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How competitive are EU electricity markets? An assessment of ETS Phase II

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HIGHLIGHTS

- The interactions between electricity and carbon prices during Phase II are investigated.
- This work also studies the determinants of EU electricity price levels and volatilities.
- Nord Pool, APX UK and EEX carbon cost pass-through rates emphasize low electricity market competitiveness.
- Powernext electricity prices Granger-cause the Phase II carbon price.
- Coal was marginally more profitable than gas during Phase II.

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ABSTRACT

This paper studies the interactions between electricity and carbon allowance prices in the year-ahead energy markets of France, Germany, United Kingdom and the Nordic countries, during Phase II of the EU ETS. VAR and Granger-causality methods are used to analyze causal interfaces, whereas the volatility of electricity prices is studied with basic and asymmetric AR-GARCH models. Among the main results, the marginal rate at which carbon prices feed into electricity prices is shown to be ca. 135% in the EEX and Nord Pool markets, where electricity and carbon prices display bidirectional causality, and 109% in the UK. Therefore, generators in these markets internalized the cost of freely allotted emission allowances into their electricity prices considerably more than the proportionate increase in costs justified by effective carbon intensity. Moreover, electricity prices in France are found to Granger-cause the carbon price. This study also shows how European electricity prices are deeply linked to coal prices among other factors, both in terms of levels and volatility, regardless of the underlying fuel mix, and that coal was marginally more profitable than gas for electricity generation. EU policies aimed at increasing the carbon price are likely to be crucial in limiting the externalities involved in the transition to a low-carbon system.

1. Introduction

Since the establishment of the European Union Emission Trading System (EU ETS), carbon prices represent a major cost for EU electricity producers. As such, the carbon price should feed into the marginal cost of electricity and hence, the power price. Traditional economic theory suggests that the rate at which additional costs feed into product prices is greater, or less, than 100% when the underlying market is imperfectly competitive. For instance, Bonacina and Gulli (2007) found that carbon prices are fully incorporated in power prices when the electricity market is, conversely, perfectly competitive. However, it is not clear to what extent carbon costs are passed through to wholesale electricity prices in practice. Various studies have reported the "pass-through" rate of the carbon cost into electricity prices in Europe. Sijm et al. (2006), for example, conclude that pass-through rates generally varied from 40% to 100% during Phase I. Others, such as Bunn and Fezzi (2008) found pass-through rates to be as low as 42%. On the other hand, Fell et al. (2013) found that carbon costs are fully passed through in most countries, perhaps by even more than 100%.

This paper investigates the extent by which EU electricity generators internalized the marginal costs of carbon emissions into their electricity prices during Phase II of the EU ETS. We look into this question by considering the thermal efficiencies of natural gas- and coal-fired electricity generation as well as their carbon intensities. We analyze four of the major EU markets, namely those of Germany, France, United Kingdom and the Nordic countries. This work also studies the influence of fuel prices on the dynamics of electricity forward price levels and volatility.

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It is expected that, in many sectors, businesses will pass on their extra carbon costs through to consumers, thus earning net profits as a result of the impact on product prices combined with the extensive free allocations of emission allowances (Smale et al., 2006).

In fact, a major characteristic of the pilot phase of the EU ETS was that almost all emission allowances were allocated for free to the installations covered by the scheme. The over-allocation of free emission permits during Phase I of the EU ETS, starting from 2005, was the cause of severe market distortions. During the first phase of the EU ETS (2005–2007), more than 2.2 billion allowances of 1 t each were allocated each year. At average current market prices for 2005, this represented a social value of approximately EUR 40 billion p.a., ca. 60% of which was allocated to the power sector (Sijm et al., 2006).

The generous rounds of free allocation, which continued until the end of Phase II (i.e., until 2012) provided windfall profits for EU power generators and resulted in the carbon market crashing in Phase I. In addition, the general economic outlook in Europe, originating from the 2008 US subprime crisis, resulted in the carbon market crashing once again in Phase II. This resulted in an extremely low carbon price and proved to be detrimental to the incentives for producers to abandon carbon intensive generation.

Since 2008, an increasing number of studies have focused on the analysis of the EU ETS. Studies such as Zachmann and Von Hirschhausen (2008) and Chevallier (2009) focused on the drivers of electricity and carbon prices, respectively. Keppler and Mansanet-Bataller (2010) were the first to analyze the interplay between energy prices during Phase I. They also considered the first of five years of Phase II, in the context of the French Powernext, albeit that market alone. However, as Phase I is widely considered a "learning" Phase, given the excessive over-allocation of free permits, and Phase III was only recently launched (in January 2013), Phase II (2008–2012) currently remains the only complete and potentially informative period available to us in the examination of the interactions between electricity and carbon prices within European markets.

Since the launch of the EU ETS, the interactions between electricity and carbon prices have been the source of thorough debates. It is not clear whether the rate at which carbon prices feed into the electricity prices of EU markets reflects the perfectly competitive market structure advocated by the EU Commission. In addition, there is a lack of studies analyzing the causal relationship between carbon and electricity prices during the full length of Phase II whilst comparing the main electricity markets in Europe.

This paper aims at (i) defining the causal interface between carbon and electricity prices in four of the major European electricity markets, (ii) inferring whether price setting in these markets represents the competitive practice of EU electricity generators and (iii) providing an analysis of the impact of fuel prices on European electricity prices and their volatility, during Phase II of the EU ETS.

The rest of this manuscript is organized as follows: the next section introduces the main concepts related to this study, describes the market data used and outlines the main methodologies of this study. Section 3 reports the main results, whereas Section 4 discusses them and compares the four European markets under analysis. Finally, Section 5 summarizes the main findings and policy implications, thereby concluding the paper.

2. Methods

Section 2.1 provides the relevant background in the form of a review of the studied electricity markets (Section 2.1.1) and a description of the relevant theories (Section 2.1.2), whereas an analysis of the data is presented in Section 2.2. Section 2.3 introduces the main econometric methods employed in this study, i.e. VAR-based analysis, Granger-causality and the AR-GARCH model, used to study the volatility interactions between our variables and the different electricity prices.

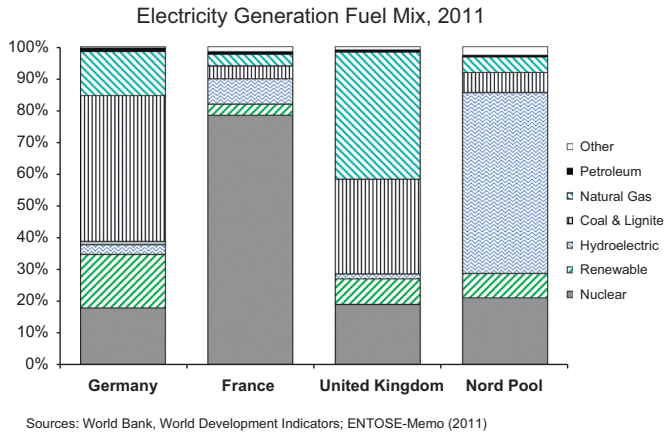

Fig. 1. The selected countries' electricity generation fuel mix (2011).
Data sources: World Bank (Germany, France and United Kingdom shares) and ENTSOE-Memo (Nord Pool shares).

2.1. Backgrounds

This section briefly introduces the markets under study and the theories related to the causal relationships between carbon and electricity prices.

2.1.1. European electricity markets

Fig. 1 depicts electricity generation by fuel for each of the studied markets. Germany mainly uses coal and lignite (46%), and some natural gas (14%). France, instead, generates electricity mostly using nuclear power (79%), but employs small quantities of coal (4%) and natural gas (4%). The United Kingdom, on the other hand, is largely based on natural gas (40%) and coal-fired generation (30%) (World Bank, 2013). Finally, the Nord Pool market is mainly dependent on hydro (53%) and nuclear power (21%) for baseload electricity generation, as well as some fossil fuels (15%) designed to serve peaking demand (Entsoe Memo, 2014).

The EU carbon scheme is subdivided into different trading periods. This paper relates to Phase II of the EU ETS carbon market (2008–12). Phase II saw a sharp reduction in the number of issued permits and represented a step towards the abolition of free allocation in favor of auctioning, which occurred from Phase III forward. Fig. 2 shows the behavior of the carbon year-ahead price during Phase II. The Phase II carbon forward price rose over 25 EUR/MT of carbon dioxide during the first half of 2008, almost reaching 30 EUR/MT. Carbon prices then crashed from July 2008, from a high of 28 EUR/MT to about 8 EUR/MT in February 2009, or a drop of about 72% in just over 7 months. The United Nations Framework Convention on Climate Change (UNFCCC) gave two main reasons for this substantial fall: reduced output in energy intensive sectors due to the economic recession[1] and the fact that the European markets' perception of future fuel prices was revised downwards (UNFCCC, 2009), as shown by the behavior of the natural gas and coal year ahead prices.[2]

[1] This implies that a lower extent to abatement is required to meet the cap, thereby providing a decrease in the carbon price.

[2] Figs. C1 and C2 in Appendix C show the behavior of the gas and coal one-year forward price levels. Please refer to Figs. B1–B4 for the energy forward price levels behavior in each of the four markets.