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Coevolution of policy, market and technical price risks in the EU ETS

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ABSTRACT

Within the EU, there have been calls for governments to provide greater certainty over carbon prices, even though it is evident that their price risk is not entirely due to policy uncertainty. We develop a stochastic simulation model of price formation in the EU ETS to analyse the coevolution of policy, market and technology risks under different initiatives. The current situation of a weak (20%) overall abatement target motivates various technology-support interventions, elevating policy uncertainty as the major source of carbon price risk. In contrast, taking a firm decision to move to a more stringent 30% cap would leave the EU–ETS price formation driven much more by market forces than by policy risks. This leads to considerations of how much risk mitigation by governments would be appropriate, and how much should be taken as business risk by the market participants.

1. Introduction

Whilst there have been consistent requests from the business sector for governments to provide greater certainty over climate policy in order to help reduce investment risk (IIGCC, 2010; Reuters, 2010; Resources for the Future, 2007; UNFCCC, 2008), it is an open question how far governments can, or should, limit exposure to the actual carbon price risk. Although carbon prices are ultimately institutional artefacts and therefore policy risk is foundational, market-based mechanisms with quantity targets are chosen to promote efficiency in price discovery and innovation in the management of risks by the private sector in ways that policy-makers cannot fully anticipate. Once created the nature of the risks that emerge in cap-and-trade emissions markets become a coevolution of regulatory interventions, economic activities, commodity prices and technological innovation. In calling for price stability beyond that of a clear policy framework, it appears that there may be a confounding of these separate risk drivers, which, as a consequence, motivates a confused demarcation of responsibilities for risk taking and mitigation between the private sector and the government.

Thus, one of the concerns of power companies, especially those seeking to invest in nuclear power, is that the price of carbon might fall below a level that makes their decarbonising investments cost-effective (EdF, 2010; Centrica, 2010). This has led to a number of proposals including a guarantee for the price of carbon for these companies (Helm and Hepburn, 2005), a firm floor to the price of carbon (Ismer and Neuhoff, 2006), or a softer "price cushion" in the event that it falls below a pre-determined level by withholding allowances from auction (Hepburn et al., 2006). Pizer (2002) showed how price instruments (taxes) and quantity instruments (caps) could be combined by introducing a floor and a ceiling on the price of carbon in a cap-an-trade scheme to achieve the benefits of both types of regulation. The UK government (DECC, 2010) has proposed the unilateral introduction of a carbon price floor via a new carbon tax supplementary to the EU–ETS carbon price, largely in response to power companies and others arguing that the current EU–ETS price is too low. The extent to which such proposals lead to an efficient allocation of risk is still an open question. Relatively little attention has been paid to whether the risks to be underwritten through such interventions would be policy-based or market-based risks. Arguably, the former would be an appropriate reason for government intervention, whereas the latter would not.

The aim of this paper is therefore to quantify the key risk factors that affect the price of carbon in the EU emissions trading scheme (EU–ETS) over different time periods in order to help shed some light on these considerations. The results indicate that policy risks tend to dominate when carbon prices are low, whereas market risks tend to dominate when carbon prices are high. Under current weak targets, this suggests a case for intervention through a price floor, but, alternatively, with a tighter cap in the EU–ETS, policy risks would be reduced and the EU–ETS rebalanced towards market-driven prices.

2. Analytical approach

The research literature on price behaviour and risk in carbon markets has proceeded along two distinct approaches. One

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approach is based on econometric analyses of historic behaviour in the market (see e.g. Taschini and Paolella, 2008; Daskalakis et al., 2009; Wagner and Uhrig-Homburg, 2009), whilst more forward-looking models examine the abatement options, which are expected to be the key drivers of the carbon price in the future. For example Seifert et al. (2008) and Chesney and Taschini (2008) consider carbon prices to be determined by the marginal cost of switching fuel, and so model variability as a function of gas and coal price variability. In contrast, because current carbon allowances are bankable in the EU–ETS, Lewis (2008) assumes future prices will ultimately be determined by the cost of clean coal technology, and uses discounting to arrive at an estimate of the current value of allowances.

The analysis in this paper follows this second approach. It is based on an abatement supply function model of the EU–ETS, where risk is included through the stochastic simulation of the key input parameters. The model builds on the approaches of Seifert et al. (2008), Chesney and Taschini (2008) and Lewis (2008) by including a more complete description of the different abatement technologies within the EU–ETS, and including the impact of technology cost dynamics and policy uncertainty. It is designed to analyse probability distributions in the carbon price, taking account of key sources of risk and uncertainty in the carbon market. The model is based on a marginal abatement cost (MAC) curve incorporating the various sources of abatement covered by the scheme. Uncertainty is represented in the model by allowing the marginal cost and quantity of abatement from each abatement option in the MAC curve to vary stochastically. This approach has the advantage that uncertainty in each element of the cost curve can be defined individually. This gives a richer characterisation of uncertainty than can be achieved by modelling uncertainty across the MAC curve as a whole. The model calibrates ranges of cost and quantities for each abatement option according to values derived from the published literature for those options. The assumptions on expected costs and the assumed stochastic variations are to be found in Appendix A.

This model has previously been applied to a general analysis of the potentially wide variation of marginal abatement costs that uncertainties in the EU–ETS mechanism imply (Blyth et al., 2009), but without any identification of the sources of risk. Since the 2009 paper, the authors have updated the model to take account of the following:

- Updated baseline energy and emissions scenario (based on the PRIMES model as reported in European Commission, 2008a) to take account of revised expectations following the financial crisis, calibrated to IEA's World Energy Outlook 2010 (IEA, 2010).
- Updated energy price forecasts based on IEA (2010).
- Updated technology cost estimates based on the various sources (see Appendix A).

The revised baseline, since the recession has substantially reduced the abatement cost estimates, is explored in a separate section below. The MAC curve for 2030 based on expected values for technology costs and abatement quantities is shown in Fig. 1. (Table 1).

It can be seen that in the model, technologies are not strictly in order of marginal cost, as in a conventional theoretical MAC curve. This is because some abatement options are assumed to be contingent on the prior implementation of other options. This is the case with off-shore wind power, carbon capture and storage, and solar PV. For each of these technologies, where technological learning is assumed to be a significant factor, the abatement option is split into more than one tranche. Early-stage implementation of the technology is taken to be more expensive than the

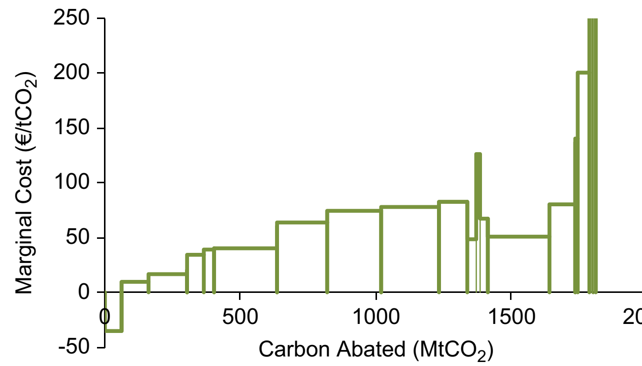

Fig. 1. MAC curve for 2030 based on expected marginal costs and abatement quantities.

Table 1
Parameters underlying the MAC curve in Fig. 1.

	Price (€/tCO_2)	Quantity (MtCO_2)	Cum'tive Q (MtCO_2)	Cumulative total (€m)
Demand variation	0	0	0	0
IGCC	−34	64	64	−2196
En Eff Industry	10	100	163	−1200
Nuclear	17	141	305	1204
Hydro	20	1	306	1229
FuelSwGas 1	20	0	306	1229
Energy efficiency 1	35	60	366	3335
Onshore wind	39	39	405	4872
FuelSwGas 2	40	0	405	4872
CCGT vs. lignite	40	230	636	14,120
FuelSwGas 3	60	0	636	14,120
CCGT vs. coal 1	64	184	820	25,890
Biomass	74	200	1020	40,713
Energy efficiency 2	75	0	1020	40,713
CDM credits	78	215	1235	57,570
Offshore wind 1	83	103	1339	66,175
Offshore wind 2	49	32	1371	67,740
CCS 1st tranche	127	14	1385	69,520
CCS 2nd tranche	68	28	1413	71,420
CCS 3rd tranche	51	229	1642	82,997
CCS industry	80	95	1737	90,588
CCGT vs. coal 2	137	0	1737	90,588
CSP	141	7	1744	91,595
Biomass industry	200	43	1786	100,135
Solar 1	426	17	1803	107,279
Solar 2	302	7	1810	109,358

mature stage of the technology. Each stage is represented by a different tranche in the MAC curve. Since the mature stages of the technology cannot be undertaken until the learning stages have been undertaken, they appear further to the right in the MAC curve than they would do if they were to take their normal place based on marginal cost. In practise, governments often introduce additional policy measures, which bring forward the expensive learning stage through support for the early-stage technologies (e.g. demonstration projects, subsidies, etc.). In our model such support can be represented by bringing those technologies to the front of the MAC curve, so that they are assumed to be rewarded and implemented outside the carbon market, whilst still contributing abatement savings that will help to meet the EU–ETS target. An important example of this is the EU's renewable energy target, discussed in the Section 2.1.

The stochastic MAC curve is constructed through Monte Carlo's simulations. For each realisation in the simulation, a new value is selected for the cost and quantity of abatement for each of 26 abatement options included in the model. These values are