,515
		2,567,355	4,540,651	7,743,955	12,773,313
			1,235,578	2,405,670	4,436,306
				425,183	1,018,139
					0

Source: authors

The real options analysis yields a flexibility value of 7,954,880 USD thousand. Combined with the DCF valuation, the total firm value is 8,798,630 USD thousand, implying a stock price of 99 USD—much closer to the market price of 109.1 USD. This suggests that the real options approach more effectively capture Altair's flexibility in innovation and strategic expansion, supporting more closely with market expectations of its future growth.

- M&A decision path

After valuing the target firm, we analyze the M&A impact to support the acquirer's decision-making. Using the two-stage compound real options model outlined in Table 1, the underlying asset is defined as Altair's firm value, and the exercise price as Siemens' proposed acquisition cost. Model assumptions including time steps, volatility, risk-free rate, and investment remain consistent with the previous valuation. The abandonment salvage value is obtained from Altair's annual report.

The firm value lattice is then constructed using equations (1)– (5), followed by the application of backward induction to compute the real options value. The backward induction process is conducted as follows:

Backward step 1 (T2, post-acquisition): In years 3 to 5, the acquirer holds the option to expand, continue, or abandon the investment. Accordingly, the terminal value at each node is defined as the maximum of the intrinsic value, expansion payoff, and salvage value—representing the three possible decisions.

Backward step 2 (T1, pre-acquisition): Year 2 represents a critical decision point where the firm chooses to continue or abandon the project. The acquisition proceeds to the second stage only if the decision is to continue. The node value equals the maximum of the expected continuation value and the immediate payoff, with the corresponding decision (continue or abandon). At Year 1, the firm decides whether to invest immediately or delay. Thus, the node value is the maximum of the immediate payoff and the discounted value of the delayed option, with decisions (start or delay). Figure 2 illustrates the real options values and optimal decisions.

Figure 2 Compound Real Options Value

Company Value Lattice

8798630.06	13741164.48	21460113.67	33515098.34	52341839.10	81744296.04
	5633866.84	8798630.06	13741164.48	21460113.67	33515098.34
		3607431.54	5633866.84	8798630.06	13741164.48
			2309881.06	3607431.54	5633866.84
				1479044.15	2309881.06
					947049.45

	T1 Deferral Option		T2: Expansion Option/Abandonment Option		
t0	t1	t2	t3	t4	t5
6864352.89	11560541.19	19666743.56	33617577.85	57161674.41	94940736.34
Delay	Delay	Continue	Continue	Continue	Expand
	3749355.62	6162867.38	10360773.77	17943203.81	32242779.34
	Delay	Continue	Continue	Continue	Expand
		2164458.92	3380320.10	5279178.03	8244698.69
		Abandon	Abandon	Abandon	Abandon
			1385928.64	2164458.92	3380320.10
			Abandon	Abandon	Abandon
				887426.49	1385928.64
				Abandon	Abandon
					568229.67
					Abandon

Source: authors

The optimal decision pathway consists of delaying the project at t1, initiating investment at t2, sustaining continuous operation from t3 to t4, and implementing expansion at t5. This strategy yields a terminal value of approximately 94940736 million, substantially exceeding the values of alternative paths. Consequently, the “delay-expansion” approach emerges as the most value-enhancing strategy for Siemens.

The advantage of the optimal path lies in its balance of risk and return, influenced by the evolution of the information technology industry. In the early stage, delaying investment effectively reduces technological and market uncertainties. In the mid-stage, value grows through scale effects enabled by enhanced operational efficiency. Finally, in the terminal stage, strategic expansion leverages industry network effects, leading to a substantial increase in value.

CONCLUSIONS

The two-stage compound real options framework developed in this study—which integrates delay, expansion, and abandonment options—was successfully applied to an M&A case in the information technology industry. The results show that this framework not only quantifies the future growth value of the target tech company more accurately (with a significant premium over traditional methods) but also identifies the "delay-expansion" strategy as the optimal decision path. This greatly improves the adaptability and flexibility of M&A decisions in dynamic, high-risk environments, fitting well with the characteristics of the high-tech sector.

This study contributes theoretically by addressing the gap in applying a compound real options framework to dynamic valuation and decision-making in M&A, while also providing firms with a more practical and flexible tool for evaluating acquisition opportunities. However, the model parameters in this study, such as volatility and risk-free rate, are based on historical data, with simplifying assumptions applied to parameter settings. Future research could extend the framework to a multi-stage compound real options model and incorporate advanced techniques for parameter adjustments.

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