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WELFARE IMPLICATIONS OF CONSUMERS SWITCHING TO REAL TIME PRICING PLANS WITH IMPERFECT COMPETITION IN ELECTRICTY 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 (see for example [1], [2], [3], [4]). The argument is that prices would then reflect incremental production costs. There is large literature on peak load pricing which analyses the efficiency gains of time of use pricing, however as argued by Borenstein and Holland [1] this literature only extends to electricity markets if all customers are on RTP. Borenstein and Holland [1] go on to 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. They consider the likely impact of market power, but are unable to draw any firm conclusions stating "it is difficult to analyze the bias from excluding 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.

METHOD

The approach here is to extend work by Borenstein and Holland [1] and Joskow and Tirole ([4], [5]) to a market structure which is vertically separated where the electricity supply companies have market power. Period one is the norm and occurs with frequency f_1. Period two, which occurs with frequency f_2, is when demand is unusually high. Customers are of two types. A fraction α face and respond to real-time pricing where their retail price p_t varies according to the time period. 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 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

$$D_t(p_t, p) = \alpha D_t(p_t) + (1-\alpha) D_t(p)$$

For traditional customers the retail companies offer a price which is the solution to the following equation:

$$\sum_t (p - p_t) D'_t(p) = 0$$

The electricity wholesale market is modelled using a Cournot approach. Firm i has baseline generation K_1^t with constant marginal cost c□ and peak capacity K_2^t which has higher running costs c□ and lower capital costs. Peak-load plants are characterised by low investment costs and high marginal running costs. The representative firm chooses capacity K_t^t, prices p_t, and rationing level α_t for each time period with Cournot assumptions about their competitors. For linear demand functions the prices, fixed fee for traditional customers and generation capacity for each time period are then solved exactly.

RESULTS

With N firms and linear demand functions,

$$D_t(p) = A_t - B_t p,$$

after some algebra the prices can be calculated explicitly,

$$p_t = \frac{N}{N+1} p_t^* + \frac{A_t}{B_t(N+1)} \quad , \quad p = \frac{f_1 B_1 p_1 + f_2 B_2 p_2}{f_1 B_1 + f_2 B_2},$$

where p_t^* are the socially optimum prices. 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 (α). As traditional customers switch to RTP off peak capacity increases while peak capacity decreases according to

$$\frac{dD_1(p_1,p_2)}{d\alpha} = \frac{f_2 B_1 B_2}{f_1 B_1 + f_2 B_2} \frac{N}{N+1}(p_2^* - p_1^*) \quad , \quad \frac{dD_2(p_1,p_2)}{d\alpha} = -\frac{f_1 B_1 B_2}{f_1 B_1 + f_2 B_2} \frac{N}{N+1}(p_2^* - p_1^*)$$

which is intuitively appealing. Using these results it is straightforward to calculate the change in social welfare as customers switch to real time pricing. Surprisingly with market power the change in social welfare is ambiguous. If the peak price mark up over long run costs is large enough than switching customers to RTP can reduce social welfare. The intuition behind this result is that with market power real time prices are higher than the efficient prices p_t^* for each time period. The traditional customers face price p each period which is higher than the optimum price in the off peak period but lower than the optimum price during the peak time period. A customer switching from RTP to traditional pricing will thus see prices during the off peak period moving away from p^*_1, however their peak prices may become closer to the optimum price p^*_2. The result is that the overall welfare impact is ambiguous.

CONCLUSIONS

The model developed here reveals a surprising feature which is important to understanding electricity markets. With market power in the wholesale market prices differ to those which a perfectly competitive market would deliver. Although real time pricing is widely advocated to increase the efficiency of electricity markets this paper shows that in the context of imperfect competition the argument is not as clear cut. The challenge for policy makers is to ensure that the efficiency losses caused by market power are not exacerbated by well intentioned policy measures to encourage real time pricing.

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