**Impacts of Carbon Prices on Competitiveness and Windfall Profits**

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## Overview

During the first two periods of the European Emission trading scheme (2005-2007 and 2008-2012) carbon certificates have largely been allocated free of charge (based on historical emissions) to the respective participating companies. The electricity sector constitutes the focus of the following analysis as utilities (with CO2-intensive power generators) are responsible for ca. 80% of the emissions covered by the emissions trading scheme. Although CO2-certificates have been allocated for free, mark-ups on prices of final goods, especially electricity, have been observed. These so-called windfall profits generated by utilities has resulted in a number of media outlets making the claim that the worst polluters profit most from emissions trading. However, according to economic theory, this mark-up is justified by the opportunity costs of carbon certificate prices (see e.g. Möst et al. 2011). A profit-maximizing power producer is only willing to generate a unit of electricity if it receives a revenue equal to its marginal cost taking into account its marginal abatement costs, i.e. market price of the carbon allowances. Since the onset of the third phase of the EU ETS in 2013, power producers are now required to purchase carbon certificates in auctions in accordance with the “polluter-pays-principle”. Irrespective of the method of allocation or the stringency of the emission cap applied, utilities pass-through their costs for carbon certificates on electricity markets (Woerdman et al. 2009). Depending on the methodology used, analyses have yieled marginal pass-through rates ranging from 50-100% (Lise et al. 2010). More recent studies have ascertained rates of up to and beyond 100% (Fell et al. 2015). The additional price margin has raised concerns regarding the international competitiveness of domestic energy-intensive industries as well as prompting a fundamental discussion about the actual distribution of economic surplus between producers and consumers.





Figure 1: Market price of electricity with and without a carbon pricing scheme

As the Figure 1 above illustrates, the carbon price (grey column) is factored into the variable production costs of the respective power generator. As is apparent from the stylised diagramm, depending on the carbon intensity of the particular technology in the electricity mix, the carbon mark-up can vary greatly. In a perfectly competitive market, price equals the marginal costs (of the price-setting technology) and no profit is realized independent from the carbon price. However, the profit of the other technologies with lower marginal costs depend on the difference between the market price and their respective marginal costs. Hence, the carbon price as well as the emission factor of both technologies have a strong impact on the producers´profits. If the emission factor of a technology is lower than the emission factor of the price setting power plant, this technology profits from higher carbon prices. In the following, we define this additional profit resulting from a lower emissions factor (as the price setting technology) also as windfall profit. Additionally, depending on the market price of the allowances and the carbon intensity of the price-setting power plant in the merit order curve, incidences of fuel switching can occur, e.g. coal replaces gas as the price-setting plant (Pettersson et al. 2012).

In the following analysis we set-up a fundamental model of the European electricity market (ELTRAMOD) and benchmark the model quality as well as its ability to derive wholesale power prices based on quantitative indicators, e.g. mean absolute error and root square mean error. In previous applications the model exhibited a mean absolute error of sorted wholesale prices of 4.8 EUR/MWh for the German-Austrian price zone and below 5 EUR/MWh for the entire model region. Furthermore, unsorted prices demonstrated a good fit with real data. Both the fit of sorted prices (base year) as well as unsorted prices (exemplary week) are shown below in Figure 2.





Figure 2: Model quality of previous ELTRAMOD applications for the German-Austrian price zone

Using the model, we examine which countries (and companies) profit from higher carbon prices. Additionally, we assess the impact of carbon prices on competitiveness, welfare distribution in Europe and determine average pass-through factors of producers.

## Methods

Analyses are performed with the electricity market model ELTRAMOD which has been developed at the Chair of Energy Economics at TU Dresden. ELTRAMOD is a bottom-up electricity market model covering the electricity markets of the EU-27 states[[1]](#footnote-1), Norway, Switzerland and the Balkan region. Commercial flows are constrained by use of Net Transfer Capacities (NTC) between these countries. Each country is treated as one node with country-specific hourly time series of electricity demand and renewable feed-in. Wind and photovoltaic based electricity generation is determined by the installed capacity and an hourly capacity factor.

ELTRAMOD is a linear optimization model which calculates the cost-minimal generation dispatch, hydro storage and cross-border exchange. The set of conventional power plants consists of fossil fuel, nuclear and hydro plants with a variety of technological characteristics, such as efficiency, emission factors and availability. Daily prices for CO2 allowances, as well as daily/monthly/quarterly wholesale fuel prices supplemented by country-specific markups are implemented. The temporal resolution is 8760 hours of a year which allows for detailed analysis of various aspects concerning the integration of intermittent renewable feed-in. Further model features and results from previous applications can be found in e.g. Gunkel et al. (2012). Based on the calibrated model for the year 2014, an analysis is performed for this base year sensitifying carbon prices as well as for the year 2025 with an adapted power plant portfolio.

## Results & Conclusions

Results will show the impact of carbon prices on the competitivenessof power plants and on windfallprofits of utilities, both for the base year 2014 and for the year 2025 (with adapted power plant portfolio). Furthermore, changes in the welfare distribution depending on carbon prices will be computed for revlevant countries in Europe. In addition, pass-through factors of carbon prices on electricity prices are ascertained for the set of European countries analysed.

To summarise, the following questions are addressed:

## 1. Do utilities profit from the emission trading scheme despite their CO2 intensive power plant portfolio?

## 2. Which European countries and utilities profit from higher carbon prices?

## 3. Are conclusions from detailed fundamental electricity market model analysis comparable with those found in the extant literature (using less intricate methods, eg. average emission factors of power plant portfolios)?

## Results from this contribution are discussed in the context of CO2 mitigation policies and implications for decision-makers in policy as well as industry are drawn.

**References**

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1. Excluding Cyprus and Malta [↑](#footnote-ref-1)