REAL OPTIONS THEORY IN COMPARISON TO OTHER PROJECT EVALUATION TECHNIQUES

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ABSTRACT

Wrong investment decisions today can lead to situations in the future that will be unsustainable and lead eventually to the bankruptcy of enterprises. Therefore, good financial management combined with good capital investment decision-making are critical to survival and long-term success of the firms. Traditionally, the net present value (NPV) and discounted cash flow (DCF) methods are worldwide used to evaluate project investments. These techniques have been classified in two major groups: sophisticated and non-sophisticated. In the former group, techniques like the DCF methods (e.g. NPV and IRR) can be found. In the latter group, techniques like the Payback Period and the Accounting Rate of Return have been included. However given that, today investments are characterized by high risks and uncertainty, DCF methodologies are inadequate to deal with these issues. Some authors argue that only the techniques that can appropriately address the problem of uncertainty (like the Real Options theory) should be applied. In this paper, the major differences between DCF methods and Real Options (RO) theory will be analyzed. Using an example, the advantages of the RO theory, compared with other methods, such as the DCF methods, in the search of better decisions will be shown. This work is expected to contribute to an increase of application of the RO Theory, by showing this technique potential.

INTRODUCTION

Investment decisions are extremely important, both from the point of view of the economic development and the business perspective. Today's global crisis only reinforces this idea. (Bennouna et al., 2010) The competitiveness of enterprises is a key factor for its success. Thus, correct investment decisions by firms are, among other aspects, essential to accomplish that objective. In this regard, the investment appraisal techniques used by firms is a question of paramount importance. Accordingly, the techniques used in the analysis of investments should provide relevant and quality information, so that the uncertainties of the future start to be present certainties. In order to avoid bad (or wrong) decisions, the academic community has, over the years, developed more accurate techniques for investment evaluation. These techniques have been classified in two major groups: sophisticated and non-sophisticated. In the former group, techniques like the Discounted Cash Flow (DCF) methods (e.g. NPV and IRR) can be found. In the latter group, techniques like the Payback Period and the Accounting Rate of Return have been included. However, several studies (Graham and Harvey, 2002, Ryan and Ryan, 2002) indicate a tendency for an increasing number of companies to use those more sophisticated methods for evaluation of investment projects. With the increase of the economic and financial uncertainty, some authors (Dixit and Pindyck, 1994, Smit and Trigeorgis, 2004, Verbeeten, 2006) claim that even those sophisticated techniques may not be as accurate as it would be necessary. They argue that only the techniques that can appropriately address the problem of uncertainty (like the RO Approach) should be applied. Those techniques (DCF) make implicit assumptions, like the reversibility of investments. In other words, an investment can be undone and the expenditures recovered. On the other hand, if a firm does not undertake the investment now, it will not be able to do it in the future and this will become unrecoverable(Amram and Kulatilaka, 1999). In fact, most investment decisions share three important characteristics (Dixit and Pindyck, 1994): a) the investment is partially or totally irreversible (i.e. the initial capital expenditure is at least partly a sunk cost); b) there is uncertainty about the investment return (i.e. the best one can do is to assign probabilities to different possible outcomes); and c) the promoter of the investment has some freedom to decide the most appropriate time to make the investment (i.e. the investment decision can be postponed in order to obtain more information about the future and thus reduce the uncertainty). These three characteristics interact to determine the optimal decision of investors. In fact, the ability to delay an investment, in order to obtain more information and thus reducing uncertainty, provides management with a valuable opportunity to modify both investment and the strategy to follow, in order to get better future opportunities or to reduce future losses.Thereby, this possibility can be seen as an option due to the fact that a company has the opportunity to

invest, or simply not investing, similar to a financial call option (Dixit and Pindyck, 1994). From this premise, the capital budgeting can be treated in the field of RO, term that was firstly used by Myers (1997). Unlike DCF methods, the ROtheory centers on the valuation of the managerial flexibility to answer to different scenarios with high levels of uncertainty. This theory is known as a modern approach for economic valuation of projects under uncertainty(Marreco and Carpio, 2006). The concept of RO arose from financial options. Its foundations lay in the Nobel Prize awarded work on the pricing of financial option contracts, developed by Fisher Black, Robert Merton and Myron Scholes. The option-pricing theory had applications for all kind of investments, whether they are financial or nonfinancial(Black and Scholes, 1973). From the first application until today, RO theory has been applied in almost all sectors, from energy sector to R&D investments (Lee and Shih, 2010, Block, 2007, Benninga and Tolkowsky, 2002, Laurikka and Koljonen, 2006). In the energy sector, RO proved that can evaluate better than DCF methods (Martínez-Ceseña and Mutale, 2011, Yang and Blyth, 2007). Same conclusions can be drawn to the natural resource extraction industries (Siegel et al., 1987, Paddock et al., 1988, Fan and Zhu, 2010).Those studies show the wide range of applicability and prove that RO theory can give better quality information to the decision makers than other project evaluation techniques (Luehrman, 1998).
The remainder of this paper is organized as follows. Section 2 gives an introduction to the theoretical background of the real options theory. Section 3 presents an application example of the real options theory. Section 4 concludes the paper presenting the main findings and some perspectives for further research.

REAL OPTIONS THEORETICAL BACKGROUND

To better understand the RO reasoning/approach, it is important to provide a brief glance over the financial options. To start with it is necessary to distinguish between a call option and a put option. A call option is a contract that gives the buyer the right, but not the obligation, to buy something at a specified price in the future (and the seller of the call has the obligation to deliver the good or asset if the call owner exercises the option). A put option is a contract that gives the buyer the right, but not the obligation, to sell something at a specified price in the future (and the seller of the put has the obligation to take delivery of the good or asset should the put owner decide to exercise his option).
The something that can be bought (or sold) with the option is called the underlying asset. The specified price is called the exercise price and the future date is called the expiration date.
In the context of real options, one can define a RO "as the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting or abandoning) at a predetermined cost, called exercise price, for a predetermined period of time – the life of the option" (Copeland and Antikarov, 2003). Therefore, an opportunity to invest is similar to a financial call option. If it is possible to find a call option like an investment opportunity, the value of that option would tell investors something about the value of the investment opportunity. So, it has to be established a relation between the investment project characteristics and the variables that are needed to value a call option, and this is shown in table 1.

Table 1: Analogy of the call option and the project characteristics

Project characteristics	Variable	Call option
Present value of expected cash flows		Stock price
Present value of investment outlays		Exercise price
Length of deferral time		Time to maturity
Time value of money		Risk-free rate
Volatility of project's returns	σ	Variance of stock returns

The value of a call option can be obtained using the Black-Scholes option pricing model, described in Equations 1, 2 and 3 (Black and Scholes, 1973)

(1)

Subject to,

(2)

(3)

As can be seen, most of the data that are needed to evaluate a project using the DCF methods is the same data that will be used in RO model.

Where DCF methods and Real Options are equal and where they are different

The DCF methods use net present value (NPV) to assess the value of an investment opportunity. Thus, NPV is no more than the difference between the project present value and the required capital expenditures, as shown in equation 4:

(4)

When this difference is positive, the investment project is accepted, otherwise is rejected. Curiously, the option value has the same value as the NPV when the project can no longer be deferred. For other words, when the option has reached its expiration date (maturity time). Equation 5 shows that:

(5)

When NPV is negative, the company does not undertake the project, so the project value is effectively zero, rather than negative. This happens because of the fact that at t=0, σ and do not affect the call option value.

These techniques differ when the decision to invest can be deferred. In this case, two sources of value arise. Firstly, it is always preferable pay later than sooner, all else being equal, because it can be earned the time value of money. By investing later, it can be earned the interest on the capital expenditures. That value is the discounted present value of the capital expenditures. In other words, is the present value of the exercise price. Secondly, deferring the decision will turn the uncertainties of the future into certainties of the present. These uncertainties can be measured by assessing probabilities of the future possible project returns. This means that the variance of the project returns will be the percentage gained or lost per year. So, a project return with high variance is riskier than a project with lower variance. Thus, their returns will be either much higher or much lower than average. These new sources of value are the "heart" of RO.

EXAMPLE: VALUING A CHEMICAL INDUSTRY

To show an application of the RO theory in comparison with de DCF methods, an example will be now presented. This case study was firstly used in the work of (Luehrman, 1998), with some differences to better illustrate the applicability of the RO and their major differences relatively to DCF methods.

The managers of a chemical industry proposed a phased expansion of their manufacturing facilities. They want to build a new plant immediately to exploit innovations in process technology. Then, they anticipate future investments. In three years, they intend to expand the plant's capacity. So, there are two investments, the first of 79.250.000,00 € and the second of 242.188.000,00 €. The other required information is presented in the tables 2 and 3. It can be seen that the NPV of the investment is almost zero. However the managers feel that this analysis is missing something.

In fact, this project can be regard as one that incorporates an option, because of the fact that the first phase of the investment buys the right to expand three years later.

Table 2: DCF calculation – Operating projections

Operating Projections	Years						
	0	1	2	3	4	5	6
1. Revenues		288,47	349,33	507,20	684,72	757,63	795,67
2. Cost of goods sold		216,38	263,05	377,86	514,24	566,73	596,78
3. Gross Profit (1-2)		72,09	86,29	129,34	170,48	190,90	198,89
4. SG&A expense		69,99	82,42	138,97	159,51	177,71	182,21
5. Operating Profit (3-4)		2,09	3,87	-9,64	10,97	13,19	16,67

The values are shown in M€.

Table 3: DCF calculation – Cash flow calculation

Cash flow calculation	Years						
	0	1	2	3	4	5	6
6. EBIT (1-taxrate)		1,39	2,58	-6,42	7,31	8,79	11,12
7. Depreciation		12,05	13,31	13,31	29,35	30,50	31,70
8. Capital Expenditures	63,40	5,14	6,02	194,64	10,14	10,33	10,78
9. Increase NWC	15,85	2,60	3,49	47,55	4,50	5,07	6,15
10. Cash Flow	-79,25	5,71	6,38	-235,30	22,02	23,88	25,89
11. Terminal value, assets (perpetuity value with 5% per year growth)							386,93
Discount factor (12%)	1,00	0,89	0,80	0,71	0,64	0,57	0,51
PV per year	-79,25	5,09	5,09	-167,48	13,99	13,55	209,15
NPV	0,14						

Values are shown in M€.

Real Options valuation

To start valuing the option, it is necessary to identify the options that are embedded in the project. Thus, the first investment gives the company the option to expand in three years. As has been said, this project can be seen in two phases, or as two different projects: phase 1 corresponds to the initial investment and phase 2 corresponds to the second investment. Tables 4, 5 and 6, summarize and evaluate these phases separately. As it can be seen, phase 1 has a positive NPV whereas phase 2 as a negative NPV. Therefore, any rational decision maker would accept phase 1 investment and reject the phase 2 investment. However, this decision would be wrong.

Table 4: DCF calculation separately phase 1

Phase 1	Years						
	0	1	2	3	4	5	6
1. Cash flow	0,00	5,71	6,38	6,89	7,38	8,47	8,96
2. Terminal value	0,00	0,00	0,00	0,00	0,00	0,00	121,09
3 Investment	-79,25	0,00	0,00	0,00	0,00	0,00	0,00
Discount factor (12%)	1,00	0,89	0,80	0,71	0,64	0,57	0,51
PV per year	-79,25	5,09	5,09	4,90	4,69	4,81	65,89
NPV	11,22	Values are shown in M€.					

Table 5: DCF calculation separately phase 2

Phase 2	Years						
	0	1	2	3	4	5	6
1. Cash flow	0,00	0,00	0,00	0,00	14,65	15,41	16,93
2. Terminal value	0,00	0,00	0,00	0,00	0,00	0,00	265,84
3 Investment	0,00	0,00	0,00	-242,19	0,00	0,00	0,00
Discount factor (12%)	1,00	0,89	0,80	0,71	0,64	0,57	0,51
PV				-172,38	9,31	8,74	143,26
NPV	-11,08	Values are shown in M€.					

Table 6: DCF calculation separately phases 1 and 2

Phase 1 & 2	Years						
	0	1	2	3	4	5	6
1. Cash flow	0,00	5,71	6,38	6,89	22,02	23,88	25,89
2. Terminal value	0,00	0,00	0,00	0,00	0,00	0,00	386,93
3 Investment	-79,25	0,00	0,00	-242,19	0,00	0,00	0,00
Discount factor (12%)	1,00	0,89	0,80	0,71	0,64	0,57	0,51
PV	-79,25	5,09	5,09	-167,48	13,99	13,55	209,15
NPV (total)	0,14	Values are shown in M€.					

In fact, phase 2 has a lot of potential, and with a small increase in variance of its returns this phase would have a positive NPV. By evaluating this phase with the traditional DCF methods, this variance is not taken into account.

As mentioned earlier, in the field of RO theory, this variance is called uncertainty.

Valuing this second phase as a growth option will provide some differences in their value. Table 7 shows the variables needed to evaluate this phase and table 8 shows the value of the option.

Table 7: Real Options input data

Real Options Input Data		
Variables	Project characteristics	Value
S	Present value of the phase 2 assets	161,31
X	Necessary investment in year 3 to obtain phase 2 assets	242,19
t	Length of time phase 2 spending can be deferred	3
r_f	Time value of money	12%
σ	Standard deviation per year on phase 2 assets	40%

Values are shown in M€.

Table 8: Option valuation

Black-Scholes Formula	
Phase 2 value	38,55 €
d1	-0,06698552
d2	-0,759805843
NPV (Phase 1 + option value of phase 2)	49,77 €

Values are shown in M€.

In the DCF methods the uncertainty is not directly incorporated in the calculations. In this example, a standard deviation of 40% was used, as proposed by Luehrman (1998). This author argues that 40% is an average value for investment projects with same risk as this. However, an analysis for different values of uncertainty was done, in order to illustrate the importance of this concept in the evaluation of projects.

Using the RO theory to evaluate phase 2 it is obtained a positive value, which could seem odd at first sight. Nevertheless, in that value is included the value of deferring the decision, and the possible variations on the returns of that phase. Figure 1 shows that even with a small variance, the phase 2 value would become positive.

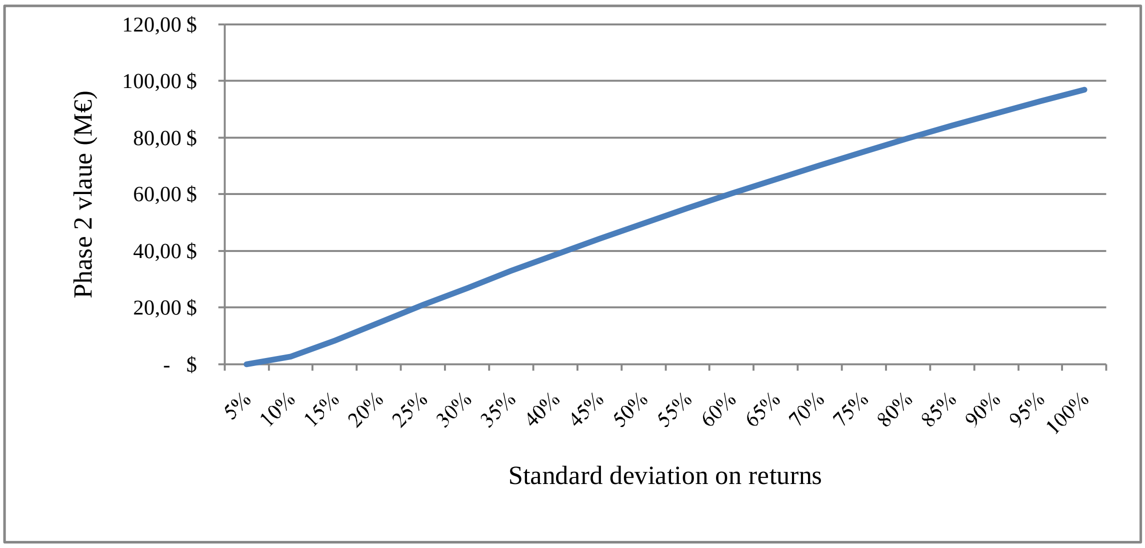

Figure 1: Phase 2 values for different standard deviation on return

A project with that variance is a project with a very little risk. So, if the decision was deferred for 3 years, the decision maker would know what happened three years later and would know what to decide. With the DCF methods the decision maker would reject the phase 2, and loose a good investment opportunity in year 3. Evaluating this investment project using RO the NPV arose from a 0,1 to a 49,77 (M€). This new NPV value is more accurate than the old NPV, because of the fact that it takes into account the deferring value and the uncertainty value.

CONCLUSIONS AND FURTHER RESEARCH

The traditional DCF methods fail in the evaluation of projects that are characterized by uncertainty and high financial risks. Those methods do not take into account the possibility of variations on cash-flows, according to market changes or sensitivity of investors. Those changes are extremely important. A project that seems good can be turned into a bad one, only by the uprising of the prices of raw materials, or a sudden crisis of the financial markets. The RO approach does not give the answer to all the issues in the project evaluation. However, it can provide more accurate information to the decision maker, giving the possibility of better decisions. Curiously, by incorporating risk in the analysis, this is done with less risk. In other words, the results obtained are more precise. Sometimes, DCF methods provide misleading information and that is the major drawback of those methods. On the other hand, RO theory is often difficult to apply in practice. In fact, uncertainties are extremely difficult to be obtained with precision and require sophisticated techniques, like simulation tools. Also, the equations that are used in RO require a great mathematical knowledge and can be arduous to apply. Even the line of thought that should be followed in order to use RO theory is different from the one that is needed in DCF methods. This rupture of thinking is as difficult as applying the methodology.

Despite the great theoretical advantages of RO approach that were pointed out, to the author's best knowledge, this approach has not been much applied (or used in real situations). So, developing software that could turn RO more "user friendly" is an important step in. The training of managers in order to raise awareness of the potential of this approach is a great way to the spread of RO. This technique can be applied to almost all investment sectors. However, the absence of applications has been an obstacle to their use. For example, in the field of renewable energy sources, which is a sector with a high level of uncertainty, the development and application of RO can provide better knowledge of their correct value. Not only on energy sector, but also in major public investments, like airports, seaports or railways, RO can be an important tool to better evaluate (or assess) the value of investments.

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