Paper

"Re-Invent" our Approach on the Mining Economics for Improved Investment Decision

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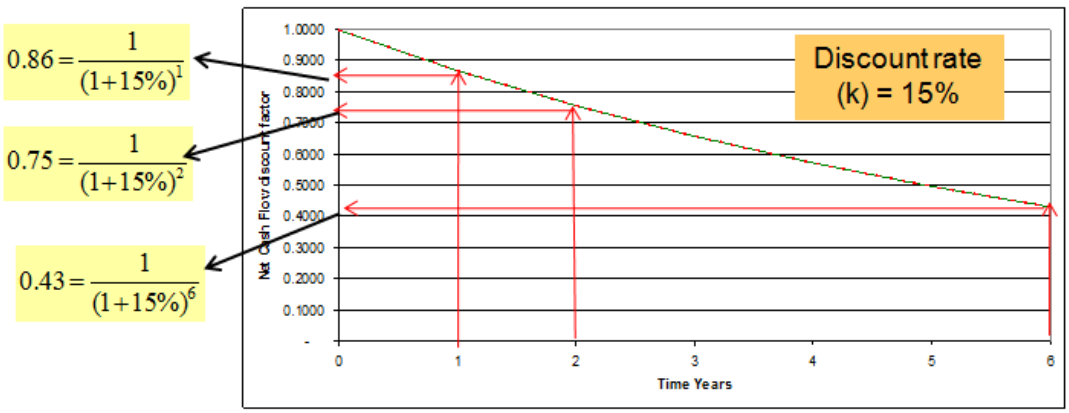
Background

Currently, business practitioners used a single corporate discount rate method for valuing uncertainty in the project valuation. This method is known on static Discounted Cash Flow (DCF)

This methodology has a limitation in recognizing uncertainty during project life and some biased in its assumption, i.e.:

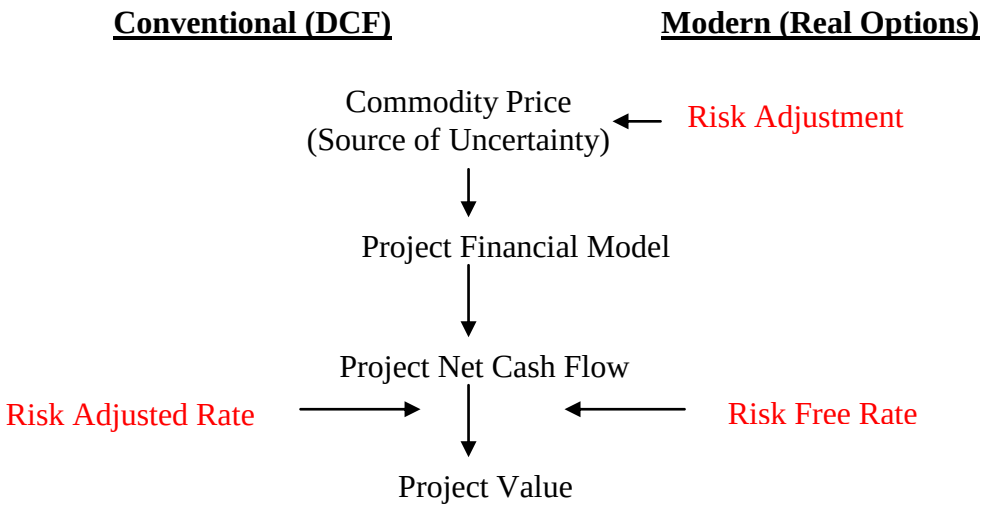
1. It is assumed future cash flows to be certain to happen.
2. Project risk does not change throughout its life
3. It is assumed once the project is undertaken; it will not be affected by any future managerial decision.

A fundamental principle of valuation theory is that investors are concerned with net cash flow uncertainty and require compensations for being exposed to risk (i.e. risk adverse). In reality, net cash flow uncertainty can vary tremendously over the life of the project due to changes in cost structure, price levels, uncertainty characteristics and operating strategy.



As shown in the above, the conventional NPV analysis would discount project cash flow using a constant discount rate. This is problematic since it violates the principle of investor risk aversion where the net cash flow uncertainty is not increasing at a constant rate (Blais et all, 2006). Using this analysis, longer the project would be put on production, higher discounting factor would be applied to the cash flow generated from the project. This would penalize the long-lived project like in mining industry.

DCF vs Real Options



Assuming the main source of the uncertainty of the project is the commodity price, figure 2 shows that in the absence of managerial flexibility, the first step in RO valuation is to apply risk discount factor to each uncertain cash flow element arising in any one period.

The difference in risk adjustment between the DCF and RO valuation methods appears to be nuanced but its consequences are potentially large. This process allows senior management to use financial market information to determine the underlying structure of risk adjustments for the uncertain variables of interest to the corporation.

The detailed project cash flow dependence on these underlying uncertain variables then determines how these underlying risk adjustments are transformed implicitly into risk discounts for the project cash flow.

The difference between DCF and RO methods of adjusting for cash flow risk when calculating a cash flow NPV can be illustrated using the concept of Net Cash Flow Risk Discount Factors (NCFRDFs). A NCFRDF calculates the magnitude of risk adjustment that is applied to each dollar of a cash flow in a particular year. It indicates the amount an investor will pay for a dollar of cash flow from a particular cash flow stream on a risk adjusted (but not time adjusted) basis.

Case Study

In this case study, we assumed the main source of the uncertainty of the project is the coal price (S) that will follow a one factor Geometric Brownian Motion (GBM):

$$\frac{dS}{S} = \alpha\, dt + \sigma\, dz$$

where:

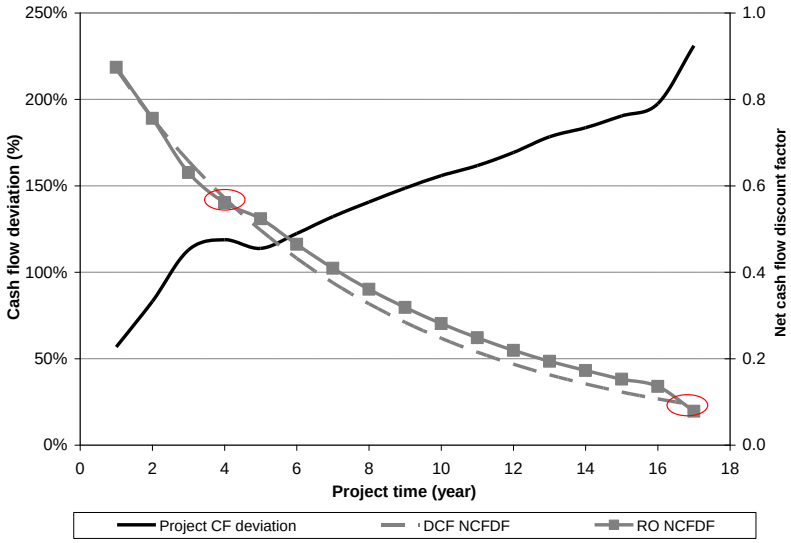
- dS = coal price different
- σ = short term price volatility (%, annualized)
- α = short term expected price growth (%, annualized)
- dz = an increment of standard winner process
- dt = time different

Based on the above price model, coal price uncertainty will increase over the life of the project. The technical and commercial data of the coal project is shown in the table below.

Parameter	Descriptions
Technical Data	
Mineable reserve (million ton)	303.7
Stripping ratio	1:8
Mine life (years)	7
Average Production plan (ton/year)	17.8
Commercial Data	
Spot price ($/ton)	60
Long term price forecast ($/ton)	60
Operating Cost ($/ton)	28
Capex ($ million)	179.2
Closure Cost ($/ton) of the coal	0.1
produced	13.5%
Royalty	41.75%
Income Tax	15%
Risk adjusted discount rate	5%
Risk free discount rate	

In this case, we investigate how DCF and RO method recognize the unique risk profile of closure cost spending in the end of the project. We would analyze how DCF and RO methods affect the uncertainty characteristics and value of project cash flow stream.

Result (1)



The above figure compare the DCF and RO risk adjustments applied to the various project cash flow streams and links these adjustments to levels of cash flow uncertainty during each year.

In each of these graphs the vertical axis on the left side represents the level of cash flow uncertainty. These are plotted with a solid black line, taken from the figure. The vertical axis on the right side represents the NCFRDFs. The DCF and RO NCFRDFs are plotted with grey lines; the dashed line with no data markers delineates the DCF NCFRDF and the lines with data markers outline the RO NCFRDFs.

The difference between 1.00 and the NCFRDF is the amount of compensation an investor requires for exposure to uncertainty in project cash flow stream.

The project cash flow uncertainty and risk discounting is provided in the figure. Cash flow uncertainty increases with time as production decline and coal price uncertainty increases. There is a jump in Year 3 and 4 due to higher capital spending in that period.

The RO NCFRDFs show that the effective project cash flow risk discounting reflects the cash flow uncertainty. For example, in Year 4 (red circle in the figure), the risk discount decreases to $0.45 per dollar of cash flow (i.e. $1 cash flow is worth $0.55 on a risk-adjusted but not time discounted basis).

Result (2)

In $ thousand	Conventional Static DCF	Modern Dynamic Real Options
Project Value	1,401,328	2,552,922

The valuation result for the coal project is presented in the above table. The following cash flows and NPV were calculated for project using both a conventional single-point forecast cash flow model (Static DCF) and a probabilistic Monte Carlo simulation model (Dynamic RO):

- A Static DCF NPV calculated using a 15% discount rate, and
- A Dynamic RO NPV calculated with risk-adjusted expected coal price and the risk-free rate of 5% with early closure option if coal price is lower than cost.

Under conventional static DCF method, the project has a present value of US$ 1,401 million using discount rate of a fifteen per cent. Under Dynamic RO method, the potential value of this coal project would be $2,553 million if we consider early closure option.

The difference is true whether Static spreadsheet or Monte Carlo analysis is used because there are non-linearities in the cash flows.

None of these values is likely to be correct. However, it is well-recognized that cash flows that are more sensitive to price variability should be discounted at a higher rate.

On average, the RO method applies a lower risk adjustment to each dollar of project cash flow than the DCF method because it is picking up coal price uncertainty and the high correlation between coal price and financial market uncertainty in its risk adjustments.

The results highlight that ignoring managerial flexibility such as early closure option can generate misleading project value estimates. Managers often have the ability to manage project risk with operational strategies and this ability can have significantly effect on project value.

Conclusion

The single point forecast can give incorrect result when such non linearity exist in project cash flow. These errors are corrected in a Monte Carlo analysis.
Monte Carlo simulation corrected these errors by recognizing cash flow non-linearities in the cash flow stream. Taxes not only introduce complicated non-linearities into the valuation process, but they also alter the riskiness of the cash flows received by project owner. DCF method discounts all cash flow streams at the same rate. Real Options method brings this out, with logically higher discounting of riskier cash flow streams and lower discounting of less risky cash flow streams.
The result shows that improper risk assessment on cash flow uncertainty properly and ignoring managerial flexibility can generate misleading project value estimates.

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“Real options uses market information to discount for the risk in the project cash flow to recognize the unique risk profile of the projects .”