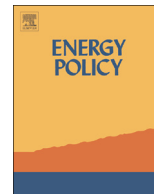




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Time-varying convergence in European electricity spot markets and their association with carbon and fuel prices

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HIGHLIGHTS

- Electricity market integration policies may have altered EU spot electricity prices.
- LACF is used to assess the changing nature of electricity spot prices.
- EU electricity spot prices show both stationary and non-stationary periods.
- Carbon and fuel prices have greater impact on British spot prices.
- In continental Europe, electricity prices have decoupled from fuel prices.

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ABSTRACT

Long-run dynamics of electricity prices are expected to reflect fuel price developments, since fuels generally account for a large share in the cost of generation. As an integrated European market for electricity develops, wholesale electricity prices should be converging as a result of market coupling and increased interconnectivity. Electricity mixes are also changing, spurred by a drive to significantly increase the share of renewables. Consequently, the electricity wholesale price dynamics are evolving, and the fuel–electricity price nexus that has been described in the literature is likely to reflect this evolution. This study investigates associations between spot prices from the British, French and Nordpool markets with those in connected electricity markets and fuel input prices, from December 2005 to October 2013. In order to assess the time-varying dynamics of electricity spot price series, localized autocorrelation functions are used. Electricity spot prices in the three markets are found to have stationary and non-stationary periods. When a trend in spot prices is observed, it is likely to reflect the trend in fuel prices. Cointegration analysis is then used to assess co-movement between electricity spot prices and fuel inputs to generation. The results show that British electricity spot prices are associated with fuel prices and not with price developments in connected markets, while the opposite is observed in the French and Nordpool day-ahead markets.

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1. Introduction

In Europe, natural gas, coal and carbon prices have been found to be associated with electricity price movements (Aatola et al., 2013; Asche et al., 2006; Bollino et al., 2013; Castagneto-Gissey 2014, Mjelde and Bessler, 2009), as the costs of generation are a large share of electricity prices. Most European states, however, have limited fossil fuel resources that can be used for electricity generation at the required scale. In recent years, concerns over the dependency on fuel imports have increased, despite growing

shares of electricity from renewable energy sources (RES-E), as conventional back-up capacities are needed to secure supply. Depending on the strength of association between electricity and fuel prices, uncertainty about the latter could impair Europe's economic competitiveness, as the cost of electricity is an important input factor in almost every industry. In fact, electricity-intensive industries have already moved from the EU to regions where it is less costly (Reinaud, 2008).

In order to achieve cost-efficient electricity prices, a well-functioning internal European electricity market has been advocated. A pan-European electricity market implies regional integration, harmonization of trading rules, increased cross-border electricity transmission and trade (European Commission, 2013). Therefore, from the perspective of assessing electricity market integration in the EU, strong associations between fuel and

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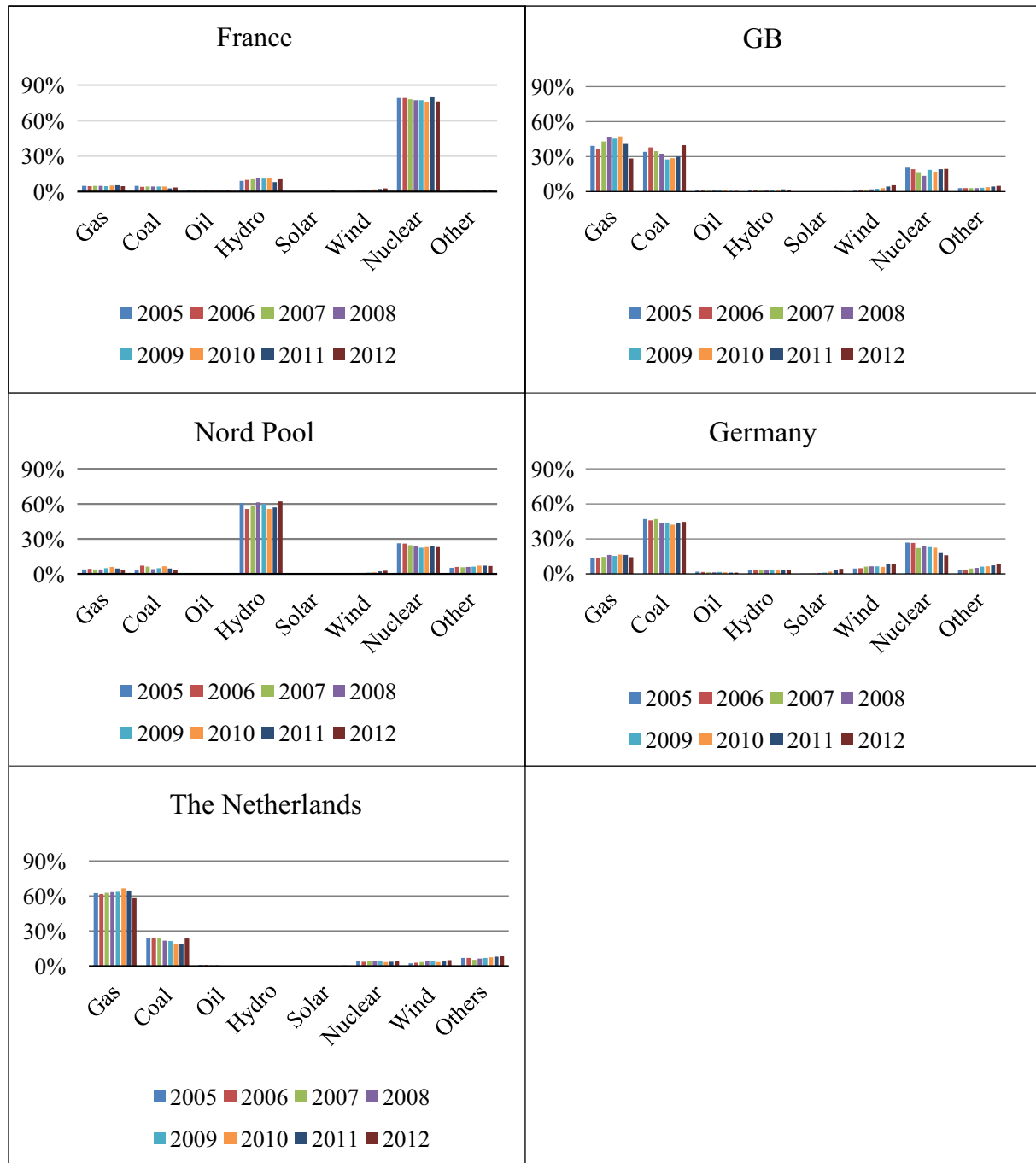


Fig. 1. Gross electricity generation mix from 2005 to 2012. Source: Eurostat (2014).

electricity prices could affect electricity price convergence and vice versa.

The aim of this study is to link research on electricity market integration with studies of associations between electricity, fuel and carbon prices. A time-variant framework is adopted in order to understand dynamics that might have been neglected, possibly leading to the mixed findings reported in the literature. We examine long-run dynamics and convergence in three large European markets, where the reliance on fossil fuels for electricity generation varies: APX-UK (Britain), EPEX-FR (France) and Nord-pool (Norway, Denmark, Sweden, Finland, Estonia, Latvia and Lithuania). Fig. 1 provides a summary of the electricity generation mix in these markets, as well as in Germany and Netherlands, whose markets are connected to at least two of the three main

ones and are also considered in the analysis. A more detailed description of the generation mix is provided in Section 1.2.1. For assessing long-run dynamics, a two-stage analysis is developed: (1) stationary and non-stationary periods of electricity spot prices are identified via local autocorrelation functions (Cardinali and Nason, 2013), (2) convergence with fuel, carbon and other electricity markets is assessed in a cointegration analysis (Johansen, 1988, 1991).

The paper is structured as follows. First, the literature on electricity market integration and assessments of fuel, carbon and electricity price associations is reviewed; the contextual framework is introduced, and the research question is outlined. Section 2 describes the methods and dataset used. Section 3 reports results, while findings are discussed in Section 4. Section 5

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