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Risk premiums in the German day-ahead Electricity Market

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ABSTRACT

This paper conducts an empirical analysis of risk premiums in the German day-ahead Electricity Wholesale Market. We compare hourly price data of the European Energy Exchange (EEX) auction and of the continuous over-the-counter (OTC) market which takes place prior to the EEX auction. Data provided by the Energy Exchange Austria (EXAA) has been used as a snapshot of the OTC market two hours prior to the EEX auction. Ex post analysis found market participants are willing to pay both significant positive and negative premiums for hourly contracts. The largest positive premiums were paid for high demand evening peak hours on weekdays during winter months. By contrast, night hours on weekends featuring lowest demand levels display negative premiums. Additionally, ex ante analysis found a strong positive correlation between the expected tightness of the system and positive premiums. For this purpose, a tightness factor has been introduced that includes expectations of fundamental factors such as power plant availability, wind power production and demand. Hence, findings by Longstaff and Wang (2004) can be supported that power traders in liberalised markets behave like risk-averse rational economic agents.

1. Introduction

Within the last decade, the German and other European Power Markets underwent unprecedented transformations. Directives and regulations issued by the European Commission aimed to open markets, ensure non-discriminatory third-party access to power grids (Directive 2003/54/EC repealing Directive 96/92/EC) and to enforce cross border trading activities (Regulation 1228/2003) in order to harmonise prices and mitigate market power of national incumbent operators. An overview of the main regulatory issues related to European Electricity Markets and their recent progress was compiled in the "DG Competition Report on Energy Sector Inquiry" by the European Commission (2007). The report focuses on concentration, market power, vertical integration, market integration, transparency and price issues and it states that some progress has been made but many barriers to free competition still persist.[1]

However, without any doubt the process of liberalisation led to an increase in power trading activities across Europe - particularly in Germany - Europe's largest economy and Power Market in terms of electricity consumption. Germany's annual power consumption amounts to 500–550 TWh. According to a recently published review of EU Wholesale Energy Markets by Rademaekers et al. (2008), estimated total annual trading turnover of German power contracts grew from 2400 TWh in 2006 to 3200 TWh in 2007. The fact that total trading turnover in 2007 amounted to around 6 times consumption can be seen as a sign of market maturity.

Nevertheless policymakers, regulators and public opinion in Europe remain suspicious of power trading activities (European Commission, 2009). This is partly due to the complexity of electricity trading and a lack of market transparency. As a result, the European Commission is addressing the issue to find which transparency requirements on trading activities are necessary to ensure a positive development of European Power Markets in accordance with the Directives and Regulations mentioned above (Rademaekers et al., 2008). As exchange-based trading covers only a small fraction of the overall trading activities in most European countries, improved transparency in terms of market participants, traded volumes and prices of the OTC market would be beneficial for regulators and policymakers in order to asses and monitor the functioning of European Power Markets.

Within this context, this paper conducts an empirical analysis of prices and premiums paid on the German day-ahead Power Market. In order to compare day-ahead EEX auction prices with prices of the preceding continuous day-ahead OTC trading, we decided to use price data provided by the Energy Exchange Austria (EXAA) as a snapshot of the continuous OTC market.[2] We find that positive and negative premiums for hourly contracts were paid only two hours prior to the final EEX auction. The average premium of daily

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[1] For additional interpretation of the DG competition report, see London Economics (2007) and Ockenfels (2007).

[2] Described more in depth in Section 3.

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delivery contracts represented by the Base block contract is slightly positive (0.61 €/MWh), but not statistically different from zero.

Premiums paid in electricity forward markets differ from those paid in markets for financial assets or storable commodities. This is due to one of the physical properties of power—it is not storable. While the constraint of non-negativity on inventory distinguishes financial assets from storable commodities, power markets are characterised by the absence of storage capacities in meaningful quantities at competitive cost. Therefore, power prices usually feature unique properties such as price spikes and heteroscedasticity.[3] For this reason, equilibrium models for commodities as described by Fama and French (1987) or Routledge et al. (2000) cannot be applied to electricity markets.

Authors Bessembinder and Lemmon (2002), Benth et al. (2008) or Pirrong and Jermakyan (2008) focus particularly on modeling equilibrium prices of forward contracts and risk premiums in electricity wholesale markets. Bessembinder and Lemmon (2002) present an equilibrium model that explicitly takes into account the physical properties of power and the convexity of the power production cost curve. According to their model, there are negative risk premiums for off-peak hours caused by low demand, little skewness and risk averse sellers. In peak hours however, buyers are willing to pay positive risk premiums due to the high demand and highly right skewed power prices. Benth et al. (2008) also developed a model that explains the existence of negative and positive forward premiums. However, their work has a different focus. They incorporate the changing relative eagerness of natural buyers and sellers to hedge their positions and test their model across different forward contract maturities.

An empirical analysis conducted by Longstaff and Wang (2004) largely supported implications by the Bessembinder and Lemmon (2002) equilibrium model in the case of the Pennsylvania, New Jersey and Maryland (PJM) Wholesale Market. By comparing hour-ahead and day-ahead prices for each hour, Longstaff and Wang found positive premiums for hours with highest demand and negative premiums for hours with low consumption levels. Although the set of data available for the German Power Market is somewhat different, we use a similar methodology as Longstaff and Wang in this paper. Pirrong and Jermakyan (2008) also propose a model to capture risk premiums – or as they denote it, the market price of risk – for power derivatives. Their analysis shows the presence of risk premiums at the PJM Market and the seasonality of these premiums. Other authors who recently published empirical analyses of electricity market premiums include Hadsell and Shawky (2007), Douglas and Popova (2008), Lucia and Torró (2008), Botterud et al. (2009) and Redl et al. (2009).

Rest of this article is as follows. Section 2 outlines the structure of the German Power Market and focuses particularly on the German Spot Market. Section 3 describes the set of data employed for the empirical analysis of premiums paid at the day-ahead market. In Section 4, tests on the significance of these risk premiums are conducted and Section 5 introduces a model that allows for the regression of ex ante measurements of risk on ex ante risk premiums. Section 6 provides interpretations of the results obtained in the two previous sections and Section 7 concludes.

2. The German Power Market

The following section gives a short summary of the present state of the German Power Market and focuses in particular on the Spot Market, it's most important features, marketplaces and trading participants. Germany represents Europe's largest Power Market in terms of consumption. The four largest electricity producers RWE, E.ON, Vattenfall and ENBW hold a market share between 70 and 85 percent.[4] There are four high voltage grids operated by four transmission system operators (TSOs). These 380 kV grids also represent the delivery points of power that is traded between market participants and on Power Exchanges. Congestion between and within the grids is currently tackled exclusively by redispatch of the TSOs. Other practices such as market splitting or nodal pricing[5] are not yet in focus. Today, the German Power Market is interconnected with a number of other European Power Markets of differing liquidity. Interaction between those markets requires transmission rights. Daily explicit day-ahead auctions are in place for interconnector transmission capacities to and from Poland, Czech Republic, Switzerland, Netherlands and France, Netherlands. Most of these countries also feature liquid exchange-based day-ahead trading, some have actively traded OTC markets. Market coupling and implicit auctioning of interconnector capacities between the German Market and the Nordpool[6] region, namely Sweden and Denmark, was established in late 2009. Market Coupling between Germany and France and Germany and Netherlands is scheduled to start in late 2010.[7]

The two main marketplaces for day-ahead trading in Germany are represented by the exchange EEX and electronic OTC trading platforms. Due to its high liquidity, EEX is widely regarded as the benchmark and reference point of the German day-ahead Power Market. The annual day-ahead volume increased from 88.7 in 2006 to 127.3 in 2007 and 154.5 TWh in 2008. Accordingly, daily spot trading volumes amounted to more than one quarter of the overall German energy demand in 2008. Like other Energy Exchanges in Europe, EEX facilitates a day-ahead market by the means of a uniform pricing auction.[8] On the day prior to delivery, price dependent and price independent hourly bids and offers can be submitted to the electronic EEX platform latest 12 p.m. Additionally, offers for individual power blocks consisting of at least two hours with the same quantity and price can be submitted. In accordance with the principle of the most executable volume, EEX clears all bids and offers and publishes hourly market clearing prices and volumes. In contrast to Electricity Pool Systems like the PJM Market it is not mandatory for energy consumers, producers and traders to participate in auctions at the exchange-based system EEX. Liquidity on the EEX Intraday Market which covers the period between the EEX day-ahead auction and the actual delivery period on the next day is only fractional compared to the day-ahead auction. Real time imbalances in the power system are balanced by generation units that can provide positive or negative primary, secondary and tertiary reserve energy. TSOs procure reserve energy on separate markets.[9]

In contrast to exchange-based trading, OTC trades take places directly between the counterparties and are often facilitated by broker companies. Transactions are executed via electronic broker platforms or bilaterally via telephone. Only standardised block contracts such as Base (delivery period h1–h24), Peak (h9–h20), Off-Peak (h1–h8, h21–h24), Night (h1–h6) and several others can be traded. Most day-ahead trading activities take place between 8 a.m. and 12 p.m. on the day prior to the delivery day. Thus, the continuous OTC market is important for market players to hedge larger volumes prior to the exchanged based auction at 12 p.m. The OTC-market can be considered to be the last forward market before

[3] For more details of power price properties see Weron et al. (2004), Bierbrauer et al. (2007), Huismann et al. (2007) or Douglas and Popova (2008).

[4] See Liese et al. (2008) and Weigt and v. Hirschhausen (2008).

[5] See Brunekreeft et al. (2005) for concepts of market splitting and nodal pricing.

[6] Energy Exchange for the Scandinavian region.

[7] Go to www.epexspot.com for more details on the CWE Market Coupling Project.

[8] See Ockenfels et al. (2008) for more EEX auction details.

[9] For more details see Swider and Weber (2007).