"The application of a real options valuation methodology to a coal mining project in New South Wales, Australia"

By

Shaun Leary
(BSc. Hons, Dip Comp Sci, MBA (Fin), MIT)

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STATEMENT OF ORIGINALITY

This dissertation contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and to my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Shaun Leary
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Abstract
This study uses a real options approach to value an operating coal mine in the Hunter Valley, New South Wales, Australia. It then compares the results with a traditional discounted cash flow (DCF) analysis, finding that not only is the methodology presented viable, but the relative simplicity of its implementation using binomial lattices makes it a realistic and feasible alternative to traditional DCF analysis.

A review of the current literature revealed two schools thought with reference to mining valuations. They were traditional valuations derived from Net Present Value (NPV), and values derived from real options analysis (RO). Valuation methodologies within the RO literature were not consistent and were found to fall within five categories, the Classic, Subjective, Market Asset Disclaimer (MAD), Revised Classic and Integrated approaches. This study uses the MAD approach, arguing that it provides a method to capture project specific and market related risks as well as being easily implemented using simple binomial lattices.

The study found that the RO approach presented a feasible and mathematically viable alternative to the traditional NPV methodology showing that a constructed portfolio using firms that undertake similar projects to those of the case study will capture both project specific (private) and market related (public) risks. Furthermore it was found that the RO analysis yielded results that were in the vicinity of 25% greater than the traditional NPV values. This was found to be in line with the literature. It is also argued that real options such as the option to expand, the option to contract, the option to wait and the option to
abandon cannot simply be added to calculate an overall RO value since there are issues of additivity that need to be considered and require more research.

This study makes a contribution to the business literature by being the first study to address the applicability of real options valuations to the coal mining industry.

**Introduction**

One of this study's primary aims is to present an alternative valuation model for financially modelling coal mines. The study does this by evaluating a currently operating coal mine and then comparing the results derived from a traditional DCF/NPV analysis with those from an alternative Real Options Valuation. It then asks the question, does the typical NPV analysis adequately capture all the value associated with the coal mining project, and if not, does the Real Options approach more adequately capture the value associated with coal mining?

In mining finance, Discounted Cash Flow (DCF) models are the basis for most project evaluations, with the conventional view that the Net Present Value (NPV) of a project is the measure of value the project will add to the firm. This premise is increasingly being challenged in the financial literature with the most viable option being the Real Options Analysis (ROA) methodology.

The ROA technique has evolved from the seminal work of Black and Scholes (1973) in financial options to present thinking, where the same principles are applied to real assets
like natural resource projects. Brennan and Schwartz (1985) presented a seminal paper linking financial options thinking to a mining project and from this point on there has been an explosion of study in regards to its applicability to natural resource projects.

Despite the theoretical appeal of ROA, current studies (Remer, Stokdyk et al. 1993; Truong, Partington et al. 2008) show that most companies still use traditional DCF/NPV methods. This study argues that there are several reasons for this, including the complicated mathematical themes often presented in the literature and secondly a lack of understanding of the shortcomings of the NPV methodology. One motivation for this study is to address this mathematical complexity and lack of NPV understanding by presenting a simple intuitive real options model. The mathematical complexity is purposely kept simple to make the method more initiative and accessible to the practioner involved in evaluations of mining projects.

The dissertation is structured in the following manner. Firstly Chapter 1, a literature review, is presented detailing the evolution of financial evaluations for natural resource projects. It reviews the development of alternative approaches to traditional DCF/NPV valuations including ROA and Hotelling's method. It establishes the ROA as the main alternative to traditional DCF/NPV methods.

After the Literature Review, Chapter 2 presents a specific methodology for valuing a coal mining project using ROA and comparing the value derived from this method to a traditional DCF/NPV analysis. This Chapter presents the method for a traditional DCF/NPV valuation detailing many of the assumptions and drawbacks that have led to it being questioned in the
literature. The five competing real options approaches are also presented. Namely, the classic approach, the subjective approach, the Market Asset Disclaimer (MAD) approach, the revised classic approach and the integrated approach (Borison 2005a). This Chapter establishes that the MAD approach is the most appropriate for this study.

Chapter 3 presents the results of a Case Study evaluation using the methods presented in Chapter 2. It builds a cash flow model based on a mining model derived from first principles. This cash flow model is included in MS Excel format in Appendix 1. The cash flow model presented accounts for the lumpy nature of cash flows in mining projects, an approach that is not previously seen in the literature. Previous literature studies using ROA to value mining projects almost always exclusively present cash flow models based on some form of probabilistic determination. This it is argued is simplistic and is not in line with industry practice where detailed Life Of Mine (LOM) models are always constructed to reflect the current estimated mining schedule. A significant contribution of this study is to show how this industry practice of constructing "lumpy" cash flow models can be reconciled with the approach that is taken in the academic literature. The study does this by arguing that that ROA using the method detailed in Chapter 2 can be "bolted" on to the back end of traditional DCF/ NPV analysis derived from the "lumpy" cash flow model. This approach will make it intuitive and more likely to be accepted by management who can still refer to the established DCF/NPV in any decision making process. Empirically this is presented as;

\[
\text{Expanded NPV} = \text{Traditional NPV} + \text{Real Options Value}
\]
The options that are considered in this case study are the option to abandon the mine, the option to expand production, the option to contract production and the option to wait. These options are well established within the literature and are shown to add 20% additional value to the Case Study. This finding is in line with the literature which typically finds similar increases in value associated with the operating options available to mine management.

Chapter 4 presents a discussion section centred on the viability of applying the method to corporate valuations within the mining industry. The practicality and its likelihood for corporate acceptance are discussed as well as some of the ethical questions surrounding a valuation methodology that increases the value of projects in the vicinity of 20% are also considered.

The strategic benefits of thinking in real options terms are also discussed. This new thinking paradigm can position the company to strike when market conditions are favourable or recognise potential investments even when traditional methods argue for rejection. Not only does this present project level benefits but on a firm wide basis it could influence mergers and acquisitions activity. By being a first mover it is argued that a firm embracing real options theory is likely to unlock value that is not recognised by its competitors.
The final component of this study is the conclusion. It argues that the study makes a significant contribution to the business literature by presenting a method in line with existing literature but building on it by presenting a methodology that is simple to use and understand and applying it to a real world coal mining operation. It uses current mining valuation practices to construct the underlying asset, the NPV, which is not contentious despite issues surrounding its derivation. The portfolio of coal assets used to derive parameters used in the ROA is more contentious. This study argues however, that its use is more valid than current subjective practices used in the literature and that its application could be applied to other commodities such as iron ore and gold for example.