Roadblocks, Sleeping Policemen and Real Options

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Real options

Introduction

Rio Tinto has been using simple real option models for about 10 years

And while we have the insights and thinking of the real options approach, we are frustrated by our inability to calculate real option values that we can rely on

Our objective is to obtain internal acceptance of calculated real option values

For this we need a **credible** and **transparent** approach

Historical approach

Asset value as stochastic variable

- Difficult to parameterise
- Serious problems with handling multiple options
- Simple to implement

Helps in thinking about options, but not a practicable valuation tool

Little confidence in calculated output

Current approach

Commodity price as stochastic variable

- Parameterisation more feasible

Allow for switching between modes, which allows multiple American options to be valued simultaneously

Allow for finite reserves

Allow for varying head grades, production rates *etc*

Computationally complex, but for a given set of input parameters have some confidence with output

Current approach (cont.)

Have built a lattice-type model in Excel

- Used Schwartz two-factor price process to model the copper price
  - allows us to handle mean reversion
  - allows us to model declining term structure of volatility
- Allowed for finite reserves
- Four different modes allowed
  - allows us to value multiple (3) American options simultaneously
- Twenty time periods

Model 2GB in size, and only takes 16 hours to run!

Current approach (cont.)

Have good reconciliation to academic literature

Initial price	Initial convenience yield	Model value	Schwartz value
$0.50	10%	0.31	0.27
$1.00	10%	2.36	2.38
$1.50	10%	5.94	5.94

Sleeping policemen

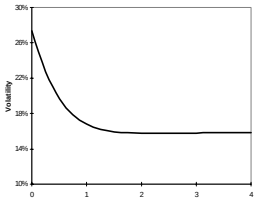
Low value options

Many options commonly talked about have little value

In the mining industry, difficult to see that shutdown options have much value

Often the options are deep-in-the-money

Mean reversion in commodity prices reduces option values

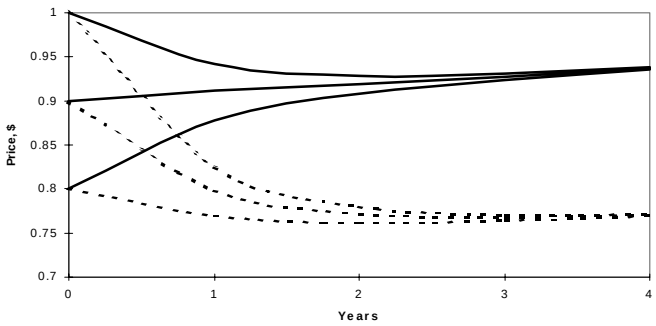


And most importantly . . .

Low value options (cont.)

Deferment/expansion options often have little value due to

- time to build; **and**
- mean reversion



Complexity

Size and complexity of model is an issue, but the lattice approach in Excel is **transparent**

Selling stochastic differential equations within an organisation would be problematic

If it could **easily** be demonstrated that the WACC approach was really a special case of the real options approach, then complexity should not be a big issue

Reconciliation to WACC

This step is essential in a corporation

But it is a difficult step that is not talked about

And it raises a number of concerns

- the treatment of taxes, including investor-level taxes
- the estimation of the market price of risk

Reconciliation to WACC - Taxes

Presumably the real options approach calculates the value of options on an all-equity asset

But not many assets are financed by 100% equity

Can we use an APV-type framework to build up an equity value when debt exists?

Or do we have have to model the debt explicitly?

How do we handle investor-level taxes?

Reconciliation to WACC - Risk

In the WACC approach assume

- all equities have a beta of **about** one; and
- constant interest rates

In the real options approach often assume

- commodity prices have systematic risk, via a market price of risk
- costs have no systematic risk; and
- constant interest rates

Reconciliation to WACC - Risk (cont.)

How good is the usual assumption of constant interest rates? Footnote 11, Chapter 9 of Brealey and Myers states

recent bond betas have been roughly 0.2, but they have been as high as 0.3 to 0.4

My crude analysis with Bloomberg supports these estimates

After adjusting for duration, this suggests that interest-rate risk could be significant

Reconciliation to WACC - Risk (cont.)

That means, to me anyway, that in the Real Options approach we need to be sure that we capture any interest-rate risk in the market price of convenience yield risk. Otherwise we might be omitting a possibly major source of risk.

More generally, it means that we want the market price of risk parameter in the Real Options approach to be **broadly** consistent with the level of risk inherent in WACC approach

Have we done this? Possibly, but difficult to be sure

Roadblocks

Forward curve

How do we estimate a forward curve going out twenty years?

We have tried, in conjunction with Cambridge University, to Kalman filter historical copper futures data

We have been unable to replicate the results contained in Schwartz (1997). Furthermore, we are unable to obtain stable parameter estimates

Forward curve (cont.)

Even if we can obtain stable parameter estimates, by Kalman filtering or whatever means, we still need to estimate the "goodness" of an historical estimate of the forward curve

If we are to have a credible valuation tool we need an estimated forward curve that is **no worse** than our in-house economist's estimate of the future spot curve. Otherwise, I fear our calculated real option values are of little use