Pricing of electricity futures based on locational price differences: The case of Finland

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We find that the pricing of Finnish electricity market futures has been inefficient during the latest 10 years, when the trading volumes of Electricity Price Area Differentials (EPADs) have more than doubled. Even though the calculated futures premium on EPADs is related to some risk measures and the variables capturing the demand and supply conditions in the spot electricity markets, there has been a significant positive excess futures premium in the Finnish market, and financial market participants should have been able to utilize this also in economic terms. This finding is new and relevant for the participants of the Nordic electricity markets also in the future, because both the speculative and hedging-based trading is increasing in the Nordic markets.

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1. Introduction

Electricity markets around the world have undergone a wave of deregulation and liberalization since the 1990s. The Nordic electricity market is a typical example of this development. In the Finnish and other Nordic markets, vertically integrated monopolies that used to manage production, transmission and sales of electricity have been restructured. Nowadays production and sales operate under free competition, while nation-wide transmission and communal-level distribution networks remain regulated natural monopolies. A natural extension to the restructured wholesale markets has been the development of derivatives markets, since electricity is a homogenous commodity in a given geographical area with sufficient transmission network, capacity and similar power system. Well-functioning derivatives market is of high importance for market participants, since electricity is practically non-storable, and hence, subject to extreme price volatility.

Similar to retail and wholesale markets, pricing of derivatives written on different reference prices in the electricity markets has gained notable academic interest. The focus of research has unsurprisingly been on the derivatives in the largest and most mature markets, such as the ones in particular states in the US, the Nordic countries, and Germany/Austria (see e.g. Bessembinder and Lemonon, 2002; Redl et al., 2009; Gjolberg and Brattested, 2011; Fleten and Hagen, 2015). Due to physical transmission congestion, local prices may differ substantially from the reference prices causing market participants to incur locational basis risks.

The Nordic market has been divided into 15 bidding areas based on transmission capacities between the areas, and Finland composes one area. Electricity Price Area Differentials (EPADs) are used to hedge price differences between a bidding area and the Nordic system price. Furthermore, Markhoff and Wimschulte (2009) note that explicit exchange-listed derivatives on the area prices do not exist, since the market was designed on purpose so that overall liquidity would not split among several products. In bidding areas where the area prices differ significantly from the system price, hedging is based on dealing with two separate contracts, which together yield an implied futures contract on the area price, that is, by using 1) a futures contract based on the system price; and 2) futures contract, commercially known as an EPAD, based on the area price difference.

Contrary to the futures on electricity reference prices, such as the Nordic system price, the previous literature on EPADs is very limited. To our knowledge, only few studies (Markhoff and Wimschulte, 2009; Kristiansen, 2004a, 2004b; Spodniak et al., 2017; Spodniak and...
Collan, 2018) on EPADs pricing have been published in academic journals previously. In addition, EPADs have been studied by Spodniak et al. (2014) and Spodniak (2015) in conference papers. The main contribution of our research is to provide new empirical results on EPADs pricing. All the previous studies have focused on the relationship between the EPADs and respective area price difference or the ex-post futures premium, and we follow this approach, too. However, unlike Marchhoff and Wimschulte (2009) Spodniak et al. (2014) or Spodniak (2015), we attempt to link the ex-post futures premium of EPADs also to abnormal supply and demand conditions that might be of high importance specifically in the Finnish electricity market.

Electricity prices (and associated costs) are of particular importance to the competitiveness of Finnish economy due to Finland’s cold climate and energy-intensive industry’s large share of GDP that cause Finland to have one of the largest energy intensities, that is, the ratio of gross inland energy consumption to GDP in the EU. The electricity market spot price in Finland has differed substantially from the Nordic system price. For example, in 2015 the Finnish monthly area spot price exceeded the Nordic system spot price on average by 54.6%, exposing the Finnish market participants to a significant basis risk. Moreover, between 2006 and 2015 the system price and the area spot prices of Norway, Sweden and Denmark were on average 10.47%, 5.97%, 10.72% and 2.86% lower than the spot price in Finland, respectively. Furthermore, the Finnish area price difference has widened during the last years.

A natural question for the Finnish market participants is whether the area price differences are reflected in the EPAD prices. Self-evidently, this question is of interest for market participants hedging the future electricity consumption and generation. Speculators alike are interested to discover whether there are profitable trading strategies to be exploited. Prices of derivatives have also wider ramifications. In a market economy they provide price signals, which are essential for an efficient allocation of resources. EPADs prices could for example provide signals for investments in transmission capacity, or production planning.

In the FTRs (Spodniak et al., 2014), operators (TSOs) would for example issue physical power exchange in the Nordic market. Trading in the day-ahead physical market takes place either bilaterally or through the secondary market. In the day-ahead spot market, the participants purchase and sell electricity for each hour for the next day according to their preliminary supply or consumption plans, which yields the spot prices for each hour. In the secondary market the trading is continuous, and participants can manage unanticipated imbalances or optimize their supply or purchase plans up to 1 hour before the delivery hour. Finally, the ancillary market maintained by the TSOs balances the power system in real-time, maintains system security and quotes the balance prices, which are used in settling the imbalances, i.e. the difference between actual generation (consumption) and electricity sold (purchased). The TSO of Finland is called Fingrid.

Trading in day-ahead physical market takes place either bilaterally in the OTC list or in the Nord Pool market. The physical spot market is operational 365 days a year and produces spot prices for each hour. Over 300 market participants from the Nordic and Baltic countries submit daily their bids to the Nord Pool before 12:00 CET. Bids are like individual demand and supply curves: they reveal the quantity demanded and supplied at a given price. Nord Pool aggregates the bids to the market-wide supply and demand curves for each hour and the spot price clears the market. The individual orders are fulfilled if price at which the quantity demanded (supplied) is above (below) the spot price. This procedure is repeated for each hour yielding a spot price for every hour, and results for the next day are published normally.
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