Foresight and Cost of Carry assumptions in the DCPM

Peer Review, Dr William Blyth, Oxford Energy Associates, Aug 2014

Scope of this note

This is a peer review of input assumptions to the DECC Carbon Price Model (DCPM). The updated version of the DCPM was not available prior to writing this note, so the viewpoints expressed are based on generic considerations of model structure, market fundamentals and outputs from the draft version of the DCPM.

Background

The DECC Carbon Price Model (DCPM) is a fundamentals-based model of the carbon market under the EU Emissions Trading System (EU ETS). The model is used to estimate carbon prices over a chosen number of years given annual caps on emissions levels and projections for business as usual emissions in all sectors and countries covered by the EU ETS. DCPM matches demand for abatement (abatement effort that needs to be undertaken to meet the cap) to supply of abatement (given by the marginal costs of technologies that need to be deployed to undertake abatement) and provides the EUA price as the equilibrium point.

The DCPM also introduces two parameters which to some extent reflect behavioural aspects of carbon pricing:

- Risk-adjusted discount rate RADR for carbon (i.e. the expected annual increase in carbon prices over time)
- Foresight – i.e. the number of years into the future over which market participants assess the degree of scarcity in the market

The peer reviewers have been asked to comment in particular on the choice of values of these two parameters in the DCPM.

Risk-adjusted discount rate

DECC proposes to reduce the RADR used in the fundamentals model from 9.6% (which was based on a review of market price forecasts presented by a range of commentators), to around 5-6% based on pricing in the futures market. This lower figure is derived from the differential between the price of an allowance of a particular vintage (say Dec 2015), and the price of an allowance of the following year's vintage (Dec 2016). The exact relationship between these different vintages depends on the particular year being assessed – the figure of 5-6% takes an average over a relatively long time horizon.

The forward curve for carbon futures follows a similar kind of trajectory to that for the forward curve for interbank commercial lending, but with an additional premium due to the additional risk of trading in a small niche market such as carbon compared to wholesale money markets where liquidity and trading volumes are much higher. This trading premium seems to be in the region of 1-3% depending on the time period.

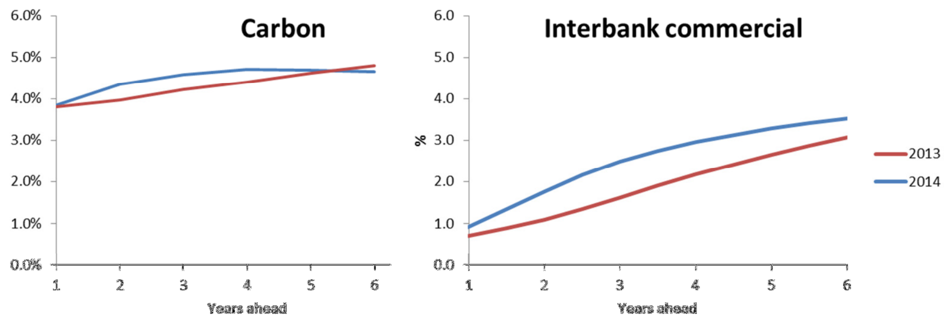

Fig 1. Nominal forward yield curves for carbon (left) and commercial bank liabilities (right)

(Source: carbon figures from The ICE, bank rates from Bank of England[1])

The chart shows a full year data-set for 2013, and compares this with data from the first 4 months of 2014. This illustrates that there can be quite considerable variation in profiles over different time series, making it difficult to reliably project values for the forward curve into the longer-term future.

The carbon futures forward curve yield figure is effectively the cost of financing a futures contract for which the carbon price has already been fixed. This trading contains some risk[2], and Fig 1 suggests that returns are higher by around 1-2% points than wholesale interbank money markets. However, these carbon price figures by no means represent a fully risk-adjusted discount rate; futures contracts do not include price risk *per se*, since the carbon price is fixed in advance in these kinds of contracts. The figure of 5-6% should therefore be regarded as the lower limit for RADR.

It is reasonable to assume that RADR should therefore be higher than this. We cannot calibrate this additional risk premium based on market behaviour, since we cannot observe expected long-term returns for a speculative investor in carbon allowances because the market is still young. However, we know that the market price of risk in other markets such as equities is a few percent – i.e. the exposure to price risk creates an expectation of a return of a few percent compared to rates on 'risk-free' assets such as government bonds. The long-run expectation of risk-return on carbon markets is likely to be at least has high as equities markets in general, given the wide range of factors that feed into price formation.

I would therefore recommend that the figure of 5-6% be used as a lower bound of RADR. A central estimate (though unobservable and harder to calibrate) would be more likely in the range 7-8%. An upper bound is hard to estimate, but could be several percentage points higher still if all the sources of uncertainty including policy uncertainty were to be valued. These figures are based on nominal yields (since they are calculated from futures contracts which are specified in nominal prices), so an adjustment for inflation expectations should be made for real discount rates. Bank of England inflation expectations are around 2% for the next 3 years[3].

Recommendation on RADR:

	Nominal	Real
Central:	7.5%	5.5%
Low:	5%	3.0%
High:	10%	8.0%

[1] http://www.bankofengland.co.uk/statistics/Pages/yieldcurve/archive.aspx

[2] Trueck, Stefan and Hardle, Wolfgang and Weron, Rafal, The Relationship between Spot and Futures CO2 Emission Allowance Prices in the EU-ETS (March 31, 2014). in Gronwald and Hintermann (eds) Emission Trading Systems as a Climate Policy Instrument - Evaluation and Prospects, MIT Press (Forthcoming). http://dx.doi.org/10.2139/ssrn.2137346

[3] http://www.bankofengland.co.uk/publications/Pages/inflationreport/irfanch.aspx

Foresight

The foresight parameter in the DCPM determines how many years ahead are included when assessing the aggregate level of abatement needed. Perfect foresight looks at the aggregate balance of supply and demand (and costs of abatement) up to the end of the modelling horizon (i.e. approximately 35 years).

It is not possible to calibrate this foresight figure with any degree of confidence. The empirical evidence that the market acts in a myopic way is rather limited. In particular, data from futures markets does not provide evidence regarding the degree to which companies take a view of future carbon pricing in their investment decisions. The DCPM assesses carbon price by looking at the cost of abatement over different time frames. Whilst some abatement options can be made using existing equipment (e.g. fuel switching), the majority especially over the longer-term requires capital investment. Since it is this capital investment that drives the underlying logic of the DCPM, it makes sense to calibrate foresight to be relevant to the investment case. Most abatement options require investment in projects that would take between 1-5 years or perhaps more just for the build phase. After that, the crucial phase in the cash-flow assessment of any investment is the first 10 years or so. Under this 'first principles' argument, foresight should be at least around 10-12 years.

Recommendation on foresight:
Low: 10-12 years
High: unlimited

Notes on interaction between foresight and RADR in the DCPM

The above discussion treats foresight and RADR as two distinct variables. Although they are separate in the DCPM, the effect of limiting foresight has a radical effect on the shape of the carbon price trajectory. In principle, RADR should be the expected price increase within the foresight horizon, since this is the rate at which investors would discount future returns on an investment in that commodity. However, running the DCPM under limited foresight when the market starts off with surplus allowances leads to a much steeper annual increase in carbon prices than predicted by the RADR.

However, running the DCPM under current market conditions of oversupply leads to prices that are lower in the early years, and higher in the later years compared to perfect foresight. Conversely, when the market is initially undersupplied, prices are higher in the early years and lower in the later years than the perfect foresight case. In both cases, the average slope of the curve is not consistent with the above interpretation of RADR as the expected slope of the carbon price trajectory.

In some sense, we might therefore equate the effects of limiting foresight to the effects of applying an increased RADR under a long foresight horizon. This equivalence makes sense when we consider the behaviour that each parameter represents. Limited foresight describes a situation where market participants simply ignore any information about supply and demand beyond their foresight horizon. Raising the RADR instead assumes that market participants would take long-term information into account in the current pricing, but discount this information significantly compared to near-term information. This may seem a minor distinction as applied to real behaviour. However, in the DCPM, the two parameters have very different effects on the results depending on the scenario being investigated. In particular, applying a limited foresight assumption can lead to the expected slope of the carbon price trajectory being reversed depending on the degree of over- or under- supply of allowances in the market. Applying increased RADR on the other hand would lead to an upward trajectory of carbon prices in both cases.

Arguably, since the theoretical underpinning of RADR approach is quite strong, and since empirical evidence for limited foresight is rather weak, this suggests that RADR should take precedence when assessing the choice of these parameters. However, given the structure of the DCPM, once a limited foresight figure is chosen, the value of RADR has little effect on the carbon price trajectory, making foresight a more dominant parameter in the model. This suggests that it would be informative to provide a sensitivity case where foresight is unlimited, and the effects of different RADR values are illustrated.

Recommendation on pairs of values for foresight and RADR:

	RADR:	Foresight:
Option 1	5.5% (real)	10-12 years
Option 2	3.0% (real)	unlimited
Option 3	5.5% (real)	unlimited
Option 4	8.0% (real)	unlimited