Contract durations in the electricity market: Causal impact of 15 min trading on the EPEX SPOT market

Joscha Märkle-Hußa,*, Stefan Feuerriegela,b, Dirk Neumanna

a Chair for Information Systems Research, University of Freiburg, Platz der Alten Synagoge, Freiburg 79098, Germany
b ETH Zurich, Weinbergstr. 56/58, Zurich 8092, Switzerland

ARTICLE INFO

Article history:
Received 29 April 2017
Received in revised form 22 October 2017
Accepted 24 November 2017
Available online 28 November 2017

JEL classification:
Q21
Q41
D53
G14
D86

Keywords:
Electricity market
15 min trading
Market design
Contract duration
Bayesian structural time series
Policy implications

ABSTRACT

The European Power Exchange (EPEX) introduced two new products in 2011 and 2014 which reduce the delivery duration of electricity from 1 h to 15 min intervals. These changes to the market design aim to better reflect the intermittent power generation from renewable energy sources. However, little is known about trading in shorter intervals and its impact on the existing market. As a remedy, our evaluation first shows that the market has quickly adopted the new 15 min contracts. Second, we estimate a Bayesian structural time series, which measures a causal decrease of electricity prices. Depending on the model specification, our results indicate that the reduction can be as high as 28% for existing hourly contracts subsequent to the introduction of 15 min trading. Third, the use of 15 min contracts coincides with intermittent power generation, as it incentivizes renewable energy providers to offer additional electricity. Altogether, our findings suggest that 15 min trading is used to balance the intra-hour volatility of renewable energy sources. Consequently, this presents a blueprint for policy-makers, who can attain similar price reductions and larger feed-ins from renewable energy sources without direct costs in all countries with high shares of renewable energy sources.

1. Introduction

The world is experiencing an unprecedented growth in carbon-free renewable energy sources, largely due to government initiatives (Bundestag, 2008; European Union, 2009; The White House, 2014). The volatile power generation of these renewable energy sources (Papavasiliou and Oren, 2014; Riesz and Milligan, 2015) challenges existing markets which were originally designed to trade electricity from controllable sources, such as nuclear, coal and gas power (EPEX, 2013; Weber, 2010). In contrast to the previous baseloads, renewable energy sources, such as solar and wind power, exhibit very different generation characteristics as their infeed strongly depends on weather conditions. For instance, feed-ins from solar power exhibit steep ramp-ups every morning followed by a sharp decline in the evening (Bunn and Muñoz, 2016; Dillig et al., 2016). Accordingly, policy-makers face the challenge of designing markets which allow for the efficient trading of renewable energy sources (Chao, 2011).

In an effort to improve the market design, the EPEX electricity exchange introduced two new products in the years 2011 and 2014 which reduce trading intervals to 15 min (EPEX, 2013). This represents a considerable decrease to only a quarter of the previous minimum duration, which was 60 min. The shorter contract duration specifically addresses the needs of market participants to handle the generation uncertainty of intermittent power sources, such as solar and wind power (EPEX, 2013; Kiesel and Paraschiv, 2017). While the market quickly adopted these products, policy-makers know little regarding the introduction of 15 min trading and its impact on the electricity market.

Hence, this paper analyzes the introduction of 15 min products beyond previous literature:

1. Trading volumes. We investigate the adoption of 15 min trading and show their trading volumes subsequent to the launch of these products. Both trading volumes increased quickly, now exceeding 1.000 MW, while the 15 min auction

https://doi.org/10.1016/j.eneco.2017.11.019
0140-9883/© 2017 Elsevier B.V. All rights reserved.
in 2014 experienced a sharper rise compared to the earlier introduction of 15 min continuous products in 2011. This highlights the need of electricity retailers and power producers for such shortened trading intervals.

2. **Causal impact on electricity market.** As a result, the price of 60 min contracts dropped considerably. For this purpose, we perform an innovative evaluation based on Bayesian structural time series to measure the causal impact of these products on the existing market. In fact, our causal analysis reveals significant price decreases, ranging in the spectrum of 11% to 28% in hourly contracts due to the introduction of shorter trading intervals. We perform multiple robustness checks to ensure the validity of our outcome, all supporting our primary finding of a causal impact. In contrast, we observe that the average trading volumes for 60 min products remains fairly stable.

3. **Cross-effects with renewable energies.** We show that these new contracts provide incentives to offer additional volatile electricity from intermittent power sources, which participants could not efficiently trade via the power exchange earlier. Hence, 15 min contracts are especially common during the ramp-ups and ramp-downs of solar power generation, as well as around peaks in wind power. Here they can be used for balancing intra-hour demand and supply, which becomes also evident when performing a correlation analysis with feed-in from these electricity sources.

The previous results provide crucial insights for governments and policy-makers all over the world, but especially in countries with a high penetration of solar and wind power. Policy-makers also need to understand potential cross-effects, since benefits to some stakeholders come at the expense of others. At the same time, even little modifications to the market design may result in large shifts of revenue, causing current stakeholders to disappear and new ones to enter the market. Therefore, it is highly relevant for government agencies and policy-makers to carefully study the impact of changes in the market design.

This paper is organized as follows: **Section 2** provides background on the electricity market design, with a focus on the combined electricity market in Germany and Austria. Then, **Section 3** describes our time series data and our methodology for inferring the causal impact of market changes, followed by **Section 4** which presents the results of this analysis. Based on these, **Section 6** interprets our findings and derives policy implications, while **Section 7** concludes with a summary and an outlook.

2. **Background**

Delivery duration presents an important parameter of electricity contracts and is usually determined by the corresponding market design. Therefore, we review previous works that investigate contract durations in electricity markets. We then describe the electricity market design in Germany and Austria before and after the introduction of 15 min trading.

2.1. **Contract durations in electricity markets**

In economics, it is well known that, in the absence of perfect information, mechanisms are required to ensure the efficient allocation of resources. Such mechanisms may be embodied by markets, which master complex allocation problems when knowledge is dispersed (e.g. McAfee, 1998). However, designing markets presents a challenging undertaking, as every detail of the design affects the strategy of market participants and, hence, an improper market design can easily fail to attain efficient allocation.

The design of markets introduces several parameters for adjustments, including contract duration as an integral lever (Saussier, 1999). In general, the optimal duration depends on two determinants, namely, market uncertainty and transaction costs (Gray, 1978). Markets with high uncertainty require shorter trading intervals, while higher transaction costs increase the incentive to use a longer contract duration. However, few econometric studies evaluate this proposition by empirical means (Saussier, 1999).

In the electricity market, various research papers advocate the introduction of contracts with shorter durations. Just (2011) identifies noticeable potential for improvement in the electricity reserve market based on a simulated equilibrium model. Neuhoff et al. (2016) analyze 15 min contracts from the perspective of optimal discretization. The authors explore auction and continuous trading with 15 min contracts but neglect to study the impact on the existing market and cross-effects with renewable power generation. Similarly, Milligan and Kirby (2010) study the likelihood of market stakeholders responding to low-resolution price signals. Furthermore, previous works expect a beneficial setting from an increased flexibility to accommodate feed-ins from renewable energy sources (Riesz and Milligan, 2015; Sioshansi, 2013). However, the previous works are frequently of a theoretical nature and thus cannot support their claims through empirical findings. In addition, discussions on demand response propose shorter trading intervals as a means of providing near-to-real-time incentives for demand adjustments (Feuerriegel et al., 2016; Hirst, 2001).

On the other hand, research also discusses potential benefits from a less granular discretization. For instance, Buechner and Tuerkucar (2005) favor longer trading intervals to ensure security of supply. Cramton and Stoft (2005) consider contract lengths in tertiary reserves, where longer contracts are beneficial for promoting investment incentives and avoiding the possibility of manipulation. Altogether, the above works expose the challenge for policy-makers to determine an optimal discretization in electricity markets. On top of that, we are not aware of any research paper that empirically studies the impact of the market design change from the introduction of 15 min contracts.

2.2. **EPEX SPOT market**

The electricity market in Germany and Austria features three different ways to trade electricity, namely, (i) a derivative market, (ii) a spot market and (iii) over-the-counter trading. In this paper, we focus on the spot market since only this market offers 15 min trading and it distributes the majority of renewable power. The spot market enables short-term purchases via day-ahead and intra-day trading. In Germany and Austria, it is operated by EPEX SPOT, a subsidiary of Powernext and EEX. Furthermore, electricity traders use the spot market to balance day-to-day, as well as intra-day, variations in demand and supply. Accordingly, the spot market faces the most imminent challenge of incorporating highly volatile renewable energy sources.

The spot market in Germany and Austria, EPEX SPOT, features different product categories, namely, auction and continuous trading, which we discuss in the following. Fig. 1 shows the bidding and delivery times of both products. Auction trading allows one to trade electricity one day ahead to fulfill the demand forecast of the subsequent day. Here, offers may be placed multiple hours before the auction closes at 12:00 noon.

---

1 The derivative market allows participants to trade standardized electricity contracts up to 6 years in advance via the European Energy Exchange (EEX). Consequently, this market is predominantly used for long-term electricity purchases. Lastly, over-the-counter trading provides suppliers and purchasers with the possibility of trading electricity directly via bilateral agreements. While this form represents the highest flexibility, it increases transaction costs and might lack the efficiency and liquidity of an exchange.
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات