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Estimating the hedging value of an energy exchange in Turkey to a retail power consumer

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ABSTRACT

The new Electricity Market Law of Turkey, enacted in March 2013, built the legal framework needed to establish a long discussed energy exchange in Turkish electricity markets. The aim of this study is to estimate the value of this prospective energy exchange.

We do this by first developing a spot price model and a link between spot and forward markets. We then use the resulting price series to compare two different energy procurement scenarios for a hypothetical retail company responsible for supplying five percent of total load. In one scenario, we assume that our hypothetical retailer procures all energy in the spot market. In another, we optimize purchases by minimizing cost subject to a risk tolerance, using information from both spot and forward markets.

Results reveal that beyond reducing the retailer's risk exposure by smoothing expected costs, the exchange could have reduced total procurement costs during the first six months of 2013 by as much as 27.3 million Turkish Lira ($14.2 million or 3.6% of the total procurement cost).

1. Introduction

1.1. Background

Power markets, by their nature, are known to bear extreme price volatility, mainly due to non-storability of electric power. It is important for participants in the electricity market to hedge their risk exposure and derivatives traded in formal exchanges are useful tools to help companies hedge risks associated with highly volatile prices. However, they have not been effectively incorporated into the power industry in Turkey and, as a result, Turkish power generators, retailers, and customers have few options for managing price risks.

The Republic of Turkey began to deregulate its electricity market in 2001, with the enactment of the EML (Electricity Market Law), which steadily increased the level of private participation, and hence competition. A spot market began operating in December 2009, but a financial forward market is still absent, exposing participants in the Turkish electricity market to price risk.

In 2013, the government passed a revision to the EML intending to fill the risk management gap by introducing the concept of "market operation", defined as the "*operation of organized wholesale markets and financial settlement of activities taking place in such markets*" [10]. The new law also established the EPIAS (Energy Market Operation Company), which was tasked, along with the exchange operator Borsa İstanbul A.Ş., with establishing an energy exchange to provide market participants with new risk management tools. The need for an energy exchange in Turkey has been discussed for a long time and, with the 2013 EML revision, the legal framework for such an exchange was put in place.

1.2. Research objective

For the buyers' side of the market, a reasonable estimate of the value of the energy futures exchange could be given by the difference in procurement cost under the status quo (i.e., purchase everything from the spot market) and under the optimal spot/futures mix. This buyers' side value is what we calculate in this study.

For the sellers' side of the market, the value of the exchange could be approximated by the reduction in the cost of capital associated with a more stable revenue stream. We leave the sellers' side analysis for future work.

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1.3. Empirical approach

In order to compare a buyer's procurement cost under the two market regimes, we simulate futures contract data using approaches of [18,11]. We first develop a spot price model and calibrate its parameters using a time series of historic prices, define a theoretical link between spot and forward prices, and simulate a series of monthly forward prices. Next, we describe a hypothetical wholesale consumer (i.e. retailing company) in the electricity market, and design and execute two electricity purchasing strategies for this consumer: one based solely on spot prices (i.e. the status-quo), and another that uses a mix of spot and futures contracts to cover the hypothetical consumer's load obligation. The difference between total electricity procurement costs associated with these two strategies gives us an estimate of how valuable a futures exchange may be for managing price risk faced by a hypothetical wholesale electricity purchaser.

We make two important contributions to existing literature. First, to the best of our knowledge, this study is the first to develop a spot and forward price model for the Turkish electricity market. Second, although several studies examine the structure of the Turkish electricity market stipulated under the new EML, based on EPIAS expectations (see, for example [1,16]), we present the first attempt to quantify the potential risk management value of an electricity futures exchange in Turkey.

The rest of the paper is structured as follows: Section 2 summarizes the background and structure of Turkey's electricity market; Section 3 describes the suggested spot price model; Section 4 presents methodology and simulation results of a futures price model; Section 5 derives the monetary value of the proposed electricity futures exchange to a hypothetical wholesale consumer; and Section 6 concludes.

2. An overview of Turkey's electricity market

The restructuring of Turkey's vertically integrated power monopoly officially began in 2001 with Electricity Market Law (EML) No. 4628. TEAS (Turkish Electricity Generation Transmission Company) was split into three separate state-owned companies in charge of transmission, generation, and trading activities,[1] and an autonomous regulatory authority was created to oversee regulation of markets for electricity, oil, natural gas, and liquefied petroleum gas.[2] State-owned Turkish Electricity Distribution Company (TEDAS) remained in charge of distribution activities. A 2013 successor Law No. 6446 created a new market-operating entity, Energy Markets Operation Company (EPIAS) to carry out operations on the day-ahead, intraday, balancing power, ancillary services, OTC (over-the-counter), and derivatives markets. Wholesale power prices have been deregulated, and retail prices are currently deregulated for most customers, and will be deregulated for all customers in the near future, which means that most participants are subject to price risk and could potentially benefit from risk management instruments.

Creation of EPIAS provided the legal infrastructure necessary for an introduction of a derivatives market integrated with the balancing and settlement market. The Turkish Derivatives Exchange (also VOB or TURKDEX) took the first step toward establishing an energy exchange in September 2011 with the introduction of the TURKDEX Base Load Electricity futures contract. Trading began in December, after the day-ahead market was established. However, despite being the only futures contract introduced, the TURKDEX base load contract has not drawn much attention. Trading volumes have been extremely low, due in part to lack of a reliable power index. In fact, almost 92 percent of TURKDEX's trade value is written on contracts indexed to the stock exchange. Since the value of the stock exchange has no obvious correlation with electricity prices, these contracts have not preformed well. The value of all power contracts traded on TURKDEX during the year 2012 was lower than the value of power contracts traded on the spot market in a single day. The Exchange has since merged with the Futures & Options Market of Borsa İstanbul in order to take advantage of superior trading technologies, but new efforts are needed to develop a more advanced energy exchange in Turkey. Gauging the value of such an exchange will be a useful policy tool to encourage its development.

3. Developing a spot price model

The first step in our analysis is creating a model to describe the existing spot price formation process, which we can then use to simulate prices of futures contracts.[3] Below, we describe the main characteristics of electricity prices and explain how we use these characteristics to develop Turkey's spot price model.

3.1. Characteristics of electricity prices

Power markets are known to exhibit extreme price volatility because electricity cannot be stored in an economically efficient way, which means supply and demand must be balanced in real time. Even a small movement in load or generation can cause dramatic price fluctuations within a short amount of time. In a 2007 paper, Bierbrauer et al. summarize the four principal characteristics of electricity spot prices: seasonality, volatility, mean reversion, and spikes.

- *Seasonality* refers to the cyclical nature of electricity demand. Cyclicality in demand leads to cyclicality in prices. Daily, weekly and yearly seasonal patterns are common in electricity prices as a result of varying levels of business activities and climate conditions.
- *Volatility* refers to extreme movements of electricity prices. Due to lack of storage, electricity markets cannot benefit from the smoothing effect of inventories. This makes changes in electricity prices more extreme than changes in oil and natural gas prices, which themselves are known to be very volatile. Fig. 1 shows the daily percent change in spot electricity prices, together with the daily percent change in the Borsa İstanbul Stock Exchange National 100 Index (BIST100) between January 2010 and December 2012. Volatility in spot electricity prices, sometimes as high as 250 percent per day, dwarfs volatility observed in the stock exchange index.
- *Mean reversion* suggests that highs and lows in the price of a commodity are temporary and that, over the long run, prices will always revert to a long-run average trend. Mean reversion is a common characteristic of commodity prices, and electricity prices are not an exception. What is different about electricity prices is that they tend to revert to the mean faster than prices of other commodities because marginal generation costs rise very

[1] Turkish Electricity Transmission Company (TEIAS), Electricity Generation Company (EUAS), and Turkish Electricity Trading and Contracting Company (TETAS), respectively.

[2] Energy Market Regulatory Authority (EPDK).

[3] In the following sections we combine and extend approaches used by authors of previous studies. For the sake of conciseness, we invite the reader to review cited papers for details of these approaches.