Resources Policy 52 (2017) 7–18

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Towards sustainable mining (Part I): Valuing investment opportunities in the mining sector

R. David Espinoza[a,*], Javier Rojo[b]

[a] Geosyntec CAT (Capital, Assets, and Transactions) Advisory, 1220 19th NW Suite 210, Washington, D.C. 20036, USA
[b] Sustainability Strategic Advisors, 16 Parkside, Rolt Street, London SE8 5JB, UK

ARTICLE INFO

Keywords:
Mining
Valuation
Asset
Sustainability
Climate change resilience and adaptation
Discounting
DNPV

ABSTRACT

Reliance on classical valuation methods such as the net present value (NPV) has often resulted in controversial asset valuations in the mining sector. An alternative method, termed decoupled net present value (DNPV), is used to evaluate mining investment opportunities. The proposed valuation method decouples the time value of money from the risk associated with the project providing a consistent valuation method free from the problems typically associated with the application of NPV. Market risks (e.g., commodity prices, foreign exchange) can be systematically combined with non-market risks (e.g., effect on operations of climate change and/or large earthquakes). More importantly, DNPV allows seamless integration of project risk assessment performed by technical experts and risk management implemented by business executives into the financial evaluation of the project. A simplified mining investment project is analyzed using traditional techniques and compared with the proposed DNPV. The example includes a discussion about how valuation is affected by climate change and earthquake risks, and how investment in resilience and adaption can be incorporated in the proposed analysis.

1. Introduction

The most popular valuation methods used in the mining industry are the net present value (NPV) technique followed by its close relative the internal rate of return (IRR). These methods consist of reducing future cash flows by a single factor that grows exponentially with time. This factor is known as the risk adjusted discount rate (RADR) because the effect of time is adjusted for risk. The main problem of combining time value of money (represented by the risk free rate) and risk in a single factor when calculating the NPV of an investment is that it artificially makes the value of cash flows that occur far in the future negligible and overemphasizes the value of earlier cash flows. Thus, the results of such an analysis can be misleading, steering corporations to adopt and government entities to accept design and operation decisions that can be detrimental to society and shareholders alike in the long term.[1] For mining investors, NPV methodologies produce high volatility in the valuation of long lived mines (30–40 years) which are comparable to the volatility associated to commodity spot prices. Moreover, the overreliance of NPV methodologies makes it nearly impossible to justify climate change reliance and adaptation investments to improve mining facility chances to withstand the effect of future significant weather events related to climate change.

Although the shortcomings of the NPV methods have been widely recognized by many industry experts (e.g., Salahor, 1998; Laughton et al., 2000; Samis et al., 2006; Guj and Garzon, 2007; Hawas and Cifuentes, 2016), and alternatives proposed, NPV is still by far the valuation method of choice. Recently, a valuation method to assess the value of long-term infrastructure projects was introduced (Espinoza and Morris, 2013; Espinoza, 2014). The proposed method, termed decoupled net present value (DNPV), addresses many of the shortcomings of the NPV method while retaining the simplicity in its presentation that has led to its popularity. The DNPV methodology consists of evaluating each of the key risks associated with a project and calculating a synthetic insurance premium for each that would be demanded by a risk neutral insurance company (if such an insurance product were actually available). This hypothetical insurance policy premium, designed to protect the project's cash flows from a shortfall below the expected values in the event of an adverse outcome of a given risk (e.g., reduction of revenues due to commodity prices volatility, increase in expenses due to technical difficulties), is termed the cost of

* Corresponding author.
E-mail addresses: despinoza@geosyntec-cat.com (R.D. Espinoza), jrojo@sustainability-sa.com (J. Rojo).

[1] The comments voiced by Dean Gehring (President and CEO of Rio Tinto Minerals) at the 2015 SME Conference in Denver, Colorado reinforce this point: "*I think we're going to see how mines are valued change. The way that we've all been valuing mines for years now is basically on net present value-type analysis, which is a very, very common understanding in a Western culture. Well, there's a lot of cultures that don't get that, and, in fact, to them, its value destroying, and I think that as we go forward, we're not always going to design mines around net present value. There'll be something else that we look at that tells us what really is the true value of that operation.*"

http://dx.doi.org/10.1016/j.resourpol.2017.01.011
Received 13 November 2016; Received in revised form 17 January 2017; Accepted 17 January 2017
0301-4207/

risk. The cost of risk is subtracted from the project's expected cash flows. The subtraction of all the relevant synthetic insurance premiums leaves the remaining project cash flows virtually riskless and the DNPV valuation for the project can then be obtained by discounting the time value of the remaining riskless cash flows using the risk free rate. In some instance such insurance instruments are available in the market place and therefore there are observable prices available (e.g., at-the-money put options for commodities or specially structured insurance policies and/or financial guarantees) that can be used in the DNPV calculation. In most practical applications, such financial instruments are not available for portions (or any) of the period under consideration so the risk of the project becoming unfavorable (i.e., the revenues being lower and/or the associated expenditures being higher than anticipated) is borne by the investor. Considering risks as costs that affect cash flows is a more natural progression of a well-established business practice of buying/selling insurance products to obtain/provide protection against insurable risks. For those risks that have not been transferred to an insurance company and/or hedge provider, the investor becomes the risk bearer against unfavorable outcomes and the estimated cost of risk their compensation for taking on such risks.

In summary, the principal feature of DNPV is the decoupling of the time value of money and risk, which allows discounting future cash flows using the risk-free rate while accounting for risk as a cost to the project. This feature is paramount for valuing long-term assets as well as liabilities (e.g., asset retirement obligations, climate change resilience and adaptation measures) as these are not reduced to negligible values by the process of discounting by an artificially high RADR. The use DNPV can facilitate the use of the captive insurance concept to manage risk for large mining conglomerates when assessing mining project assets, which is the focus of this Part I dissertation on mining sustainability. Valuation of long-term liabilities associated with mining activities, which must go hand in hand with asset valuation, is the subject of a Part II companion paper (Espinoza and Morris, 2017).

2. The perils of using risk adjusted discount rates

Common to most mining valuation analysis is the selection of a constant RADR to calculate the NPV of an investment. If the selected RADR is greater than the project's currency risk-free rate, then the discount rate has been adjusted for risk. The seemingly innocuous assumption of using a constant RADR throughout the investment period can have a significant effect in investment decisions particularly for long term investments with long-term future liabilities such as those of mining.

Risks that can affect investment cash flows can be from many different sources and evolve over time in many different ways. These risks are typically classified in the literature as: (1) systematic (i.e., priced, non-idiosyncratic, non-diversifiable, public, market); and (2) non-systematic (i.e., unpriced, idiosyncratic, diversifiable, private, non-market). Systematic risk is associated with the type of asset to be created (e.g., commodity prices for mining projects). Non-systematic risk is a project specific risk and could be technical (e.g., the amount of ore mineral available in a geological formation and its grade) as well as non-technical (e.g., changes in the local tax code, changes in environmental regulations). The classical text book expression for calculating the NPV of an investment considering all the associated risks listed above using discrete cash flows is given by Eq. (1):

$$NPV = \sum_{t=0}^{T} \frac{\widetilde{C}_t}{(1+r)^t} \tag{1}$$

where T is the maturity (i.e., investment period), $\widetilde{C}_t$ is the expected value of a stream of uncertain future net cash flows (C_t), and r is RADR that lumps time value of money and the risks described above. The approximate continuous representation of NPV as a function of time is given by Eq. (2):

$$\frac{\widetilde{C}_t}{(1+r)^t} \approx \widetilde{C}_t e^{-rt} \tag{2}$$

The classical equation to estimate the discount rate to account for market risk is given by the Capital Asset Pricing Model (CAPM) in Eq. (3):

$$r = r_f + (r_m - r_f)\beta \tag{3}$$

where r_m is the expected rate of return of the overall market (e.g., the S &P500 stock index); r_f is the risk-free rate; and β (i.e., the company beta) is a parameter that measures the systematic risk of the asset relative to the market, and the difference (r_m-r_f) is known as the systematic risk premium (r_p). Consistent with Robichek and Myers (1966), the time value of money is accounted for by the first term (i.e., the risk-free rate) in Eq. (3) whereas systematic risk is accounted for by the second term. Although modern portfolio theory predicates that investors should not demand a risk premium for non-systematic risks, such a predicament is only valid for sufficiently liquid securities that can be traded in the open market where elimination of non-systematic risk can be easily achieved through diversification. For investment in real projects/assets, the average investor would typically demand compensation to take on non-systematic risks as the amount invested and the cost of analyzing multiple investment opportunities can be significant. Examples of investors demand for additional compensation to account for nonsystematic risk abound. For instance, investors typically add a country risk premium (a theoretically diversifiable risk) when evaluating mining investing opportunities. Similarly, in the biotech industry, the selected discount rates are affected by clinical success rates.

To account for non-systematic risks posed by one-off projects, an additional risk premium (r_{ns}) is included to lump several non-systematic risks together (e.g., Samis et al., 2006). Hence, Eq. (3) can be modified simply as (Eq. (4)):

$$r = r_f + r_s + r_{ns} \tag{4}$$

where $r_s = (r_m - r_f)\beta$ represents the systematic (i.e., market). Congruent with systematic risks, a compensation for non-systematic risk takes the form of an additional risk premium added to the risk free rate as shown in Eq. (4), implicitly assuming that systematic and non-systematic risks are governed by the same stochastic processes.

Although this simple approximation is consistent with popular representations of market risk and is easy to implement in discounted cash flow models, its impacts can be significant because of the sensitivity of NPV to the selection of the discount rate, particularly for long term projects. Using the continuous representation of NPV on the right-hand side of Eq. (2) to explore the influence on the project NPV of the apparently innocuous simplification of adding risk premiums to the risk-free rate to account for systematic and non-systematic (i.e., market and non-market) risks, the value of the investment can be expressed as (Eq. (5)):

$$C_t e^{-rt} = C_t e^{-(r_f + r_s + r_{ns})t} = C_t e^{-r_f t} e^{-r_s t} e^{-r_{ns} t} \tag{5}$$

Or alternatively as (Eq. (6)):

$$NPV(C_t, r) = NPV(C_t, r_f)\, F_s\, F_{ns} \tag{6}$$

where NPV(C_t, r_f) represents the time value of money and $F_s = e^{-r_s t}$ and $F_{ns} = e^{-r_{ns} t}$ represent the risks reduction factors that vary from 1 to 0 (Fig. 1) and account for systematic (i.e., market) and non-systematic (i.e., non-market) risks, respectively. Risk reduction factors equal to 1 indicate that there is either no risk (i.e., r_s = r_{ns} =0) or that time t=0. Risk reduction factors equal to 0 indicate that risks are infinite (i.e., r_s = r_{ns} =∞) or that time t=∞. Thus, the project NPV can be interpreted as the cash flow at time t discounted using the risk free rate to account for the time value of money and further adjusted (reduced) to account for market risk (F_s) and non-market (non-systematic) risks (F_{ns}). It follows from Eq. (6) that, independent of the actual stochastic