Cyest

CASE STUDY

Quantitative Risk Assessment using Dynamic Financial Analysis (DFA)

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History of DFA

Having stemmed from military scenario modelling principles during the Second World War, Dynamic Financial Analysis [DFA] has evolved to become an established actuarial valuation methodology used to quantify value, risk as well as value at risk.

A simplified application of early DFA principles was deployed to great effect by the famed scenario modelling unit of the Shell Petroleum Company in the late 1970's (the influence that this unit had on strategic decision making has been regarded as a major driver of Shell's success from 16th largest petroleum firm to 2nd).

More recently (in the last 2 years), a more sophisticated (and accurate) iteration of DFA has been successfully used by large corporations for the valuation of large capital investments; it is this latest iteration of DFA that Cyest has begun implementing for its client base. We have no doubt that this proposed methodology will be the most advanced evaluation of project risk and value applied within the mining industry, and that more importantly, it will provide decision makers with insight that will result in a project configuration that will yield the highest value for the lowest risk.

What is DFA?

Simply put, DFA is a stochastic methodology that provides a probabilistic range (or distribution) of values, as opposed to a single 'crisp' or discrete value such as a single NPV, or IRR, or ROI. DFA does this by allowing for different inputs to a scenario (be they external factors such as exchange rate, commodity prices etc. or internal factors such as estimated efficiencies, capital cost, etc.) to be entered as a distribution.

The distributions of different inputs are derived from rigorous regression and stochastic analyses of the historical values demonstrated by those input variables, (or by a credible proxy). The DFA methodology then weights the impact of each input distribution accordingly. In other words DFA provides a means of calculating a distribution of overall value based on the weighted distribution of each input variable or assumption. For example if the exchange rate has a wide distribution spread (e.g. it is unpredictable and high risk), but because of the limited dependence on foreign purchases for a given project, the net impact of exchange rate on the value distribution will be low.

Finally, the DFA methodology goes one step further in that it allows for the probabilistic modelling of the dynamics between the different input variables. For example – historical analysis may show that there is a relationship between exchange rate, gold price and inflation or between scale of the operation and efficiencies achievable. The use of 'copulas' quantifies the relationship between different variables and as such results in more accurate risk and value modelling.

Figure 1: Traditional Valuation Methodology using Crisp Inputs

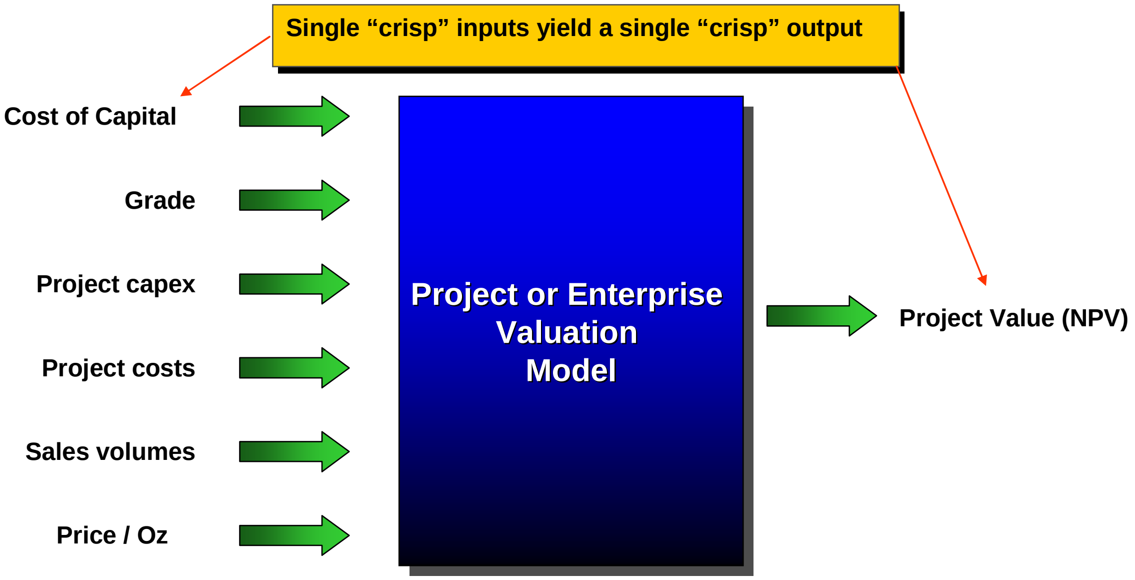
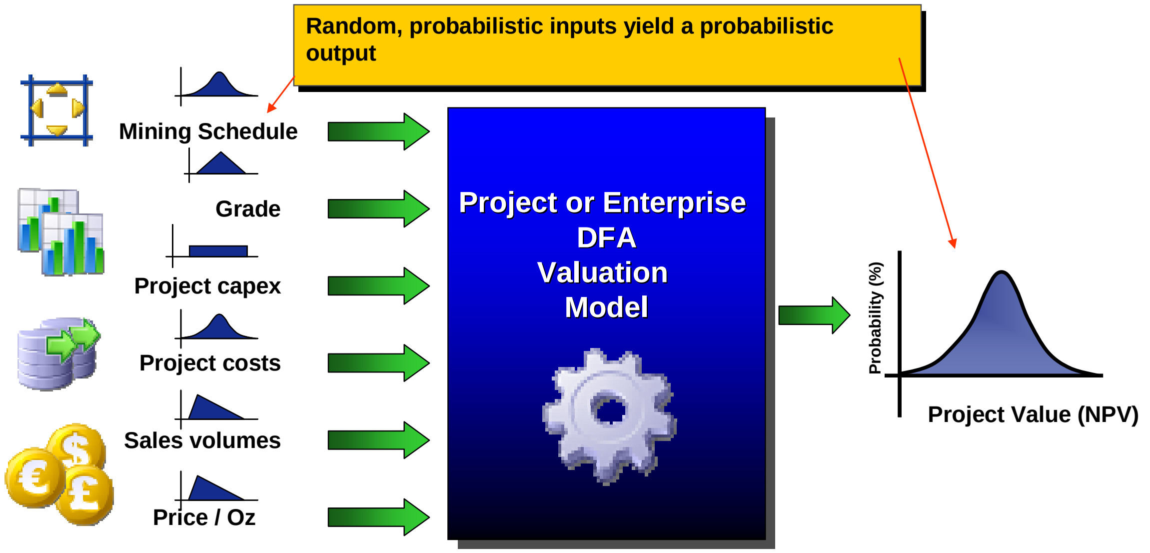


Figure 2: DFA Modelling Methodology



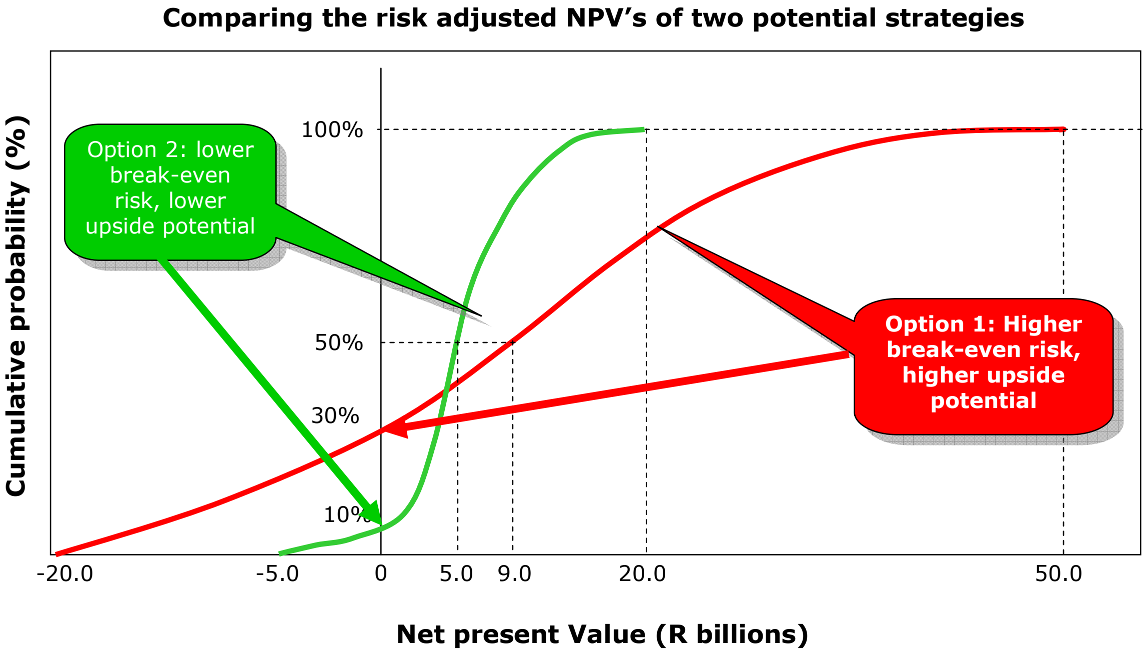
DFA in Practice

DFA, applied to the valuation and risk quantification of large capital projects, is not used to simply decide if a project is a 'go' or 'no go'; Simple static or crisp scenario modelling will achieve this. Rather DFA will show how a project can best be configured to yield a ratio of the highest return profile for the lowest risk profile.

Project configuration in this context can refer to amongst others – sequencing of events or project milestones, funding configuration (cash vs. debt vs. equity) and the timing of funds, the introduction of hedging instruments (and other risk mitigation strategies) and the introduction of different engineering options.

DFA does this by allowing a scenario modeller to quantify different risk and value profiles that will result from different configurations as illustrated graphically in *figure 3* below. In this real example below, the cumulative frequency distribution chart indicates that project option 1 has a mean NPV of 9.0 but has a probability of failure (i.e. NPV<0) of 30%, whereas project option 2 has a mean NPV of 5.0 but only a 10% chance of failure. In this real case example, option 2 applied some risk mitigation strategies that involved spending additional capital. This reduced the mean NPV for the project but reduced the variance of the NPV and therefore reduced the project down-side risk.

Figure 3: Cumulative Frequency Distribution



Risk Attribution

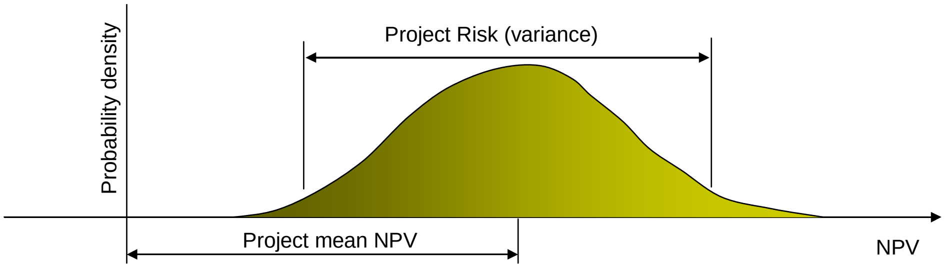
Risk attribution is another output of DFA, and this clearly indicates where the areas of highest risk are, and in so doing indicates where the greatest management attention must be focussed as shown in the schematic in *figure 4* below.

Risk attribution differs from sensitivity analyses where each variable is tested in isolation in order to assess their impact on the mean NPV. Often, the fact that NPV is exceptionally sensitive to changes in a specified variable is not always relevant to the analysis, if that variable is highly predictable and exhibits little variation. For example, if material costs are fixed contractually, the fact that the NPV would fluctuate wildly if these increased is of little relevance – as it is extremely unlikely that this would occur and is low risk.

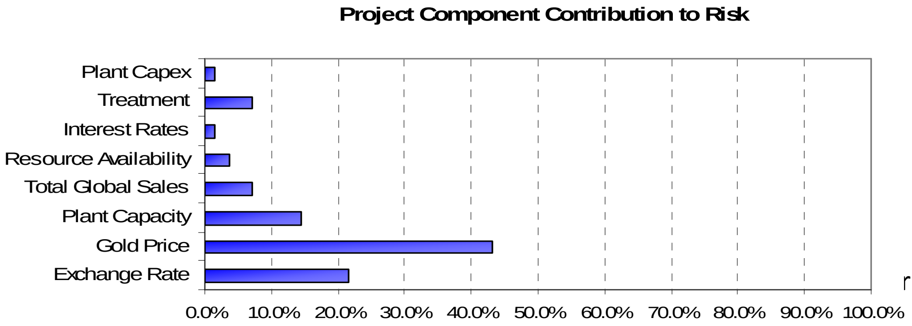
Risk Attribution is a measure of ‘how much’ that variable contributes to the total risk (variance) of the NPV distribution, relative to the exposure of the other considered risks. Therefore, in the example below in *figure 4*, the sum of the risk attributions from each variable adds up to 100%, i.e. if only a single input variable had a variance distribution and all other inputs were deterministic inputs (100% probability) then that variable will contribute 100% to the risk attribution of the variance on the NPV – implying that all project risk is from that single variable.

The risk attribution graph (*Figure 4*) allows users to quickly identify inputs that contribute highly to the risk of the project, and apply mitigation strategies (such as hedges or operational measures) to reduce these. This would have to be done with due consideration to the cost-benefit of the proposed change as the riskiest component of NPV does not necessarily have the highest impact on ultimate profitability.

Figure 4: Risk Attribution



The Risk contribution analysis chart explains the percentage contribution of the various variables to project risk.



DFA is a natural extension of Economic modelling as it incorporates uncertainty into selected input variables and therefore quantifies risk accurately.

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