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A new index for electricity spot markets ☆

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ABSTRACT

Different indexes are used in electricity markets worldwide to represent the daily behavior of spot prices. However, the peculiarities of these markets require a careful choice of the index, based on mathematical formulation and its statistical properties. Choosing a bad index may influence the financial policies of market players, since derivative pricing and hedging performance can be deeply affected.

In this paper with an initial theoretical analysis, we intend to show that the most widely used indexes (simple arithmetic average and weighted average with current volumes) are poor representatives of the spot market. We will then perform an analysis of the hedging strategy on a derivative instrument (an Asian option) written on a reference index. The resulting simulations, applied to OMEL (Spain) and EEX (Germany), are sufficiently clear cut to suggest that the decision to adopt an index to represent properly a market must be taken very carefully. Finally we will propose a new index (*FAST* index) and, after comparing it with the previous indexes, will show that both theoretically and practically this index can be taken as a good electricity market synthetic indicator.

1. Introduction

The restructuring process of the electricity sector in many countries worldwide has been accompanied by the opening of competitive spot electricity markets. Derivative markets have been also introduced to meet the needs of hedging for private and public companies. Derivative markets have been modelled following the example of financial markets. Table 1 describes synthetically the major differences between electricity and financial markets (for energy markets in general see Lucia and Schwartz, 2002; Pilipovic, 2007). As is well known, electricity markets are relatively recent; liquidity is still low (compared to the extent of bilateral contracts), due to the limited storability and transportability of electricity; spot prices are highly dependent on temporal and local supply and demand conditions, business activity, weather conditions, etc. As a consequence, the "storage limitation" problem causes a highly volatile day-to-day behavior of the spot prices, far more volatile than in financial markets. Seasonality is also very strong, during the day (peak vs. off-peak hours), during the week, during cold and hot seasons.

All these specific peculiarities make electricity markets hard to model. Therefore, extreme care should be given to any attempt to introduce specific instruments, which most of the time are necessary to make the market work. We refer in particular to the choice of the market index, which, we claim, can cause dramatic domino effects both on spot and derivative markets. The crucial point is that the currently used indexes are not representative of their market, as we will try to show. The properties a good market index should satisfy go back to "level zero" statistics (see for instance Balk, 1995, 2008). By definition, a market index is a synthetic indicator: in the particular case of electricity markets, a daily index should reflect faithfully the behavior of the 24 hourly prices. In the presence of a derivative market, the choice of the market index, if possible, becomes even more crucial, as, in general, the index is the natural underlying variable for many derivatives. In this paper the issue of the electricity market indexes is discussed, as adopted in most markets worldwide. Through a simulated and historical series analysis the currently used indexes result to have serious drawbacks, both on the spot and the derivative side. We show that an index based on the arithmetic price average, adopted by electricity markets worldwide (Table 3), is weak from the statistical and economical point of view, it can be easily manipulated by a dominant player and is a poor underlying for derivatives, as we see in the case of an Asian option (see Section 3.1). On the other hand, an index based on the price average weighted by current volumes, adopted in Italy for PUN prices

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Table 1
Major differences between electricity and financial markets.

Issue	In financial markets	In electricity markets
Maturity of market	Several decades	Relatively new
Market activity (liquidity)	High	Low
Impact of storage and delivery	Low	High
Impact of meteorological events	Low	Very high
Impact of seasonality	Low	Very high
Impact of economic cycles	High	Low

(Table 3) overestimates price changes and therefore is a bad underlying for hedging purposes (see Section 3.2). A new index (the *FAST* index[1]) is here proposed, which is based on the robust theoretical basis provided by axiomatic index number theory, describes the spot market faithfully and thus can be taken as a good underlying for derivatives (Section 4).

In Section 2 the economical and statistical properties that a good market (electricity or financial) index should satisfy will be listed and commented. Section 3 contains the description of the indexes currently adopted in electricity markets worldwide. Their drawbacks will be highlighted. Section 4 is dedicated to the new proposal, the *FAST* index; by an historical simulation on the German and Spanish markets the hedging performance will be compared through an Asian option based on the three indexes analyzed here. Conclusions are drawn in Section 5.

2. Motivations of this work

As mentioned in the Introduction, this work is motivated by the need of improving the way the dynamics of electricity prices is measured and to overcome the inadequacy of the price indexes currently in use in the electricity market, namely the arithmetic price average index and the weighted (by current volumes) average index. The ineffectiveness of these indexes can be maintained both in economic and statistical terms. Indeed, these points of view are deeply interlinked, since poor statistical properties of the price index turn into a scarcely consistent economic meaning. In this section, we briefly outline the economic and the statistical arguments on which we base our criticisms. A deeper and more specific analysis is given in Sections 3 and 4, where the indexes are discussed in full detail.

2.1. Economic relevance of electricity price indexes

We discuss three areas on which the adoption of an index can have a relevant impact on electricity, financial or commodity markets: market viability, description of the market, derivatives.

2.1.1. Market viability

To be successful, a market has to be viable, i.e. the same opportunities should be given to all players. A market is said viable when it does not allow arbitrage opportunities, i.e. it does not allow positive returns without risk of loss. If on the contrary such a possibility is allowed, then some investors could spoil the market by taking advantage of it infinitely many times, at the expense of others. A necessary condition to prevent arbitrage opportunities is that the traded assets must be priced consistently. Thus, the index should represent the underlying price dynamics properly, so as to convey effective information to all players.

A market can be manipulated in many ways. In the case of electricity markets, it most often occurs on the side of a dominant producer. In electricity markets a common form of dominant position asserts itself when a producer is needed to satisfy the open demand, or, in other words, the joint offers of all other suppliers do not fulfil it (especially during peak hours). The process of liberalization of electricity market has not been fully accomplished (Commission of the European Communities, 2004). Typically, former national producers still own important quotas of the domestic supply. They can therefore exert a dominant position and still act as market makers. This is the case of ENEL in Italy or ENDESA in Spain. Even though in some countries (e.g. Spain and the United Kingdom) the ex-monopolist was split into two or more companies, nevertheless the risk of silent collusion is very strong: for the Spanish market see Fabra and Toro (2005); for the British market see Matacangay (2001) and Wolfram (1999). With this picture in mind, the spot market index should play a role in discouraging speculation by producers or those in a dominant position. The risk of prices being manipulated by a dominant producer (or by colluded players) is very high. This is confirmed by a general perception that market power is being exercised systematically (Commission of the European Communities, 2004). Since the Authority is monitoring the market by inspecting the index in the first place, the index itself should be robust against manipulations: this unfortunately is not the case of the arithmetic index (or the simple average of hourly prices). Therefore, it seems very odd that, in all countries, the index based on the arithmetic average has been adopted (see Table 3). In fact, we will see in Section 3.1 that this index lends itself to a particularly insidious way of manipulating spot prices. This opportunity, open only to dominant producers or colluded suppliers, can have devastating effects on market viability, thereby discouraging its use.

2.1.2. Market description

The index must obviously be "accurate". In electricity markets, in particular, the index is often taken as a benchmark by government and consumer associations to monitor the national economy. A sudden rise in electricity prices, described in synthesis by the daily market index, can affect in the short range the retail and wholesale pricing of many commodities and industrial products. Thus, the index (for instance the daily one) should reflect the behavior of the last 24 h. While this statement seems quite obvious, an index that is too sensitive to peaks in prices and volumes can negatively influence macroeconomic issues. In fact, an index that reacts abnormally to sharp changes in prices and volumes overestimates their effect. This happens in particular when the weighted average with current volumes is adopted, given the positive correlation between current prices and volumes (see Section 3.2).

2.1.3. Derivatives

Most of the derivatives traded in the electricity markets have been borrowed from the financial and commodity markets. See Table 2 for a short list of electricity derivatives. In OTC markets we find also a wide range of derivatives (spark spread options, block options, hourly options, virtual power plants, virtual storage).

We assume that firms buy derivatives to hedge against the volatility of a risk factor, such as the cost of electricity. Since the objective is risk reduction, the firm will obviously be happy if such an hedging instrument will indeed greatly reduce or even eliminate that risk. For hedging purposes the natural criterion to rank the performance of a derivative instrument is "the more it reduces risk, the better" (see for instance Mello and Parsons, 2000).

[1] *FAST* is an acronym of the authors' names: FAlbo, FAttore, STefani.