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Time-zero efficiency of European power derivatives markets

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HIGHLIGHTS

- We test time-zero efficiency of derivatives power markets in Germany, France and Spain.
- Prices in Germany, considering liquidity and transaction costs, are time-zero efficient.
- In France and Spain, limitations in liquidity and representativeness prevent conclusions.
- Liquidity in France and Spain should improve by using pricing and marketing incentives.
- Incentives attract participants to exchanges and encourage them to settle OTC trades in clearinghouses.

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ABSTRACT

We study time-zero efficiency of electricity derivatives markets. By time-zero efficiency is meant a sequence of prices of derivatives contracts having the same underlying asset but different times to maturity which implies that prices comply with a set of efficiency conditions that prevent profitable time-zero arbitrage opportunities. We investigate whether statistical tests, based on the law of one price, and trading rules, based on price differentials and no-arbitrage violations, are useful for assessing time-zero efficiency. We apply tests and trading rules to daily data of three European power markets: Germany, France and Spain. In the case of the German market, after considering liquidity availability and transaction costs, results are not inconsistent with time-zero efficiency. However, in the case of the French and Spanish markets, limitations in liquidity and representativeness are challenges that prevent definite conclusions. Liquidity in French and Spanish markets should improve by using pricing and marketing incentives. These incentives should attract more participants into the electricity derivatives exchanges and should encourage them to settle OTC trades in clearinghouses. Publication of statistics on prices, volumes and open interest per type of participant should be promoted.

1. Introduction

The ongoing liberalization process of electricity markets in Europe has many challenges, such as increasing efficiency in spot and derivatives markets, and promoting European market integration. The extent to which these challenges are met is of paramount importance for market participants, regulators and external investors who include power derivatives in their investment portfolios. Besides that, the European Commission (EC) is also promoting actions to ensure efficient, safe derivatives markets, including power derivatives markets (EC, 2009).

In this paper, we focus on one crucial, but hitherto neglected, aspect of informational efficiency of European power derivatives markets. Extant evidence largely concentrates on studying whether spot and (usually near-term) derivatives prices are linked by a set of efficiency conditions, related with size and characteristics of the risk premium. Key limitations of this literature are difficulties in capturing the complex behaviour of the forward risk premium across contracts and over time, see Cartea and Villaplana (2008) among others. Benth et al. (2008) provide an explanation for sign and magnitude of the market risk premium by modelling market players and their risk preferences by applying certainty equivalence principles. However, given that ex-ante risk premium between spot and derivatives contracts is not directly observable

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from market data, it is always dependent on the spot price model chosen.[1]

An alternative approach is to study the degree of time-zero efficiency of electricity derivatives markets using derivatives contracts only. This is a minimal condition for market efficiency and, consequently, inferences regarding resource-allocation efficiency of these markets based on our results are limited. No-arbitrage condition between swap prices and their corresponding replicating portfolios are well known. However, as far as we know, in the case of European power derivatives markets, extant literature does not address this issue. In other words, it seems that this basic efficiency test has not been applied to those derivatives markets. Ours is a first step to fill this gap in the literature. Furthermore, our approach has the advantage of dispense altogether with the problematic estimation of risk premia.

In this context, time-zero efficiency means a sequence of prices of the derivatives contracts having the same underlying asset but different times to maturity which implies that prices comply with a set of efficiency conditions that prevent profitable arbitrage opportunities. In this paper we investigate whether statistical tests, based on the law of one price, and trading rules, based on price differentials, are useful for assessing time-zero efficiency in a given power derivatives market.

Given that, by far, the most liquid derivatives contracts in the electricity markets are forwards, futures and swaps,[2] we apply tests using swap prices data from three of the biggest electricity markets in the Euro area. The German Market, which is Europe's largest power market in terms of consumption, the French Market, which is the second largest European market, and the Spanish Market which is the fifth largest market (EC, 2014). In the case of the German and French markets, we use data from EEX (European Energy Exchange). In the case of the Spanish market, we use data from OMIP (Iberian Energy derivatives Exchange).

Salient causes of problems in European electricity markets are market inefficiency, market power, inelastic demand, and constrained supply. Regarding the first point, extant literature largely focuses on assessing either (i) the degree of spatial integration across European spot markets or (ii) the degree of integration between spot prices and (near-term) derivatives prices in a given country. The degree of spatial integration across spot (or day-ahead) European markets is addressed in Bower (2002), Boisselau (2004), Zachmann (2008), and Bunn and Gianfreda (2010) among others. The overall conclusions suggest that significant spatial integration exists, although this integration is not homogeneous across Europe. In addition, this integration tends to increase over time. Regarding the issue (ii) most papers focus on the extent to which, in a given market, forward prices are unbiased predictors of future spot prices or whether the basis (the difference between current spot and forward prices) contains useful information for forecasting changes in spot prices. See Lucia and Schwartz (2002), Wilkens and Wimschulte (2007), Cartea and Villaplana (2008) and Furió and Meneu (2010) among others. Bunn and Gianfreda (2010) report some results on the predictability of forward prices of the French, German, British, Dutch and Spanish power markets and they conclude that there is an efficiency problem in all these markets since optimality conditions are never satisfied simultaneously, and they observe perfect forecast ability only in one market. On the specific issue of arbitrage opportunities, Capitán Herráiz (2014) studies the extent to which they are present and are profitable in the case of OMIP auctions, CESUR auctions and VPP auctions[3] in the scope of MIBEL (the Iberian Electricity market), by means of an analysis of the existence of arbitrage opportunities amongst trading mechanisms and maturities. Nevertheless, the important issue of whether, in a given European electricity market, prices of derivatives contracts with different time to maturity obey time-zero efficiency conditions that prevent profitable arbitrage opportunities has not been studied so far.[4] This paper aims to fill this gap in the literature.

To do so, we present several tests for assessing the time-zero efficiency of a swap power market. First, we test the law of one price between a swap contract with a given maturity, say one year, and its replicating portfolio, constructed using contracts with shorter maturities, say one month, by means of unit roots test, cointegration analysis, price convergence tests and price variance tests. Second, we apply some trading rules based on price differentials and on violations of zero-time arbitrage conditions. We apply tests and trading rules using eight years of daily data of prices of monthly, quarterly and yearly swap contracts from the three markets we study. The sample spans data of the German market from June 1, 2004 until December 31, 2012, of the French market from July 3, 2006 to March 19, 2014 and of the Spanish market from July 3, 2006 until June 6, 2014. We take into account relative liquidity of contracts and of their replicating portfolios, as well as transaction costs such as bid-ask spreads, trading fees and clearing fees.

In the case of the German market, after considering liquidity availability and transaction costs, results are largely consistent with time-zero efficiency. In the case of the French and Spanish markets, limitations in liquidity and representativeness are challenges that prevent definite conclusions. We recommend some policy measures to meet these challenges. Specifically, liquidity in French and Iberian markets should improve by using pricing and marketing incentives. These incentives should attract more participants into the electricity derivatives exchanges and should encourage them to settle OTC trades in clearinghouses. Publication of statistics on prices, volumes and open interest per type of participant should be encouraged. The results of this paper are therefore relevant for evaluating liberalized electricity markets in Europe.

The remainder of this paper is organized as follows. Section 2 presents time-zero efficiency tests. After we describe the data in Section 3, we report results of empirical analysis in Section 4. Section 5 discusses the impact of liquidity and representativeness. Section 6 contains conclusions and policy recommendations.

2. Time-zero efficiency tests

In this section, we present definitions for the variables we use as the basis for time-zero efficiency tests and present some guidelines for its practical implementation.

[1] In the application of their model to the EEX market Benth et al. (2008) employ a two-factor spot market model without spikes and with a constant level to which the prices mean-revert. However, Bierbrauer et al. (2007) suggest that, in the case of the EEX market, a regime-switching model using two regimes and with a Gaussian distribution in the spike regime outperforms alternative models.

[2] In most electricity markets, forward and futures contracts guarantee delivery of the electricity over a period of time (e. g. monthly or yearly contracts) rather than at a fixed future time. As Benth and Koekebakker (2008) argue the nature of these contracts are very similar to a swap exchanging a fixed price for floating (spot) electricity price during the defined period. In fact, swap contracts are integrals of traditional fixed delivery time forward contracts. If the contract is purely financial, the contract is settled in cash against the system price, during the delivery period. Thus, financial electricity contracts are swap contracts, exchanging a floating spot price against a fixed price. On the other hand, if the contract is taken to physical delivery, it may be converted into what is the equivalent of a one-month swap.

[3] In CESUR auctions, the agents trade energy contracts for last resort supply (Contratos de Energía para el Suministro de Último Recurso). In VPP auctions, the agents trade energy contracts for Virtual Power Plant capacity.

[4] Shahidehpour et al. (2002) provide an overview of arbitrage strategies in electricity markets, but they focus largely on cross-commodity arbitrage.