Valuing Mining Projects Exposed to Cost and Mineral Price Uncertainty

Most future input prices (unit costs) in the mining industry are not known with certainty. This can have important effects on asset value and management. One criticism of most past mining industry applications of real options analysis (ROA) is that they have neglected to consider the effects of this type of uncertainty. This paper explores a few of the issues that arise in discounted cash-flow (DCF) and ROA asset valuations, if a specific type of input price uncertainty is considered.

In particular, we look at the effects of the correlation of unit costs with output mineral prices. Specialised capital and labour costs, for example, tend to be high/low if mineral prices are high/low or have gone up/down unexpectedly. The first "rent" effect occurs if the market for mining services is not completely competitive. The second "quasi-rent" effect occurs if it takes time for the suppliers of these services to adjust the amounts they supply in the face of unexpected changes in demand.

We first examine, using both ROA and DCF methods of analysis, some relatively simple assets where the asset cash-flow dependence on input and output prices, and of the input prices on the output prices, is linear. Two points are made.

First, for a set of given input price expectations, DCF estimates of the value of these assets will be independent of the level of input price uncertainty, unless the discount rate is adjusted to reflect the change in risk. ROA estimates of value will automatically pick up the effects of different levels of risk. If the unit costs are generally correlated with the macro-economy (as will be the case with a rent effect and most quasi-rent effects, if the output prices are so correlated), for a set of given input price expectations, a greater level of input price uncertainty would decrease the estimate of the value of the costs in the asset cash-flows, because of the greater risk discounting that it induces. This would increase the ROA estimate of the value of the asset as a whole.

Second, it has been conjectured that a greater similarity between revenue and cost uncertainty, by making revenue and cost discounting more similar in ROA analyses, will tend to mitigate some of the differences between the structure of ROA and DCF value estimates. This would decrease the benefits of a shift from the use of DCF methods of analysis to the use of ROA.

We analyse variations of two previously published petroleum industry examples of analyses of assets with linear cash-flows to explore these matters.

We then examine an asset where there are non-linearities in the dependence of asset cash-flows on prices. These may be due to non-linear price models, non-linear taxes or flexibility in project management. In the specific asset we analyse, which is also based on a previously published petroleum industry example, the non-linearities arise from flexibility. In this case, we find some similarities and

some differences in structure of the effects of input price uncertainty on asset value.

The example is of an mineral deposit in the final year of its development lease, where there is an option to sanction development immediately, or to appraise or wait for another year and decide then between development or abandonment. At sanction, there is a production capacity choice to be made, and after sanction there is an annual abandonment option.

Again, two points are made.

First, if the input price expectations are roughly the same, input price uncertainty of the simplest kind (stemming from a linear "rent" effect) again increases ROA estimates of asset value and leaves the DCF value estimates roughly the same.

Second, rather than mitigating the differences between DCF methods of analysis and ROA, cost uncertainty in this example accentuates the losses from using DCF methods if ROA should be used. Unit cost uncertainty interacts with the differences in the methods of value estimation to make the management policies suggested by DCF and ROA more different in the presence of this uncertainty.

All of this suggests that the industry should keep track of the uncertainty in its input prices, and their correlation with output mineral prices and with each other. This paper shows how this would be useful for project analysis. Further work is likely to show that it would also be useful in the development of appropriate risk management policies.