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Carbon Pricing

Fundamental Drivers of CO_2 Prices During the Second Phase of the European Union's Emissions Trading Scheme

Master Thesis
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Executive Summary

Problem Statement

By ratifying the Kyoto Protocol, the European Union and its member countries have pledged to reduce their greenhouse gas emissions to a level eight percent below 1992 emissions. The EU has set up an emission trading system (ETS) as a means to comply with this requirement. The EU-ETS has at first been set up in two phases: phase I from 2005 to 2007 was intended as a test run and to gather the necessary experience, phase II from 2008 to 2012 was concurrent to the Kyoto commitment period.[1] The EU-ETS covers several emission-intensive industries and roughly 45% of the EU's greenhouse gas emissions. Firms in scope of the scheme are endowed with a certain amount of allowances at the beginning of every year. They have to cover the amount of greenhouse gases they emit during that year by surrendering a corresponding amount of emission allowances.

If a company finds its costs for emission reduction measures to be high, it may want to buy permits from other firms facing lower abatement costs. By basic microeconomic reasoning, the permit market will reach an equilibrium where the CO_2 price corresponds to the marginal abatement costs. This maximizes efficiency in the sense of maximized welfare. The concept of emissions trading is therefore viewed as an optimal tool to achieve a given emission reduction target.

Since its inception, scientists have striven to understand the pricing process within the EU-ETS. To that end, two interesting strands of research have emerged. The **first research line** is linked to the microeconomic rationale given above. It imposes a business-as-usual scenario where firms do not take any action to abate emissions. Reducing emissions below that level is subject to a cost function, in turn depending on the set of possible abatement measures and their effectiveness. The derivative of this cost function, the marginal abatement costs, are equal to the CO_2 price when the market is in equilibrium. Thus exists a link between the cost for abatement measures and the permit price, which is looked for in empirical data. A common proxy for the abatement expenditures of an electricity company is the cost difference between

[1]The third period has later been agreed upon and is running from 2013 to 2020. A fourth period is planned for 2021–2028

one MWh produced in a coal fire plant and one MWh produced by gas combustion.

The **second research line**, by contrast, assumes that firms have little to no influence on their emissions, which accordingly follow a stochastic process. Companies strive to hedge the resulting risk of non-compliance by buying and selling permits on the market. The driving force behind CO_2 prices in this context is the aggregate probability of exceeding the emissions cap.

This master thesis derives one model representing each research line. The two resulting models are then compared on a theoretical basis and in terms of model fit. By this procedure, the main emission price drivers during phase II of the EU-ETS are identified.

Procedure

A fundamentals-based CO_2 price model is derived on the basis of Hintermann's 2010 model.[2] The theoretical foundations and Hintermann's original specification are derived in a first step. This base model is estimated using FGLS, imposing an ARCH process for the error terms. The model is then gradually extended: Alongside Hintermann's procedure, square and interaction terms are taken into account, as well as one- and two-day lags for gas, coal and CO_2 prices. In a last step, possible extensions to Hintermann's model are tested: Industry equity indices serve as a proxy for activity in the corresponding polluting factories. Consumer confidence is included to account for overall economic activity and outlook. Lastly, electricity prices and crude oil imports representing consumer demand in the sectors in question are added to the model.

In Hintermann's options-based 2012 model,[3] the probability to exceed the emission cap is determined by the daily emissions process. Since there are no corresponding data available, the process is simulated using rainfall and electricity consumption figures. The coefficients to simulate these two processes are estimated by maximum likelihood. The two processes' expected values and variances are calculated for each trading day and aggregated to the probability of non-compliance. In a second step, this probability is regressed against CO_2 prices using non-linear least squares. The model is adapted to account for an important policy change: While it was not possible to bank permits from phase I into phase II, banking from phase II to phase III was allowed. A second term is added to the model, which incorporates the consequential condition that phase II prices have to be equal to phase III prices at the end of the trading phase (provided that the cap has not been reached).

[2] cf. Hintermann 2010.
[3] cf. Hintermann 2012.