REAL-TIME PRICING AND IMPERFECT COMPETITION IN ELECTRICITY MARKETS

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Overview

Electricity markets are generally considered to suffer from a demand side flaw as many customers face prices that do not vary according to time of use. Economists have argued that moving to real-time electricity pricing (RTP) is an important reform that would improve the efficiency of electricity markets. The argument is that prices would then reflect incremental production costs. Borenstein and Holland (2005) show that if electricity markets are competitive then "efficiency gains from RTP pricing are potentially quite significant." They acknowledge however that a more complete analysis would consider the effect of market power. The purpose of this paper is to address the gap in the literature by developing a model of the electricity with market power and using it to analyse the welfare impact of switching to RTP. The model developed shows that the potential efficiency gains as customers moved to RTP pricing plans are increased considerably when market power is taken into account. More customers on RTP plans reduces the ability of firms to exercise market power. The efficiency gains depend on the volatility of the socially optimum price and the volatility of the mark up. The more volatile prices are across different time periods the higher the efficiency gain. We also find that as customers move onto RTP plans firm profits are reduced which suggests that firms will be reluctant to facilitate such a transitions which in turn suggests that policy interventions may be needed.

Methods

The approach here is to extend work by Borenstein and Holland (2005), Borenstein (2005), Holland and Mansur (2006). and and Joskow and Tirole (2006, 2007) to a market structure which is vertically separated where the electricity supply companies have market power. There are *T* time periods. Each time period occurs a fraction f_t of the year with demand increasing with *t*. Customers are of two types. A fraction β face and respond to real-time pricing where their retail price p_t varies according to the time period with the rest on fixed price contracts. With perfect competition in the retail sector the retail price for RTP customers equals the wholesale price that the supply firms charge. Customers with traditional meters are charged a flat rate *p* which does not vary according to the time of use. Retail firms buy on the spot market and offer two part tariffs with homogenous customers. Those on traditional meters face demand $D_t(p)$ in each period while those on RTP demand $D_t(p_t)$ in each period. Total demand for each period is then $\widehat{D}(p, p_t) = \beta D_t(p_t) + (1-\beta)D_t(p)$. The electricity wholesale market is modelled using a Cournot approach. Firm "i" has baseline generation with constant marginal costs c_t^i and investment costs I_t^i. We assume that for each time period different technologies are efficient- so for example base-load plants operate for all periods while the last plants dispatched in period T are the peakers. The representative firm chooses capacity and prices for each time period with Cournot assumptions about their competitors. The N firms are assumed to be identical. For linear demand functions $D_t(p_t) = A_t - B_t p_t$ the prices, fixed fee for traditional customers and generation capacity for each time period are then solved exactly in terms of p_t^* the perfectly competitive prices, and the demand function parameters.

Results

For N firms identical firms and linear demand functions $D_t(p_t) = A_t - B_t p_t$ the prices, fixed fee for traditional customers and generation capacity for each time period are then solved exactly with p_t^* the perfectly competitive prices

$$p_t = p_t^* + \frac{1}{N+1}\left(\frac{A_t}{B_t} - p_t^*\right) + \frac{1}{N+1}\frac{1-\beta}{\beta}\sum_s^T f_s B_s \left[\frac{A_t}{B_t} - \frac{A_s}{B_s}\right]$$

Using these prices it is straightforward to calculate the long run impact of changing the proportion of RTP customers. In the model developed here prices are independent of the fraction of customers who pay real time prices β. As traditional customers switch to RTP off-peak capacity (that is for low values of t) increases while peak capacity decreases. Firm profits always decrease. Overall energy consumption surprisingly doesn't change. The social welfare gain is given by

$$\frac{dSW}{d\beta} = \frac{1}{2}\operatorname{var}(p_t^{*}) + \frac{1}{2}\operatorname{var}(M_t) + \frac{1}{N+\_1}\operatorname{cov}(p_t^{*}, M_t)$$

Where M_t is the markup, “var” is the variance and “cov” is the covariance. The social welfare gain is always positive and is higher for imperfectly competitive markets compared to perfectly competitive ones.

We fit the model to the New Zealand electricity market and find modest efficiency gains of about 3% is everyone moved to real time pricing contracts. However there is a large fall in profits (11%) and a large increase in consumer surplus (10%).

Conclusions

Our results show that efficiency gains are higher as price volatility increases. Current plans to decarbonise the power system involves increasing significantly the amounts of intermittent renewables which is expected to increase price volatility dramatically. Our results suggest that facilitating customers to move to RTP plans should be a key feature to help make power markets in the future work efficiently. Furthermore since firms will see their profits decrease they have little incentive to encourage switching – which suggests there may need for new policy to facilitate such a change.

References

Borenstein and Holland (2005). On the Efficiency of Competitive Electricity Markets With Time Invariant Retail Prices, RAND Journal of Economics, 36(3), 469-493 2

Borenstein, S. (2005), The Long-Run Efficiency Of Real-Time Electricity Pricing, Energy Journal, Vol 26, No 2, 93-116 3.

Holland, S., Mansur, E. (2006). The short-run effects of time-varying prices in competitive electricity markets. The Energy Journal, Vol. 27, No 4, 127-155.

Joskow, P. and Tirole, J. (2007). Reliability and Competitive Electricity Markets, RAND Journal of Economics, Vol 38, No 1, 60-84 5.

Joskow, Paul and Tirole. J. (2006), Retail Electricity Competition, RAND Journal of Economics, Vol 37, No 4, 779-815