REAL OPTION METHODOLOGY FOR THE EVALUATION OF IT PROJECTS

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ABSTRACT

Current project valuation framework under the Net Present Value (NPV) method has been proved to be incomplete, as it fails to accurately account for uncertainty. Traditional financial tools fail because they neglect to account for the value of flexibility. The standard NPV approach assumes that project risks remain constant over the life of the strategy. It, also, fails to factor in the full range of opportunities that a new and innovative strategy may create for a firm in the future. We show how one can use Real Option methodology in order to determine optimal financial path to fund new technology deployment within a risky environment. Moreover, in this paper we demonstrate, with the use of a simple numerical example, how the Real Options methodology can be implemented within an IT project deployment.

Keywords: Real options, Discounted Cash Flow, flexibility, risk management, investment evaluation

1. INTRODUCTION

Over the past twenty years, many papers have been published documenting the use of Option pricing to value different types of claims on real assets. Lander and Pinches (1998) make an attempt at providing a summary categorisation of the main papers by grouping them according to the topic or area they developed the real option theory for. While the theory started to be applied to the natural resources industries, they show that the areas now covered include mergers and acquisitions, real estate, manufacturing and even law and advertising, amongst others. Although the areas of application never cease to grow, the *types* of real options that have been modelled are now pretty much recognized and listed as in the following section.

1.1 Main Types of Real Options

The main types of Real Options, as cited in the bibliography (Bhagar, 1999) are the following: Option to defer, Option to abandon, Option to switch inputs, outputs, or risky assets:, Options to alter the operating scale, Growth options, Staged investment options, Option to switch inputs, outputs, or risky assets, Staged investment options

1.2 Practical implementation difficulties

Many authors stress the benefits, when using Option pricing, of not having to use risk-adjusted discount rates and utility functions. However, we need to recognise new difficulties that emerge from the necessary relaxing of standard financial option assumptions, in particular the assumption of *complete markets*. The two main implementation problems are as follows.

1.2.1 Modelling the state variables

The largest potential stumbling block for real options lies in the fact that the underlying asset is rarely a *traded* asset and that it is not always clear what its stochastic process is. This means that our concept of a continuous risk-neutral hedge to value our option collapses. Rubinstein (1976), however, shows that option-pricing formulas can still be derived under risk aversion, but that we still require as input the current value of the underlying asset. The literature copes with this by assuming that it is possible to *span* the asset by finding a twin-security or a dynamic portfolio that has identical risk characteristics as the underlying. Mason and Merton (1985) point out that this is the same assumption as for the DCF approach of finding the discount rate by finding a twin security with an identical risk profile and finding its rate of return using the CAPM. Moreover, assuming a twin-asset is found, there may be a "rate-of-return shortfall" (McDonald and Siegel 1985, Trigeorgis 1996 and Brennan and Schwartz 1985) that necessitates a dividend like adjustment. In general though and for all attempts to mask the fact, "*when the value of the underlying asset cannot be estimated accurately, there may be insufficient market information for a credible options analysis*" (Teisberg, 1985).

1.2.2 Non-exclusivity and non-instantaneous exercise of real options

For a financial option, the property rights and the contract are clear: the owner has an exclusive right to exercise the option according to an agreed payoff function at a particular point in time. For an option on a real asset though, this is clearly not the case. The option may be *shared* between several companies, there may not be a *specific period* over which the firm has rights to the project and exercising a real option may take a long period of time. The non-exclusivity problem can be solved in the aptly named "option-games" theory, where option pricing and game-theory are combined. The theory is complicated, but does show that the effects of competitive behaviour can be modelled (chap. 9, Trigeorgis 1996, Kulatilaka 1997 and Dixit and Pindyck 1994). A solution to deal with the non-instantaneous exercise problem is to model the cash flows during the exercise period as flows of dividends. The uncertainty surrounding these problems does nevertheless deal a blow to real option pricing methods.

2. Definition of high-tech (IT) companies and projects

Our analysis is limited to high-tech companies, which are companies that are using and investing in *new technology* as the basis of the

operations. The reasoning is that it includes the obvious "new economy" type of companies, such as Internet firms, but also certain firms in telecommunications, media, power, biotechnology, pharmaceuticals and petrochemical industries. The common characteristic we are aiming to catch is that of high uncertainty and potentially huge growth: characteristics that could justify the application of real option pricing.
The emphasis will, however, lie on valuing Internet, telecommunication and Biotechnology firms. Not only do they have desired characteristics in terms of uncertainty (being at the frontiers of discovery) and managerial flexibility (generally young and flat management structures with venture capitalists encouraging "uncommon" business plans) but also it is almost impossible to value them conventionally. Furthermore, from our presumption that:

Firm value =Value of assets in place + Value of growth options

we can assume that the value of young high-tech companies will consist principally of growth options (see Kester (1984), Pindyck (1988), which, when exercised, create new assets in place as well as new options. Assuming these assets in place disburse revenue, the thinking is consistent with "hockey-stick" revenue profiles for high-growth companies over time. The second inflextion point can thus be interpreted as when the company has exhausted its most valuable growth options and settles down to an "old economy" growth profile.

3. A specific case: the development of ADSL technology

During the last years, a significant broadband demand has been generated in Western Europe. The growth was very high during 2005: forecasts show that the expected broadband penetration in the residential market will be 20–25 % in year 2005 (Stordahl (2004), Stordahl et al. (2003), Stordahl et al. (2002a)). The most relevant broadband technologies are Digital Subscriber Line (DSL), Hybrid Fibber Coax (HFC), Fibber-To-The-Home (FTTH), Fixed Wireless Access (FWA), Wireless Local Area Network (WLAN), multiple ISDN lines, Digital Terrestrial Television (DTT) and also satellite solutions to cover the rest market.
The European Commission has recommended a market driven and technology neutral broadband evolution. The incumbent operators face competition from the Local Loop Unbundling (LLU) operators, the cable operators and to some extent operators using fixed wireless access and fibre-to-the-home solutions (Stordahl et al. (2002d), Stordahl et al. (2001)). The incumbent operators have started to rollout Asymmetric Digital Subscriber Line (ADSL). The second step is to use enhanced technologies like ADSL2+ and Voice DSL (VDSL) with the potential of a much broader spectrum of services.
A very important issue that high tech companies (including Telecommunication companies) involved in financing risky projects deal is the designation of the strategic premium--the gap between the apparent economic value and the actual value of an investment project, as determined by the marketplace. To this direction, we are going to investigate a powerful new risk-management tool that's rapidly gaining favour with financial evaluation of IT projects:

the Real Options methodology. In particular, we are going to incorporate and demonstrate the use of this methodology into the evaluation of an investment example in Broadband Technology.

4. BROADBAND TECHNOLOGY IN THE E.U.

The broadband forecasts for the different technologies are modelled by starting to develop broadband penetration forecasts for the total broadband demand in the Western European residential market. Several surveys show that the aggregated long-term demand for many Information and Telecommunication Services, ICT, has a diffusion pattern.
A four parameter Logistic model has been applied for forecasting long-term broadband penetration from the Western European market, which is also documented by Stordahl (2004).
The broadband technologies, as mentioned above, are segmented in four main groups: ADSL, ADSL2+/VDSL, Cable modem (HFC) and other technologies, such as: Fixed Wireless Broadband Access (FWA) systems, Fibre-to-the-home and Fibre-to-the-building systems, Power line systems, Direct-to-the-home satellite with return channel and Digital terrestrial television systems. Predictions of the growth of market share between different broadband technologies have been developed based on different Logistic forecasting models.

4.1 Broadband technology Penetration Overview

According to data provided by the OECD, Belgium, the Netherlands, and Switzerland lead European countries in overall broadband penetration. Belgium boasts 37.4% broadband penetration among all households, with the Netherlands close behind at 37.2% penetration, and Switzerland at 36% penetration. Greece, Ireland, and Germany trail all European countries in broadband penetration. The average broadband penetration among all households in Europe is 20.6%. Note that if these figures follow the same pattern as in the U.S., broadband penetration among active users in Europe would approach 65 to 70% in the top three countries.

5. REAL OPTIONS METHODOLOGY

The use of Real Options to evaluate (IT) projects derives from a central principle: *every plan is an option*. Every project remains an option, as long as management has the freedom to accelerate, cancel, defer, or expand it. And this freedom has value that can be analyzed quantitatively. That may sound like a simple idea, but its implications are considerable because the marketplace values options differently than real assets (Trigeorgis (1996)).
The decision to invest (in general) in an IT (specifically) project, with a highly uncertain outcome, is conditional on revisiting the decision sometime in the future. This is similar in its implications to *buying a financial call option*.
A financial Call Option permits *(but not obliges)* the owner to purchase stock at a specified price *(exercise price)* upon the expiration date of the option. Accordingly, an initial IT investment will permit *(but not oblige)* the investor to commit to a particular technological area – that is, buy the entitlement of the

future stream of profits – upon the predetermined date for revisiting the initial investment decision. The analogy between the IT (and specifically, *broadband investment*) project and the stock option can be summarized as follows:

• The cost of the initial project is analogous to the price of a financial call option.

• The cost of the follow-up investment needed to capitalize on the results of the initial IT project is analogous to the exercise price of a financial call option.

• The stream of returns to this follow-up investment is analogous to the value of the underlying stock for a financial call option.

• The downside risk of the initial investment is that the invested resources will be lost if, for whatever reason, the follow-up investment is not made. This is analogous to the downside risk of a financial call option.

• Increased uncertainty decreases the value of an investment for risk averse investors. In contrast, and in combination to with the possibility of higher returns, increased uncertainty (volatility) increases the value of an initial project if it is considered an option to a potentially very valuable technology.

• A longer time framework decreases the present discounted value of an investment. In contrast, the value of an initial project may well increase with time if considered an option to longer-term, high-opportunity investments. It has, thus, been argued that when an investor commits to an irreversible investment the investor essentially exercises his call option. In other words, the investor «*…gives up the possibility of waiting for new information to arrive that might affect the desirability or timing of the expenditure; [the investor] cannot disinvest should market conditions change adversely*» (Dixit and Pindyck (1994), p.6).

On the other hand, for most investments there exists some abandonment value in terms of a salvage value or the opportunity to simply shut down should the project become unprofitable. Thus, in each investment there is an inherent value in the ability to stop investment or redirect resources to another project. Real investment opportunities, then, usually involve multiple options whose individual values most often will interact and should be valued together (Trigeorgis (1996)).

6. NPV, EXTENDED NPV AND REAL OPTIONS

The criticism of conventional NPV, pointing at the difficulties of this project appraisal method to account for the 'true' value of uncertain investment projects, is usually well taken. First of all, one of the major flaws of the NPV method is the assumed discount rate (Brealey and Myers (2000)).

Criticisers of NPV often assume that managers will use the same discount rate for all cash flows. While this is often the case, it is not out of necessity. One of the major benefits of NPV (as opposed to the Internal Rate of Return – IRR -) is that it is simply a summation of the cash flows (CF) of different time periods (1, 2, …,n) allowing the use of a different discount rate (r) for each cash flow (net benefit).

In addition, it is argued that the NPV approach does not really eliminate the case for project delay as it is frequently accused of doing. A positive NPV does not necessarily mean that a project

should be best undertaken immediately; it may be even more valuable if undertaken in the future. Similarly, a project with a currently negative NPV might be come a profitable opportunity if we postpone it for a while. Taking into account the option to delay is accomplished by evaluating the project at each alternative investment date (option) and choosing the one with the highest NPV (Brealey and Myers (2000)). Likewise a project may have a negative NPV because of excess maintenance or capacity in later time periods, which can be abandoned resulting in a possible altered positive NPV project. Each abandonment option scenario is evaluated, and the one with the highest NPV is chosen.
The value of the Option, on the other hand, is inherently tied to its degree of associated risk, which is approximated by the volatility of the underlying asset (investment). For an IT (i.e. telecommunication) project, risk can be divided into three categories: *(a) technological risk*, *(b) market risk* and *(c) risk due to exogenous events*. Since it is unlikely that adequate historical risk data exists for the project, it is necessary to once again use a *'twin' portfolio* to derive this value. If a traded 'twin' cannot be established – which is often the case with IT projects as mentioned above – it will be necessary to choose a risk premium associated with the project from such models as the Weighted Average Cost of Capital (WACC) of the firm associated with the project and is made up of two parts, the risk free rate that accounts for the time value of money, and the risk premium which accounts for the riskiness of the project.
As mentioned by Trigeorgis (1996), the *expanded NPV* (noted as *NPV**) will be the sum of the conventional, static NPV and the option "premium", consisting on the flexibility value and the strategic value:

Expanded NPV* = NPV + Σ (value of flexibility options) + Σ (value of ''strategic'' options)

The key assumptions of the Real Options methodology are the same that apply at the Black-Scholes (1973) model of option pricing.
Although the Black-Scholes model has its own vulnerabilities, it seizes the ''flexibility'' of an investment, that we have already discussed, and it is most often associated with valuing options on financial securities, it has been adapted to valuing call options on non-financial assets.
The precise functional form of the model appears below, along with an overview of the variables in the model (analogous IT variables are shown in parentheses):

- Stock price (present value of cash flows from investment, V_T)
- Exercise price (extent of follow-on investment in IT, **X**)
- Time to expiration (length of time that decision can be deferred, **T**)
- Risk-free rate of return (yield on government bond, r_f)
- Volatility (variance and standard deviation of cash flows, **σ**)

The Black-Scholes formula for computing option value (C) is defined as:

$$C = V_T N(d_1) - Xe^{-r_f T} N(d_2)$$

Where: $d_1 = \left[\ln(V/X) + \left(r_f + \sigma^2/2\right)T\right] / \sigma\sqrt{T}$

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

N(.) = probabilities from the cumulative normal distribution

$V_T - X$ indicates the call option's terminal value

$V_T - Xe^{-r_f T}$ indicates the call option's current value

Having a Real Option means having the possibility for a certain period to either choose for or against something, without binding oneself up-front. Real Options are valuable because they incorporate *flexibility*. Real option evaluation accounts for the value of flexibility embedded within projects as illustrated in Figure 1 (see Appendix).

7. Critiques and Issues on Real Options Theory

Increasingly, real options theory has been proposed as a major means of managing investment uncertainty. Recent empirical findings by Busby and Pitts (1997) and Graham and Harvey (2001) also report growing attention and use in practical investment decisions. However, there are concerns about applicability from financial options theory to real options valuation. For example, the classic Black and Scholes formula assumes that the underlying asset is traded in order to construct a hedged riskless portfolio with a long position in the asset and a short in the option. By applying the no-arbitrage condition, the risk-neutral valuation is utilized to derive the value of the option. In practice, the real assets do not quite fit with the original assumptions, thus causing major critiques on the real options theory. In the section, we will start with the comparison between financial options and real options, discuss the pitfalls of the real options analysis and how to avoid them, and finally address some issues related to real options.

7.1 Comparison between Financial Options and Real Options

Generally, most option pricing models use six different input variables: the underlying stock, the exercise price, volatility of the stock, the time to maturity, the risk-free interest rate, and the stock dividends. When we apply the option approach to real asset valuation, the nature of the six input variables must be changed in order to make use of the analogy.

Analyzing the real option problem is no easy task. Perlitz, Peske, and Schrank (1999) propose a structured model to analyze the input variables for real option valuation. In order to structure the real options problem, the model suggests to begin with identifying the type of embedded options, and then determining the nature of the input variables. Major critiques on real options theory arise from violation of the variable assumptions and determination of the variables.

7.2 Critiques on Real Options

As mentioned earlier, one of the important assumptions in the Black and Scholes model is the tradability of the underlying asset, which allows for the use of the risk-neutral valuation in financial markets. With real options however, most of the underlying assets in investment projects are not traded in the market so that it is not feasible to form the replicating portfolio needed to validate the arbitrage-free analysis. In some cases the underlying asset does not exist or even though it does, it may not be liquid enough to sell the real asset short (Sick, 1995).

Throughout the literature on capital budgeting, remedy for violation of tradability is to assume the existence of complete markets. Complete market means that we can always replicate the payoff of the focus asset from a perfectly correlated single asset or an equivalent portfolio of marketed securities. With the complete market assumption, we are able to hedge away all the risks by dynamically trading securities. The replicating approach is greatly facilitated by the early literature in Cox and Ross (1979) to value financial options with alternative stochastic processes. Mason and Merton (1985) further suggest the complete market assumption be applied to real asset valuation. A good example is in Majd and Pindyck (1987), who value the timing option under the complete market assumption. They point out that the complete markets allow us to calculate the fair value that would prevail should such assets were traded.

One way to deal with the unavailability of the twin asset is suggested by Copeland (see Copeland, Koller, and Murrin, 2000, pp. 406-407; Copeland and Antikarov, 2001, pp. 94-95) with the use of the Marketed Asset Disclaimer (MAD) assumption.

Another difficulty associated with the underlying asset is the assumption of the geometric Brownian motion, which allows the variance of the underlying asset increasing over time. The geometric Brownian motion may be realistic for speculative asset prices like stock or financial futures but not for all the asset prices. Dixit and Pindyck (1994, pp.74-79) state that while in the short run the oil price tends to fluctuate randomly up and down, in the long run it ought to draw back to a certain level. In the situation like this, the mean-reverting process (or known as the Ornstein-Uhlenbeck process) may be more appropriate. Thus, it is very crucial to figure out the proper stochastic process in the real options valuation.

The third difficulty resulting form the underlying asset is the measurement of the underlying volatility. Since the option value is very sensitive to the volatility of the underlying asset, misestimated volatility can lead to significant error in option valuation. Perlitz, Peske, and Schrank (1999) discuss five different kinds of volatility: the future, the implicit, the seasonal, the forecast, and the historical volatility. Of course, the future volatility is usually unknown, so we have to use the other four types of volatility as an estimate. If none of the four types of volatility is available, often researchers use the "proxy" variable as an estimate. Another issue regarding volatility rests on the treatment of risk as exogenous or endogenous parameters. As we know that conventional financial option pricing theory treats market uncertainty as an exogenous factor. In the situation of real

investments, it may not be the case since the firms can influence investment uncertainties through active project management.
Normally, the future volatility is unknown but determines the eventual option value. The historical volatility is derived from the historical data. The forecast volatility is provided and published by specialized companies. The implicit volatility can be calculated by using option market prices and certain option pricing models. The seasonal volatility can be found when the underlying asset has seasonal movements.

This issue is to identify different sources of uncertainty and then to handle them individually. For example, in their framework for valuing infrastructure investments, Kulatilaka and Wang (1996) recognize two sources of uncertainty in infrastructure projects: technological risk and market risk. By identifying the two sources of uncertainty and providing different treatments, they show that project value can be increased significantly. Lint and Pennings (1998) and Doctor, Newton, and Pearson (2001) raise the implementation issue on real options. They find that there are clearly common R&D situations where relevant data is unobtainable. Even though the data is somewhat available, they may not be "clean" enough for management easily plugging them into the real options models. For example, the conventional Black and Scholes model is to value Europeans options, which can only be exercised at the expiration date. For staging R&D projects, it is easy to decide the time to maturity. In other cases of investments, management may have difficulties in deciding the type of options – European or American and in deciding when the option will expire.

8. CONCLUSIONS – FURTHER DIRECTIONS

Using conventional NPV calculus can impel to misleading results and a wrong focus, with respect to IT investments. As we showed in this paper, using a hypothetical (but possible) example, a valuable part of future projects might be abandoned completely using a conventional NPV methodology, whereas they would be accepted making use of Real Options methodology. This is an important observation, as the competition between investment projects and funding within large companies is often high. The Real Options analysis recognizes that such contingent decisions would in fact reduce the risk exposure of a firm willing to make an investment in IT projects, while retaining all the upside benefits. Hence, the Real Option based evaluation gives more realistic estimates for investment decision, taking into account all the benefits of managerial flexibility.
Through the last years, Real Options methodology has found wide acceptance in the mining, petroleum, pharmaceutical and, generally, in industries, where volatile and uncertain R&D projects are implemented and evaluated and the need for flexibility is very essential. Real Options models should have a place in the «arsenal» of corporate decision-makers because of the high uncertainty and costs of irreversible investments.

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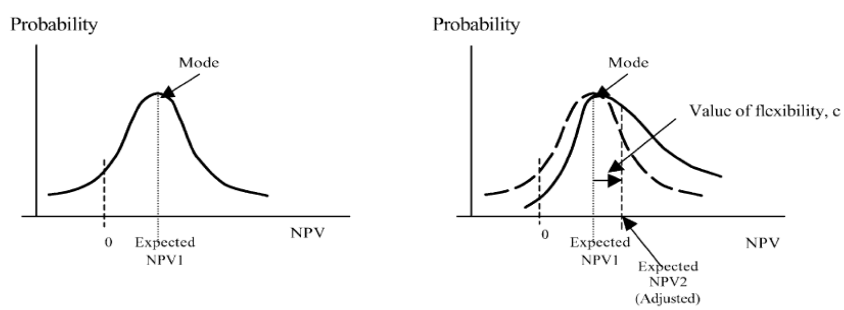
APPENDIX I



(a) Traditional Project Evaluation

(b) Project Evaluation with Flexibility (Asymmetry Distribution)

Figure 1: The probability function with and without flexibility

Table 1: Cash flow analysis for the Investment (values in mil. €)

Cash Flow analysis									
Year	**Revenue**	**Cost**	**Profit**	**Discounting Factor (r=10%)**	**PV**	**I**	**NPV(I1)**	**V1**	**NPV(V1)**
1	8	-7,5	0,5	0,90909	0,45455				
2	8,2	-7,9	0,3	0,82645	0,24793				
3	9	-6,5	2,5	0,75131	1,87829	9	6,76183	11,5	8,64012
				NPV =	**2,58077**				

Table 2: Value of the ''strategic'' option to invest

Finding the Value of a Call Option (i.e. Real Option) Using the Black-Scholes Model

	Financial Option		Real Option
Rf =	Risk-free interest rate	=	Risk-free interest rate
T =	Time until the option expires	=	Time until the investment expires
X =	Exercise price	=	Cost to expand the project (year 3)
P =	Current price of the underlying stock	=	NPV of the follow up investment (year 3)
σ =	St. deviation of the stock's rate of return	=	St. deviation of the project's rate of return

APPENDIX II
INVESTMENTS EMBEDDED WITH OPTIONS: AN EXAMPLE[1]

Given the objections analysed above, a short numerical (hypothetical) example will clarify the differences and the implications of the functionality of the two diverse and different approaches (NPV and Real Options).

Let us assume that a hypothetical Greek telecom company (supposably named TELCOM) decides to penetrate the broadband market in Romania. As a first step, the company considers acquiring an established local telecommunication company, ''Firm Z'', which is willing to transfer its ownership to the Greek buyer. The market valuation put the company at *€ 4,90* million (I^0). Assuming that with no follow-up investment made after acquisition, Firm Z can still generate revenues for 3 years, and the expected cash flow of Z is as shown in Table 1.

After 3 years, TELCOM has the option to make an *additional investment* of € 9 million (I^1), to expand its production line, which might generate more cash flow and profit and lead to a sustainable business with *a market value* of € 11,50 million (V_1).

When calculating NPV, a 10% annual discount rate is used, which is supposed to be the (annual) Weighted Average Cost of Capital for TELCOM (see Table 1, Appendix).

When evaluating the acquisition investment using Discounted Cash Flow (DCF) based calculation and reasoning, we get the value of the Firm Z with second stage expansion option as:

$$NPV(Z) = NPV1 + NPV2 + NPV3 + \frac{8,64 - 6,76}{(1+0,10)^3} = 4,46 \quad \text{(million €)}$$

The Net Value of this acquisition opportunity can be given as:

$$NPV'(Z) = NPV(Z) - I^0 = 4,46 - 4,9 = -€\ 0.44 \text{ million } (<0)$$

According to DCF evaluation criterion, the proposed acquisition of Firm Z is economically not viable since the NPV is negative. The second stage expansion option held by TELCOM with the acquisition of Firm Z is analogous to a real option on the investment value. Hence we can use Black and Scholes formula to value this option of

[1] We owe to mention that the idea of the numerical example used in this paragraph, was mainly inspired by the research paper of Yeo et al. (2003).

follow-up investment. Table 2 draws the parallel between the inputs needed in valuing a call option on stock and this expansion to a real option (see Table 2, Appendix).

Now, let us apply the Real Options' theory. With the net present value of the follow up investment as the initial value P = € 8,64 (million) and the investment as the strike price X = € 9 (million). The *time to maturity (T)* is 3 years. We estimate the volatility of the telecommunications industry to 35%, i.e. σ = 0.35, and risk free interest rate is 3,5%. Input these number into Black and Scholes formula, we get the value of this second stage investment option is *C =3,55*. The value of the option, C, feeds on σ, the volatility of the telecommunications-related stock value P (S), and on T, the (Real) Option's time to maturity. The asymmetrical distribution of V as illustrated earlier in Figure 1, also, implies that the upside potential is good with higher option value, C, with increasing σ (and risk) and T.

So the value of the acquisition of Firm Z should equal the option value added to the NPV's for the first three years i.e.

$$NPV(Z)^{option} = NPV1 + NPV2 + NPV3 + c = 2,58 + 3,55 = 6,13 \quad \text{(€ million)}$$

Therefore the net value of this acquisition opportunity of firm Z to TELCOM is:

$$NPV'(Z)^{option} = NPV(Z)^{option} - I_0 = 6,13 - 4,9 = 1,23 \quad \text{(€ million)}$$

Now the NPV turns positive and the project (investment) should be acceptable. If one wonders how come the investment rejected by simple NPV based evaluation looks attractive from a real option point of view - that is by taking into consideration the value of the option – and where this additional value came from, the answer is that by assuming that TELCOM commits to completing the second stage expansion investment, the NPV valuation ignored an important value of flexibility that the firm really had.