ESTIMATING THE VALUE OF AN ENERGY EXCHANGE FOR TURKEY

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Overview

Power markets, by their nature, are known to bear extreme price volatility, mainly due to non-storability of electric power. Consequently, it is important for electricity market participants to hedge price risks. Derivatives traded in formal exchanges are effective tools to help companies hedge such risks. In Turkey, however, there is at present no electricity futures exchange. All trades take the form of bilateral contracts on the spot market. Lawmakers have been discussing the benefits of an exchange for years and some steps have been taken toward such an exchange.

Turkey first began to deregulate its electricity market in 2001, with the enactment of the Electricity Market Law (EML). During the years following the enactment of EML, the level of private participation, and hence competition, in the market increased steadily. In December 2009, a spot market began to operate. A financial forward market, however, is still absent, exposing participants in the Turkish electricity market to price risk. A 2013 update to the Electricity Market Law built the legal framework for the establishment of an energy exchange.

In this study, we estimate the risk management potential of the proposed futures energy exchange by simulating a set of procurement strategies that could be employed by a hypothetical electricity buyer, and deriving the associated energy cost savings. A futures exchange will give market participants the option to purchase futures contracts for at least some of their energy requirement, aiming to create an optimal mix of spot and futures purchases to minimize total procurement costs. Thus, the difference in procurement costs for a hypothetical company under the status quo (i.e., purchase everything from the spot market), and the procurement cost for a mix of spot and futures contracts, optimized to the company's assumed risk preferences, should provide us with a reasonable estimate of the value of the energy exchange to our consumer.

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. And second, we present the first attempt to quantify the potential value of an electricity futures exchange for a hypothetical electricity buyer in the Turkish energy markets.

Methods

Since a futures market does not yet exist in Turkey, there is no data on electricity futures or forward prices. In order to simulate a forward price series, we begin by collecting historical spot prices for the Turkish electricity market between January 2010 and December 2012 and calibrating the parameters of a spot price model to these data. The resulting spot price model is formulated as a two-regime switching model, with a mean reverting regime (a la Vasicek, 1977) composed of a stochastic component and a seasonal (weekly and yearly) deterministic component, and a Gaussian spike regime. Spikes are defined as observations lying at least three standard deviations away from the mean.

Next, we define a theoretical relationship between spot and forward prices (following Weron, 2007) as a risk premium an investor is willing to pay to avoid holding a risky asset (the market price of risk), and use the resulting econometric forward price model to simulate a series of forward prices for weekly and monthly forward contracts.

After we obtain a simulated forward price series, we describe a hypothetical electricity market consumer, and design and execute two electricity purchasing strategies for this consumer: one based solely on spot prices (i.e. the status-quo), and another based on a mix of spot and futures contracts to cover the hypothetical consumer's total load obligation (as described in Woo et al., 2004). Finally, we compare total electricity procurement costs associated with these two strategies, the difference between which gives us an estimate of how valuable a futures exchange would be to our hypothetical electricity purchaser in terms of the risk management potential it affords.

Results

Calibration of our chosen spot price model reveals the expected seasonal patterns in spot prices: prices peak during the middle of the weak (Tuesday through Thursday) and during the summer months (especially July and August).

The seasonal component accounts for a large fraction of price variation over time. Just over four percent of all observations are identified as price spikes. Upon deviation, spot prices are estimated to revert to the mean in a little more than three days – a daily mean reversion rate of 0.36. Our spot price model replicates the trend of actual spot price data quite well, although simulated price spikes appear to be slightly muted.

Analysis of the forward price model suggests that market participants tend to overestimate price volatility in financial markets, as has been reported by other authors (e.g. see Botterud et al., 2002 and Bierbrauer et al., 2007). This is important because it ultimately inflates one's willingness to pay for futures contracts and therefore reduces the ultimate potential for risk management. Our forward price model replicates actual average spot prices well for only three of the first six months of 2013, and appears to lag the direction of change in observed spot averages by one month.

Finally, our procurement strategy simulation reveals that the value of an electricity futures exchange for a hypothetical retail company during the first six months of 2013 would have been a maximum of 27.3M Turkish Lira (approximately $14.2M) or around 3.6 percent of the total procurement cost. The buyer's assumed risk tolerance affects the magnitude of these savings.

It's important to note that these estimates are based on simplifying assumptions and are valid only for the time period that we investigate (January-July 2013). The realized average spot price for the months of April and June happened to be 48% and 30% higher than their historical averages, which means the ability to hedge risk was quite valuable during these months.

Conclusions

In this study we develop and calibrate models for spot and futures electricity prices in Turkish electricity markets, and estimate the risk management potential of a Turkish electricity futures exchange that is currently under development. We find that Turkey's spot electricity prices follow predictable mid-week and summer peaks, and that during the first six months of 2013 an optimal mix of spot and forward contracts would have lowered total procurement costs for a hypothetical power buyer by as much as 3.6 percent ($14.2M or TL27.3).

Our results are useful for three reasons. First, companies in the Turkish electricity market can use the spot price model developed here as a tool for forecasting future spot electricity prices and correcting their price volatility expectations. Second, the exchange operator can use our forward price model to price derivatives, while market participants can use it to estimate a fair value for the derivatives they intend to buy or sell. And finally, once the exchange is launched and actual forward prices become available, price models can be improved and estimated savings may grow. Although our estimates appear low in percentage terms, they still amount to millions of Turkish Lira. The savings could in turn be diverted to strengthen transmission networks and improve system reliability.