Valuation and Timing of Corporate Acquisitions: Do Real Options Perform Better Than Net Present Value?

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Abstract

This article is a case study analyzing the valuation process and the timing choice of a corporate acquisition project using a comparison between the net present value rule and the real option method. It seems that when a corporate acquisition project is done under the right circumstances and well executed, this could mean a huge profits and a win-win for shareholders of both the acquiring and the target company. However, in many cases the results of acquisitions turn out to be negative for one, or both of the parties. Actually, this type of investment is characterized by the risk of paying sunk costs especially for the acquirer. For reaching a win-win result from corporate acquisitions, valuation issues and the optimal timing choice play a major role. In this article, the net present value criterion and real options were used to calculate the project's value and optimal timing of investment. We started by calculating the average and the simulated net present value. Then, we used real options approach. The acquisition option was evaluated with the Black and Scholes model (1973). The timing option was evaluated with the binomial model of Cox, Ross and Rubinstein (1979). Our case study suggested that real options can produce more sensible recommendations regarding the acquisition project value and the investment timing than the traditional net present value rule. It also showed the benefits of real options beyond valuation aspects. In particular, the optional way of thinking can help structure discussions between the managers of the targets companies and the acquirers to establish a roll-out plan of the closing process.

Key Words: Real Options, Corporate Acquisition, Net Present Value, Acquisition Option, Timing Option, Case Study.

Introduction

Since the Myers publication on real options (1977), there has been a growing number of publications about the benefits of the real option method, rather than the conventional net present value (NPV) rule, to support investment decisions in the presence of high uncertainty and flexibility. Since Smits and Triantis publications in 1995, corporate acquisitions projects are well fitted to the use of real options. These kinds of projects combine high capital intensity with a high degree of uncertainty.

In order to preserve competitiveness and enhance shareholder value for both acquirers and targets companies, NPV analysis presents many limits. Actually, the corporate acquisition investment is faced with multiple uncertainties related to future synergies, the fairness of the target documents and specially the competitive risk. However, literature on real options approach of these kind of projects is dominated by theoretical contributions, with very few detailed case studies.

Most of the time, the real options theory is illustrated with simplified examples that do not reflect the complexity of the target company valuation process and the choice of timing for the closing. Case studies often lack details concerning the methodology used to calculate option value.

In this article, we present a real case study, in which real options are used to make a value and to identify the optimal investment timing in the roll-out of the corporate acquisition project. We evaluate the acquisition option and the timing option using two models: The Black and Scholes model and the binomial model. We also explain how to estimate key parameters such as underlying assets, strike prices, volatility….

We explore the benefits of using real options to support a corporate acquisition decision in a context of high uncertainty. As it is traditionally done in the real options literature, we show that real options can lead to a more appropriate investment's valuation and optimal timing than the NPV approach.

The article is organized as follows: first, we start by describing the corporate acquisition decision which is presented in two scenarios (imminent or deferred acquisition) and present the average and simulated NPV. Then, we explain how the corporate acquisition can be analyzed through a real options approach and concentrate on the options valuation. Finally, we present a discussion on the benefits of real options for the valuation and timing choice of acquisition projects.

The Context of the Corporate Acquisition Decision

The target company, « ZINGINDU » is a company specialized in manufacturing of steel structure for construction and industrial equipment. Its registered capital is about 220 000 Euros. It employs nearly 30 people with an annual turnover between 4 and 5 million Euros.

The acquirer, « X INGENEERING » is a Civil Engineering and Public Works company. It has a wide range of skills in the field recognized by the professional engineering certification authority for infrastructure, building and industry. Both companies are located in the French area, Lille.

In 2006, the acquirer had the possibility to take over the target company according to an acquisition schedule forecast fixed at 30/09/2006 as closing date. Given the high level of uncertainty underlying the success of the acquisition project, the question is whether it was better to postpone the purchase decision of the target company by 31/07/2007at the latest.

Every alternative investment (imminent or deferred acquisition) has a different purchase price. The basic price varies as result to the changes in certain operating variables between the valuation date of the target company and the closing date. The earn out is due to a bonus related to the target company's performance during the integration phase, generally presented in earn out clauses. Earn out refers to a pricing structure in acquisitions where the sellers must "earn" a part of the purchase price based on the performance of the business following the acquisition. It means that a part of the purchase price is paid after closing based on the target company achieving certain financial goals.

Analysis of the Alternative of the Target Company's Immediate Acquisition

The overall price offered by the acquirer is calculated from:

- A basic price of 1 000 000 Euros that involves:

(1) The historical performances of the target company, (2) the correction of Working Capital Requirement (WCR) particularly high until 30/09/2005 and (3) the remaining dividend paid in respect of 2004 with 98 000 Euros and a dividend of 127 720 Euros approved in 2005. This price is also formed by a minimum cash flow of 200 000 Euros until 30/08/2006. Any amount less than the one above suggests an adjustment to the acquisition price equivalent to the difference with this threshold.

- A first additional price equal to the net income for the year 2006, excluding exceptional items (unusual charge that a company accrues in the ordinary course of its business. For example, the wages a company pays may be exceptionally large in a given year because of the amount of overtime that employees work. This differs from an extraordinary item which is also unusual but does not accrue in the ordinary course of business). It should be set to 31/01/2007, and refunded in equal amounts in January 2008 and in January 2009.

- A second earn out based on the target company's performance during the financial year ended 30/09/2007. This price is set at 50% of the operating income surplus (after adding back the wage cost of the manager) relative to a threshold of 450 000 Euros. The payment of the second earn out is planned for January 2008. According to all these elements, we obtain an imminent purchase price equal to 1 274 337 Euros.

Analysis of the Alternative of the Target Company's Deferred Acquisition

Unlike the immediate acquisition of the target company, the acquirer here considers the possibility to postpone the closing date until 31/07/2007. The basic price proposed to the target company is estimated at 1 200 000 Euros. This price includes the historical performances of the target company as well as a dividend of 275 000 Euros approved in 2006. Only one earn out is planned by the acquirer. It is to be paid upon the closing of accounts by the board of directors of the target company. The determination of the earn out is made on the basis of the portfolio valuation of the target company's development during the financial year ended 30/09/2007. This earn out is estimated at 50% of the net income recorded in the same period, provided that the amount of cash flow on the balance sheet is at least equal to the net income. The earn out will be paid by the acquirer in January 2008 and repaid in January 2009.

The deferred purchase price offered by the acquirer is equal to 1 350 450 Euros.

Profitability and Risk Analysis of the Acquisition Decision

Alternatives for acquiring the target company are subject to financial projections over 10 years period.

A positive NPV means that the target company acquisition project creates value and the return on investment is quite sufficient to compensate the investments made. However, a negative NPV means that the acquisition of the target company's future cash flows is a destruction of value, that is to say, the performance is less than the cost of capital. To calculate the NPV, we need to know the cost of capital. This latter corresponds to the compensation of capital providers for (1) the time value of money and (2) the risk taken on the expected cash flows. The cost of capital is estimated at 9, 45%. For confidentiality reasons, we are not allowed to present the company's business plan.

Table1. NPV of the target acquisition project

Acquisition Scenario	Value of the acquisition project (in Euros)	Investment cost (in Euros)	NPV (in Euros)
Immediate acquisition of the target company	1 245 579	1 274 337	-28 758
Deferred acquisition of the target company	1 358 041	1350 450	-7 591

The projects of immediate and deferred acquisition have a negative NPV. Therefore, they are not cost-effective. The target company acquisition project is a major and, at the same time, irreversible investment. The uncertainties of the success surrounding this investment are numerous. However, they are not taken into account in the calculation of the traditional average NPV.

The Acquisition Project: A Risky Investment

The acquisition of the target company « ZINGINDU » is characterized by the presence of many sources of uncertainty that affect the project's profitability. Three categories of sources of uncertainty have been identified: the evolution of the turnover, the earn outs' values and the changes in the basic price (only in case of an immediate acquisition of the target company).

Strong Uncertainty Over The Turnovers

The Duty Free turnover corresponds to the production sold by the target company. It is estimated by the amounts of its billings. The sharp rise in steel prices has affected the prices of metal constructions. It has artificially increased the billing amounts and consequently the turnover level. The clientele of the target company is divided into two types of markets: private markets (88% of sales) and the public markets (12% of sales).

Table2. Distribution hypothesis of the « Private markets turnover » variable

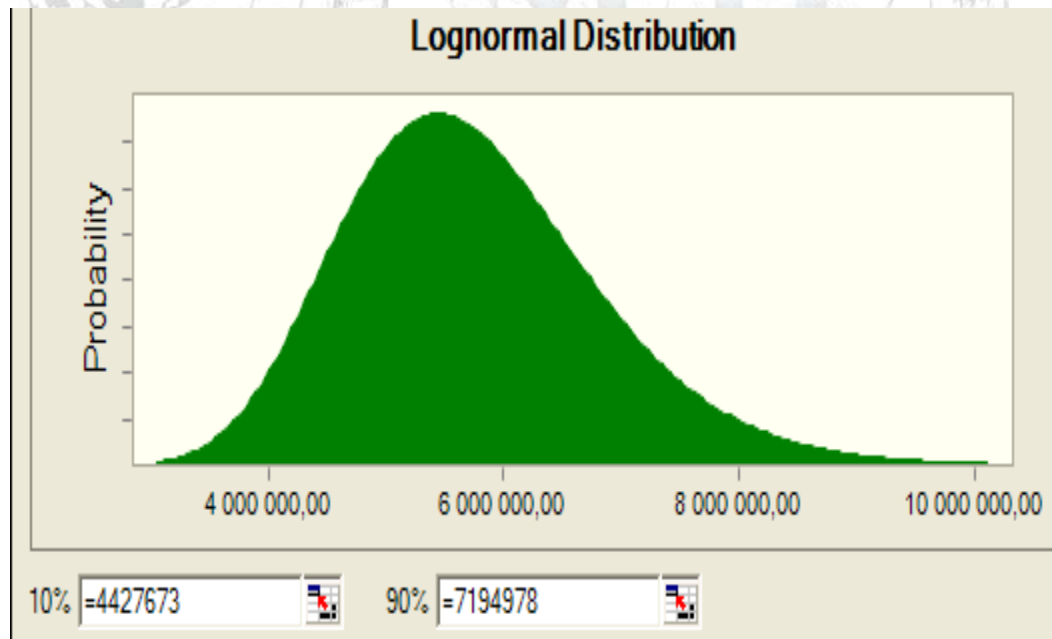| Sources of uncertainty variables	Notations	Distribution laws	Values (in Euros)
« Private markets turnover » variable in the immediately acquisition	RCMPR	Log-normal	Minimum value at 10% confidence interval: 4 427 673 Maximum value at 90% confidence interval : 7 194 978
« Private markets turnover » variable in the deferred acquisition	RCMPR'	Log-normal	Minimum value at 10% confidence interval: 4 560 503 Maximum value at 90% confidence interval : 7 410 827

Figure1. Probability distribution of the « Private markets turnover »
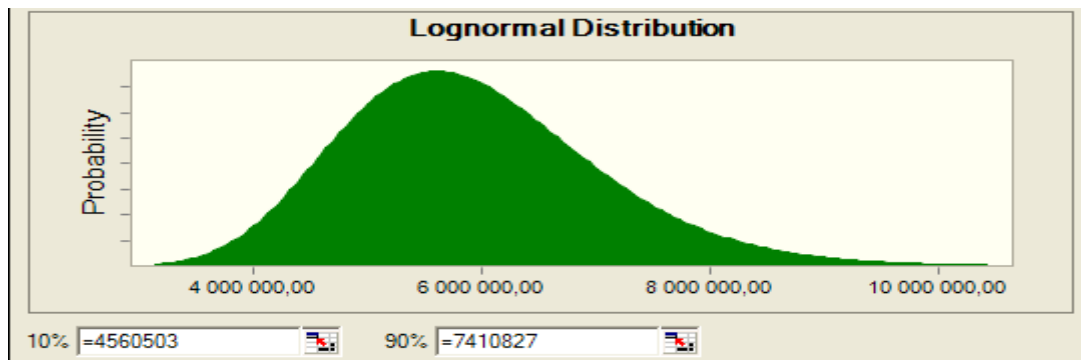variable in the immediately acquisition case

Figure2. Probability distribution of the « Private markets turnover » variable in the deferred acquisition

Table3. Distribution hypothesis of the « Public markets turnover » variable

| Sources of uncertainty variables	Notations	Distribution laws	Values (in Euros)
« Public markets turnover » variable in the immediately acquisition	RCMPU	Log-normal	Minimum value at 10% confidence interval: 603 774 Maximum value at 90% confidence interval : 981 133
« Public markets turnover » variable in the deferred acquisition	RCMPU'	Log-normal	Minimum value at 10% confidence interval: 621 887 Maximum value at 90% confidence interval : 1 010 567
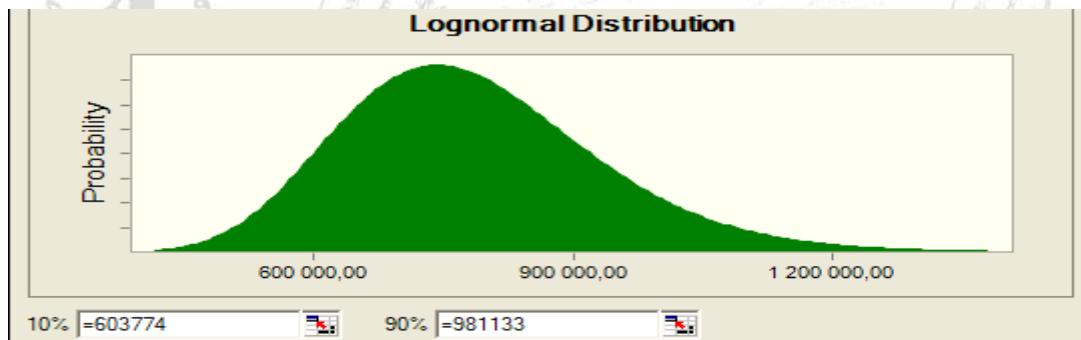
Figure3. Probability distribution of the « Public markets turnover »
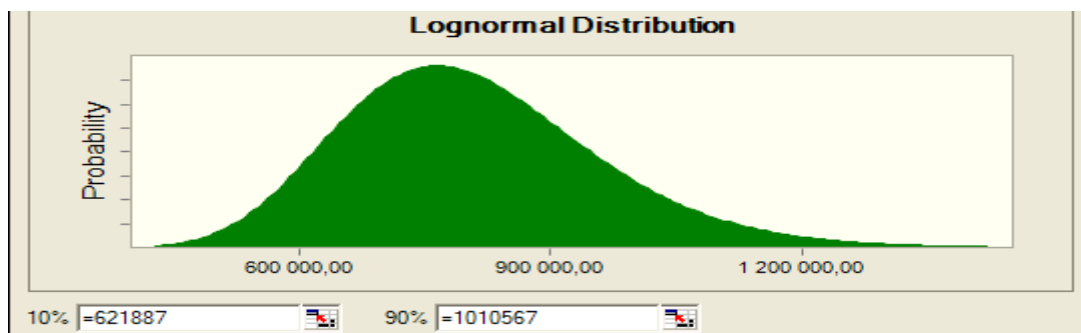variable in the immediately acquisition case

Figure4. Probability distribution of the « Public markets turnover »
variable in the deferred acquisition case

Uncertainty over earn outs

The first and second earn outs are defined either (1) from operating results, or (2) from the net income at the close of a financial period 2006 and 2007 and (3) in certain cases from the future cash flow levels. At the time of the evaluation of the target company acquisition project, the acquirer can not determine with certainty neither the amounts of these income, nor the amount of future cash flows. Consequently, the developments of the earn outs between the evaluation and the closing date are uncertain.

Table 4. Distribution hypothesis of the « First earn out » variable and the « Second earn out » variable

Sources of uncertainty variables	notation	Distribution laws	values (in Euros)
First earn out in the immediately acquisition	CP1	Triangular	Minimum value : 250 800 Most likely value : 321 266 Maximum value : 415 800
First earn out in the deferred acquisition	CP1'	Triangular	Minimum value : 135 953 Most likely value: 172 240 Maximum value : 220 923,5
Second earn out in the immediately acquisition*	CP2	Triangular	Minimum value : 22 103,07 Most likely value : 58 390,2 Maximum value : 107 073,45

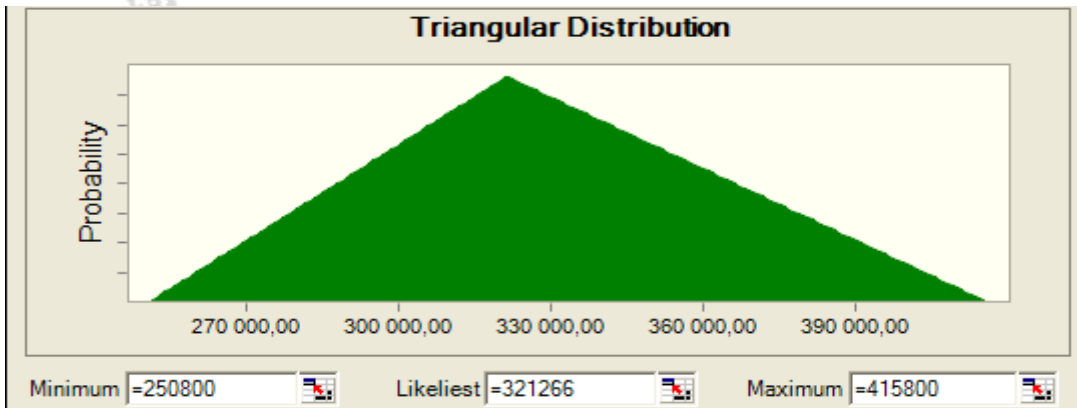*There is no second earn out in the deferred acquisition case

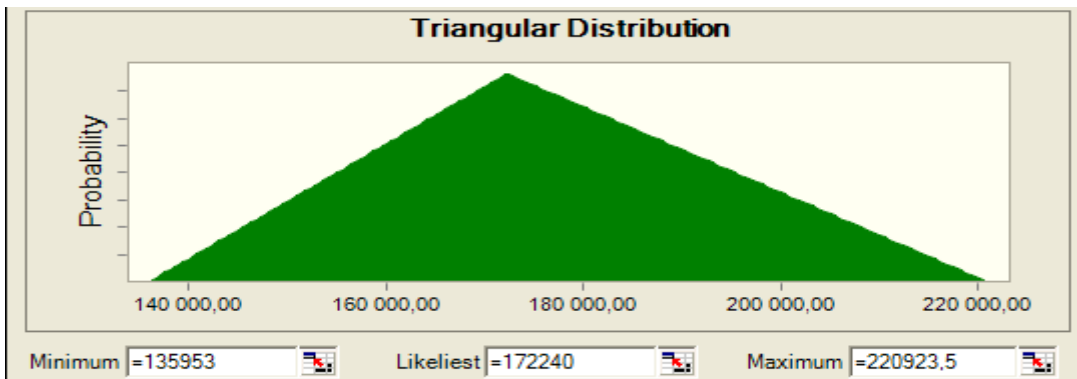Figure5. Probability distribution of the « First earn out » variable in the immediately acquisition case

Figure6. Probability distribution of the « First earn out » variable in the deferred acquisition case
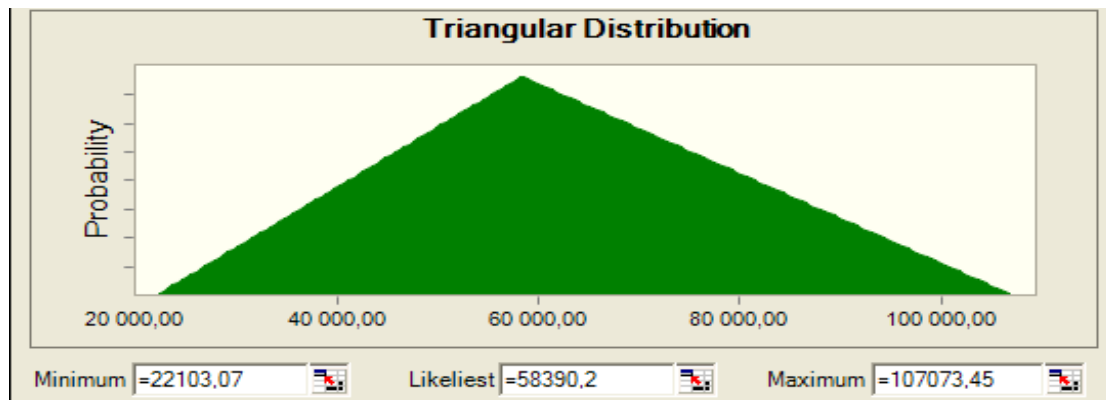
Figure7. Probability distribution of the « Second earn out » variable in the immediately acquisition case

Uncertainty Concerning the Basic Price Exclusively In The Case of an Immediate Acquisition (PB)

The basic price is considered a source of uncertainty as the evolution of the amount of cash-flow recorded until 30/08/2006 is random.

Table5. Distribution hypothesis of the « Basic price » variable

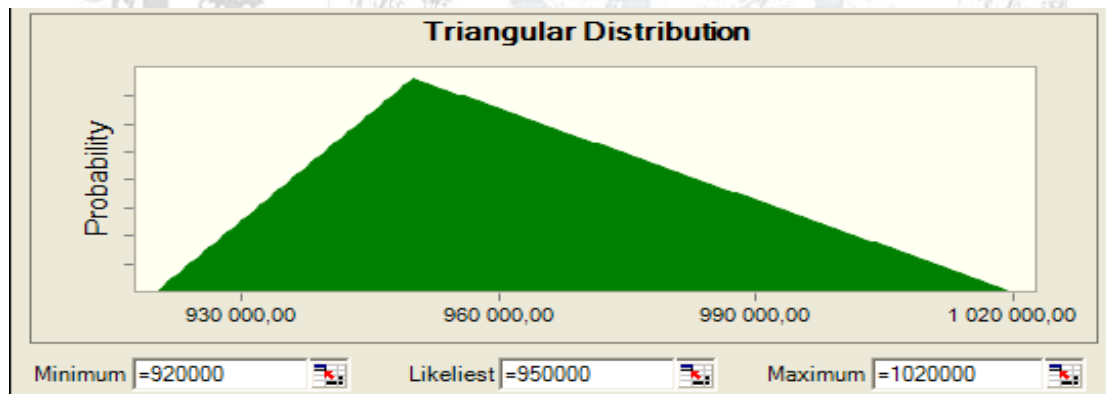| Sources of uncertainty variables	notation	Distribution laws	Values (in Euros)
« Basic price » variable	PB	Triangular	Minimum value : 920 000 Most likely value : 950 000 Maximum value : 1 020 000

Figure8. Probability distribution of the « Basic price» variable in the immediately acquisition case

Table6. Hypothesis concerning the Correlations between the sources of uncertainty in the immediately acquisition case

Sources of uncertainty Variables	RCMPR	RCMPU	PB	CP1	CP2
RCMPR	1	0,2	0,4	0,7	0,5
RCMPU	0,2	1	0,25	0,2	0,15
PB	0,4	0,25	1	0,5	0,45
CP1	0,7	0,2	0,5	1	0,65
CP2	0,5	0,15	0,45	0,65	1

Table7. Hypothesis concerning the correlations between the sources of uncertainty in the deferred acquisition case

Sources of uncertainty variables	RCMPR'	RCMPU'	CP1'
RCMPR'	1	0,2	0,7
RCMPU'	0,2	1	0,2
CP1'	0,7	0,2	1

A more appropriate assessment of the value of the target company acquisition project is to describe the risk of over-mentioned variables by probability distributions. It is about varying, at the same time, the various sources of risks and to take into account the impacts and correlation that they have on each other. This methodology carries out the Monte Carlo simulations on the NPV of the target company acquisition project.

A More Sophisticated Risk Analysis: The Monte Carlo Simulations

Simulate a net present value is a question of determining its evolution when we vary the sources of uncertainty using probability distributions. The method is to create a large number of scenarios from samples of these probabilities. An assessment of the probability distribution of the NPV is subsequently performed for each scenario of the target company acquisition. This provides us with information about the expected value, the range of possible outcomes and negative risks of the target company acquisition project. For each alternative of the target company acquisition, we carry 10,000 random draws.

The Monte Carlo simulations are obtained using Crystal Ball software and designed to integrate into an Excel spreadsheet.

Distribution of the NPV Obtained by the Monte Carlo Simulations In The Case of an Immediate Acquisition

Figure 9 shows the distribution profile of the NPV obtained by the Monte Carlo simulations (10 000 random draws) in the case of an immediate acquisition of the target company.
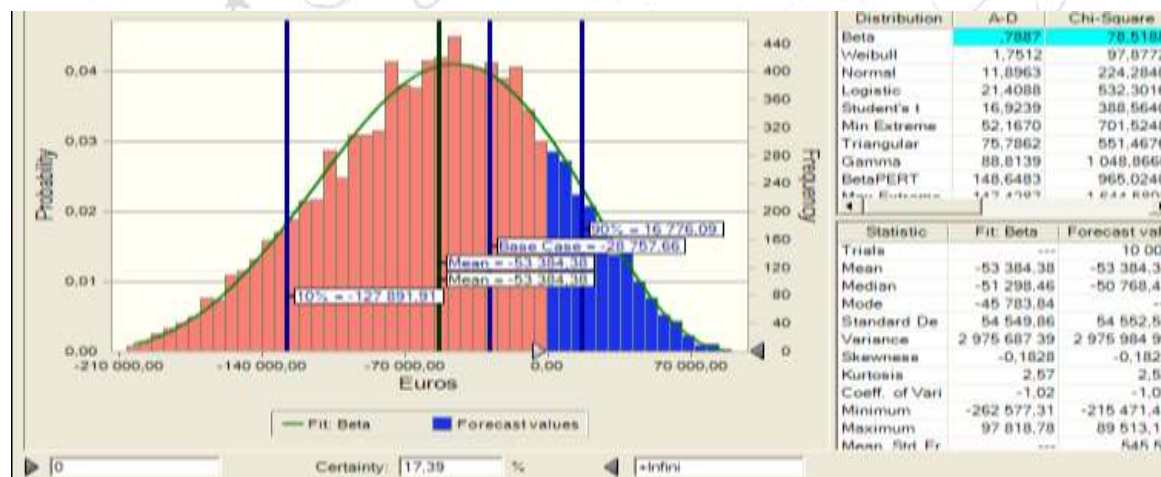

Figure9. Distribution of NPV using Monte Carlo simulations in the immediately acquisition case (with a subsidy of -28 758 Euros)

Based on the Kolmogorov-Smirnov test, which is a non parametric test, the NPV of the immediate acquisition project follows a beta distribution averaging -53 384, 38 Euros and a standard deviation of 17 250, 18 Euros. The NPV can reach 16 776, 09 Euros for a 90% confidence interval.

Although the NPV implies a negative average, there is a non-zero probability that it can be positive. The Monte Carlo simulations on the NPV of the acquisition project shows that this probability is about 17, 39 %. Consequently, the abandonment of the acquisition is not necessarily a good decision.

Analysis of the NPV Sensitivity to the Sources of Uncertainty In The Case of an Immediate Acquisition

The analysis of the NPV sensitivity shows that it is primarily sensitive to 4 sources of uncertainty: the first (CP1) and the second (CP2) earn outs that respectively explain a variance of 31, 6% and 25% of the NPV. The basic price shows 23, 2% of the variance of the NPV. The turnover from private markets indicates 17, 7% of the variance of the NPV.
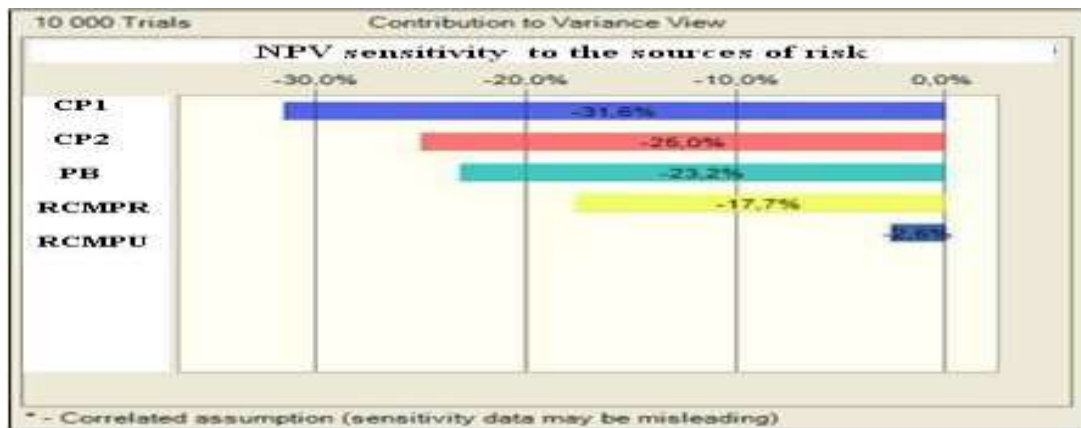

Figure10. Analysis of the NPV sensitivity to the sources of uncertainty in the case of an immediate acquisition

Distribution of the NPV obtained by the Monte Carlo simulations in the case of a deferred acquisition

Figure 11 shows the distribution profile of the NPV obtained by the Monte Carlo simulations (10 000 random draws) in the case of a deferred acquisition of the target company.
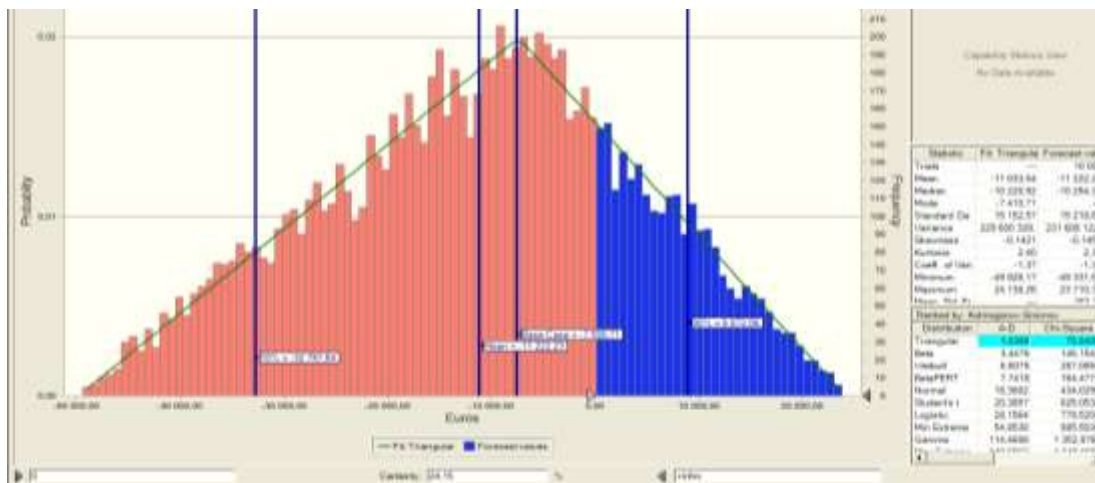

Figure11. Distribution of NPV using Monte Carlo simulations in the deferred acquisition case (with a subsidy of -7 591Euros)

Based on the Kolmogorov-Smirnov test, the differed acquisition project follows a triangular distribution. When postponing the closing date, NPV can achieve positive values with some combinations of sources of uncertainty (8 872, 56 Euros for a 90% confidence interval). As such, the probability of a positive NPV is estimated at 24, 15%.
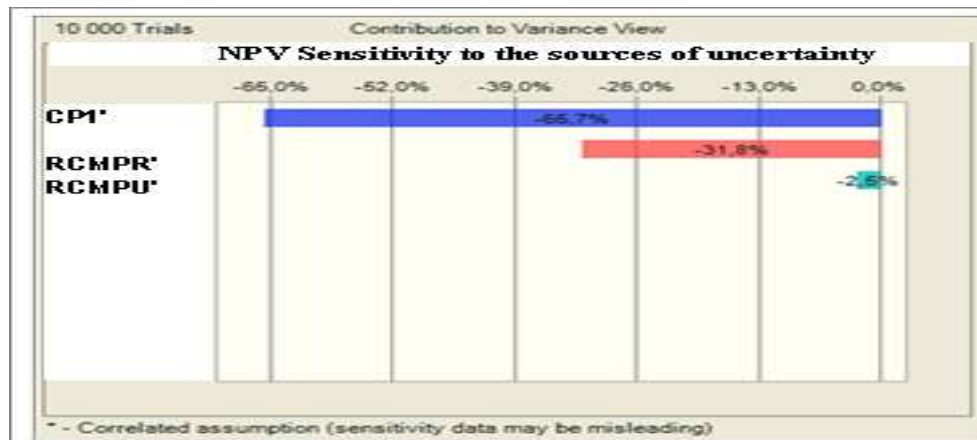

Figure 12. Analysis of the NPV sensitivity to the sources of uncertainty in the case of a deferred acquisition

The NPV is extremely sensitive to variations of the first earn out defined when postponing the acquisition as well as to turnovers from private markets. These two variables explain 65, 7% and 31, 8% respectively of the NPV variance.

Analysis of the Obtained Result from the Calculation of the Average And Simulated NPV

According to the criteria of the average NPV, we can conclude that the scenarios of immediate and deferred acquisition of the target company are unprofitable. The acquisition project should never be undertaken as it is considered to be a value-destroyer for the acquirer. Having completed the calculation of the average NPV by the Monte Carlo simulations helped to better define the risk of the project. However, these tools give a misleading picture of the profitability and the risk profile of the acquisition project because they include unrealistic configurations. If, for example, the acquirer postpones the target company acquisition date, and notices during or after this period that the acquisition is not profitable, then he will abandon this project. This possibility is not included in the calculation of the NPV. Consequently, the criterion of the NPV has several limitations. It does not include the value associated with active management of the acquisition project. It assumes that the manager has no influence on the project's progress like to postpone or abandon it in case of the event of adverse economic conditions.

Moreover, the average NPV assumes that the discount rate is unique and constant. Actually, companies require either a largely positive NPV to invest, or they calculate the NPV applying a discount rate higher than the theoretical rate (Porter, 1992). In most cases, companies adopt the rate used by the companies operating in the same sector of activity, despite the significant differences in their cost structures and the level of risk they are exposed to. This practice can significantly influence the NPV because the wealth created by an investment is extremely sensitive to the discount rate. Lastly, investing in an acquisition is usually achieved in an uncertain context. It is essentially characterized by the presence of sunk costs that are not taken into account by the criterion of the average or simulated NPV.

These various findings lead us to propose the real options approach as an alternative to assessing the corporate acquisitions projects and the choice of their implementation time. To circumvent the problem of determining the discount rate, the acquirer may make the assumption of no arbitrage opportunities and apply the risk-free interest rate. This solution is possible with the use of the optional approach.

The real options approach is likely to make improvements by providing a dynamic management of the target company acquiring process, when the acquirer has the opportunity to react in real time with regards to changing economic conditions, by choosing to intensifying actions and selecting an opportune time. This particularly involves making the most of the ability to adapt, pursue, abandon or postpone the acquisition project of the target company as uncertainty is gradually resolved over time with the arrival of new information. However, we wonder if the total value of the acquisition project is equal to the increased NPV of the value of options, or if the total value of the project is equal to that of the options. When the project has a growth option, its total value is equal to the sum of the NPV and the options value. However, when the investment decision involves the immediate or delayed launch of the project, the project value can then be compared to the value of real options.

In our case study, we focus on the real options considered both in the case of an immediate or deferred acquisition of the target company. The options we calculate therefore replace the NPV values. Thus, we will devote the next section to assessing immediate acquisition opportunities and closing date postponement by the real options methodology.

Real Option Analysis of the Acquisition Decision

In general, real options analysis corresponds to the application of financial options theory to "real" investment decisions made by companies. The holder of a financial call option has the right, but is not obliged, to purchase an underlying asset (V) for a predetermined price (K) (the exercise price) within a given period of time t (American option) or at a fixed future date (T) (European option). If, during that period (or at the date (T) in the case of a European option), the underlying asset price is higher than the exercise price, the option holder can exercise the option. This generates a pay-off which corresponds to the difference between the underlying asset price and the exercise price. If the underlying asset price remains lower than the exercise price, the option holder does not exercise the option, and the received pay-off is zero.

Similarly, an investment opportunity like company acquisition in a highly uncertain context can be analysed as an option. The underlying asset price (V) corresponds to the future cash-flows generated by the project. The exercise price (K) corresponds to the initial cost of investment sunk costs which have to be paid by the acquirer to the target company. If the project is very risky, the company holding a real option can wait until the uncertainty on the value of the cash-flows generated by the project is totally or partially resolved. Subsequently, if it turns out that the project value is higher than the investment sunk costs, the company can exercise the real option and make the investment. In the contrary case, the company abandons the option and does not invest.

Definition of Studied Options

The launch date of the target company acquisition project is determined according to the value opportunities of the immediate target company acquisition and the waiting period for the arrival of new information on the economic situation. In optional terms, the acquirer holds a portfolio of real options. This portfolio consists of an immediate option to acquire the target company and an option to postpone the closing date. These two options are mutually exclusive, because the practice of one involves automatically the abandonment of the other.

The immediate acquisition option gives the acquirer the right, but not the obligation, to proceed with the purchase of the target company, by 30/09/2006, following the terms of the acquisition defined with the seller (basic prices, additional price, calendar). The timing option gives the acquirer the right, not the obligation, to postpone the closing date at the latest by 31/07/2007 in accordance with the deferred acquisition assumptions (basic prices, additional price and calendar).

Characteristics of Options

The acquisition and timing option present the following characteristics:

- Underlying asset: cash flows generated following the transfer of the target company securities to the acquirer;
- Strike price: investment necessary to acquire the target company;
- Remaining time to maturity: 112 days, that is to say 0,311 years for the acquisition option in September 2006.This date corresponds to the period between the receipt of the information memorandum of the target company and the closing date. For the timing option, the remaining time to maturity is estimated at the latest, by 416 days, that to say 1,15years. Beyond this period, the target company acquisition opportunity would have no economic interest.
- Option type: the immediate option of the target company acquisition is a European option. It is hardly realized prematurely because the acquirer benefits from the period of exclusive negotiations with the target company to develop the work of the acquisitions audits. It is therefore unusual to shorten the required period lift the suspensive clauses in favor of a closing faster than the one originally planned in the vesting schedule.

The investment in an acquisition project is a very complex and sophisticated operation for the acquirer. In this respect, it requires a lot of preparation that leads us to estimate that the average frequency to review such a decision, when there is no competitive pressure, is around 12 months. However, the main competitor of the acquirer plans to acquire the same target company in December 2006 if the acquirer waives the project in September 2006. Due to the existence of the competitive threat, the acquirer may be required to use his timing option on the same date defined by his competitor. We consider that the timing option is an American option. It may be, then, exercised prior to the scheduled maturity date.

We evaluate the acquisition and timing options by two different methods:
- The options' analytic evaluation method: the Black and Scholes formula (1973) developed in continuous-time;
- The binomial trees method of Cox, Ross and Rubinstein (1979) developed in discrete-time.

Determining the Value of Parameters

The Underlying Value (V)

The underlying value corresponds to the future cash flows generated by the acquisition project of the target company in 10 years period. In the case of an immediate acquisition scenario, it corresponds to the difference between future cash flows generated by the acquisition project and that would be generated if the project was not realized. In the case of a deferred acquisition scenario, we take into account the additional cash flows compared to those of an immediate closing.

The Strike Price Value (K)

The strike price of the target company immediate acquisition option corresponds to the investment required to purchase its securities. The strike price of the timing option corresponds to the investment required to postpone the closing date to July 2007.

The investment costs to acquire the target company can be classified into two categories: some are fixed like the basic prices of a deferred acquisition, while others are variable as is the case for the immediate acquisition basic price. The latter depends on the level of cash flow recorded until 30/08/2006. Earn outs are also a variable component of the strike price. They are adjusted according to the evolution of operating results and net results at the end of 2006 and 2007. This is a key issue in determining the strike price.

The Black and Scholes model was developed to enhance the value of an option whose strike price is assumed to be constant, regardless of the price of the underlying at the time the option is exercised. This implies that only fixed investment costs should be included in the strike price. Variables investment costs are reduced by the value of the underlying.

Regarding the timing option, we do not consider investment in the acquisition project itself, but rather the additional investment required for the postponement of the closing date. The deterministic component of the strike price of the timing option is the difference between the basic price of the immediate acquisition scenario and the basic price of the deferred acquisition scenario. The variable component is created from the differences between the one supplement price provided in the event of a postponement of the closing date and the earn outs generated in the case of an immediate purchase of the target company.

The Value of Volatility (σ)

In the case of financial options, volatility is determined either from the course of the underlying asset (the historical volatility), or from the price of derivatives. In the latter case, we are talking about implied volatility. As regards the real options theory, the classic approach of Amram and Kulatilaka (1999) stipulates that we should assimilate that the risk profile of the volatility investment of a listed asset in the financial markets. In our case study, there is no listed asset whose evolution correlates with the target company acquisition project.

To achieve a more accurate estimation of volatility, Copeland and Antikarov (2001) propose an alternative which is to conduct the Monte Carlo simulations on the possible values of the project and subsequently calculate the volatility observed for all draws made at random. This method of calculating volatility is not possible when the underlying takes negative values. However, in the case of our example, the majority of the cash flows obtained are negative. So, the Monte Carlo simulations do not allow us to determine the value of volatility. We therefore choose to conduct sensitivity analysis of option values at different levels of volatility ranging between 10% and 50%. This approach allows us to highlight the change in the option value when the risk increases.

The Discount Rate (r_f)

In the case of financial options, the market is said to be "complete". It is thus possible to construct a riskless portfolio, composed, on the one hand, of the option and on the other hand, on the underlying asset purchased forward. According to Trigeorgis (1996), the discount rate used in the sphere of real investment must be between the weighted average cost of capital and the risk-free rate, without giving any explanation on the methodology for its calculation. In the real options theory, the underlying asset is not listed on financial markets. The market is said to be "incomplete". The assessment of real options could be done in a «risk-neutral» world which allows us to use the risk-free rate (r_f) as the discount rate, while assuming no arbitrage opportunity exists. The cash flows from the studied options are updated at a risk-free interest rate. It corresponds to the emission rate of the state bonds with long term maturity. For this purpose, we use the fungible treasury bonds with maturities of 10 years.

Evaluation of the Acquisition Option Using the Black And Scholes Model

The Black and Scholes model (1973) is the best-known model in the assessment of options in continuous time. It is designed primarily to assess the European options in the absence of dividend to the underlying asset. This model is widely preferred and adopted by researchers given the simplicity of its assumptions and the clarity of its concepts.

The following notations are the basic variables used in this model:

V: price of the underlying asset; C: price of a European call option; K: strike price of the option; r_f: risk free interest rate; σ : volatility of the underlying asset; T: the maturity date of the option; N ( ): the standard normal distribution.

The value of a call option on the maturity date is stated as follows:
$$C = V\,N\,(d1) - K\,e^{-rf\,T}\,N\,(d2)$$

With
$$d1 = \frac{\ln\left(\frac{V}{K}\right) + \left(rf + \frac{1}{2}\sigma^2\right)T}{\sigma\sqrt{T}}$$

And
$$d2 = d1 - \sigma\sqrt{T}$$

The price of a call option corresponds to a probable support value, deducted from the discounted value of the option strike price and weighted by the probability of paying that price at that date. The term (d1) corresponds to the probability than the maturity date the underlying price exceeds the strike price. The term (d2) is the probability that an ongoing put option expires.

The results of the assessment of the target company immediate acquisition are shown in the following table.

Table8. The acquisition option parameters

Element	Value (in Euros)
Uderlying asset	871 242
Exercice price	950 000
Risk free rate	3%
Duration (years)	0, 311

Table9. Evaluation of the acquisition option by the Black and Scholes model

Element	Volatility				
	10%	20%	30%	40%	50%
Acquisition option value (in Euros)	1 914,53	14 607,66	31 749,08	50 261,31	69 141,9

In the immediate target company acquisition scenario, the NPV is negative (-28 758 Euros) while the value of the acquisition option is strictly positive (table 9). This indicates that the project deserves to be retained. It is important to note that, the acquisition option value increases significantly when volatility increases, reaching values of 69 313, 96 Euros for a volatility of 50%.

The Black and Scholes model allows us to calculate only the European option. But the timing option is an American option. To assess the American option by the Black and Scholes model, we should use Black's approximation. This technique was also used by Benaroche and Kaufman (1999, 2000), Iatropoulos, Economides and Angelou (2004). In this article, we use the binomial model, which is more adapted to American options.

Evaluation of the Timing Option Using The Binomial Model

The binomial model is developed by Cox, Ross and Rubinstein (1979). It involves forming a binomial tree to calculate the values of the underlying asset and the option at any point in the tree. We then calculate the options for a number of steps equal to 10.

The underlying asset is described by a Geometric Brownian Motion (GBM) because the larger the steps number, the more discrete distribution tends towards a continuous distribution. One of the fundamental contributions of option theory is to calculate the amount of premium that must be the same whatever the risk the investor is exposed to. In the world of real investment, investors have different attitudes towards risk. It is in this context that Cox, Ross and Rubinstein proposed an evaluation method « risk-neutral ». Under this method, the value of a replicating portfolio and the value of the generated options are assumed to be independent from the degree of risk aversion. They assume that the coverage of the underlying asset (formed from the combination of options and a replicating portfolio) reported a risk free interest rate that will remain constant whatever the risk aversion. The probability distribution used is the binomial. The binomial process will be represented by a binomial decision tree. The option pricing models developed in discrete time are based on the principle of dynamic programming which consists of the following three steps:

- The tree creation;
- Calculate the option value at the end node of the tree;
- Progressive calculation of the option value from the previous node, the value of the first node is the value of the option.

The creation of the binomial tree of the option price is made starting from the date on which we want to value the option until its expiration date. At each decision node, we assume that the underlying asset can increase (up) or decrease (down) based on a specific factor (u) or (d). (u $\geq$ 1 and 0 < d < 1). Therefore, if (V) is the current price of the underlying, the price of the next period is given by:

Or

$$V_{up} = V.\, u$$

$$V_{down} = V.\, d$$

The factors used to determine the increase or decrease of the underlying value is calculated by taking into account the volatility of the underlying (σ) and the duration of each step measured in years (t). Thus,

And

$$u = e^{\sigma \sqrt{t}}$$

$$d = e^{-\sigma \sqrt{t}} = \frac{1}{u}$$

The price of options is weighted by its achieving probability. So (p) is the probability of the underlying value to increase, and (1-p) the probability of the value to decrease. The option value must be updated by the risk-free rate (rf), reduced from the underlying dividend yield (q) over the life of the option.

$$p = \frac{e^{(rf - q)\, t} - d}{u - d}$$

In our case study q = 0.

In a second step, we determine the option value. To do this, the investor is, as a first step, at the option maturity stage to calculate the pay-off for the different possible values of the underlying asset. Every last node of a branch of the probability tree, the option's value is its intrinsic value is given by the following expressions:

Max [(V − K), 0].

After calculating the option value at the last node of the binomial tree, the investor goes back in time and calculates the optimal strategy at each decision node. He then obtains the option value at t_0. The expected value option obtained at each decision node is given by the following formula:

Expected option value = [p × Option up + (1-p) × Option down] × e⁻ʳᶠᵗ

Expected option value = $[p \times \text{Option up} + (1-p) \times \text{Option down}] \times e^{-rft}$

The results of the assessment of the target company deferred acquisition are shown in the following table.

Table10. Timing option parameters

Element	Value (in Euros
Underlying asset	290 972,63
Exercise price	175 805
Risk free rate	3%
Duration (years)	1,15

We are again faced with the challenge of the volatility estimation. We will therefore conduct sensitivity analyses of volatility.

Assumptions

PV Asset Value ($)	290972.63
Implementation Cost ($)	175805
Maturity (Years)	1,15
Risk-free Rate (%)	3,00%

Intermediate Computations

Stepping Time (dt)	0,0230
Up Step Size (up)	1,0153
Down Step Size (down)	0,9849
Risk-neutral Probability	0,5190

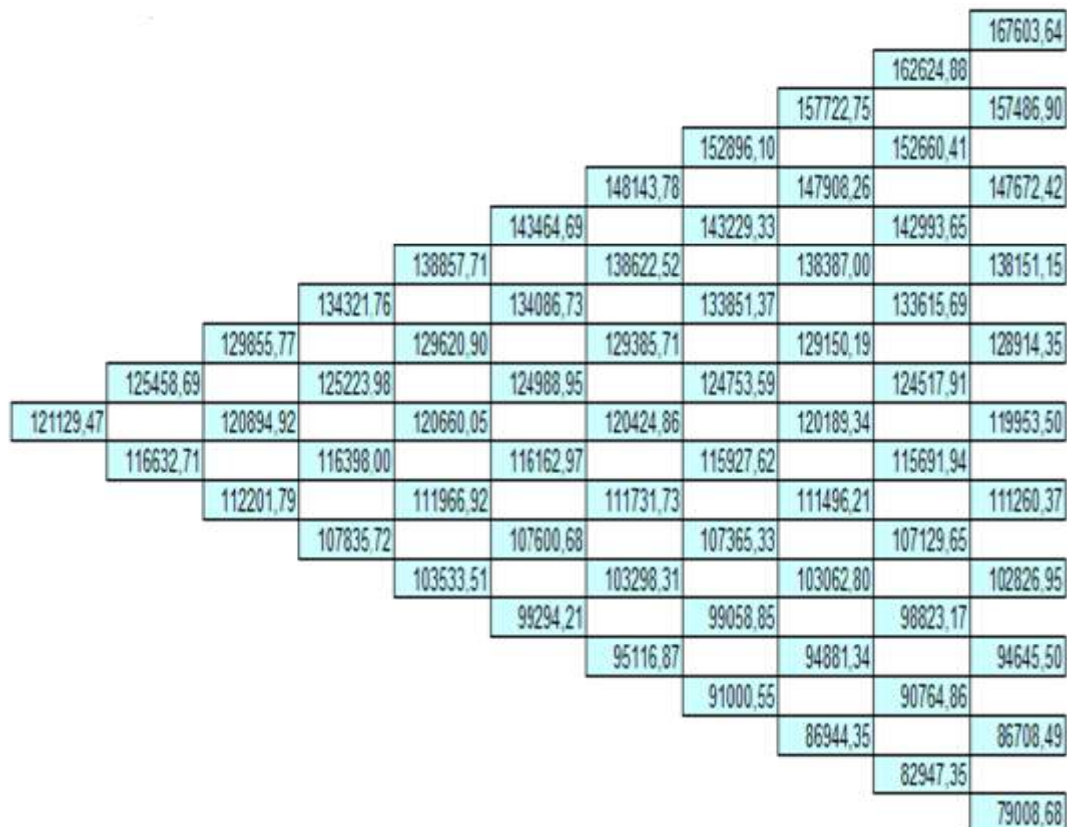Figure 12. Calculation of the timing option value with the binomial model

Figure13. Timing option valuation lattice when $\sigma = 10\%$
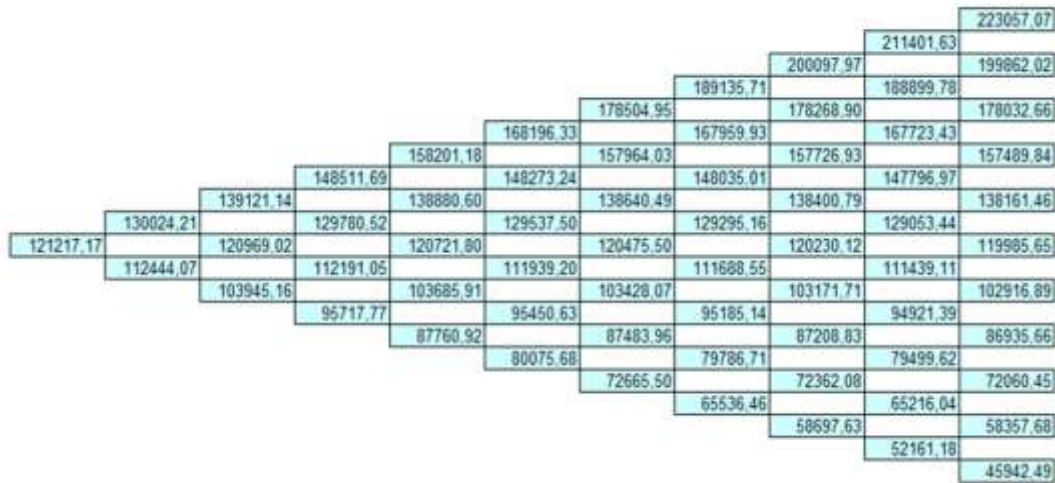
Figure 14. Timing option valuation lattice when $\sigma = 20\%$
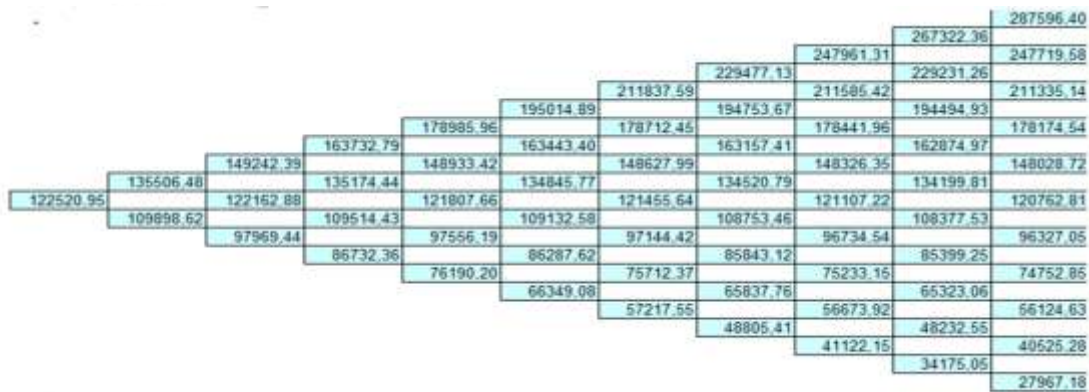

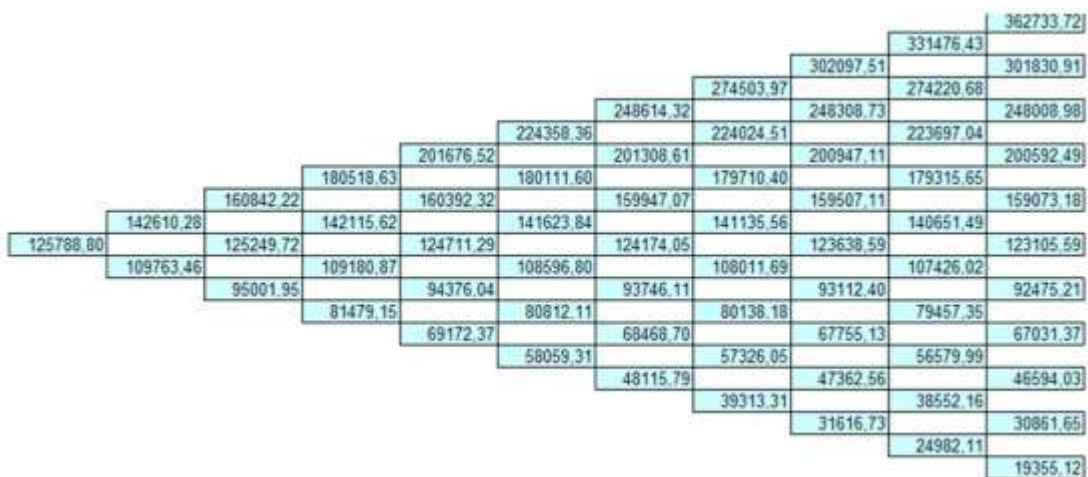Figure 15. Timing option valuation lattice when $\sigma = 30\%$

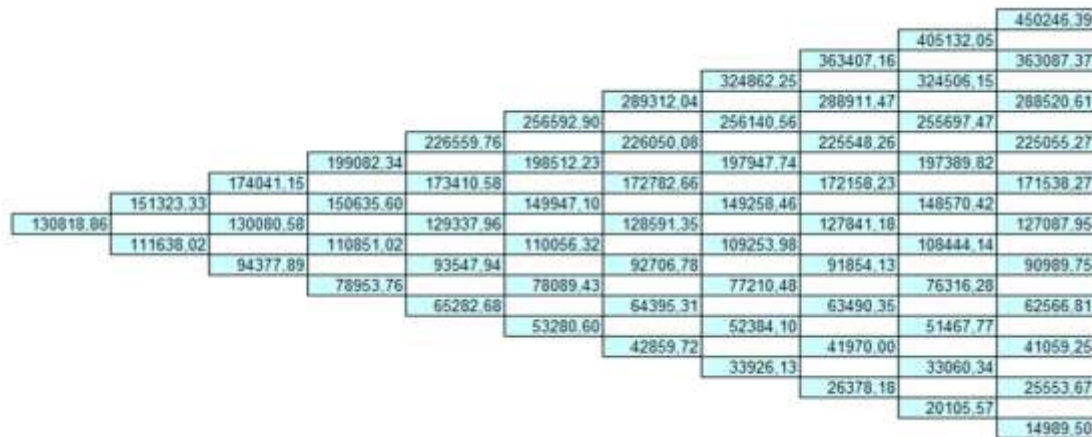Figure 16. Timing option valuation lattice when $\sigma = 40\%$

Figure 17. Timing option valuation lattice when $\sigma = 50\%$

Table11.Evaluation of the timing option by the binomial model

Element	Volatility				
	10%	**20%**	**30%**	**40%**	*50%*
Timing option value (in Euros)	121 129,47	121 217,17	122 520,95	125 788,8	130 818,86

When evaluated by the binomial model, the timing option value is equal to 121 129, 47 Euros with 10% volatility and 130 818, 86 Euros with 50% volatility. Faced with the choice between launch and abandonment of the acquisition project studied by the NPV, real option method introduces an additional alternative: the postponement of decision of the target company acquisition.

In this case study, the delay has a value which is that of the timing option. Indeed, the acquirer has the opportunity to collect information that will allow him not to purchase the target company unless the market conditions are favorable.

Benefits of Using Real Options in the Evaluation and Acquisition Timing

A Better Evaluation of the Target Acquisition Project

Conventional decision support tools such as NPV presented two main drawbacks. On the one hand, they include unrealistic configurations, which can lead the acquirer, in an automatic way, to give up an acquisition project with a negative NPV. On the other hand, they do not allow us to compare the benefits and risks related to the deferral of the acquisition.

The Real options have solved both problems and provided relevant recommendations on the evaluation and the optimal timing of acquisition. The acquirer has the opportunity to purchase the target or to postpone the investment by one year, and thus holds a European acquisition option and an American option to defer the acquisition.

In the immediate target company acquisition scenario, our results show a strictly positive value of an acquisition opportunity by the real options method, whereas the same opportunity had a negative value according to the NPV criterion. Indeed, the optional approach is particularly interesting when the acquisition opportunity is considered unprofitable. This is explained by the fact that uncertainty is a source of value creation in the optional approach.

The more the target acquisition opportunity is considered risky, the more it acquires value. This indicates that the project deserves to be retained. The value creation of the target company acquisition project is enhanced when volatility increases. Consequently, real option approach builds for a positive perception of the uncertainty.

A Better Understanding of the Optimal Acquisition Date

In the choice of timing, the real options approach helps explain why, even if the NPV is negative, it is not necessarily appropriate to abandon the project immediately. The NPV classic criterion does not take into account the fact that it is possible to postpone the acquisition decision. The timing option value gets increasingly important, with the postponement of closing date.

Obtaining a strictly positive timing option value, shows that delaying the purchasing decision is more appropriate than the immediate abandonment. Faced with static and binary decision to launch or not the project, real options approach introduces an additional alternative: the postponement of the target purchase. It covers generally the possibility to delay the closing date whilst waiting for the improvement of the target company conditions or the overall economic situation.

Table12. The contributions of real options in the evaluation and the acquisition timing

Acquisition decision	-Undertake the acquisition project immediately when the acquisition option value is higher than the timing option value
	-Postpone the acquisition decision when the timing option value is higher than the acquisition option value
Relevance of the decision tool	-More relevant recommendation compared to the NPV on the acquisition project value: the value increases when the volatility increases
	-Establishment of a clear link between the value of the target acquisition and the level of uncertainty
	-More relevant recommendation compared to the NPV on the optimal timing of investment: introduction of the postponement of the closing date scenario

Conclusion

This article shows that real options can lead to a more appropriate investment's valuation and optimal timing than the NPV approach. Our case study illustrates the benefits of using real options to determine a value and the optimal investment timing for a corporate acquisition project with uncertain conditions and limited competition.

It basically answers the following three questions:

-What are the limits of the average and simulated NPV approach in terms of evaluation of the target and its determination timing of acquisition?

- How to assess the opportunities of a target acquisition and the choice of optimal timing by the real options method?

- What are the contributions of managing acquisition projects by real option approach?

Before talking about real options, the first contribution of this paper is the detailed analysis of the sources of uncertainty affecting the value of the target company acquisition project. The simultaneous variation of

sources of uncertainty in the context of 10,000 random samples allowed us to get a lot of scenarios of the changes in the NPV. With a more detailed analysis of uncertainty by the Monte Carlo simulations, the NPV calculation was made non-deterministic.

Moreover, this article explored the benefits of the real options approach for the acquisition decision. It showed that, in the context of uncertainty, real options can provide a more appropriate project valuation compared to the conventional NPV calculation. This stems from the fact that real options take into account the value of managerial flexibility. In this case, management has the possibility to defer the project in one year time, should the economic situation become unfavourable. Because they incorporate the value of waiting into the analysis, real options can provide a more sensible recommendation on investment timing than the NPV approach.

Whereas the real options literature still relies significantly on theoretical contributions, this article offers insights in using an actual case study. The main contributions of this article are two fold. For practitioners, this article provides a detailed application of real options analysis and valuation on real corporate acquisition data. In particular, we present two models to the valuation of acquisition and timing options: the continuous time model of Black and Scholes to evaluate the European acquisition option and the binomial model to evaluate the American timing option.

This research also expands the traditional scope of analysis covered by the real options literature. Most articles concentrate on the role of real options as a pure valuation tool. This case study shows that real options can help establish a roll-out plan that will be regularly updated, and guide the acquirer along the entire project's life-time.

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