The use of Real Options Analysis as a valuation technique: An investigation into South African mining companies.

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by

Robert Harry Nichol
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Supervised by: Lance Stringer
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2. This research report is my own work.

3. I have not allowed and will not allow anyone to copy my work with the intention of passing it off as his or her own work.

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Robert Harry Nichol  
Date: 8 December 2014
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Abstract

The resource sector, and the South African one in particular, contains a significant amount of uncertainty. Companies have the opportunity to create significant value and competitive advantage from this uncertainty, through correct strategic decision making and the incorporation of flexibility.

Real Options Analysis (ROA) is a sophisticated valuation technique which has the ability to account for this uncertainty and flexibility, thereby providing companies with both a financial and strategic decision making tool. While the theory surrounding the topic is abundant, the international use and adoption of the technique into real world situations is minimal.

This Masters of Business Administration Research Report adopts a qualitative approach using semi-structured interviews with numerous valuation experts to investigate the use of ROA as a valuation technique within South African mining companies. Additionally, the report seeks to evaluate the current valuation trends within the South African mining sector and where the future of valuations and ROA lies.

The research suggests that the use and adoption of ROA is hampered by the complex and mathematical nature of the technique, in conjunction with management’s lack of education surrounding the valuation methodology. It was acknowledged however that ROA is well suited to use within the mining sector and offers significant value when applied correctly to the right situations. The findings suggest that the use of supplementary techniques is of importance amongst valuators and that potential exists for ROA as a technique to supplement the findings of primary valuation techniques, namely the Discount Cash Flow (DCF) model.

The overriding theme is that the future of valuations lies in the collaboration of a simplistic, transparent and well-known technique such as DCF, with a more complex and powerful technique, such as ROA, which offers the ability to offer additional insight and knowledge. The focus moving forward needs to be on the creation of such a model and how best to drive the adoption of this seminal concept.

Keywords: Real Options, Real Options Analysis, Discounted Cash Flow, valuations, uncertainty, flexibility, decision making tool, South African mining, project valuations.
1 Introduction

1.1 Research Area and Problem

“Business conditions are fraught with uncertainty and risks. These uncertainties hold with them valuable information. When uncertainty becomes resolved through the passage of time, managers can make the appropriate mid-course corrections through a change in business decisions and strategies. Real Options incorporate this learning model, akin to having a strategic road map, while traditional analyses that neglects this managerial flexibility will grossly undervalue certain projects and strategies.” (Mun, 2006, p. 6)

The international mining sector is no stranger to volatility and risk. The industry faces continuous issues such as fluctuating commodity prices, unpredictable exchange rates, environmental concerns, labour issues and resource depletion. These factors, experienced throughout mining companies worldwide, resulted in a downward trend in share price, revenues and profits in 2013 (Deloitte, 2014). Additionally these risks and uncertainties were compounded during 2013 with a considerable slowdown in the Chinese growth rate, sending iron ore and coal into near oversupply and weakening commodity prices globally.

The importance of the mining sector for South Africa cannot be underestimated as it continues to add significant value to the GDP, with contributions to employment, taxes and export revenues (PwC, 2013). However, on the back of a weak international market, trends similar to those occurring in the global market were seen across the South African mining sector in 2013. The decreases seen in profitability and loss of market capitalisation were in line with global mining counterparts and although the weakening rand somewhat shielded the export market, the increase in cost base was an additional factor which negatively impacted on the South African mining sector (PwC, 2013).

The uncertainty and risk in the SA market, when compared with the rest of the world, is amplified by labour unrest and violent strike action over the past three years. Additionally the mining sectors’ large increase in impairment provision (the writing down of a company’s capital value) which increased from R2 billion in 2012 to R25 billion in 2013, highlights the difficulty and concerns with long-term decision-making in volatile markets (PwC, 2013). The risk and uncertainty felt by companies in the SA mining sector is further emphasised in the
table below (Table 1) which shows the key concerns held by South Africa’s major mining companies.

**Table 1: The top corporate risks as disclosed by SA mining companies**

<table>
<thead>
<tr>
<th>Risks – SA Mining Industry</th>
</tr>
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<tbody>
<tr>
<td>Labour unrest</td>
</tr>
<tr>
<td>Socio-economic impact</td>
</tr>
<tr>
<td>Volatile commodity prices &amp; foreign exchange fluctuation</td>
</tr>
<tr>
<td>Energy cost increases and power fluctuation</td>
</tr>
<tr>
<td>Safety and employee health</td>
</tr>
<tr>
<td>Loss of social license to operate</td>
</tr>
<tr>
<td>Resource nationalism and regulation uncertainty</td>
</tr>
<tr>
<td>Infrastructure</td>
</tr>
</tbody>
</table>

(PwC, 2013)

Although mining companies have a good record of openly disclosing the risks they face, they struggle to link these risks to the effect they have on financial performance (PwC, 2013). Moving forward the mining sector will need to accurately incorporate these uncertainties and risks into valuations (Deloitte, 2014), opening up the opportunity for the use of Real Options Analysis (ROA) and in so doing allowing for a substantially more accurate and realistic analysis.

### 1.2 Purpose and significance of research

“Behind every major investment decision lies some calculation of what that investment is worth. The evaluation of these investment decisions is a key driver in a company’s overall performance.” (Campher & Vlok, 2014, p. 194)

The importance and accuracy of a mine valuation is for both the company and its shareholders. Firstly, from an internal company perspective, mining is an extremely capital-intensive investment – a significant amount of research and development (R&D) and capital are invested into a mine prior to the creation of a revenue stream. Therefore if capital is required, as is usually the case, it is crucial that the mine is correctly valued at a figure which reflects its true projected worth. Secondly, from a shareholders’ perspective, investment into the commodities
sector is appealing as commodities are an attractive long-term investment and somewhat of a shelter in times of economic crisis (Baurens, 2010). This highlights the importance of investors comparing the market value of a mine/project to that of the assets book value before making a decision on whether to invest.

It is apparent in multiple papers (Block, 2007; Bowman & Moskowitz, 2001; Guthrie, 2009) that ROA is a more adequate method of judging projects which contain options when compared to the more traditional approach of Discounted Cash Flow (DCF). Although this finding is widely recognised amongst both academics and practitioners, the use of ROA in the real world isn’t as prolific (Baker, Dutta, & Saadi, 2011). However, with the increase in uncertainty and risk within the mining sector (Deloitte, 2014; PwC, 2013), the traditional, unsophisticated approach of the DCF model may need to be replaced by a model, such as ROA, which is able to account for these factors.

The purpose of this report is to investigate the extent of use of ROA as an asset valuation methodology within the South African mining sector. Using a keyword search of academic literature over the past 5 years, it was established that little exists surrounding the use of ROA in South Africa. In particular, no research on the use of ROA in South African mining industry was found. The majority of the report will be exploratory in nature and offer a starting point from which further analysis and exploration can take place. The ideal outcome will be the establishment of the extent of use of ROA by SA mining companies, as well an understanding of the expected uptake of the technique. Further, the researcher hopes to build an understanding of what alternative valuation techniques are being considered by mining companies and the criteria that management use when selecting these valuation techniques. Lastly the researcher plans to get a perspective of where valuation methodology is going in the future and whether Real Options will form a part of this.

### 1.3 Research Questions and Scope

The main research question is, “To what extent is Real Options Analysis being used in South African mining companies?” The research will be addressed in an exploratory nature and hopes to shed some light on the current state of project valuation techniques within the context of the South African mining sector.

The main research question consists of two sub-questions, which will supplement the primary findings by offering additional insight and knowledge.
“What criteria do management of mining companies use for deciding whether or not to use ROA as a valuation technique?”

The intention of this sub-question is to discover what companies think of ROA as a valuation tool. The researcher aims to determine the factors that have influenced its use by uncovering the user’s opinions regarding the benefits and drawbacks of ROA in practise. The researcher feels that the creation of these factors will lead to an understanding of the key criteria that management use when selecting a valuation technique.

“What intention does management have for ROA as a valuation technique and what future do they envisage for the technique?”

The second sub-question looks to explore the role of ROA, whether it is being used as a primary valuation technique or as a supplementary technique to complement simpler and more well-known techniques. Further it looks to provide an understanding into management’s thoughts on the importance of valuing uncertainty and flexibility, as well as to uncover the respondent’s belief surrounding the future direction of ROA and valuation techniques in general.

1.4 Assumptions

A key assumption underlying the report is that the South African mining sector is similar to that documented in international literature. Globally SA’s mining industry is seen as being fraught with volatility of commodity prices, exchange rate fluctuations and unpredictable labour issues – all critical factors in the valuation of a mine/project. The second major assumption is that the number of companies interviewed will be adequate to allow conclusions to be drawn for an entire industry, and that all participants interviewed from the firms will be suitably qualified. Finally, the researcher has made the assumption that participants interviewed shared information openly and honestly.

1.5 Research Ethics

In all social research, including qualitative research, ethical principles become a fundamental part of the research. This report forms part of the research community and will have the key ethical issues of research at its core: trust, respect and a general notion of “right and wrong” (Eriksson & Kovalainen, 2008). Ethical consideration will be a key focus throughout the report.
and will include the principles of: informed consent, avoidance of deception, confidentiality, credibility and plagiarism (Eriksson & Kovalainen, 2008).

Due to the use of interviews in the data collection process, the researcher was required to obtain a clearance form from the UCT Research Ethics Committee (REC) in order to conduct research involving people. Additionally, each of the respondents signed a consent form acknowledging their willingness to participate and their understanding surrounding the scope and purpose of the interviews. Because the nature of interviews requires the collections of personal opinions and ideas, all information and data will be treated as confidential findings and will only be released once permission from the respondent has been granted. Additionally, in order to protect the participants, all data and findings will be stored in a secure location and kept anonymous.
2 Literature Review

The literature studied for this research report commences with a discussion surrounding valuations, describing its core purpose and variety of uses. The most traditional and commonly used valuation techniques are then analysed. The report then takes an in-depth look at the theory underlying Real Options and how it works, before its use as a capital budgeting technique in the mining sector and its practical application in the real world are explored. The chapter then studies the international usage of ROA before looking at current valuation trends within a South Africa and in particular the use of ROA. The chapter concludes with the researcher laying out the propositions that were tested during the study.

2.1 Valuations

All assets have value, both financial and real, however the key to successful investing is understanding not only the value of these assets, but also the source of this value (Damodaran, 2012). The core issue surrounding valuation arises from the attempt to determine the value of the asset today. This valuation is primarily calculated by the cash flows expected in the future, discounted at the opportunity of capital cost (Firer, Ross, Westerfield, & Jordan, 2012). With this attempt comes a significant amount of uncertainty, both from the investment as well as the valuation technique itself (Damodaran, 2012).

The accuracy of a valuation is deemed critical as when people invest they have an expectation that on the sale of this investment, the value of the investment would have increased by an amount that compensates for the risk taken. It follows that determining an accurate or fair value for the asset is necessary for both the purchase and sale of an asset (Koller, Goedhart, & Wessels, 2010). Additionally the value placed on an asset is important from both the perspective of the shareholders (current and potential) as well as the management, both of whom require these valuation to make their decisions.

It is understood that sound financial management and capital investment are critical for a company’s success and that this can be aided through realistic and accurate valuations. (Bennouna, Meredith, & Marchant, 2010). Additionally it can be seen that valuations can form a significant part of management’s tool kit to ensure the correct decisions are made (Deloitte, 2014). The uses of valuations are extensive with the most popular uses including, financial
reporting, buying/sale of assets, mergers and acquisitions, recapitalisation, impairments and strategic business planning (Hitchner, 2011).

With a large amount of applicable uses (Hitchner, 2011) and a variety of valuation techniques from which to choose (Damodaran, 2011b) it is key to note that there is a variety of key criteria that management consider when confronted with the decision on which valuation technique to implement. The criteria, listed in Table 2 below, highlight the importance of valuation techniques to a company, as well as the multitude of factors that need to be considered by management prior to selection (Damodaran, 2012; Koller et al., 2010; Mun, 2006).

**Table 2: Valuation criteria considered by management**

<table>
<thead>
<tr>
<th>Criterion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical accuracy of valuation technique</td>
<td></td>
</tr>
<tr>
<td>Mathematical complexity of valuation technique</td>
<td></td>
</tr>
<tr>
<td>Ease of understanding of valuation technique</td>
<td></td>
</tr>
<tr>
<td>Use of valuation technique as a strategic planning tool</td>
<td></td>
</tr>
<tr>
<td>Standardisation of valuation technique across industry</td>
<td></td>
</tr>
<tr>
<td>Ability of technique to account for volatility and risk uncertainty</td>
<td></td>
</tr>
<tr>
<td>Ability of technique to allow for flexibility</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Damodaran (2012); Koller et al. (2010) & Mun (2006)

Literature shows that the majority of capital-intensive companies have a primary valuation method which is supplemented by a second and even third technique (Frykman & Tolleryd, 2010), allowing for a deeper understanding of the underlying investment and the comparison of numerical values.

The section below looks into the valuation techniques available, with a specialised focus on the primary valuations techniques used, namely the Discounted Cash Flow (DCF) and Multiples Valuation (Koller et al., 2010).
2.2 Valuation Techniques

There are multiple valuation techniques that can be used to value assets, such as companies and projects. Some valuations can only be used in specific situations, while others are preferred as supplementary techniques to the more recognised primary valuations. As discussed above, this decision comes down to a variety of considerations that need to be evaluated by the evaluator.

The most commonly used valuation models include,

- Discounted Cash Flow (DCF)
- Ratio-based valuations / Multiples valuation
- Residual income model
- Internal Rate of Return (IRR)
- Economic Value Added (EVA)
- Dividend Discount Model (DDM)
- Market comparison valuation
- Net-Asset Value (NAV)
- Real Options Analysis (ROA)

While there are many more types of valuations as well as hybrids of the above models, this report provides an overview of the two most common techniques, DCF and Multiple Valuation.

2.3 Discounted Cash Flow

The Discounted Cash Flow model is the most commonly used valuation technique by financial specialists when they are faced with decisions surrounding capital budgeting and returns on investments (Campher & Vlok, 2014). The expected future cash flows from the investments are discounted back by a risk-adjusted factor, consequently the higher the market and project risk the less attractive the project. It is also commonly recognised that if the net present value of the project returns a positive value then the project should be accepted as it is deemed to be creating value for the company. A key driver of DCF’s popularity is that the firm's value is based is on the cash flow generated by the company and not on the accounting profits, which can be easily manipulated (Koller et al., 2010). The main advantages of the DCF model include its simplicity and implementation-friendly design, which results in the findings being easily communicated and the model being widely accepted throughout all industries (Guthrie, 2013).
Despite its popularity, it is widely acknowledged by theorists and practitioners that the use of the DCF approach as a capital budgeting technique contains flaws (Brennan & Schwartz, 1985; Guthrie, 2013; Putten & Macmillan, 2004; Trigeorgis, 1993). In support of this Baker, Dutta and Saadi (2011) note that DCF does not reflect a realistic valuation of the investment, as it fails to account for Real Options which are an integral part of capital budgeting. Additionally the DCF model assumes that the investment is irreversible (Dixit & Pindyck, 1995) and that in contrast to reality, project decisions for DCFs are required to be made at the beginning of each project, thereby fixing the cash flow streams into the future (Mun, 2006).

The above factors lead to the DCF model being viewed as extremely inflexible – a significant flaw in the model. An additional concern surrounding the DCF model is its inability to adjust the risk factor applied throughout the entire project life-cycle, resulting in all risk being deemed to be accounted for by the selected discount rate (Mun, 2006). Further, the model disregards the stochastic nature of output price variation and while this approach towards price uncertainty may be acceptable for projects where the output price is reasonably predictable, it fails to address the natural resources industries where output price swings are not uncommon (Baker et al., 2011; PwC, 2013). Due to the operations of a resource mine being extremely vast, an additional concern surrounding the use of the DCF model in the resource industry is the model’s inability to value the entire life of the asset. The result is that in the latter part of the project the discount rate diminishes the additive value, causing a lower return than what could possibly be achieved (Lilford & Minnitt, 2005).

The DCF model continues to offer companies significant benefits and hence has become the most widely used valuation technique both internationally and across all sectors. Therefore in looking to future of valuation we must be realistic in our approach and need not look to dismiss the model entirely, but rather to look into where the shortfalls arise and how these can be overcome.

2.3.1 Multiples Valuation

The Multiples Valuation model is regularly used as a supplementary approach to the DCF model or when less information is available (Lie & Lie, 2002). The Multiples Valuation model is primarily used as a plausibility test against the cash flow forecast which has been created. The technique compares the market value of an asset relative to a key statistic, against those of
similar companies (Koller et al., 2010). The most popular multiples techniques used across all industries are Enterprise Value to EBITDA and the Price-to-Earnings (PE) ratio, these are due to the wide availability of the information required as well as the importance assigned to “earnings from assets” as a driver of value (Damodaran, 2011a).

Koller et al. (2010) state that there are 3 key requirements in order to carry out the comparable multiples analysis.

- Ensuring the correct multiple is used
- Calculating the multiple in a consistent manner
- Using the right peer group (industry) for comparison

The advantages surrounding the use of valuation multiples include the simplicity of the model, which is extremely user-friendly and easy to understand (Suozzo, Cooper, Sutherland, & Deng, 2001). Additionally the model is relevant as it focusses on key statistics used by other investors, which are commonly available. The usefulness of the model is that it provides a framework from which informed decisions can be made, however with the above being said Suozzo et al. (2001) state that the model does come under criticism from valuation experts. The key criticism levelled against the Multiples Valuation model is that it only takes a snapshot of the current view of the company, thereby failing to capture the dynamic and evolving nature of business. Additionally it oversimplifies information by combining it into a single figure, making it difficult to establish what the true value drivers within the company are. Lastly the comparison of multiples is often misunderstood, with users comparing the ‘same’ values between companies, however these may have been manipulated using different accounting practises.

In summation, if the DCF and Multiples Valuation models contain the limitations discussed above, it must be asked why adjustments to models have not been made, or additionally if new models are being considered to assist in overcoming these shortfalls?

Research conducted by Colwell, Henker and Ho (2002) shows that top managers do not strictly follow the DCF guidelines but rather, in order to allow for flexibility, managers make ad-hoc adjustments to the DCF valuation model. Baker et al. (2011) state that although these adjustments allow for a more realistic evaluation, a more complete and comprehensive method of allowing for overcoming the shortfalls of the traditional models, such as inability to account
for uncertainty within the projects and the influence of management, would be to implement the use of Real Options Analysis.

### 2.4 Real Options

#### 2.4.1 Theoretical Overview

The term “Real Options” was initially used by Myers in his 1977 article “Determinants of corporate borrowing” and was based on the theory of financial options, which was pioneered by Black and Scholes (1973), Merton (1973) and Cox, Ross and Rubinstein (1979). Real Options Analysis is simply the method of applying financial option pricing theory to the valuation of a real world investment which contains flexibility (Borison, 2003). It is the Real Options model's ability to handle flexibility and situations which involves significant upside and downside risk and that creates a significant advantage over the DCF model (Baker et al., 2011).

Mun (2002) defines a financial option as the right, but not the obligation to buy or sell an asset, whereas a real option can be seen as “a right but not an obligation to undertake some business decision” (Baker et al., 2011, p. 22). The comparison between financial and Real Options can be simplified using an example. Bowman and Moskowitz (2001) divide a project into two stages, the first stage is a small initial investment which gives the company the right to partake in the project, the equivalent of the company purchasing a financial option. The second stage occurs once more information is known and is the decision on whether or not the company must make a larger investment in the project, this resembles the decision on whether the company should exercise the financial option.

<table>
<thead>
<tr>
<th><strong>Table 3: Comparison between a financial option and a real option</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Option</strong></td>
</tr>
<tr>
<td>Current value of stock</td>
</tr>
<tr>
<td>Exercise price</td>
</tr>
<tr>
<td>Time to expiration</td>
</tr>
<tr>
<td>Stock value uncertainty</td>
</tr>
<tr>
<td>Riskless interest rate</td>
</tr>
</tbody>
</table>

Source: Martínez & McKibben (2010, p. 228)
Although there are many similarities that can be seen between financial and Real Options, theorists (Mun, 2006; Yeo & Qiu, 2003) point out that important differences also exist. Firstly, while the expiration time for financial options is usually several months, the expiration time of Real Options is far longer (multiple years) with some exotic-type Real Options having no expiration date. Secondly, the underlying asset for a financial option is simply the stock price, while for a real option there is a host of business variables. A final key difference is that in the case of Real Options, management can increase the option value through their decisions, flexibility, assumptions and actions, while the same cannot be said for financial options.

The theory surrounding Real Options highlights its potential as a valuation technique and how the opportunity for significant benefit exists if the valuation methodology is correctly applied within a suitable context.

### 2.4.2 How Real Options Work

Real Options deal with making decisions surrounding investments, the most common being the capital budgeting of projects. The core responsibility of the Real Options valuation method is determining the “financial market value” (Borison, 2003). The result from this calculation forms the basis of a company’s strategy and influences the decisions made. These factors have resulted in the use of Real Options Analysis being widely acknowledged as a strategic tool. Janney and Dess (2005) explain that the key to understanding how Real Options is used, is the acknowledgement that there is value in resolving uncertainties in any decision.

There are multiple types of Real Options available for use by management, as different types are needed to assist the variety of real-life options that face companies. Trigeorgis (1993) initially explained the types of Real Options through the practical application of a project, resulting in the option to defer, expand, or contract. Using a more mining-focused approach Colwell et al. (2002) investigated the ownership of a mining operation with the option to open, close or abandon the mine. Additionally in a 2005 paper, Janney and Dess (2005) believe that all Real Options can be separated into four distinct types – immediate entry, immediate exit, delay entry, and delay exit. Subsequent to this in a more recent survey, Baker et al. (2011) looks at the six most commonly used types of real options as discussed in financial literature. In his survey he asks companies who use Real Options to state which of the six they commonly use. The results presented in Table 4 below, show that the majority of the respondents reported...
use of all six Real Options. The findings are reported in decreasing order of use: growth (85%),
the right to defer (80%), flexibility (77%), abandonment (69%), staged investment (67%), and
entry and exit (51%).

Table 4: Different types of Real Options

<table>
<thead>
<tr>
<th>Real Option</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>Option to increase capacity</td>
</tr>
<tr>
<td>Right to defer</td>
<td>Option to delay investment</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Option to alter output or input</td>
</tr>
<tr>
<td>Abandonment</td>
<td>Stop use of the investment, obtain salvage value</td>
</tr>
<tr>
<td>Staged Investment</td>
<td>Staggering the investment into stages, re-analysing at each stage</td>
</tr>
<tr>
<td>Entry &amp; Exit</td>
<td>Option to exit investment &amp; re-enter in more favourable conditions</td>
</tr>
</tbody>
</table>

Source: Baker et al. (2011, p. 16)

The survey (Baker et al., 2011) highlights the variety of Real Options that are available as a
tool to management to assist with capital budgeting. Additionally it emphasises the ease of
interchangeability between the types of real options used once a firm has implemented and
understood the use of Real Options Analysis.

The pricing techniques of Real Options form a concern for management, as the sophistication
of the valuation method is significantly more complex than the DCF model (Baker et al., 2011).
Block (2007) states that the three primary Real Options pricings models approaches that have
been used in real options evaluations are the binomial lattice, Monte Carlo Simulation and the
risk-adjusted decisions tree.

Binomial Lattice model:

The binominal option pricing model uses a multiplicative binomial distribution to
assess the future value of the underlying asset. A critique of the binomial model for
Real Options investment analysis is that the binominal tree can grow problematically
large over long forecast periods. However, the binomial model is most effective when
there is only one fundamental source of uncertainty. Additionally, the binomial model
requires less mathematical knowledge than other Real Options models and, as with the
finite-difference schemes, it is intuitive and practical in nature (Lander & Pinches, 1998).

Monte Carlo model:

The Monte Carlo approach (Boyel, 1973) is a sophisticated risk analysis tool which has gained increasing popularity in recent years (Bennouna et al., 2010). Unlike the Black-Scholes or binomial lattice approach, the Monte Carlo approach is able to manage path-dependant payoffs and multiple uncertainties. Additionally the approach is not limited by the assumption of a normalised probability distribution. A critique of the model is that a comprehensive understanding of advanced mathematical techniques are required (Boyel, Broadie, & Glasserman, 1997; Longstaff & Schwartz, 2001).

Risk adjusted decision trees:

This model is similar to the Monte Carlo model in that it is highly sophisticated and complex, and therefore requires a significant understanding of mathematics in order to fully understand the model. It is primarily used for options with sequential risk. Similarly to the Binomial Lattice model, a critique of the model for ROA is that the decision tree can grow problematically large over long forecast periods (Damodaran, 2012; Lander & Pinches, 1998).

In addition to these three primary pricing options models, more specialised and complex models (Brennan & Schwartz, 1985; Longstaff & Schwartz, 2001; Trigeorgis, 1991) do exist, however these are either infrequently used or based on the same fundamental principles as above.

2.4.3 ROA as a capital budgeting technique in the mining sector

“Real Options Analysis is a valuation and strategic decision making tool that applies financial option theory to real assets.” (Martinez & McKibben, 2010, p. 228)

The concept of Real Options as a capital budgeting technique has been around for almost three decades, with Colwell et al. (2002) attributing Brennan and Schwartz (1985) with the first theoretic paper to use Real Options methodology to value physical assets. In what has become one of the most well-cited articles in this area of research, Brennan and Schwartz (1985) treat the output price as stochastic. This results in the use of this model being extremely well-suited
for analysing natural-based resource projects. Evaluation methods for capital budgeting such as ROA, which are able to incorporate flexibility are generally accepted to be more accurate and realistic than the non-flexible traditional methods (Brennan & Schwartz, 1985; Mun, 2006; Samis, Martinez, Davis, & Whtye, 2012). Although Zhang et al. (2014) state that the use of Real Options has initially focussed on the capital budgeting, they mention that over the past decade it has been significantly extended as analytical tool for areas such as, natural resource investment, new products to start ups, corporate acquisitions and the purchasing of factories.

Zhang et al. (2014) further states that ROA is best-suited to offering an accurate valuation of the mine, by its capabilities to take into account uncertainties and operational flexibilities such as commodity prices, changes in operating and capital costs, extraction rates, technology improvements, etc. Additionally Real Options can be used for valuating key managerial decisions such as opening, closing, expansion and contraction of production according to the changes in market conditions.

The benefits surrounding the use of Real Options in the mining sector is highlighted by the Figure 1 below. The figure shows the real gold price between 1968 and 2012. It validates the worldwide trend of gold-producing companies’ decisions to delay projects between 2000 and 2012 as the price of gold substantially increased (Zhang et al., 2014). The moderate volatility seen in the gold price creates an incentive for delaying the investment and waiting for future price information to come in, so better-informed decisions can be made.
Schwartz (2013) explains that the major concern with traditional techniques is that projects with a variety of options within them are often overlooked. The use of Real Options opens us up to the opportunity to explore the value that could be associated with growing, delaying or abandoning an investment. Although pertinent to all investments, these options are of significant importance to mining companies, from that fact that numerical value attributed to unutilised mineral deposits is often significant (Uberman, 2014).

Moel and Tufano (2002) offer a more complex and detailed example of ROA and its ability to account for both uncertainty and managerial flexibility. Through empirical research they examine the opening and closing decision of 285 developed North American mines in response to the commodity price fluctuation, using a Real Options model developed by Brennan and Schwartz (1985). In a slight adjustment to the model, Moel and Tufano (2002) allow for the “portfolio effect” which states that companies may take into account the profitability of mines at their other locations when considering a decision to close a mine. For the purpose of the study mines were classified into being in one of three states; open, temporarily shut or permanently abandoned. Although non-economic reasons exist for the closing of mines, such as environmental concern and resource depletion, this study focused purely on mines which had shut due to economic factors. The result of the study indicated that strong correlation existed
between the decision to re-open or close the mine and the following factors; commodity price, costs of operating/maintaining the mine, operations prior to opening/closure and the volatility of market. Significantly the study showed that Real Options Analysis offered a close set of predictions to the real-world decisions and can be used to explain the closing and re-opening of mines.

In a more recent study conducted by Martinez and McKibben (2010), a small gold deposit is evaluated while under the focus of gold price uncertainty. The paper shows that while more difficult to implement, the Real Options Analysis allows for a clearer and more accurate overview of the mines performance, allowing analysts to look at maximising the upside potential of the project while minimising the downside risk. The study emphasises that flexibility and uncertainty are important components to be considered for investment projects and shows that option pricing frameworks such as ROA provide a powerful tool for analysing these components (Schwartz, 2013). We find because Real Options places value on management's ability to make decisions: it is found that the Real Options valuation will produce a figure that is higher than static DCF valuation, which assumes a single decision pathway and fixed outcomes (Mun, 2006). Guthrie (2013) agrees with these findings by stating that a DCF model undervalues the worth of projects and in particular when projects are in the initial stages and significant options are available to the client. The more uncertainty and opportunity for flexibility, the greater the embedded option that exists.

It is not surprising from the above that capital-intensive industries such as oil and gas or mining have embraced the use of real options more significantly than others. It is in these industries we find that, “volatility and uncertainty is high and the need for flexibility is at a premium” (Yeo & Qiu, 2003, p. 250). Additionally in a PwC (2013) report focussed on the SA mining sector, it is stated that the uncertainty within the SA mining sector is comparatively high and that the need for companies to understand and react to this uncertainty is critical.

Putten and Macmillan (2004) consider a different approach to previous ones put forward as they propose that the core problem regarding Real Options application lies in the assumption that the DCF analysis and Real Options Analysis are mutually exclusive. They state that it is beneficial to supplement the use of the DCF model with that of ROA model, thereby overcoming the weaknesses in the DCF capital budgeting approach. They explain that the data required for both models is similar and therefore the DCF analysis should be performed first to
obtain the base findings before using the ROA technique to expand the information and knowledge surrounding the valuation. Further, Putten and Macmillan (2004) state that ROA complements the DCF model as it provides a value on management’s ability to abandon a project before investing large amounts of capital into it.

A similar thought process is held by Campher and Vlok (2014) who suggest that rather than using two separate approaches, they integrate the two approaches into one model. Campher and Vlok (2014) state that the integration of models would better reflect the reality and complexity of a company’s potential projects when compared with a standard DCF model and that it additionally offers an ease of understanding and more transparency when compared with a full ROA approach. The use of both techniques will form an overlapping area where decision tools from both approaches are brought out to maximise the understanding of the valuation (See Figure 2 below). The figure also highlights how currently the techniques are used for different decision climates depending on the level of uncertainty, while in the new setup the same model could be applied to all situations. It must be noted that the new model does not offer the same in-depth analysis as a pure ROA technique, as less variables are permitted, meaning more assumptions need to be made.

**Figure 2: DCF and ROA complimentary area**

2.4.4 Real Options in Practice Internationally

“More than 30 years after the term was coined, Real Options have yet to be adopted by most companies as a tool for strategic decision making” (Baker et al., 2011, p. 19). Although the subject of Real Options has thrived in academia with numerous books being published on the topic (Amram & Kulatilaka, 1999; Copeland & Antikarov, 2003; Guthrie, 2009; Mun, 2006), the same cannot be said for the implementation of the theory by management, where the lack of use in real-world analysis internationally has been highlighted in many papers (Baker et al., 2011; Block, 2007; Guthrie, 2013; Putten & Macmillan, 2004).

The poor uptake of ROA by management is highlighted in a 2005 survey on American Fortune 1,000 companies (Block, 2007), in which companies were surveyed to see whether they were using Real Options Analysis to complement traditional analysis. Of the 279 respondents, only 40 (14.3%) were currently using Real Options. In a similar study on large sample of Canadian companies conducted (Baker et al., 2011), the results were similar with only 36 of 214 (16.8%) of the respondents reporting the use of ROA as capital budgeting tool.

However, Martinez and McKibben (2010) believe that the recent downturn in the world economy has shown that the need for operating flexibility and strategic adaptability will be crucial for the long-term success of resource-based companies. Additionally Martinez and McKibben (2010) state that it is the early planning stages, prior to the completion of the feasibility study, where there is the largest scope to explore options, assess project risk and implement changes focussed on cutting cost and maximising upside potential. Moel and Tufano (2002) believe that this flexibility, which aligns closely with the flexibility needed when evaluating mining projects, is one of the primary reasons that there has been considerable research done in the field of Real Options. It is this flexibility that provides management with a much-needed tool to assist in creating the company’s strategic path (Baker et al., 2011).

In a report by Deloitte (2014), they highlight that if companies are to succeed going forward, they are not only going to have to improve efficiency, they will be also be required to scale their operations to suit the individual projects. They state that this can be achieved through understanding difference between the project’s value and the price the market places on the project, as this will assist with companies' funding practises.

The question must therefore be asked “why are more companies not using ROA?”
A range of theories have been suggested as to the reasons why real option-based models are not being used in practice, with the most commonly cited theories from international surveys conducted by Baker et al. (2011), Block (2007), and Bowman & Moskowitz (2001). The key finding, central to all three surveys, was the lack of understanding of Real Options models by management. The complexity and sophistication of the models, along with the fact that most managers do not have the expertise to understand the workings of the model, result in managers being unwilling to implement ROA as a valuation tool. Additionally, further discouragement of the use of ROA is due to a lack of top management support, as well as the DCF model being seen as a tried and tested technique, which is accepted throughout industry.

According to Stout, Xie and Qi (2008) it is imperative that managers become knowledgeable regarding the workings of Real Options before they can be expected to use it as an approach for capital budgeting. Additionally Baker et al. (2011) conclude that as the DCF technique took decades to become a well-known technique for analysing capital budgeting, and that given the complexity of Real Options, this same trend might be experienced by ROA.

There is little doubt that in theory Real Options offers the user-substantial benefit which is hard to find in the more commonly known valuation techniques. However at this stage there appears to be minimal literature both internationally and locally offering examples and case studies of how ROA has been implemented in real-world applications and the benefits that have arisen as a result. If ROA is to grow as a valuation technique in the future, this gap in literature will need to be closed.

### 2.5 Valuation techniques within the South African

In a capital budgeting literature survey on South Africa, conducted by Correia (2012) between 1972 and 2008, it was found that a significant growth in the use of the DCF model had occurred. The survey found that the DCF model was the most widely use valuation method within South Africa, with 82% of companies reporting its use. These findings were supported by a research paper focussing on Capital Budgeting techniques in the SA mining companies (Maroyi, 2012) which showed that of 13 major mining companies listed on the Johannesburg Stock Exchange 69% of mining companies reported the use of the DCF valuation technique.
In another South African-based survey focussing on the use of capital budgeting practices, conducted by Correia and Cramer (2008), it was found that there was a very low utilisation (10.7%) of Real Options Analysis methods, such as decision trees and the Monte Carlo model. Additionally Mokenela (2006) reports that in a survey of the top 40 companies on the Johannesburg Stock Exchange only 9% of respondents indicated a use of Real Options in project evaluation.

Lilford and Minnitt (2005) compare a range of valuation techniques, with reference to the South African gold industry. They conclude that “the most fundamental limitation governing all valuation methodologies rests with the valuer” (Lilford & Minnitt, 2005, p. 40). The statement from Lilford and Minnitt (2005) emphasises the concern that the complexity of Real Options is detrimental to the uptake, as it requires a person of substantial mathematical ability to build the model and additionally requires significant education of management. These thoughts align with the perspective of Stout et al. (2008) who imply that management education is a core driver of the uptake of Real Options.

Although there is literature, primarily in the form of surveys, surrounding the use of valuation techniques in South Africa prior to 2008, there appears to be a lack of literature that focusses solely on the use of Real Options Analysis. In addition, there has been little published in the last five years regarding the capital budgeting techniques of the South African mining sector and the trends that can be expected in the future. Interestingly we find that above findings are in contrast to the international community which continues to produce significant academic literature on the subject of Real Options.

2.6 Summary and Proposition

It is evident from the literature above that the uncertainties and risks involved in the mining industry are increasing and that in order for companies to be successful in the future they will need to find a valuation technique which better interprets and accounts for these factors. In the South African context, the volatility of the mining sector is further exaggerated when compared to that of developed countries, primarily due to the fluctuating exchange rate, labour concerns and political instability.
The literature shows that valuation techniques not only play a role as a financial reporting tool, but offer management a key decision-making tool which is critical to the business's direction and overall performance. It is accepted that currently the DCF valuation technique is the primary technique used for valuation purposes and offers users substantial benefits including simplicity and transparency. Although based on the company’s projected cash flow, resulting in what the majority of management refer to as a “fair valuation”, it is widely recognised that significant flaws exist within the DCF model. The DCF model can only allow for a fixed decision path, thereby making it unable to account for management’s flexibility within projects. Additionally the DCF model cannot account for varying uncertainty as it is only capable of adjusting for risk using a single discount risk factor. It is from these downfalls where the interest and opportunities surrounding Real Options is created.

Theorists continue to emphasise the significant accuracy and value that can be offered by Real Options Analysis, as it is able to accommodate both the uncertainty and volatility within a project while also evaluating the potential options. Thus ROA’s value lies in its ability to assist as both a financial reporting tool and – more importantly – a strategic decision-making tool. Despite these benefits, international studies have identified a number of challenges that have reduced the adoption of Real Options, with recent surveys showing that the lack of use by management is primarily due to the sophistication and mathematical complexity of the models. It however, is valuable to note that throughout all the surveys which were analysis there continues to reflect a small range (8–18%) of companies who have implemented the use of Real Options Analysis as a valuation technique, providing evidence that ROA can and is being used in a real world context. The table below summarises the benefits and concerns surrounding Real Options.
Table 5: Major benefits and concerns of Real Options Analysis as a valuation technique

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical accuracy of valuation technique</td>
<td>Mathematical complexity of valuation technique</td>
</tr>
<tr>
<td>Ability to allow for flexibility</td>
<td>Standardisation of valuation technique across industry</td>
</tr>
<tr>
<td>Ability to account for volatility and risk uncertainty</td>
<td>Ease of understanding of valuation technique</td>
</tr>
<tr>
<td>Use of valuation technique as a strategic planning tool</td>
<td></td>
</tr>
</tbody>
</table>

The researcher looks to understand whether these same benefits and concerns described by academic literature are of equal importance amongst valuation experts in the SA mining industry.

The propositions below reflect an overview of the key findings which have emerged from the literature. Further the propositions aim to uncover the answer to the report’s main research question and the sub-questions, as discussed previously (see Chapter 1.3).

2.6.1 Proposition 1
The use of accurate valuation techniques in the mining sector is critical for the future success of companies.

2.6.2 Proposition 2
Simple and implementation-friendly valuation techniques are being more commonly used than more complex and accurate valuation techniques.

2.6.3 Proposition 3
ROA offers a well suited technique for valuing natural resource-based projects, as it allows for the inclusion of uncertainty and significant flexibility regarding decisions.
2.6.4 Proposition 4
The poor adoption of ROA as a valuation technique is driven by its mathematical complexity, which results in a lack of understanding by management.

2.6.5 Proposition 5
Resource companies need to increase their operational and strategic flexibility, highlighting the need for future valuation techniques to accommodate these factors while remaining transparent and easy to understand.
3 Methodology

“Qualitative research is particularly relevant when prior insights about a phenomenon under scrutiny are modest, implying that qualitative research tends to be exploratory and flexible because of ‘unstructured’ problems” (Ghauri & Gronhaug, 2005, p. 202). From the literature review above, it is evident that little research has been done regarding the use of Real Options Analysis in the South African mining sector. Therefore, in order to investigate the usage of ROA within the South African mining context, the researcher investigated the current trends surrounding valuation techniques using a qualitative structure.

3.1 Research Approach and Strategy

The report, which is exploratory in nature, uses a qualitative research method based on an interview process.

Peshkin (1993) states that the use of a qualitative research study allows for a clear description on the topic to be revealed and that this enables the researcher to create an interpretation surrounding the insights gained on the topic being investigated. Additionally the qualitative study helps the researcher test the validity of certain assumptions, claims and theories used, providing the researcher a base from which to evaluate the topic.

The qualitative inquiry, which was based on an interview process, allowed for different views on the topic to emerge, as the respondents' replies were given in an open-ended style of communication (Henning, van Rensburg, & Smith, 2004). Furthermore, the use of the interview process enabled the researcher the opportunity to discover the participants' beliefs and perspectives about the facts, their present and past behaviours, as well as their views on what should be done in certain circumstances (Leedy & Ormrod, 2010). The topic was explored from multiple perspectives and in a way that encouraged responses that were meaningful and probing, resulting in significant and valuable data being gained by the researcher surrounding the topic in question.

The responses collected were interpreted by the researcher in order to determine the extent of use of Real Options Analysis as a valuation technique, as well as the current valuation trends within the South African mining sector. The report uses inductive reasoning as the conclusions drawn and theories created are based on the outcomes of the interviews (Leedy & Ormrod,
Additionally using the research format mentioned above, the researcher was able explore a relatively unknown topic and guide the participants into offering insight and knowledge that the researcher could not have foreseen (Eriksson & Kovalainen, 2008).

### 3.2 Research Design, Data Collection and Research Instruments

The report took on a qualitative styled approach (Leedy & Ormrod, 2010), with the goal being to gain an understanding of the topic through the respondents personal experiences, insights and thoughts. The information was gathered using face-to-face, semi-structured interviews. The interviews were conducted with personnel who have had extensive experience with valuations within the SA mining sector. Due to the South African mining sector being predominantly based in Gauteng, all ten interviews were held in Johannesburg. A discussion with the international mining consultant was held via a Skype interview as the respondent was situated in London.

The use of a semi-structured interview allowed for the opportunity to let the conversation evolve and provided a wider lens on the participants' overall thoughts on the topic. The creation of the guiding questions (see Appendix A) ensured that the interview covered all necessary topics, while not creating the questionnaire style of structured interviews (Cooper & Schinder, 2008). The interviews roughly followed the framework presented in Table 6 below, as it looked to align with the propositions uncovered in the literature.

**Table 6: Interview guide framework**

<table>
<thead>
<tr>
<th>Part 1: The purposes and accuracy of valuation techniques</th>
<th>Understanding what a valuation technique is its different uses as well as the importance of accuracy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2: Current valuation techniques</td>
<td>Discussion surrounding primary valuation techniques, including why such techniques are used and what criteria have driven these decisions.</td>
</tr>
<tr>
<td>Part 3: Real Options Analysis</td>
<td>Discussion surrounding Real Options theory, its advantages and the variety of uses available to management.</td>
</tr>
<tr>
<td>Part 4: Downfall and complexity of ROA</td>
<td>Discussion on the adoption and extent of use of ROA within the SA mining sector. Discussion surrounding ROA drawbacks.</td>
</tr>
<tr>
<td>Part 5: Future of valuation techniques</td>
<td>Discussion on the future of valuation techniques and whether ROA will be a part of this future. Ways of driving ROA growth.</td>
</tr>
</tbody>
</table>
The research methods instruments used included a review of the current literature as seen in Chapter 2, an interview guide which can be found in Appendix A, and the responses from the interviews conducted, of which selected quotations can be seen in Appendix B.

3.3 Sampling

The population selected for the research of this report includes all South African organisations and individuals who undertake the exercise of valuing mining assets, such as mines or mining projects. The researcher used a non-probability sampling technique, purposive sampling, to identify participants for the interview process. The use of this methodology resulted in the interviewing of participants who had a vast amount of experience and were able to offer the researcher a significant amount of insight and knowledge surrounding the proposed topic (Cooper & Schinder, 2008).

The researcher initially envisaged interviewing only employees from companies who formed part of the Chamber of Mines South Africa (COMSA), so as to obtain a narrow and focussed opinion on the use of Real Options Analysis as a valuation technique in the SA mining sector. However due to the lack of knowledge surrounding Real Options Analysis, this left the pool of “experts” to be interviewed very small and securing interviews proved difficult. Therefore a decision was taken to expand the population by including individuals from non-mining organisations such as investment companies, mining consultants and research companies.

In order to ensure that the data collected was accurate, the researcher’s target population was focussed on interviewees who could be defined as valuation experts and additionally had in-depth knowledge and experience in dealing with valuations in the SA mining sector (Cooper & Schindler, 2003, p. 152). Having worked in the mining sector previously, the researcher was able to utilise contacts known in the industry to secure the interviews. Additionally the researcher used a snowball sampling technique (Wegner, 2010) by asking each interviewee to recommend additional candidates who they would recommend as potential interviewees. In the end, the researcher was able to conduct 10 interviews with valuation experts with knowledge applicable to the South African mining sector. Additionally, a discussion was held with an international valuation expert with prior experience in South African mining industry to help the researcher gain some perspective on the current international situation and how it compared to findings uncovered about the SA mining sector.
3.4 Data Analysis

To ensure the gathering of information was accurate and comprehensive, the researcher documented each interview by note-taking and tape-recording. Following this, each interview was transcribed and analysed.

The cornerstone of the data analysis was identifying common themes amongst the responses collected (Leedy & Ormrod, 2010). Following the transcription of the interviews, the researcher took on the following steps (Creswell, 1998; Leedy & Ormrod, 2010),

- Identified statements that related to the topic, sorting out the relevant information from the irrelevant
- Grouping the statements into categories which related to the various themes that emerged
- Developed an understanding and insight surrounding the topic being explored
- Concisely combined and summarised the data collected

Once the above framework and tools of a qualitative study had been applied to the findings, the researcher constructed the analysis, discussion and conclusions of the topic, thereby creating a better understanding of the topic in question.
4 Research Findings, Analysis and Discussion

4.1 Introduction

This section will first present a profile of the interviewees, detailing their position, company and the type of company. For the purpose of anonymity, names of the respondents will not be divulged. Following this an analysis and discussion of the findings that have emerged from the interviews is presented. The findings and analysis are structured around the proposition set out and themes that have emerged. Where applicable, direct quotes from the respondents have been used.

4.2 Profile of Respondents

In total, 10 interviews were conducted with various South African mining valuation specialists who have had dealings with Real Options Analysis. Additionally, a Real Options Specialist from the UK offered an international view on the topic at hand. Consideration was given to individuals selected, who were chosen from a variety of companies who deal with mining valuations from different perspectives. Upon completion of the interviews, strong common findings emerged from the interviewee responses and as a result the researcher believes the sample size is able to fairly reflect the thoughts surrounding valuations within the SA mining sector.

Table 7: Interview respondents

<table>
<thead>
<tr>
<th>RESPONDENT</th>
<th>COMPANY</th>
<th>COMPANY TYPE</th>
<th>POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MacQuarie</td>
<td>Investment Bank</td>
<td>Analysts</td>
</tr>
<tr>
<td>2</td>
<td>Teal Mining</td>
<td>Mining Consultant</td>
<td>Projects Manger</td>
</tr>
<tr>
<td>3</td>
<td>Sibanye Gold</td>
<td>Mining Company</td>
<td>Finance Team Leader</td>
</tr>
<tr>
<td>4</td>
<td>ABSA</td>
<td>Investment Bank</td>
<td>Finance Team</td>
</tr>
<tr>
<td>5</td>
<td>Avior Research</td>
<td>Research Company</td>
<td>Executive Analysts</td>
</tr>
<tr>
<td>6</td>
<td>Renaissance Capital</td>
<td>Research Company</td>
<td>Senior Analysts</td>
</tr>
<tr>
<td>7</td>
<td>Samancor Chrome</td>
<td>Mining Company</td>
<td>Financial Manager</td>
</tr>
<tr>
<td>8</td>
<td>African Rainbow Minerals</td>
<td>Mining Company</td>
<td>Project Head</td>
</tr>
<tr>
<td>9</td>
<td>ENRC Management</td>
<td>Mining Consultant</td>
<td>Mining Manager</td>
</tr>
<tr>
<td>10</td>
<td>Insights</td>
<td>Mining Consultant</td>
<td>Owner</td>
</tr>
</tbody>
</table>
4.3 Application and importance of valuations

The theory in Chapter 2.1 revealed that valuations are used for a variety of reasons across all industries, with the most common being financial reporting, buying/selling of assets, mergers and acquisitions, recapitalisation, impairments and strategic business planning (Hitchner, 2011). It is this diverse range of purposes that has resulted in so much academic and practical attention being applied to valuations over the course of history, whether it be the valuation inputs, inner working of the model or the final valuation outcome. As this research report explores Real Options Analysis, one of the most mathematical and complex valuations, the researcher set out to discover what key purpose the SA mining sectors uses valuations for.

For what purposes does your company use asset valuations?

The different uses of valuations were wide-spread across all respondents with the core purposes including:

- Valuing the worth of an asset (a project or company)
- Entry and exit strategies for potential projects
- Acquisition or impairment of an asset
- Staging an investment
- Valuing opportunities that exist within a project

Additionally, two respondents noted that through the financial valuation of projects, it allows for ease of comparison between projects of different natures. This is of major assistance to managers who are involved in the decision making processes of large companies with a wide business scope. This thought process of comparison reappears in later discussions where the need for commonality and consistency in valuations plays a large role in the popularity of the DCF model and the slow adoption of ROA.

Respondent 5 commented that the variety of uses of valuation techniques within the mining sector was due to the high uncertainty and flexibility that exists within the industry. This uncertainty and flexibility results in management continuously looking at the different options available and calculating the next best move for their company. Additionally respondents noted that the valuation of uncertainty and flexibility was extremely tough and the ability to truly
evaluate these factors was not possible using all valuations techniques and is the key strength in the Real Options argument (Baker et al., 2011).

A major theme which was intertwined throughout all the purposes of valuations was the way ROA continuously contributes to the strategic direction of a company and the importance of its role as a primary decision-making tool. The respondents commented that strategic decision-making was critical to the future success of a business and that far too little future planning is done within South African companies. One respondent commented that use of certain valuation tools such as Real Options encourages continuous strategic planning by management and was thus an integral part of all decision making.

In line with these findings, it was continuously noted by the respondents that the importance of producing a realistic and accurate valuation figure cannot be underestimated. The thoughts of Koller, Goedhart and Wessels (2010, p. 3) are in agreement with the respondents' as they state that “value is the defining dimension of measurement in a market economy”. Theory suggests that Real Options can provide additional knowledge, insight and accuracy into a valuation, encouraging the researcher to establish the importance valuation experts place on the accuracy of a valuation.

*What level of importance do you or your clients place on the accuracy of a valuation?*

Nine of the 10 respondents reported that the accuracy of the valuation figure is of critical importance to both their own company and their clients. Additionally, as valuation experts, the respondents emphasised that accuracy was a key criteria of their job performance and an area of significant focus. Regarding the subject of valuation accuracy, Respondent 1 stated, “It’s massively important, one of the key reasons clients employ us is to ensure that the valuations they use are accurate and fair.”

It was noted that companies base their long-term financial decisions heavily on the valuation figures produced and therefore management feel it is only appropriate that a significant amount of time and knowledge is spent on a valuation. It was mentioned that additional time is spent on areas over which the company has control. The example given was that a mining company usually has control over the cost to extract and process the ore body, therefore this area of the valuation is done as accurately as possible to assist in the correct decision-making.
“When valuing something like the potential cost of building a mine we try be extremely accurate, for a large mine this valuation can take us anywhere between 3 – 5 years. Costs are an area we feel we have relative control over, so it is vital that we account for it as best we can. On the other hand, it is nearly impossible to predict future resource prices so we almost go for a “best guess” type approach, or try see what the market consensus is.” ~ Respondent 8.

The concern surrounding a more relaxed approach to finding some of the input figures (such as best guess or market consensus), was that management relied primarily on the very final valuation figure on which to base their decisions, as opposed to dissecting and understanding the entire model (Suozzo et al., 2001). This approach results in all underlying assumptions being important and affecting the final valuation figure. Additionally if a company uses market consensus figures the respondents mentioned that they were never allowing themselves the opportunity to possibly discover value that was hidden from the rest of the market, thereby denying themselves the opportunity of a finding some competitive advantage. The researcher believes the above points are substantial enough to create the argument for the companies who insist on evaluating every assumption in detail and analysing the majority of their data internally. Respondent 2 commented that, “management need the right valuation figure, so they can make the right decision, it’s as simple as that... So they will do everything in their power to ensure they’re looking at the best data.”

Additionally almost all respondents agreed that management and shareholders could easily understand and relate to financial numbers. No matter the type, size or geographic location of the project or asset, management and shareholders are continuously weighing up the financial reward versus the potential risk involved and deciding whether the investment is suitable for their company at this moment and also going forward.

“The risk reward ratio always needs to be sufficient in order to go into an investment, so it’s the valuation that helps us asses this.” ~ Respondent 5

One respondent felt that the accuracy of valuations was not as important within their particular role as an internal company analyst for a well-known financial institution. The respondent commented that prior to asking for funding companies have usually done a significant amount of work on the feasibility of the project, so the bank's role is to check the underlying assumptions of their valuation model and confirm they are satisfied with the assumptions and
final valuation figure. The respondent additionally stated that as there are so many underlying assumptions the valuation can only attain a limited level of accuracy and that the bank's primary concern rather lies with the credit check of the client and what measures they can put in place to minimise the downside risk.

A key message that emerged from the interviews was that often the amount of information available to perform a valuation was limited and therefore companies were required to do the best they could with information available. Respondent 1 noted that the outcome of a valuation is only as accurate as the information fed into to it, highlighting the importance of the work done surrounding both understanding and managing these inputs. A concern raised by around 50% of the respondents regarding the drive for accuracy within a valuation was that the valuations are based on significant assumptions and that this factor is far too often overlooked.

“"It always comes down to the accuracy of the assumptions made - garbage in, garbage out… the majority of people don’t understand that the underlining assumption with regards to the resource models and therefore they do not understand what determines the accuracy of a valuation or cash flow." ~ Respondent 2

Additionally, the respondent believed that the valuations were more about confirming management's ‘gut feel’ and that they could be easily manipulated into providing the answers that management were looking for. Therefore, although management emphasised the importance of accuracy, they were unknowingly applying a bias which was affecting the accuracy of the valuation. One respondent noted that their important project valuations were carried out by a third party contractor so as to eliminate any bias. Further the respondent reported that there had been significant variance between valuations constructed by consultants and those constructed by the project managers. The respondent stated that while consultants were usually eager for a project to go ahead, as this would lead to more business, managers were more cautious as they realised that a failed project would have serious consequences for both themselves and their company. The comments highlight the need to be aware of the different perspectives people hold and how these perspective create some form of bias which effects the outcome of the valuation (Damodaran, 2011b).

The findings collected speak to and align with the first proposition that was to be tested, as the drive for accuracy was noted by all the respondents.
Proposition 1: The use of accurate valuation techniques in the mining sector is critical for the future success of companies.

However, we find that at some stages the level of accuracy demanded leaves one in a difficult position. Although the need for the most accurate and realistic figures possible exists in order to make an informed decision, one needs to additionally be cognisant of the underlying assumptions upon which the valuation is being made. The severity of these assumptions should guide the extent to which the demand for accuracy is enforced. These assumptions, along with management’s need to fully understand the valuation, play a significant role in management’s decision to insist on simple and transparent valuation techniques which can be easily understood. The next section looks into such techniques discussing both the advantages and pitfalls that present themselves.

4.4 Simple and Implementation friendly valuation techniques

While respondents commented that accuracy was of key importance, they also emphasised that managements were only content with valuation techniques that they could fully understand. The need for this balance resulted in the researcher looking into the criteria used to determine a company’s primary valuation technique.

What criteria is used in determining the selection of a valuation technique, and could you describe your company’s primary technique?

Campher and Vlok (2014) state that the DCF method is the primary valuation technique currently used within the international and South African mining sector. The valuations experts interviewed by the researcher offered the same conclusion, with all 10 respondents confirming that the DCF model was both their own, as well as their clients', primary valuation technique. Additionally the majority mentioned that this technique had been used for past 10 years and that their company was relatively satisfied with the methodology and the outcome.

The respondents listed numerous benefits surrounding DCF as a valuation technique, the key benefits including:
- Mathematically simple and easy to model
- Management’s comfort and understanding of the technique and its outputs
- Transparency throughout the DCF model - allowing for simple and effective sensitivity analysis
- A clear link between the operation and financial side of the business

Respondents commented that the transparency of the model allows for management to easily adjust the model if required, further enhancing their understanding and confidence in the technique. They felt that management always wanted to feel in control of the situation by having their finger on the pulse and that the DCF model allowed them this opportunity. Management’s support of the company’s valuation model proved to be a major consideration by all respondents and an aspect that weighed heavily in favour of the DCF model.

“With DCF it’s easier to tweak the model along the way, so for example, you can predict margins to stay flat for a period and then maybe assume they drop off slightly a few years in... Whereas if you are using a very mathematical model like Real Options, you put your values in and then you run the model. It’s very difficult to tweak the model inter-year without extensive knowledge on how to create the model… so that’s why a lot of people, like management, prefer the [DCF] model.” ~ Respondent 5

An interesting comment by two of the respondents was surrounding the definition of “accurate and realistic”. The respondents stated that management perceived the DCF model as accurate as it was based on the company’s projected cash flow. Additionally as the DCF model was the commonly accepted technique they trusted that it must produce realistic figures, otherwise no-one would have adopted it in the first place.

“It’s very subjective, you ask me whether I think the DCF model is accurate… well I guess it depends on the type of project… I’ll tell you something though, management think it’s accurate. Don’t forget they know nothing else, so this is the valuation yardstick they measure accuracy with.” ~ Respondent 7

A prominent theme discussed by 6 of the 10 respondents was involving the heuristics behind the choice of DCF as a valuation technique. There was clear evidence that an important factor
behind the choice of DCF was that this valuation technique was the accepted method across all industries and had been so for the past 20 years. Directly relating to this was the concept of commonality, where respondents confirmed that it was critical that they use the same valuation techniques as those used by their financial advisors and potential funders.

“We make sure we use the same techniques as both our auditors and funders. How can we discuss what the best decision to make surrounding an asset is, if we do not come to the same value?” – Respondent 3

The respondents highlighted that the success of models such as DCF, PE multiples and market comparisons is driven by their transparency and ability to be pulled apart and easily analysed. 50% of the respondents commented that with all the assumptions that underlie valuations, their companies try to keep valuations as simple as possible and that models such as DCF cater towards this need. Additionally a respondent reported that often the simple, straightforward valuation can come to very similar results when compared to the complex techniques, thereby making management wary of spending extensive time with complex valuation techniques. In line with this, an additional theme discussed by the respondents was the concept of “Time versus Benefit”. The majority of the respondents noted that in reality time is always a critical factor and that you are often under pressure to produce an answer quickly, so it is easy to fall back onto the DCF method which creates significant value within a reasonable time.

Throughout the interviews the criteria for selecting a valuation technique included key focus areas such as:

- Mathematically simple
- Easy to understand
- Commonly accepted by industry
- Ability to provide an accurate and realistic valuation figure
- Time vs benefit
- Enhancement of management’s decision making ability

The respondents implied that benefits of the DCF align very closely with the criteria used in selecting a valuation technique and that this was the primary reason why the DCF was now the primary methodology used throughout all industry and in particular in the mining sector.
It became evident that it was very unlikely that any valuation technique would displace the DCF model as the primary valuation technique within the coming years. The researcher therefore decided to investigate what the most popular secondary valuations techniques being used to supplement the DCF model were, and what benefits these supplementary techniques offer.

*Does your company use a supplementary valuation technique, why / why not?*

All the respondents discussed the decision to use a combination of valuation techniques, with some stating that finding a range of values which agreed with each other was a critically important way to build confidence in the valuation figures that were being produced. They stated that while the DCF model would be their primary valuation tool, another two valuations commonly used were a “market related PE multiple” or a “market comparison to a similar type project/asset”. The respondents felt that these valuations enabled the companies to get a good understanding of where the real valuation figure may lie.

In contrast to literature (see Chapter 2.2) the respondents emphasised the market comparison technique was widely used as a check against the DCF model and was of extreme relevance to mining sector. The respondents noted that because commodities are traded using an international spot price this makes comparisons across the entire industry applicable and useful. Additionally Respondent 6 commented that in order for a mining company to be successful in the industry, they needed to sit on the lower half of the industry cost production curve. This results in comparisons between global projects becoming paramount to a projects long term sustainability in the commodity market and additionally proving that the comparison techniques ability as a decision tool.

“We use a lot of comparisons, especially with regards to the cost of our production. We feel that this valuation technique is pretty accurate as you are valuing your mine or project against very similar types of projects… additionally we see the markets are priced efficiently resulting in usually very realistic figures. ” ~ Respondent 8

Having a range of valuations which are relatively close together allows management to be confident that the value they are looking at is realistic. Conversely, if the range was too wide the respondents stated that this encouraged management to probe slightly deeper into each valuation to try determine why this was the case. This probing ensures that the valuations are
being properly reviewed and that management are more comfortable with the final decision they make. It was interesting to note that respondents felt a range of similar valuation figures offered a more accurate valuation, even though they understood that often none of the valuation techniques used incorporated the true value of the options available to them.

The findings from the respondents agreed with Proposition 2 which was set out by the researcher.

**Proposition 2: Simple and implementation-friendly valuation techniques are being more commonly used than more complex and accurate valuation techniques.**

Despite the above findings, the respondents did note that these techniques did not adequately account for the uncertainty and risk that exists within mining projects. The biggest complaint surrounding the DCF model was the use of a single risk adjustment factor throughout the entire life span of a project. Additionally they acknowledged the DCF model did not allow for management flexibility and the ability to respond to the uncertainty that arises (Martinez & McKibben, 2010; Zhang et al., 2014). The respondents stated that it was these limitations in the DCF model which had initially created their interest in the valuation technique of Real Options Analysis and their exploration or use of the technique was based around uncovering the value that exists within this uncertainty and flexibility.

4.5 Real Options in the SA mining sector

Theory suggests that ROA offers a solution to unlocking the value that lies within uncertainty and management flexibility, and additionally that the transition from DCF modelling into Real Options modelling is suitable, as the information required is similar (Campher & Vlok, 2014). The researcher therefore aimed to undercover the respondent's view on ROA and where ROA could possibly add value.

*What do you understand by the term “Real Options Analysis”, how do you see it contributing as valuation technique?*

The primary view held by the respondents was that Real Options has the ability to ensure that management go through the process of valuing the potential options available to them and additionally guiding management into making better strategic decisions. The respondents
stated that ROA is a great strategic tool as it allows management the opportunity to build and value a range scenarios that could unfold during the course of the project.

“Real Options can help management structure their decisions regarding which projects to invest in, especially in mining when there are so many factors and options to consider when entering a project… This is further exaggerated in South Africa where additional labour issues and political risk needs to somehow be accounted for.” ~ Respondent 2

Martinez and McKibben (2010) agree with the respondents, stating that it is in the early planning phases where management have the widest range of options to consider and where the most value is embedded. Additionally, the respondents noted that significant uncertainty exists within the SA mining sector, mentioning concerns such as, decreasing productivity, unpredictable commodity demand and pricing, increasing production costs, technical ore body stripping, labour issues and political instability. With these factors at play it is imperative that mining companies provide themselves the opportunity to remain flexible so as to capitalise on opportunistic situations that arise (PwC, 2013).

“Due to the volatility that exists within commodity prices you find that this often creates an embedded option. If there is a large movement in the commodity price it results in different scenarios opening up. An option that needs to be looked at currently is one where you invest now when the commodity price is low, and then when the price spikes you will be in a position to make the most it [the situation].” ~ Respondent 2

Much of the commentary made was regarding being in the right position for the next commodity super-cycle and was based on the premise that the respondents believed this was not the case within South Africa during the last commodity super-cycle between 2000 – 2008 (Farooki, 2012). This failing by the majority of the SA mining companies prompted comments from the respondents encouraging a wider use of Real Options thinking by SA mining companies. The respondents acknowledged that if a company was going to be able to react to changes, such as a rise in commodity prices, the companies had to understand the options available to them and have created the project in a way that allows for flexibility.

Respondent 10, a mining consultant, emphasised this point through a case study which was done recently with one of their clients. Their client was looking to mine a new resource that
had never been extracted before, therefore the unknowns included; the extraction rate, price of the commodity, grade of the resource, long-term demand and many others. Due to the unknowns that existed the risk of the project was extremely high and additionally, in order to be competitive from a cost perspective, there was a common thought process that the mining and production facility would need to significantly large so as to create the lowest the production cost per ounce possible. This resulted in the client needing an enormous amount of upfront capital expenditure, however due to the risk of the project both the client and consultants concluded that this type of investment would not be possible. The consultant therefore decided to build flexibility into the project by offering the following solution. The mine would start with a small extraction and production facility, thereby requiring far less capital. Once some of the unknowns, such as the extraction rate, price of the commodity and grade of the resource was known, the risks assigned to the project could be recalculated and it could then be decided whether an expansion into a larger production facility was worthwhile. Although this approach was more costly overall, the flexibility allowed for the project to become feasible as the capital input and related risk became realistic. The options presented to the client were run through a Real Options programme and allowed the client to look at the potential scenarios that existed and how they could best capitalise on these.

“Capital funding is such a hard thing to obtain nowadays, so you don’t want to only be using a technique such as NPV, as you find it often requires a large capital outlay… So rather using a Real Options type approach you can stage your investment and take a lot of the future risk out the project.” ~ Respondent 9

This ability of ROA to place a physical value on the embedded options which lie with assets/projects, was a key contribution brought up by the respondents. Real Options not only assigns value to the embedded options but also places a value on management as it accounts for management’s decision making during the project.

“DCF doesn’t account for the flexibility that lies with management, for example, if a mining project is making losses, you have the option to abandon or postpone this project, this option has significant value.” ~ Respondent 5.

Zhang et al. (2014) emphasise this same point by stating that more than offering realistic and accurate valuations, Real Options can assist in making “managerial decisions such as starting
mining, abandonment, expansion, and contraction of production rates accordingly to changes in market condition” (p. 2).

The above findings highlight the value that can be extracted from the use of Real Options and in particular within a mining context. These finding aligned with Proposition 3 which the researcher aimed to explore.

**Proposition 3: ROA offers a well suited technique for valuing natural resource based projects, as it allows for the inclusion of uncertainty and significant flexibility regarding decisions.**

However, the findings also provide reasoning that the use of the Real Options valuation should be growing significantly within the mining industry, therefore the researcher decided to investigate the adoption of ROA by mining companies within South Africa.

### 4.6 Uptake of Real Options with SA mining sector

International theory suggests that both the use and adoption of Real Options as a valuation technique is relatively poor, with no widely used approached to ROA being applied to capital budgeting problems (Baker et al., 2011; Block, 2007; Guthrie, 2013). The researcher therefore set out to explore what the respondent’s exposure to Real Options has been and why they believed this was the case.

*To what extent does your company use Real Options Analysis and why do you believe this is the case?*

The use of ROA within the SA mining sector appears to be minimal, with future growth prospects for the technique in its purest form expected to be extremely slow. 8 of the 10 valuation experts stated that although they are aware of the benefits of the Real Options, they still do not use the technique within their company. The major reasons for not using Real Options included the following:

- Over-complicated and mathematical – a black box type approach
- Lack of understanding and education surrounding ROA by management
- Too time-consuming for the benefit created
The primary theme that ran throughout all 10 interviews was surrounding Real Options and its mathematical complexity. All the respondents commented that in order for maximum benefit to be achieved from the technique a significant understanding of the model and mathematics was required. Additionally, three respondents commented that adjustments of the model could not be done easily and therefore a Real Options specialists as well as sophisticated computing was usually required. The respondents noted that the mathematical stigma attached to technique was detrimental to the adoption of ROA and was the main reason why companies and management avoided it. The findings surrounding the concern about the valuations complexity was not surprising and is in agreement with the conclusion of international surveys previously conducted (Baker et al., 2011; Block, 2007; Bowman & Moskowitz, 2001).

The common diagnosis was that due to management’s lack of education in the field of Real Options and probability, they lacked understanding and confidence in the results produced. The respondents noted that management worry about these “black box” type approaches as they are unwilling to let go of the responsibility. Management want a clear understanding of how these valuations are reached as these values play a significant role in assisting them in making decisions. Further, respondents reported that management were unwilling, or did not have the time, to learn or understand the new technique as they were unsure whether the additional time spend on understanding and modelling a more technical technique, such as Real Options Analysis, would add significant value to their decision making process. According to Stout, Xie and Qi (2008) the only way management will adopt techniques such as ROA, is if they are educated surrounding the methodology, therefore management’s lack of education on the benefits and uses of the technique are a major concern surrounding the future growth of ROA.

“We sometimes use stochastic modelling, a Monte Carlo type model, the problem is that the shareholders are not educated on these models, so they have no idea how they work and how to interpret the outcomes… it all looks very foreign to them. Pitching to your audience is of key importance and because management understand exactly how a DCF works, at least they can challenge what we’ve done and this allows them to gain confidence in our assumptions and model.” ~ Respondent 8
“If you have got someone who knows Real Options then you are talking the same language and very quickly they get a lot of confidence from the Real Options model, but generally that’s not the case.” ~ Respondent 7

One respondent commented that the only way to drive the adoption of Real Options within a company was through an ‘internal champion’. The internal champion needs to be a respected senior manager who is extremely knowledgeable and passionate about the subject of Real Options and what it has to offer as both a valuation and a strategic tool. Only through this internal champion will fellow managers start to consider looking at sophisticated models. The respondent believed that through explanations and guidance by ones fellow peer, management would begin to gain confidence in the concept and see the benefits that exist when using Real Options.

Three of the respondents stated that their company’s unwillingness to take on techniques such as ROA was due to their concern surrounding the assumptions that underpin all valuations. The respondents argued that there were already many assumptions that went into the creation of a DCF, and if you extrapolated this for an options approach where you add in even more assumptions, their management felt that at this stage the resultant value began to lose validity. These comments seem somewhat misinformed, as literature shows that the use of ROA helps limit the amount assumptions made. When using ROA many of the assumptions made in a DCF model are left as variables, examples include factors such as the commodity price, ore extraction rates, labour cost and so on (Mun, 2006).

The remaining two respondents who reported that they currently used Real Options techniques, such as the Monte Carlo model, noted that the use of this type of technical was infrequent and used only as a supplement to the more common techniques (DCF, PE multiples, market comparisons). These findings, although cursory in nature, align with extensive surveys completed in America (Block, 2007) and Canada (Baker et al., 2011) where no companies reported using ROA as a primary valuation technique and additionally less than 17% of respondents reported using ROA as a valuation tool to supplement their primary analysis.

Respondent 5, a mining stock analyst, commented that their use for Real Options was primarily because they felt that the DCF technique undervalues the mining stocks by around 20-30% of the market price, due to its inability to account for management’s flexibility and the embedded
options that lie within the projects. The use of Real Options enables them to get a sense of what
the optionally premium on a mining share in the market is. If the Real Options valuation is in
line with that of the share price, they then are able to look one year down the Real Options
decision tree (see Chapter 2.4) and this figure should represent a realistic future share price.

Additionally Respondent 8, a project manager at a large mining house, stated that although
their use of Real Options was infrequent they had gotten significant value out of using it when
they had multiple projects running simultaneously. They were constantly faced with different
options for their portfolio structure and the use of Real Options aided these investment-type
decisions. The respondent believed that the use of these types of valuations would continue to
be used more regularly within their valuation team as a supplementary method, yet the
respondent was unsure as to when company management would begin to recognise its potential
value and fully embrace the technique.

The above two respondents provided excellent examples of how the use of Real Options can
be integrated into a company’s decision-making process. The use of ROA cannot be forced on
management hastily. However, if done correctly, using small projects and applied to certain
situations which suit the methodology, the results can be extremely valuable and hard to
dismiss. Interestingly, 30% of the respondents reported that although their company does not
currently use Real Options as a valuation techniques, they believed it could add significant
value to the decisions made across their project portfolios. With the limited capital available,
the respondents commented that it was crucial that companies be in position to maximise their
capital expenditure on the correct projects and believed ROA offered them this opportunity.
The above findings are supported by literature (Baker et al., 2011; Mokenela, 2006; Parry &
Firer, 1990) which reports that the majority of companies who are involved in capital
investment have secondary and even tertiary valuation techniques to ensure the valuations are
accurate and are supported by a sufficient amount of analysis.

In a discussion with an international consultant based in London, whose firm specialises in
providing mining valuations using the Real Options methodology, the respondent noted that
the opinions and thoughts surrounding Real Options in South Africa companies were similar
and comparable to those companies based internationally. The respondent commented that in
terms of valuation techniques and mining methods South Africa was in line with international
standards and although the risk of mining within the company were often higher, there was no
evidence to suggest the valuation or strategic decision making approaches differed.

“With many SA mining companies, such as Anglo and Lonmin, now carrying dual listings in
London and Johannesburg, there is very little difference between the valuation and decision
making procedures in place… you find the overall approach to business by all mining houses
are very similar.” ~ International Respondent

Respondent 10 felt that the use of techniques such as Real Options were ahead of their time
and that only in another 10 years would companies truly start building optionality into their
valuations. Regarding failure of the technique to gather traction, the respondent believed that
the key was surrounding a misunderstanding by management as to what exactly what building
optionality into a project entailed. Additionally, Boer (2010) states that management often
misunderstand risk, which results in a misunderstanding of opportunities and that this
negatively impacts on the strategic business planning.

“Management mention the term optionality in their press releases all the time… They say
things like, “we looking to ensure we maximise the optionality within this project” but they
don’t truly understand what the practical implications of building in and using optionality
entails.” ~ Respondent 10

Although the respondents see benefit in Real Options as a valuation technique, it is clear that
the mathematical complexity and management’s lack of understanding have caused both the
use of Real Options and well as the adoption of Real Options to be unappealing to management.
This finding supports the international literature and Proposition 4, as set out by the researcher.

**Proposition 4: The poor adoption of ROA as a valuation technique is driven by its
mathematical complexity, which results in a lack of understanding by management.**

With the above findings discovered, the researcher looked to focus on the future development
of valuations and whether ROA would play a role in it.
4.7 Incorporating strategic and operational flexibility into future valuations

Supporting evidence was found in both theory and from interviews emphasising the need for management to uncover the value embedded within the uncertainty and flexibility of projects. Additionally, as one of the primary benefits of ROA is to uncover this value, the researcher would have hoped to find that Real Options would begin taking traction as a valuation technique within the current market. However, the adoption and use appear to be minimal both internationally and amongst the respondents. The researcher therefore inquired into the future of valuation techniques looking to discover how uncertainty and flexibility would be accounted for.

*Where do you see valuation techniques heading in the future, and why is this the case?*

One of the most interesting themes to emerge from the interviews was comments surrounding the transference of the Real Options concept towards more practical and well-known techniques. Around 60% of the respondents stated that they believed that although their companies or clients were not using ROA techniques such as Monte Carlo, they were still bringing the concept of optionality either into their current valuation methods or into their general strategic thought processes.

The one school of thought surrounding this topic, was an unwillingness to change from the current valuation model (DCF) to a more sophisticated model (ROA) and rather attempt to build optionality in by using a more complex DCF model such as Dynamic DCFs. The respondents mentioned a variety of ways of adding in flexibility, through the use of a probability weighting or even running all the different scenarios through Excel using On/Off switches. This concept is noted by Colwell, Henker and Ho (2002) who refer to findings that management would rather make slight adjustments to the standard valuation approaches thereby attempting to allow for flexibility. Although these type of methods cannot compete on valuing optionally when compared with Real Options models (Baker et al., 2011), the shift in mind set and academic understanding required by management is far less, proving them to be more popular amongst management.

“Our DCFs are extremely technical and detailed, we look at everything we can with the utmost precision... We look at all the options available to us, can we close this shaft and rather open...
that shaft, or we can open both at the same time… I must say, I feel our DCFs are so comprehensive they almost act like a simplified Real Options model.” ~ Respondent 1

“We bring in different kinds of options and scenarios in to what you could call a complex DCF type model… you can build some flexibility into your DCF, if you think about Real Options, they are basically valuing the output on an option and then applying a probability factor of the outcome happening. So it’s basically a probability weighting on your scenarios, that’s all it is.” ~ Respondent 4

The use of this hybrid type model, incorporating both the universally accepted DCF model and incorporating the use of options, aligns directly with the thoughts of Campher and Vlok (2014) who look to implement an integrated capital budgeting visual mapping framework comprising of both methodologies. Interestingly Respondent 10, a consultant with significant Real Options experience, disagreed with this line of thinking. The respondent commented that when combining the methodologies the user would attempt to simplify the mathematics behind the Real Options models, by holding more variables constant. Further the respondent stated that the decision to hold more variables constant by making assumptions was undoing the value and core purpose of Real Options.

“You find people are trying to simplify these models by removing variables and making more assumptions. It results in them keeping the most important factors like the commodity price and extraction rate constant. This defeats the whole point as that is where the value and opportunities lie.” ~ Respondent 10

Another hybrid type methodology used, which was mentioned by three respondents, was ensuring the teams involved in the projects ran through the various possible scenarios available and valued each one individually. Respondent 2 noted that although the company’s project team did not use ROA they were continuously made to consider the implications if their key assumptions shifted in either direction. The respondent emphasised that considering optionally was particularly crucial within the mining sector, as the movement of the commodity prices were substantial and hard to predict (Zhang et al., 2014). The respondent noted that while most mines had the ability to ramp up production when commodity prices were high, through increasing the amount of production shifts and mining lower grade areas, this potential ramp-up in production had its limits. Additionally, because the creation of a new mine could take
anywhere from 5 – 10 years to complete, if companies wanted to be in a place to take control of high commodity prices then considerable long-term planning which considered a variety of scenarios was necessary.

“You need to always be looking ahead, the gold price is currently around $1200 now, however if it was to spike to $2000 would we be in a position to take advantage of this? I am continuously asking my team to consider the options available, to make sure we are in a position to capitalise if changes occur… Scenario planning is something I drive continuously within the company.” ~ Respondent 2

It must be noted that the two respondents whose companies are currently using ROA believed that the use would continue to increase in large companies. “For large companies like your Anglos and BHP’s, you absolutely have to look at ROA, because it offers you flexibility and that is so key where you have a huge range of projects” (Respondent 9).

While uncertainty existing in the SA mining sector was a theme which ran through the majority of the interviews: the concern was not only focussed on the SA mining sector and economy, but rather it was agreed that the uncertainty and volatility existed throughout the international mining sector as a whole.

“The amount of variables and volatility within the mining sector is not unique to South Africa, the bulk of these variables are seen by all mines no matter where they are situated… It’s not just the SA economy that’s having a tough time currently, this GFC [global financial crisis] has affected everyone.” ~ Respondent 7

The respondents highlighted that the key is to ensure that when the commodity prices do eventually bounce back, SA companies have positioned themselves in such a way that they can take advantage of the situation. A key tool in making sure this position is obtained is through the use of scenario planning and valuing optionality and flexibility within potential projects.

Additionally there was consensus amongst respondents that a move away from the DCF model would not occur in the next 10 years as this method has become the international standard across all sectors. The convenience and value it adds is substantial considering its simple and transparent setup. The respondents stated that until a simple technique came along which proved beyond doubt that it provided better valuation figures, or was a more suitable decision
tool, that the majority of companies would continue with use of the DCF model. Further, none of the respondents mentioned a plan to increase the use of pure Real Options valuations, therefore the researcher enquired as to what the respondents thought the future of Real Options entailed.

*Where do you feel Real Options Analysis is going as a valuation technique in the future?*

The overall response was that the likelihood of a technique such as ROA becoming a widely used valuation technique within the next 5-10 years is very doubtful, as the majority of management are looking for valuations techniques which are simple to model and can be easily understood. The respondents, however stated that it was likely that more mathematically complex techniques would start being used in conjunction with the DCF model. These finding align with work done by Putten and Macmillan (2004), who state that ROA must be used as a supplement to the DCF model to assist in overcoming the weaknesses within the DCF technique. The DCF model can be used to evaluate the base findings, while ROA can then be brought in to increase the knowledge surrounding the valuation and assist in making the right decisions.

40% of the respondents stated that they believe the future of ROA lay in the advancement of computing which would help decrease the amount of time spent modelling. However these thoughts were followed up by statements insisting that the Real Options models would have to become more transparent and be designed in such a way as to assist understanding amongst management. Respondents did however comment that there does seem to be a possible potential for the growth of ROA as supplementary technique through both the education of management as well as the use valuation within the correct context. Respondents further commented that because management currently distrusted the outputs of ROA and were extremely comfortable with the current DCF model, the adoption of ROA would be extremely slow and would have to be driven by large, innovative mining houses.

In summation, although Real Options offers significant value as the decision tool, the complexity and black box nature of the methodology seems to be detrimental to its popularity amongst valuation experts and management. Additionally while the DCF method is preferred as it offers management a transparent and simple decision which can be easily understood, it cannot offer the same insight and knowledge when compared to a Real Options model. The
findings above are in line with Proposition 5 and highlight that in reality changes to both Real Options as well as more the simplified DCF model are necessary if an optimal methodology is to be found.

Proposition 5: Resource companies need to increase their operational and strategic flexibility, highlighting the need for future valuation techniques to accommodate these factors while remaining transparent and easy to understand.

The use of Real Options in South Africa and the challenges faced regarding the adoption resonate with those seen in more extensive international studies. With theorists and respondents both acknowledging the benefits and downsfalls of both DCF and ROA, the way forward seems to offer two options. The one option looks to be based around the ability to integrate the concept of Real Options into the more popular, practical and transparent DCF technique without losing the value offered by ROA, as seen in a paper by South African researchers, Campher and Vlok (2014). The other option, put forward by Putten and Macmillan (2004), is based on the current practices of companies using ROA, in that ROA and DCF do not need to compete against each other as valuation techniques but rather that ROA must be seen as a supplementary technique to assist the DCF model.

4.8 Research Criteria: Limitations, Reliability and Validity

There are various limitations that need to be considered when addressing this research report. The main data limitation is whether the 10 organisations interviewed are enough to represent the view of the entire population (Leedy & Ormrod, 2010). Additionally, due to the non-random sampling technique employed, there may be bias that the views given do not represent the South African mining sector. The researcher has attempted to limit this bias by choosing a diverse range of companies with different perspectives on mining valuations (mining companies, mining consultants, research companies and investment banks), as well as ensuring the companies selected were of sufficient size and the respondents were of adequate experience and knowledge.

From the methodology perspective, the concern lies in the amount of impact and influence the researcher had on the qualitative study (Leedy & Ormrod, 2010). The limitations are significant as the researcher’s opinion, past experiences and interpretations have influenced the data collected, the concepts that have been deemed important, as well as the conclusions that have
been drawn from the findings. It must be noted however, that the researcher is cognisant of the bias and limitations that exist within the report and therefore has continuously checked the assumptions and decisions made in an attempt to reduce these consequences.

The reliability of the research conducted was ensured by a comprehensive and strict documentation procedure which covered the entire process (Eriksson & Kovalainen, 2008). The process was documented in a formal manner which has been made accessible to peers to ensure they are able to review the procedure and the documents. Therefore should they wish to establish whether the correct process was followed and if necessary to replicate the process this would be possible. The reliability was further increased, as the researcher conducted all interviews personally to ensure the same consistency was maintained across the data collection.

The validity – the accuracy, meaningfulness and credibility of the approach to the research report – was of critical importance to the report validity as a whole (Leedy & Ormrod, 2010). Validity can be separated into two sections, internal and external. Internal validity, as explained by Leedy and Ormrod (2010) refers to the extent to which sufficient controls are put in place. These controls ensure that the design and data of the report can be used by the researcher to draw accurate conclusions surrounding the cause-and-effect relationships that exist. The in-depth research into both the literature surrounding the topic and the methodological approach has ensured the internal validity of the research report. The external validity, which looks at the applicability of the research to the outside world, is significant for this research report topic. The research surrounding ROA in the mining sector was primarily selected due to its current presence and potential in the valuations world both academically and practically, and therefore the findings of the report are both valid and topical.
5 Research Conclusions and Recommendations

5.1 ROA as a valuation technique within the SA mining sector

The report set out to determine “to what extent ROA is being used within South African mining companies?” However, in order to fully understand the topic at hand the researcher explored two sub-questions which aimed to supplement the primary research question and offer deeper insight surrounding the topic at hand.

“What criteria does management of mining companies use for deciding whether or not to use ROA as a valuation technique?”

The first sub-question laid the foundations of discussion, as it allowed the respondents to discuss both what criteria they reviewed when deciding on which valuation technique to employ and additionally in what ways ROA failed or met these criteria.

The findings revealed six key criteria which the respondents focussed on as they evaluated the credibility of a valuation technique (see Chapter 4.3). It was interesting to note that in the areas where ROA fell short, it was found that the DCF model excelled. The DCF model was found to excel in following four areas,

- Mathematical simplicity
- Ease of understanding
- Time vs benefit paradigm
- Acceptance as industry norm

A constant theme throughout the paper has been ROA’s inability to offer a mathematically simple and easy-to-understand technique which encourages management’s buy in. Additionally the failure of ROA to meet both these criteria has resulted in the ‘Time versus Benefit’ concern which management hold regarding Real Options. In complete contrast to this, it is these three areas where we see DCF’s strength as a valuation technique. The DCF model is able to offer users these benefits, which has resulted in the technique becoming widely accepted across all industries and thus making the move away from this technique by a company both unlikely and difficult.
Further, it was seen that in areas where there were concerns regarding the DCF model, the ROA technique proved to hold strong and offer additional insight and knowledge.

- Ability to provide an accurate and realistic valuation figure
- Enhancement of management’s decision making ability

The discussion surrounding accurate and realistic valuations was a subjective one, as it emerged that people of different levels of valuations experience had different understanding as to what defined 'accurate' and 'realistic'. Respondents reported that the majority of management believed that DCF offered sufficient accuracy, however they further commented that the management often misunderstood both the underlying assumptions involved in the creation of the valuation model and further the value Real Options could uncover. The respondents believed it was this misunderstanding by management which led to techniques such as the DCF model being regarded as accurate. The valuation experts however acknowledged the significant value that ROA could offer, with the majority concluding that the use of it would result in “more accurate and realistic valuations”. The acceptance of the above findings, results in a direct correlation to ROA offering managers an opportunity to make better decisions. Beyond this, it was also stated that the use of Real Options ensures management continuously evaluate the options that are available to them. This strategic planning results in business being able to adapt and capitalise on any sudden changes within the market, proving ROA to be a tool which drives strategic planning.

The criteria examined for the selection of valuation techniques lies in favour of the DCF model and provides evidence for the lack of use of ROA within the SA mining sector. These findings align with comprehensive international studies which produced similar results to those described above (Baker et al., 2011; Block, 2007; Guthrie, 2013). Additionally what clearly emerged was that the traits of ROA and DCF complement each other significantly and that these two valuations need to be used in combination with each other.

Despite the findings that the extent of use of ROA is relatively small, even as a supplementary technique to that of the DCF model, there is without question benefit that can be taken from use of the model, especially within the SA mining sector. The second sub-question intended to look into what primary purposes ROA was being used for and in what direction the respondents believed the future of valuation techniques are heading.
“What intention does management have for ROA as a valuation technique and what future do they envisage for the technique?”

It is evident from the respondents that ROA is recognised as a sophisticated and useful valuation technique. Its ability to value risk and flexibility within projects results in it not only being offered as a more accurate and realistic financial valuation tool, but more importantly ensuring that management consider it for strategic planning and decision making. The respondents commented that there were certain situations in which Real Options offer significant additional value. Such circumstances included projects with extreme risk or significant flexibility, and examples given included the mining of a new resource or an investment decision involving a range of options, emphasising that ROA had already been used successfully within the SA mining sector. It seems that the use of ROA lies in its ability as a strategic decision-making tool, offering management that additional information, which could make a significant difference to final outcome and decision. It seems that extreme benefit and potential exist for a valuation technique such as ROA, however the next focus is surrounding the education of valuators and managers on the technique itself.

ROA’s future as a valuation technique reflected the findings seen in the literature where respondents did not see ROA becoming a primary valuation technique in the near future. However, it is evident that in the current market conditions there is a real need to value the uncertainty and flexibility that exists within mining projects. The respondents felt that the best solution was involving the incorporation of Real Options into the current valuation process.

The researcher believes that this incorporation could be demonstrated in two different ways. The first potential model would be the combining of the DCF model along with the ROA model, thereby creating an integrated model, as proposed by Campher and Vlok (2014). The proposed model still uses DCF as the foundation capital budgeting technique, however it additionally integrates an active mapping framework which plots the investment across different options based on both the DCF path as well as Real Options pathways.
As seen from Figure 3 above, the integrated model looks to get the best benefits out of both models, in order to achieve integration. Additionally, it can be assumed that the new model will primarily be used during valuations where the decision climate aligns with that usually seen for Real Options applications. Although the new model appears more transparent and easier to understand than a normal Real Options type approach (i.e. Monte Carlo), it must be understood that the full value of the embedded option will not be realised and that only a limited amount of flexibility and uncertainty is allowed within the integrated model. The model hopes to attract users who are interested in the concept of Real Options, but do not have experience in the field of options or a strong mathematical knowledge base.

The second model that the researcher believes can offer substantial value is the one currently being employed by most mining houses who use Real Options. The model is one where a DCF valuation is first done to get a static valuation of the project, following this an in-depth Real Options Analysis is run, incorporating the potential opportunities and risk seen within the project. In this case the ROA is used as a supplementary technique with the final result...
providing a figure which can be compared against the static value. The difference in values being the valuations represents the value of the embedded options within the project.

Figure 4: Model 2 - DCF and ROA used in combination

Although the structure of the second model offers nothing new, the researcher believes that this model offers the best results. Additionally through the education of current valuation users, and management in particular, the adoption of the technique can be vastly improved. A key finding from the research was surrounding the lack of education and understanding that management hold towards Real Options. Throughout the interviews the respondents stressed the importance of management’s role in all decision-making processes and managements need to be confident about the inner workings of the technique if it was to be accepted and implemented.

The researcher believes that through simplified real-life cases and graphical illustrations the concept of Real Options and the benefits it offers can be easily transferred to management. Additionally, as suggested by one respondent, the use of an internal champion to drive the use of Real Options within a company may prove extremely helpful. In summation, the second model sees Real Options being used in its purest form, meaning that the same drawbacks and concerns seen in the report’s findings will apply to the model at hand. However, the researcher is confident that if the management are sufficiently educated and the valuation is positioned as a supplementary technique to that of the primary DCF model, this two-pronged approach to valuation process can offer significant reward to its users.
In conclusion, the extent of use of Real Options within the South African mining context is limited, however there is an understanding amongst those who work with valuations that Real Options offer significant value. Currently there exists a missing link between the benefits highlighted by theory and implementation into a real-world scenario. The researcher believes that if Real Options is to become a widely used valuation technique, its success is based around management buy-in and correct implementation.

5.2 Recommendations for future research

The researcher believes that from the above findings there are three areas that need to be further researched if the use of Real Options is to be improved with the mining sector. As the findings showed that the situation within South Africa seems to reflect closely to that seen internationally, the researcher does not feel that these recommendations need be only applicable to South Africa, but rather can be looked at throughout the Real Options community as a whole.

The first is regarding the valuation criteria, used by both valuation experts and management. The researcher believes that more information surrounding the criteria, including the ranking of the criteria in order of priority, would go a long way in helping academics create valuation techniques in such a way that they are practical for real world use. A key failing of Real Options has been its lack of suitability within real world applications. Therefore if academics are able to understand what criteria users and management deem most important, they may be able to adjust the technique so it is more suitable for users.

Secondly, the researcher believes that more work needs to be reported on companies that are currently using Real Options, both internationally and locally. The lack of information is primary due to companies' unwillingness to share what is often described as “company secrets” or what they envisage to be their “competitive advantage”. This lack of communication and sharing of knowledge is detrimental to the progression of Real Options and valuation techniques as a whole. The researcher feels that faster progression can be achieved through the collaboration of mining companies and the sharing of information and ideas. The discovery of what results and successes are being seen regarding the use of Real Options will assist significantly in driving both the education and adoption of Real Options.
Lastly, the researcher feels that significant work is needed regarding “how to drive the adoption and implementation of Real Options” into a company’s current valuation process. It can be seen from the findings that although the valuation experts understood the benefits of ROA, they were unable to persuade management to implement ROA as a supplementary technique. Work needs to be done on how to encourage management to adopt Real Options, whether it’s through education of management, internal champions or other methods. Additionally more work needs to be focussed on making the implementation of Real Options simple and user-friendly, thereby assisting users changing over from more well-known and simpler methodologies such as the DCF model. It appears that this area will continue to be the largest hurdle for the success of ROA as a valuation tool. The researcher therefore believes that this concern should only be tackled once a better understanding of the first two areas has be achieved.
6 References


7 Appendix A – Interview Questions

The questions below will be used to guide the semi-structured interviews:

Background

1. How many years of experience do you have relating to valuations? Of these, how many have been focussed on the SA mining sector?
2. Can you describe your company, its primary function and focus areas?
3. Can you describe your job function and your role within the organisation?
4. How long have you worked for your current organisation?

Application and importance of valuations

5. What does the term valuation technique mean to you?
6. For what purposes does your company use asset valuations?
7. What level of importance do you or your clients place on the accuracy of a valuation?

Simple and implementation friendly valuation techniques

8. What criteria is used in determining the selection of a valuation technique?
9. Could you describe your company’s primary valuation technique?
10. Does your company use any supplementary valuation techniques, why / why not?

Real Options in the SA mining sector

11. What do you understand by the term “Real Options Analysis”?
12. How do you see Real Options Analysis contributing as valuation technique?
13. What do you believe are the biggest benefits of ROA as a valuation technique?

Adoption of Real Options with SA mining sector

14. To what extend does your company use Real Options Analysis and why is the case?
15. What type/model of ROA does your firm use and for what application is it applied?
16. What do you believe are the biggest drawbacks to ROA as a valuation technique?

Incorporating strategic and operational flexibility into future valuations

17. Where do you see valuation techniques heading in the future?
18. Where do you feel Real Options Analysis is going as a valuation technique in the future?
## Appendix B – Selected Interview Responses

### Proposition 1: The use of accurate valuation techniques in the mining sector is critical for the future success of companies.

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<tr>
<th>Response</th>
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<td>I would say we usually use valuations like the DCF model for valuing our assets, especially when we looking at an acquisitions, it’s crucial we don't overpay for an asset, we've seen that mistake being made by other companies and their share price gets punished for it… alternatively it's also obviously used from a disposable point of view like an exit strategy, so when we looking to sell off the project or mine, we try work out what we believe the project will be worth to the potential buyers... Then if we stop talking from a project perspective and look more from a financial perspective, we find that our financial team is always valuing mines for impairment purposes. Do they need to write the asset down at all? Is the value that we saw there, still there now? It is big decisions like these where valuation plays an important role.</td>
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<td>The importance of creating these valuations comes into play when you have a variety of investment options and you need to try and decide which one to choose. For example, if I told you, you could invest 100k into a mining project in Africa or Australia and get the same return, you would probably choose the Australian one as it’s a safer bet. However if I told you the African would offer an additional 25% return to the Australian one, you would now start to try work out the risk versus reward and which investment is best. Now with valuations this risk is taken into account, so you have a final figure which is comparable across all projects. That right there, is the benefit of valuations and you can see why they important as a decision making tool.</td>
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You find the reason people use valuations for so many different purposes within mining, is due to all the risk and choices available to them... There is so much for management to consider so if they are able to break their options down by evaluating them and getting some concrete figures then this makes their life easier and it helps them decide which option they should take... I guess management also want to be able to justify the decisions they make to their board, so by evaluating all their options they’re also covering themselves from some blame if thing goes wrong...

You see one of things we need to consider is how tough it is to place a value on uncertainty and flexibility… with Real Options it takes a significant amount of time to build the model, so it really is time sapping.

One area where ROA is a real winner, is that it is constantly making you think strategically and plan ahead. As a strategic tool it stops management from being lazy as they always having to consider what the different outcomes could be. This planning is critical if a business wants to do well, as you need to be able respond quickly if there is a change in the market dynamic... It's almost a joke how few SA companies do proper strategic planning... I think Real Options would be good for a lot of companies as it would almost force them into thinking strategically and long term.

The valuations we produce are important to both ourselves and our clients... They [our clients] use these valuations to making important decisions… it's usually for very strategic decisions, so you can see why it’s important... You find if we trying to choose between projects, we need to determine which project we should be investing in at this current moment and deciding which project will create the greatest return for our shareholders, so it's important we give our clients the correct info, so they can make the right decision... We obviously assist them in the decision making process, because it's our model, so we really understand it [the model] completely.
It's massively important, one of the key reasons clients employ us is to ensure that the valuation they have is accurate and fair… You must remember they [management] often base their entire investment decision on that last little valuation figure that comes out, so I think that this just highlights the importance of our work and the accuracy required…”

When valuing something like the potential cost of building a mine, we try be extremely accurate, for a large mine this valuation can take us anywhere between 3 – 5 years. Costs are an area we feel we have relative control over, so it’s vital that we account for it as best we can. On the other hand, it is nearly impossible to predict future resource prices so we almost go for a “best guess” type approach, or try see what the market consensus is.

Management need the right valuation figure, so they can make the right decision, it’s as simple as that... So they will do everything in their power to ensure they’re looking at the best data…. You must remember when we talking about valuation models it always comes down to the accuracy of the assumptions made - garbage in, garbage out… the majority of people don’t understand the underlining assumption with regards to the resource models and therefore they do not understand what determines the accuracy of a valuation or cash flow.

The risk versus reward ratio always needs to be sufficient in order to go into an investment, so it’s the valuation that helps asses this.

Valuations are a lot about confirming managements gut feel... management have usually been in the industry a long time and so have a pretty good idea of the risks and rewards that can be expected from the different projects. I almost that management use valuations as a tool to conform ND support what they always felt... It's pretty easy to manipulate a valuation, a small tweak of an assumption can swing a valuation significantly... yes, I do think it’s important that valuations are accurate, but you have got to look carefully at the assumptions and also try gauge what benefit will management get out if that deal goes ahead as often I feel that management, whether knowingly or unknowingly are applying a bias which is significantly affecting the accuracy of the valuation.
Proposition 2: Simple and implementation friendly valuation techniques are being more commonly used than more complex and accurate valuation techniques.

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<tr>
<th>Responder</th>
<th>Proposition 2: Simple and implementation friendly valuation techniques are being more commonly used than more complex and accurate valuation techniques.</th>
<th>The key with management is although they looking for accuracy, the most important thing you can offer them is understanding, they want to be able to understand what's in front of their eyes... statistical probability is way too complex, so most of them don’t understand ROA... they understand the DCF model, this is a valuation technique they are comfortable with… that’s why it's [DCF] so popular.</th>
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<td>Responder</td>
<td>A key benefit of ROA is that you can draw outputs from it so easily… so it's really easy to see how one thing [input] is affecting another… so when you running sensitivities analysis across the model, you can very quickly work out what the key drivers of your projects are, that's really important to note.</td>
<td>So our company has been using DCF's since the early 90's… it [the methodology] may have changed slightly, maybe we put more effort into calculating the inputs or the discount factor, but for the most part it’s the same. So people are really comfortable with how it works and the values it produces... people understand the downfalls of the model and that's an important part of understanding any model... I really can't see many companies moving away from DCF, managers are really comfortable and I guess satisfied with the model as it is.</td>
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<td>Responder</td>
<td>The DCF model is by far the industry norm, I don't any of my clients use anything but that, it the main method everywhere... We obviously make sure we use the same technique as both our auditors and funders. How can we discuss what the best decision to make surrounding an asset is, if we don’t come to the same value?</td>
<td>I would say the beauty behind DCF is that it’s really simple to understand, you don’t have to be an accountant or maths guru to see what's going on and why and</td>
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how it’s affecting the value that’s being produced. The whole process is right in
front of your eyes so it gives you confidence in the model.

DCF is useful because it helps to tie in both the operational side of things and the
financial side of things… you have the operational level detail, and you can get
as detailed as you like… then you can overlay the whole, I suppose, the financial
side of things which makes it really easy to see what things on the operation side
are affecting things on the financial side… this is of huge value when you trying
to unlock the key value drivers.

With DCF it’s easier to tweak the model along the way, so for example, you can
predict margins to stay flat for a period and then maybe assume they drop off
slightly a few years in... Whereas if you are using a very mathematical model like
Real Options, you put your values in and then you run the model. It’s very
difficult to tweak the model inter-year without extensive knowledge on how to
create the model… so that’s why a lot of people, like management, prefer the
[DCF] model.

It’s very subjective, you ask me whether I think the DCF model is accurate… well
I guess it depends on the type of project… I’ll tell you something though, management think it’s accurate. Don’t forget they know nothing else, so this is
the valuation yardstick they measure accuracy with.

It’s interesting to note that sometimes I find the simple valuations I run, on maybe
one excel sheet page, give me the same answers, or very close to, as of those very
detailed ones created by large research companies who spend hours and hours
calculating and get very detailed... I'm not saying all this work is wasted but it
definitely makes management double check themselves, as they wonder whether
all that additional work is worth it... At the end of day there are always huge time
pressures, so you often find people weighing up the “benefit vs time” and then
deciding to go with the DCF model. Is it right? Well I don't know, but I do know
that it's what I do... so I'm guessing it's the same for a lot of other people.
We use a lot of comparisons, especially with regards to the cost of our production. We feel that this valuation area is pretty accurate as you are valuing your mine or project against very similar types of projects… additionally we see the markets are priced efficiently resulting in usually very realistic figures.

The main reason we use comparisons is so that we become comfortable in the values we are getting... basically like we've discussed you need a lot of different valuations to try and give you a holistic picture. If you’ve got a number of valuations, you can have one high, one low and then one in middle, so it makes sense that this one [in the middle] could probably be where the fair value is going to lie... In terms of supplementary methods we usually use PE Multiples and market comparisons just because the information is relatively easy to find...

When management see values that are close together all coming from different methods, they get a lot more confident in the value and also in their decision making ability... the value looks more realistic too them... On the other hand, if the values are far apart, they start too worried about why this is the case and it usually results in them digging deeper into each valuation and trying to find out what is going on and whether it is right... I guess even when the values are far part it's a positive, as it makes management analysis deeper and hopefully at the end of it, they understand why they have the values they do and they become more confident about making decisions, which I suppose it the major point of valuations…
Proposition 3: ROA offers a well suited technique for valuing natural resource based projects, as it allows for the inclusion of uncertainty and significant flexibility regarding decisions.

Real Options can help management structure their decisions regarding which projects to invest in, especially in mining when there are so many factors and options to consider when entering a project… This is further exaggerated in South Africa where additional labour issues and political risk needs to somehow be accounted for... You can really use real options as planning tool, it makes people think about the future... it's almost similar to Clem Sunter and scenario planning where you looking at all options available to make sure you have covered your bases.

You speak of valuing uncertainty and risk, and I can tell you one thing, there is plenty of that in SA mining. It's almost laughable when we sit down and try to create a 5 year plan for our business, we have so many factors to consider and worst of all we actually have no clue as to which way these factors might move... I'm talking about things like productivity, commodity demand, commodity pricing, production costs, technical stuff like ore body stripping... then don’t forget all the labour issues and political nonsense that exists in SA and I haven’t even mentioned the environmental and safety stuff which is getting more and more hectic as the years go on.

Due to the volatility that exists within commodity prices you find that this often creates an embedded option. If there is a large movement in the commodity price it results in different scenarios opening up… An option that we look at currently is one where you invest now when the commodity price is low, and then when the price spikes you will be in a position to make the most it [the situation].
I think SA let has let itself down over the past 15 years, we weren’t ready for the commodity super-cycle which occurred between 2000 and 2010... If you look at Australian and how they capitalised on it, we could be where they are, expect we messed it up. Now although that's come and gone I think we can learn from it and think Real Options can have a place in ensuring we ready for the next super-cycle or maybe even just a commodity spike. If you use Real Options it's continuously making your plan ahead so that if there's change in the commodity price you ready to capitalise on it.

We had a client that was looking to mine a new resource... it had never been extracted before so there were a truckload of unknowns... the extraction rate, price of the commodity, grade of the resource, long term demand, I mean a whole bunch... because there were so many unknowns this results in very high project risk... I mean there's so much guess work going on, it’s a joke... anyway because of the risk we end up with a WACC [risk adjustment factor] that’s extremely high... and then like every miner in the world the client also thinks that in order to be number one [producer in the world] he better build a huge plant so that his cost per ounce is low. Now me and the client are looking at each other and saying there is no way with such a high risk, we can look to sink this capital into the project, the shareholders won't allow it and it doesn't even make sense from our perspective... but we also looking at this project and saying, it's a great opportunity, we can’t just chuck it out, so I say, “what can we do to make this feasible?” The answer is that we build in flexibility... I suggest they start with a small extraction and production facility, so now the amount of capital needed is far less... then once some of the unknowns, such as the extraction rate, price of the commodity and grade of the resource become known, we can revalue the project. We can adjusts the risks assigned to the project and work out whether an expansion is feasible... The approach is more costly overall, but at least it makes the project feasible... By building in flexibility I offered the client a safer option which the shareholders would sign off one – it all made sense... I guess that right their highlights the value of flexibility.
Capital funding is such a hard thing to obtain nowadays, so you don’t want to only be using a technique such as NPV [DCF based], as you find it often requires a large capital outlay… So rather using a Real Options type approach you can stage your investment and take a lot of the future risk out the project.

DCF doesn’t account for the flexibility that lies with management, for example, if a mining project is making losses, you have the option to abandon or postpone the project, this option or let’s call it decision, has significant value.

DCF doesn’t account for management’s flexibility… It [flexibility] especially comes into play when you start looking at options like delaying a project... Look at Lonmin Plats at the moment, they have roughly half the world’s platinum reserves underground, so because commodity prices are so low and plus they have the added pressures within South Africa, they looking at possibly abandoning a few mines for the next 10 years... then I guessing that when the demand and commodity prices increase again they’ll look to reopen them. I mean, it's pretty obvious that [this decision] has value, so then we should account for it.

It’s largely about capturing the ability of management to adapt to change… Accepting that there are always going to be changes in the future which you cannot predict right now... If you have a few projects and you have the option to choose which one you should invest in first and which one you should hold, then that’s a great time to use real options... ROA is about giving you the price of optionality, so you can see what options are available. This knowledge will hopefully assist in helping managers make better decisions.
Proposition 4: The poor adoption of ROA as a valuation technique is driven by its mathematical complexity, which results in a lack of understanding by management.

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<td>I've seen ROA being used before, but hardly. It really isn't used much in SA and I can’t really comment internationally… Most of my dealings with it are from a theoretical side, I have read a lot about it and used a Monte Carlo type approach now and again, but it’s definitely not widely used, that's for sure, it’s just too technical for your everyday man on the street. I wish it wasn’t but it is, that’s the sad truth.</td>
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<td>Yes, I understand benefits of the Real Options, but I still don't use it… there lots of reasons why it's not popular… firstly because it so complicated, not everyone, or actually hardly anyone understands how these models work, it’s a black box approach, you just chuck in some inputs and it spits out the result., we then meant to accept the results that as 100% true? No way! You pretty much have to be a maths genius to fully understand the model… and it’s this lack of understanding by both valuators and management is why no one wants to use it, and I guess that makes sense.</td>
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<td>We spoke about it early with the DCF model and how the &quot;time vs benefit&quot; thing was so worthwhile, well a lot of people don't hold the same view about Real Options. They see how much time, effort and resources are needed to create it, understand it and then eventually apply it and they decide against using it.</td>
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<td>A big problem with ROA is that you can’t make adjustments to the model that easily… because it’s so technical you often have to just put in the inputs in and then read the outputs. That’s not case with DCF where you easily able to adjust it [the model] as you see fit… Also you have to understand computers to really deal with ROA. Those computer programs are not simple and you need a good understanding of them if you are going to use the technique correctly.</td>
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Without doubt the biggest setback which affects the adoption of Real Options, is management’s lack of education. They don't understand the technique and how it works. You can't really expect them to use or even encourage the use of a technique they don't understand. Actually it almost works the opposite way, where management shy away from Real Options and would rather stick with a simpler version if it means they fully understand what its offering.

We sometimes use stochastic modelling, a Monte Carlo type model, the problem is that the shareholders are not educated on these models, so they have no idea how they work and how to interpret the outcomes… it all looks very foreign to them. Pitching to your audience is of key importance and because management understand exactly how a DCF works, at least they can challenge what we’ve done and this allows them to gain confidence in our assumptions and model.

If you have got someone who knows Real Options then you are talking the same language and very quickly they get a lot of confidence from the Real Options model, but generally that’s not the case.

Although I mentioned we use Real Options, is not all that frequent. I mean we primarily use DCF and I would say we spend the majority of our time dealing with this technique. But like I said we do use supplementary techniques because we think it’s important that we have a combination of values. But I must be honest, there are the more common techniques like PE multiples, market comparisons, payback period... you know that sort of stuff.

Well for us the use of Real Options was mainly because we felt that the DCF undervalues the mining stocks... And by quite a substantial amount... I'd say as much as around 20-30%... It's like I mentioned earlier, it comes down to its inability to allow for management making decision while a project is going on. This means that in a project there are options available which have not been valued... these options have value so we can't ignore them, and that’s why we use ROA... Ideally what we want to find is that the Real Options price of the mining share is in line with that of the market share price, then we can just look one year
down the [Real Options decision] tree and this figure should represent a realistic future share price. Once we know this price we can then make the decision whether we buy, sell or hold the share.

We don't use Real Options that often, but I must say that when we have I've found it particularly useful. We mainly employ it when we have multiple projects running all at the same time... because it’s then when we left with a decision on where to invest our money. The Real Options help us to see where we can get best value out of the projects, given all the options available. It assist us in making the right decision... From the valuation teams perspective we enjoy Real Options and that's why we use it in certain situations... We don't really distribute these findings to management, as they have no idea what's going on... It's hard to say when they'll [management] embrace it [Real Options] or even if they ever will, I guess they need to understand the full potential before they start embracing it.

With many SA mining companies, such as Anglo and Lonmin, now carrying dual listings in London and Johannesburg, there is very little difference between the valuation and decision making procedures in place... you find the overall approach to business by all mining houses are very similar.

Management mention the term optionality in their press releases all the time… They say things like, “we looking to ensure we maximise the optionality within this project” but they don’t truly understand what the practical implications of building in and using optionality entails.”
Proposition 5: Resource companies need to increase their operational and strategic flexibility, highlighting the need for future valuation techniques to accommodate these factors while remaining transparent and easy to understand.

I would say we include flexibility into most of our models… we build very complex DCF’s that have lots of information, but we still try and keep the inputs as simple as possible... the trouble is that your DCF models gets very complex as you try to build optionality in, so you then constantly need to update the model every time new company results or figures come out, as these feed the model… so it almost becomes impossible to keep it up to date and after a while the time vs benefit factor starts coming in again... it's a very fine balance between optionality and practicality.

The main reason we don’t want to move to ROA is that it's too complicated, it's not even in our skill set and our management don't understand it either... We would much rather adjust, tweak or add to current DCF model, this way we get to build in different scenarios but people also understand what we doing and why the result is as it is. We have a variety of ways of adding in this type of project flexibility... the main one is through probability weighting, trying to determine what might happen, the probability of it happening and what this change might cause... the other is by creating all these different options on a excel sheet and then running through them by switching them on and off and looking for changes, analysing the best case and worst case… It makes you realise what's important and what you need to focus on.

Our DCFs are extreme technical and detailed, we look at everything we can with the utmost precision... We look at all the options available to us, can we close this shaft and rather open that shaft, or we can open both at the same time… I must say, I feel our DCFs are so comprehensive they almost act like a simplified Real Options model.
We bring in different kinds of options and scenarios into what you could call a complicated DCF type model... you can build some flexibility into your DCF, if you think about Real Options, they are basically valuing the output of an option and then applying a probability factor of the outcome happening. So it’s basically a probability weighting on your scenarios, that’s all it is.

You find people are trying to simplify these models by removing variables and making more assumptions. It results in them keeping the most important factors like the commodity price and extraction rate constant. This defeats the whole point as that is where the value and opportunities lie.

So my company doesn’t use Real Options, but I would still say we use an 'Options Philosophy'. I am always considering the "what if" scenarios and looking at them from both sides and seeing whether I would be in a situation to capitalise, or have a competitive advantage if there was to be this shift in a variable.

You need to always be looking ahead, the gold price is currently around $1200 now, however if it was to spike to $2000 would we be in a position to take advantage of this? I am continuously asking my team to consider the options available, to make sure we are in a position to capitalise if changes occur… Scenario planning is something I drive continuously within the company.

For large companies like your Anglos and BHP’s, you absolutely have to look at ROA, because it offers you flexibility and that is so key when you have a huge range of projects.

The amount of variables and volatility within the mining sector is not unique to South Africa, the bulk of these variables are seen by all mines no matter where they are situated… It’s not just the SA economy that’s having a tough time currently, this GFC [global financial crisis] has affected everyone.
I mean the chances of Real Options becoming a primary valuation technique and taking over from DCF in the next 10 years is pretty much zero… It doesn't fit the bill for a primary valuation technique. However I must say that with computing getting better I feel that in the next 10 years we could see it being used more on the side... as kind of a second weapon... Once people have done the DCF model they’ll then run a Real Options model... I guess the trick is how to encourage people to run this more technical model?  

The future of valuations lies in computing, as computers get smarter and faster, they soon going to just add data straight from the market and churn out a value without us asking for it... That helps Real Options because currently people are scared of their technical nature, so if people start to use and trust computer programs more, they'll eventually start to use Real Options more regularity.