Real options valuation: The modern day technique in capital budgeting and decision-making?

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ABSTRACT

Over the years, the discounted cash flow approach (DCF) has been the valuation technique choice of many practitioners, academics and corporate finance managers. Such valuation techniques include the NPV, IRR and Payback. These techniques are widely employed due to their intuition and easy computation. However, these techniques do not tell us what to do next after accepting or rejecting a project. The shortcomings of DCF models are addressed by the Real Option Valuation (ROV). The ROV approach takes into account the stochastic nature of underlying project drivers (such as sales volume and the selling price) and managerial flexibility. This study sought to test the applicability of the real options to value managerial flexibility. Precisely, this paper sought to determine whether ROV serve as adjunct to the existing DCF techniques, or replaces the existing capital budgeting techniques in emerging markets like Zimbabwe. Two embedded options were identified, namely the abandonment and expansion option. The study found out that apart from DCF valuation techniques being currently employed by the firm, they can as well incorporate Real Options Analysis to decision making because if accurately valued and timeously executed, real options do add firm value.

Key words: Capital Budgeting, Real Options, Discounted Cashflow, Binomial Option Pricing

1. INTRODUCTION

Project valuation is taken to be one of the fundamental aspects of investment selection and decision making because managers are always faced with the dilemma of allocating scarce financial resources. The allocation is both a strategic and a financial task because they have to choose among the various projects identified, one that maximise shareholder value. If they choose a project with poor prospects in the future, they would have destroyed shareholder value. The ideal project is the one whose net revenues during the production phase are higher than the initial investment cost (Gumbo, 2009).

Several techniques are used by managers to value projects. Over the years, managers have been relying on static DCF techniques such as the NPV, IRR and Pay Back. With the DCF approach, the NPV of a project is determined by discounting the future cash flows at the risk-adjusted discount rate. In most cases, the risk-adjusted discount rate is the firm's WACC, assuming that the firm and the project have the same market risks (Brandao et al, 2005). However, as noted by Guthrie (2009), these techniques do not incorporate managerial flexibility. This flexibility in capital budgeting and decision making is known as *"Real Options"*. Managerial flexibility gives managers the freedom to alter the course of the project as new information filters in.

The concept of "Real Options" was first discussed by Professor Myers in his (1977) seminal publication. Professor Myers argues that a firm's investment opportunities can be observed as call options on real assets. In his 1977 persuasive presentation, Myers pointed out the shortcomings of DCF techniques and analysed the significance of a company's policy in the capital budgeting practices. Professor Myers is of the opinion that firms should make investments based on Real Option analysis rather than traditional DCF techniques. This view is shared by Guthrie (2009) who observed that real option analysis give managers the ability to value projects in such a way that recognises their flexibility. Following this noble submission by Myers, several academics have taken it as their task to validate his proposition. Among the great contributors to the topic have been Borison (1985), Trigeorgis (1996), Majd & Pindyck (1989), and Kulatilaka (1993).

Real Options have mainly been applied to the area of natural resources largely because they are traded; hence they offer the opportunity for arbitrage (Damodaran, 1996). Several scholars such as (Keser (1984), Kulatilaka & Marks (1988), Quigg (1993), Capozza & Sick (1994) and Nichols (1994)) have hailed the adoption of the Real Option methodology.

Regrettably, progress on the implementation of Real Options methodology to the steel industry in Zimbabwe is very slow, if ever it exists, despite their wide acceptance and recognition. The goal of this paper is to test the applicability of the BOPM to value managerial flexibility. The objective is to show that this technique (ROV) may serve as adjunct to the existing DCF techniques, not to replace the existing capital budgeting techniques. The study seeks to make meaningful contribution to the body of knowledge by illustrating the applicability of ROV technique to value managerial flexibility in the steel industry, where to date empirical evidence in the area is scanty.

The rest of the study is organised as follows. Section 2 looks at Literature related to the subject under discussion, both theoretic and anecdotal. Section 3 highlights the research methodology. It describes the model, its assumptions, input variables and justification of such a model. Section 4 provides an analysis and interpretation of the data. After having made all the computations in Excel, such findings needed to be discussed and recommendations made, where appropriate. This was done in Section 5. This section also recommended areas of further research.

2. LITERATURE REVIEW

2.1 Evolution of Real Option Methodology

The concept of option pricing is assumed to have started at the end of the 19th Century (Chvalkovska & Hruby, 2000). In 1877, Castelli made the first publication of a book concerning the option pricing and its relation to price volatility and the possibility of using options in bond arbitrage and stock exchanges. Bachelier, in 1900, explored the key mathematical principles of option pricing. His findings was the application of arithmetic Brownian Motion on price movement modelling, which forms the basis of contingent claims valuation. However, his works were not widely accepted and recognised because of its too much orientation towards mathematics of finance and being too complicated for financial economics (Courtault et al, 2000).

The continuous time random walk model was later reintroduced by Paul Samuelson in the 1950s, however, with modification from arithmetic to Geometric Brownian Model (GBM) (McKenzie, 2003). Kassouf & Thorp (1965) further developed the model to illustrate the associationship of warrant prices and the underlying. They later on applied the theory in actual stock trading, deriving the delta-neutral hedge ratios to create perfectly hedged portfolios on stocks and bonds, making huge amounts of money. Later on, Merton 1973, Black & Scholes 1972, developed the most fascinating theory of contingency claim valuation based on Brownian motion popularly known as the Black Scholes Option Pricing Model (BSOPM). This model marked a new era in the pricing of financial instruments and in 1977, Scholes and Merton were honoured for their great works through the accordance of the Nobel Prize for Economics. Unfortunately, Black had passed away (Chvalkovska & Hruby, 2000).

Professor Myers (1977) noted that the option pricing theory concept could be extended to the pricing of corporate and project investments. Later, in his 1984 article, he suggested that the real option methodology has the ability to cover the wide gap concerning strategic planning and finance. In his own words, Myers (1984) argues, "Strategic planning needs finance. Present Value calculations are needed as a check on strategic analysis and vice versa.....Corporate finance theory requires extension to deal with real options." In the same article, Professor Myers indicated that deterministic DCF models have both advantages and shortcomings in project valuation. He highlighted the various shortcomings of DCF techniques and suggested the use of the famous BSOPM, to address these shortcomings. Hayes & Abernathy (1980) quoted in (Gui, 2011), also recognised that traditional valuation methods are insufficient to capture the value embedded in real options.

Trigeorgis (1987) has made enormous contributions to the real options panacea. His contributions have been through developing real options models and his research efforts were towards the subject area. The studies of Copeland et al (2000) and Amran & Kulatilaka (1999) have also made key contributions and made inroads into the Real Options research. Today, the option pricing theory is being applied in many areas including R&D, Airlines, Manufacturing, and Biotech etc. The penetration of the option theory into these fields was facilitated by Cox, Ross and Rubeinstein in 1979, who simplified the model. The Cox et al (1979) model applies to discrete time periods.

Early work on the application is found in the pricing of oil prospects by Paddock (1988), Siegel and Smith (1988). Since then, Real Options have been applied to different sectors of the economy (Kogut & Kulatilaka, 2004). The broader concepts of Real Options theory began with the inclusion of the technique in the textbook of Brealey & Myers (1983), who demonstrated its use in Research & Development investments. Ross (1978) examined risky projects and identified inherent investment opportunities in these projects as Real Options. Trigeorgis (1993) outlined the several categories of Real Option according to flexibility differences: abandonment option, staged investment option, switching option, growth options, interacting options, and options to alter operating scale. Mun (2002) also provides a comprehensive list of Real Options that are applicable to industry using day to day terminology.

2.2 Empirical Literature

To date, research indicates that Real Options are gradually being incorporated into capital budgeting and decision making process of many industries. This has been the case because Real Options are able to capture management flexibility and uncertainty. Flexibility brings a number of actions management may take, to add value to the firm. This flexibility, as noted by Muharam (2010), comes in different forms mainly; deferral/ waiting options, altering options, switching options, growth/expansion options, abandoning or shutting down options. Philippe (2005) noted that much of the research on RO applicability has been in the area of natural resources. This is largely because natural resources are traded commodities, thus making them appropriate for arbitrage reasoning.

The ***deferral option*** is mostly considered in the field of gas and oil exploration (He, 2007). According to Brach (2003), this option gets its price from reduced uncertainty that arise from the postponement of the project until further information filters in. Amran & Kulatilaka (1999) also observed that investing later preserves the time value of money. The pioneering paper in this regard, was the Paddock et al (1988) presentation. Paddock et al, developed a Real Option model to assess the value of an undeveloped oil reserve. The authors found an embedded option in the undeveloped field which is similar to a call option that is written on a stock that pays dividends. The proprietor of the undeveloped oil field has the right but not the obligation to develop the field at a later date. If he does not exercise the option, he forgoes production revenue (i.e. the asset dividend). The developed reserve value is assumed to follow the Brownian motion.

McDonald & Siegel (1986) were the first to study the option ***to wait*** investing in a project. They assumed that the project's present value profits and causes the investment costs to be stochastic hence follow the Geometric Brownian Model. They allowed Project cash flows to jump to zero, thus they added a Poisson jump to the procedure. The authors examined the significance of the value to postpone an investment by supposing that the company is keen to invest in a synthetic fuel plant which cannot be used for other purposes. They found that if the investment expenditure cannot be reversed, then the deferral option is truly valuable with an option premium of 10 to 30%. More so, Song (2006) laments that delaying may add value to the firm if further information and changing conditions are incorporated into the decision making process.

However, Brach (2003) argues that the postponement value could be reduced by the value the firm establishes from a competitive position or a pre-emptive technique that does not require postponement. Damodaran (1996) also recognised a number of issues when using options theory to value real options. Firstly, he noted that the underlying asset (the project) is not tradable. This makes it very hard to approximate its value and variance. Secondly, the price path followed by project values may not follow the path of option pricing approaches. He criticised the conjecture that project values pursue a diffusion process, and that variance is constant for a considerable period. These suppositions may be hard to validate in real life projects. Thirdly, the timeframe for which the company has rights to the venture may perhaps be unstipulated due to the fact that rights to a venture are not legal restrictions; therefore, they can quickly diminish in value. Under these conditions, the projected maturity time of the project will be indeterminate.

Studies on the topic continued and in 1990, Trigeorgis made an assessment of a multinational natural resource venture. Despite the fact that the project had negative net present value, Trigeorgis recognised three options using the Binary option pricing methodology namely ***delay, abandonment and conversion of scale options.*** Trigeorgis opinion was that the project was worthy undertaking after considering real options implanted in the projects.

In the same year, Myers & Majd (1990) studied the ***abandonment option.*** This option bestows the business the right but not the obligation to abort the venture if projected cash flows are less than the salvage value. Under these circumstances, the firm can choose to discontinue the project and get the disposal value. Myers & Majd (1990) present a firm with an option between production technology that has a secondary market and another that does not have a secondary market due to equipment specialisation. Their work shows that if production is halted before the machines are exhausted; the former machine is more valuable than the latter because of the imbedded managerial flexibility. In addition, they observed that the option to abandon has more value in industries that require high capital, financial services industry and new products that are being launched in new markets. In contrast, Damodaran (1996) did not observe this abandonment value. He reasons that the abandonment value is uncertain because it may shift during the life span of the venture, thus it becomes difficult to harness option pricing methodologies. Furthermore, it is likely that salvage from terminating a project may not be realised, rather liquidation may actually be costly, and for example, the firm may have to incur compensation to the retrenches, thus eating up any salvage value realised.

Grafstrom & Lundquist (2002), assessed whether the value of a North Sea oilfield varies depending on whether Real Option valuation or Discounted Cash flow approach is employed. They developed a partial differential equation to price the option and solve it numerically, subject to set boundaries. Convenience yield was estimated from market data applying relationships between futures and spot prices. The authors established an option value of $56,720 million, which translates to a premium above the certainty equivalent value of nearly thirty seven percent. They concluded that managers need to supplement the Real Option approach with a discounted cash flow valuation.

These debates point out the significance of real options in capital appraisal decisions. However, in the Zimbabwean context, work in this area is still scanty hence this study will seek to make contributions to the existing body of knowledge.

3. RESEARCH METHODOLOGY

3.1 Research Design

This study uses the case study research paradigm, in line with the literature of Muharam (2010) and Trigeorgis (1996) to examine the applicability of real options to the steel industry in Zimbabwe. According to Zainal (2007), the case study approach enables us to get a rich understanding of the subject under study. The choice of the steel industry was based on significant uncertainty in steel prices and unpredictable demand for the commodity. These factors make the steel industry to be a candidate for real option analysis (Ozorio et al, 2013).

3.2 The Model

The paper adopts the Cox, Ross & Rubinstein (1979) – CRR- Binomial Option Pricing model (BOPM). The binomial model considers discrete time periods in which the asset price can either rise or fall. On maturity, the option price is given as its intrinsic value i.e.

$$\text{Max } [S_t - X, 0] \text{ for a Call}$$

$$\text{Max } [X - S_{t,} 0] \text{ for a Put}$$

Using backward alteration, we can work the option value backwards, starting with payoffs on maturity, such that we have:

(1)

Where;

Vt is the option value at time t

is the option value at time t + Δt given the underlying price at time t + Δt goes up by a rate of u from time t.

is the option value at time t + Δt given that the underlying price at time t + Δt goes down by a rate of d from time t.

It is worth to note that as $\Delta t \rightarrow 0$, the Binomial method approaches the BSOPM value.

For American options, a decision has to be made in each time period, whether to exercise the option immediately (thus killing it) or else keep it alive (waiting). This choice according to CRR (1979) is determined by;

3.5

Adopting the CRR (1979) model the general valuation for a call for any number of periods (n) can be written as:

(2)

For a put;

(3)

3.3 Model Inputs

This case study assumed American options (which can be exercised anytime) on the Ophir Steel (actual name withheld for ethical reasons) in Masvingo-Zimbabwe. The options of my interest were;

- Abandonment and
- The Expansion option

To obtain the value of each option the researcher gathered the following input parameters;

3.3.1 Time to maturity (T)

Ophir Steel, Masvingo subsidiary reopened on the 18th May 2012, after shutting down at the height of the economic meltdown, in 2008. The current production is expected to run for 9 years, when the owners of the firm expect to recoup their initial investment, hence the tenure of the abandonment option is 9 years.

3.3.2 The Exercise price (X)

This is derived from the current funding put up to resume operations. From the data provided by the company, they injected US$16 million, hence X = $16 million.

3.3.3 The current value of the underlying asset (S)

This is the NPV of the investment at today's expectation of production output and sponge iron price being fetched on the world markets. The NPV is determined using the following input parameters.

- Annual volume of sponge iron produced. The firm intends to produce 54 000 tons annually for the next 5 years, and then increase output by 25% annually. They also have the option to double output after the same period (5 years).[1]
- Sponge iron price, as driven by forces of supply and demand to be at a constant $250 per ton.
- Depreciation of Fixed Assets is estimated at $100,000,00.[2]
- The discount rate. The firm's borrowing cost was used as the discount rate for calculating the current value of the investment, and was estimated at 20%[3]. With these input parameters the current value of the project was US$-7,574,121,58.

3.3.4 Volatility of the underlying asset (‰)

The logarithmic cash flow returns approach described by Mun (2002:227) was used to calculate the volatility of the firm's future cash flow returns and their respective logarithmic results for the period 2012 to 2016. This formula used was:

Volatility (δ) = (4)

This was estimated to be 14,03%.

3.3.5 Risk free interest rate

This was taken to be the average yield on government paper.

3.4 Data Analysis

Option prices and lattices are calculated and illustrated using MS Excel and Spreadsheets designed by Gumbo (2009). NPV computations were done on a simple spreadsheet template that the researcher designed. Sensitivity analysis was also performed on a simple spreadsheet that we developed to show how the Real Option Values and Discounted Cashflow values changes as input parameters are altered.

4. RESULTS AND ANALYSIS OF RESULTS

4.1 DCF Valuation

4.1.1 Traditional NPV without flexibility

Using the data provided by the company, an NPV of -$7,574,121,50 was derived.

According to the NPV criterion, projects with NPV less than zero are not worth venturing into. As such, this project should be abandoned immediately as it destroys shareholders' value. However, as earlier discussed, the NPV criterion only tells us whether to accept or reject the project with no further course of action.

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1 The author used the first production estimates to value the abandonment option where production will be constant for 5 years then rise by 25% annually. These are the values they used to estimate future cashflows assuming normal operations. The firm expects, provided the operating environment permits to double output in the same period. I then assumed this to be the Expansion option available to the firm.

2 As provided by the firm.

3 As provided by the firm.

In determining the NPV value, three important assumptions were made:

- º The plant will operate at full capacity, and all the sponge iron produced will be sold.
- The price is constant and will not move during the life of the project i.e. it remains $250,00
- A discount rate of 20%.

BUT,

- Is it realistic to operate at full capacity and sell all the sponge iron produced?
- Is it realistic that sponge ore prices will remain fixed?
- The choice of the discount is always subject to debate since there is no way to prove that it is the realistic hurdle rate for the firm.

Even if there are impractical assumptions made in the NPV approach, the method still gives us a yardstick to assess the value embedded in real options.

4.1.2 Traditional IRR

The project's IRR was estimated to be 6,11%. This rate is below the WACC, therefore, such an investment is not worth undertaking as it offers shareholders a return far below their expectation on their committed resources. As in the NPV analysis, the IRR does not give us further decisions. Table 1 provides a summary of DCF values

Table 1: DCF Values

Methodology	Value	Decision
NPV	-$7,574,121,00	Reject the project
IRR	6,11%	Reject the project

As shown in the above table and discussed above, the current project should be abandoned immediately as it does not bring any wealth to the shareholders.

4.2 Real Options Valuation

As discussed in the preceding chapter, two Real Options were identified for this project, namely the expansion and abandonment option. To value the options, the Binomial Option Pricing Model built on a simple spreadsheet was applied and used the following input parameters, to work out the value of the options.

Table 2: Summarised Input Variables

Variable	Symbol	Abandonment Option	Expansion Option
Project Life Span (Years)	T	9	4
Initial Investment Cost	X	$16,000,000	$10,000,000
Present Value of Current Project Cashflows	S	$9,447,936,53	$9,576,393,36
Risk Free Interest rate	Rf	10,67%	10,67%
Volatility of Future Cashflows	Δ	14,07%	25,9%

4.2.1 Expansion Option

In order to increase production to the maximum level in line with Kyoto Protocol on environmental pollution, the firm plans to commit additional resources to the tune of US$10 million dollars in year 6. With that, the additional investment output is expected to double i.e. increase by 100%. This Expansion option was calculated as a European Call option. The value of the option was estimated to be $13,088,000 and the resultant Flexibility value (NPV due to expansion) was valued at $3,511,606,64. The **option payoffs** are the figures in bottom cells e.g. ($17,760,586; $8,605,952) in the lattice tree. The detailed lattice tree is shown in Appendix 1. The payoffs were derived by equation 3.4. For example, the payoff of $17,760,586,00 was derived as the Max[NPV of expansion, Option value] which turned out to be the Max[$9.152787.00,$17,760,586,00].

The Real Option theory states that; if

Option Value > Current NPV	Exercise the option
Option Value < Current NPV	Do not exercise the option

In this case, the NPV of expansion now, was $9,152,787,00 and the Binomial Option value was $13,088,000. In this case, the firm should exercise the option to expand by committing an additional $10,000,000,00 in Year 6 for favourable cash flows beyond 2017. If they do not commit the additional resources in future, they cannot capture the upside potential to be brought by the perceived surge in demand.

These findings concur with Muharam (2010) and Gui (2011). Muharam derived an expansion option value of ¤3.22 million from a project with an initial NPV of ¤-0.56 million, after the firm had committed an additional ¤5.212 million in the fourth year of operation. The Expanded NPV was ¤2,66 million. On the other hand, Gui carried out a Case Study of Nike when it opened the Beijing flagship. For a project with an NPV of $1,6 million, it had an embedded expansion option value of $2,06 million.

4.2.2 Abandonment Option

The abandonment option for salvage value was priced as an American Put on the current project. The valuation of this abandonment option largely depends on the salvage value, which represents the exercise price (X).

Given the above data (in Section 3), the firm's abandonment option was estimated to be $16,434,693,00 and a corresponding NPV due to abandonment of $434,693,00. The option payoffs are the figures in bottom cells e.g. ($16,434,693) in the lattice tree (Appendix 2). Values in red show the option payoffs e.g. $16,434,693,00. This value was derived as the Max [Salvage Value, Call Value] i.e. the Max[$16.434.693.00,$17.760.586.00].

Pursuant to the Real Option theory, if

Present Value of Cashflows < Salvage Value	Abandon the project
Present Value of Cashflows > Salvage Value	Do not abandon the project

From these results above, the firm should immediately abandon the project and enjoy a salvage value of $16,434,693,00. This is because the present value of future cash flows is far less than the terminal value of the project as a result of output prices falling below profitable rates.

Such results were also obtained by Muharam (2010). She applied the Real Option concept to a project with an initial negative NPV of ¤-0.56 million, a salvage value of ¤6.5 million and derived an option value of ¤1.84 million with an ENPV of ¤1.28.

The option values presented above are shown in the table below.

Table 3: Summary of Option Values and corresponding flexible value

Base Case

S = $9,447,936,53 X = $16,000,000,00 Salvage Value = $4,500441,39 Life, T = 9

NPV = -$7,574,121,58 Volatility = 14,03% Risk free interest rate = 10,67%

NPV due to Abandonment = Option Value – Initial Investment (X)

NPV due to Expansion = Option Value – Present Value of Cashflows (S)

Option Type	Option Value	Flexibility Value
Expansion	$13,088,000,00	$3,511,606,64
Abandonment	$16,434,693,00	$434,693,00

4.3 Summary of DCF and Real Option Values

The results discussed above of DCF and ROV methodologies are presented here for quick analysis.

Table 4: Summary of DCF and Real Option values

			Real Options Analysis	
	NPV	IRR	Abandon	Expand
Value	-$7,574,121,00	6.11%	$16,434,693,00	$13,088,000,00
Flexible Value	N/A	N/A	$434,693,00	$3,511,607,00
Decision	Reject	Reject	Abandon Now	Expand

Using only DCF valuation techniques, the firm should abandon the project immediately as it destroys shareholder value. However, if Real Options implanted in the venture are analysed, managers have a third choice to make. In the case above, managers can exercise the abandonment option by fore going the project today and enjoy a salvage value of $16,434,693,00. If they are optimistic about future demand, they can exercise the flexibility of expanding output to maximum capacity in line with the Kyoto protocol on environmental pollution.

These findings highlight the major shortcomings of traditional DCF techniques which are addressed by Real Options namely;

- Inability to account for the stochastic nature of important parameters e.g. selling price and output which derive revenues.
- Does not incorporate flexibility which managers can exercise during the course of the project.

This leads us to analyse the main advantages of Real options over static DCF models.

1. **Flexibility**
   According to Karamitos (2009), managers can change the course of the project in reaction to fluctuating market conditions.
2. **Timing**
   Both Karamitos (2009) and Dalal (2005) identified that real Options can take into account the impact of timing in a project. The option to wait or expand or abandon, derived from Real Option Valuation can really add considerable value to a project.

3. **Large projects valuation**
   Gui (2011) find out that for high investment/high risk-return (HI/HRR) such as the steel industry, Real Options are very useful to value such projects. As supported by Dalal (2005), DCF techniques were found to be inadequate to make investment decision.
4. **Does not incorporate the discount rate**
   One of the assumptions of the NPV calculation is that the discount rate used for present value calculations is accurate and the same for all projects. But in reality, this discount rate is difficult to assign a value Damodaran (1996). Projects carry different risks, so the choice of the discount rate should be aligned to the project's risk. On the contrary, Karamitos (2009) hails the Real Option methodology because it does not incorporate WACC (discount rate) in its calculation. The only problem of the discount rate to Real Options regards the input variables such as the NPV derived from static DCF valuation.

4.4 Analysis of Results

Applying the Binomial Option Model, the study found out that the firm has two options embedded in the current project namely; the abandonment and expansion options. The results showed the flexibility value that could be created by Real Options application. These results demonstrate that Real Options can be meaningfully applied to the steel industry. In addition to DCF valuation, managers should also look at Real Options that they currently have and incorporate them into their capital budgeting and decision making process to make better valuations.

These results are consistent with the findings of Muharam (2010) and Gui (2011). Muharam (2010) identified four Real Options embedded in a steel plant in India; namely the deferral, cancellation during construction, expansion and abandonment option. She found out that Real Option Valuation provides managers with a framework for allocating scarce resources, contributing to SMEs strategic management.

Although Real Options add considerable value to a project, they suffer from the following shortcomings. First, as discussed in the work of (Mun (2002), Dalal (2005), Karamitos (2009)) closed form solutions such as the Black Scholes Option Pricing Model and Simulation are quite complex for managers. Managers can be scared to adopt such methodologies. Secondly, though the Binomial Option Model is quite user friendly and intuitive, its computation can become bushy and tedious. Wang (2003) argued that, as the lattice tree becomes very big, there is no cross checking mechanisms to check if the tree is built correctly. Third, one needs to devout his time and have the ability to work on minor detail to make Real Option Analysis meaningful Dalal (2005).

Above all, the merits of adopting Real Options should always outweigh the cost of obtaining the benefits, to justify its adoption.

5.0 CONCLUSION AND RECOMMENDATIONS

The Real Option methodology has proved that it can be effectively used as a supplement to DCF valuation in valuing investments with a lot of uncertainty and requiring huge initial investments. The NPV approach works well in mature and stable growth industries.

Traditional DCF can be viewed as a special case of ROA in the event there is little or no uncertainty. When the underlying asset's standard deviation approaches zero, the ROV approaches zero and the project's value is defined by a DCF model. Real Options only work in economies that have a high degree of uncertainty and management has the flexibility to alter the project's course. The NPV is negatively associated to the degree of risk in a project because the risk is embodied in higher discount rate (WACC). However, in Real Options analysis the higher the risk, the higher the return. Quoting Mr. P. Knight (the Nike co-founder of Nike), Gui (2011) observed that managers continuously seek new ways to evaluate investments to improve resource allocation. The Real Options concept is available for such managers.

Although Real Options have not yet been widely accepted as a complimentary tool to DCF valuation, the results of this research suggest that Real Options will become a valuation tool of choice tomorrow. Although managers at first resisted the adoption of DCF valuation in the past, they gradually understood it and today it is employed widely. A survey by Baker et al (2001) in Canada and Palka & Knapkova[4] in Czechoslovakia, showed that Real Options are gradually being incorporated into capital budgeting techniques of many companies.

Basing on the research findings, the following recommendations were made:

First, to make the Real Options concept a reality and widely accepted, more literature on the topic must be included in the curriculum of MBA, Msc/MCom students in universities. Some of the students are managers and some will become managers tomorrow and equipping them with the framework theoretical thinking of Real Options, makes the approach easy to introduce. An interesting survey conducted in India showed that about 80% of the stock market players are college leavers who would have received a teaching on the topic. Second, with the advent of powerful software such as PDL, RISKOPTIMIZER, DERIVAGem and Crystal Ball, valuation of Real Options is simplified. Managers should make use of these powerful tools. This will make penetration of Real Option concepts to managers easier. Fourth, managers should accept methods that provide compelling value added propositions. Such approaches must provide managers with a comparative advantage over competitors. Fifth, for consultants to present and analyse the results to management can be very trivial. This is because they assume Real Options to be "black boxes". Start by comparing ROV techniques and DCF valuation techniques. Then demonstrate the benefits of Real Options, without bringing out the complex PDEs. The Real Option process has to be transparent, indicating a step by step process, clearly demonstrating when the DCF short falls as addressed by ROV.

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