THE RELATIONSHIP BETWEEN SPOT AND FUTURES PRICES: AN EMPIRICAL ANALYSIS OF AUSTRALIAN ELECTRICITY MARKETS

Rangga Handika, Macquarie University, Phone +61410850416, E-mail: rangga.handika@mq.edu.au
Stefan Trück, Macquarie University, Phone +61 (0)2 9850 8483, E-mail: stefan.trueck@mq.edu.au

Overview

The deregulation of electricity markets worldwide has transformed the market structure from monopoly to competitive markets where market prices are determined by supply and demand. It is well-known that electricity prices exhibit features like seasonal patterns, price spikes, mean reversion, price dependent volatilities and long term non-stationarity [3], [5], [6], [7].

This paper represents a pioneering study on examining the relationship between spot and futures prices in electricity markets across different states (New South Wales-NSW, Queensland-QLD, South Australia-SA and Victoria-VIC) in Australia. While there has been some work done on the modeling of Australian electricity markets so far, the relationship between spot and futures prices has not been investigated thoroughly. First, we investigate the magnitude of the futures premiums at different time instances. Furthermore, we examine how the correlation of the futures premiums across the considered electricity markets. Another part of this study is to investigate whether the bias in the futures price can be explained by the behavior of the spot price in the pre-delivery period (month or quarter).

This paper is organized as follow. Section 1 provides a brief introduction and considers previous empirical and theoretical work on the issue. Section 2 describes the peculiarities Australian electricity markets. Section 3 explains the ex-post futures premium, and general equilibrium electricity futures premium model. Section 4 describes the data and discusses the empirical results. Section 5 concludes.

Methods

We provide a descriptive statistics of electricity spot and futures prices in Australian markets. We calculate the average daily spot price as the average of 48 half-hourly electricity spot prices. We also identify the periods when the average of realized spot prices are at their maximum or minimum price levels in order to explore the seasonality in Australian markets.

Then we examine the magnitude of futures premiums at different time instances applying a methodology similar to [10]. We calculate the ex-post futures premium as the difference between the last trading day futures price and the realized average spot price during the delivery period of the futures contract. We also examine the correlation of the futures premiums across the considered Australian electricity markets.

In a final step, we investigate whether the bias in the futures price can be explained by the behavior of the spot price during period prior to delivery. Hereby, we extend the general equilibrium model of electricity forward prices as suggested by [1], [9], [10]. We also perform residual diagnostic analysis to test the robustness of our results that are based on a multiple regression model with several explanatory variables. A standard classical regression model assumes that the residuals should be constant (homoskedastic) and exhibit no autocorrelation [2], [4], [11], [8]. We perform a White test [12] to test for heteroscedasticity and a Durbin Watson test to investigate autocorrelations in the residuals.

Results

We find that the highest monthly average prices occur during winter for the NSW and QLD market and in summer for SA and VIC markets.

We further find economically and statistically significant positive ex-post futures premium in all of the considered states except SA.

Regarding the factors affecting the futures premium, we find that the bias in the futures price increases (decreases) when the last quarter average spot price increases (decreases) and volatility of spot price decreases (increases). Our results are robust and satisfy the necessary homoskedasticity and no-autocorrelation assumptions of a standard regression model.

Conclusions

We conclude that Australian electricity markets exhibit significant futures premiums. The existence of the premium can be explained by the non-storability of electricity as a commodity and additional liquidity risk in the markets. We also show that the observed futures premiums are highly correlated across different markets. The correlation tends to be higher for peak load futures contracts. We find significant evidence that the futures prices in Australian markets cannot be considered as an unbiased estimator of the future spot price. We show that the bias can at least partially be explained by the mean and volatility of spot prices in the previous quarter. Our results also confirm that the market participants in Australian electricity markets are risk averse.

References

1. Bessembinder, H & Lemmon, ML 2002, 'Equilibrium Pricing And Optimal Hedging In Electricity Forward Markets', The Journal of Finance, vol. 57 no. 3, pp. 1347 – 1381.
2. Brooks, C 2008, Introductory Econometrics For Finance 2nd edition, Cambridge University Press, Cambridge UK.
3. Burger, M, Klar, B, Müller, A & Schindlmayr, G 2004, 'A Spot Market Model For Pricing Derivatives In Electricity Markets', Quantitative Finance, vol. 4, pp. 109 – 122.
4. Hill, RC, Griffiths, WE & Lim, GC 2008, Principles Of Econometrics 3rd Edition, John Wiley & Sons Inc., New Jersey USA.
5. Huisman, R, Huurman, C & Mahieu, R 2007, 'Hourly Electricity Prices In Day-Ahead Markets', Energy Economics, no. 29, pp. 240 – 248.
6. Kanamura, T & Ohashi, K 2008, 'On Transition Probabilities Of Regime Switching In Electricity Prices', Energy Economics, no. 30, pp. 1158 – 1172.
7. Karakatsani, NV & Bunn, DW 2008, 'Intra-Day And Regime-Switching Dynamics In Electricity Price Formation', Energy Economics, no. 30, pp. 1176 – 1797.
8. Koop, G 2009, Analysis Of Economic Data 3rd edition, John Wiley & Sons Ltd., West Sussex England.
9. Longstaff, FA & Wang, AW 2004, 'Electricity Forward Prices: A High Frequency Empirical Analysis', The Journal of Finance, vol. 59, no. 4, pp. 1877 – 1900.
10. Redl, C, Haas, R, Huber, C & Böhm, B 2009, 'Price Formation In Electricity Forward Markets And The Relevance Of Systematic Forecast Errors', Energy Economics, no. 31, pp. 356 – 364.
11. Verbeek, M 2008, A Guide To Modern Econometrics 3rd Edition, John Wiley & Sons Ltd., West Sussex England.
12. White, H 1980, 'A Heteroskedasticity-Consistent Covariance Matrix Estimator And A Direct Test For Heteroskedasticity', Econometrica, vol. 48, no. 4, pp. 817 – 838.