Real-time pricing in electricity markets

Borenstein - simulate outcomes under several different circumstances. (different elasticities/shares on RTP)

- Lots of political resistance to real-time pricing.
- Looks at investment incentives
  - demand is vertical under uniform pricing in the SR. (since prices are constant wrt. investment)

(*) Structural study of savings from daylight savings.

Elasticity ↑, share on RTP ↑ ⇒ equilibrium capacity ↓

Welfare gains relative to flat prices can be substantial.

The source of the rest of the price variation is that there are several different technologies for creating energy.

Second best linear prices

Ex. Hotelling bridge:

- $C = F$
- $MC = 0$
- $P = MC \Rightarrow P = 0 \Rightarrow TR = 0 < TC$

Problems with $P = MC$

- No true lump sum taxes

- Informational issues. Why not say that benefit exceeds cost if you don't have to pay?

Alternatives

- $P = AC$
- Non-uniform pricing
- Ramsey pricing

Ramsey

- maximize social welfare s.t. breakeven constraint
- n products $k = 1, \ldots, n$
- Dmd $q_k = D_k(p)$
- $S(q)$: gross surplus
- $R(q) = \sum_{k=1}^{n} p_k q_k$ revenue
- $C(q)$ cost
- $S^n(q) = S(q) - R(q)$ - net CS
- $\pi(q) = R(q) - C(q)$

Want to

$$\max \; S(q) - C(q)$$

$$\text{s.t.} \quad \pi(q) = R(q) - C(q) \geq 0$$

$\mathcal{L} = S(q) - C(q) + \lambda[R(q) - C(q)]$

FOCs: $\frac{p_i - c_i}{p_i} = \frac{\lambda}{1+\lambda} \frac{1}{\eta_i}$, $\eta_i \equiv$ demand elasticity

- if products are independent

$\frac{p_i - c_i}{p_i} = \frac{\lambda}{1+\lambda} \frac{1}{s_i}$, $s_i \equiv$ superelasticity

- if not independent
  - $s_i > \eta_i$ if complement
  - $s_i < \eta_i$ if substitute

Ramsey number: $\frac{\lambda}{1+\lambda}$

- French approach: λ is exogenous
  - Taxes are set so that λ is achieved
- alternatively, λ can be endogenous

Need to know a lot as a regulator to be able to use this

Can decentralize Ramsey pricing by setting a global price cap

- $\max \sum_{k=1}^{n} p_k q_k - C(q)$

  s.t. $\sum_{k=1}^{n} w_k p_k \leq$ constant

(*) Go through the Ramsey problem to show equivalence

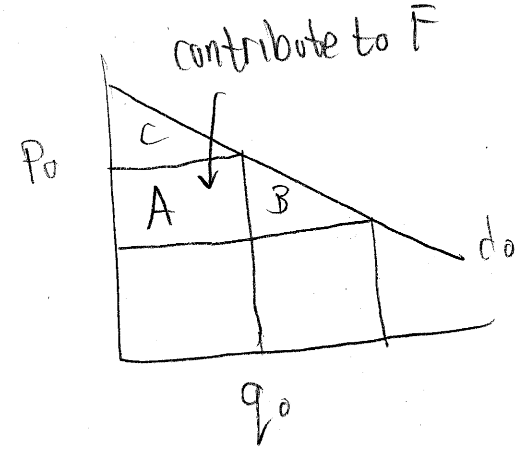
Ramsey may be "sustainable" vs. free entry if:

DRAC + TRC + weak gross substitutes

declining ray average cost — trans-ray convexity

Nonlinear pricing:

Two part tariffs.



Suppose P_0 > MC (Ramsey price)

- Need to ensure we still get A from these consumers

Charge A + part of B. Consumers then get C + the other part of B.

Choose between:

- Ramsey price P_0
- Two part tariff:

$T = A + \lambda B \quad \lambda \in (0,1)$

$t = MC$

$\max_{P(q)} CS + \Pi$ s.t. $\Pi \geq 0$

Simple case:

- $C = F + cq$ $\Rightarrow$ losses if $P = MC$
- n consumers, represented by
  - $S_i(q_i)$ = gross surplus to i of consuming q_i
- Let $v_i(p) = \max_q \{S_i(q) - pq\}$

$\Rightarrow \frac{\partial v}{\partial p} = -q_i(p)$ by envelope conditions

Consider nonlinear tariff:

- $R(q) = T + tq$

i purchases $q_i(t)$ if $v_i(t) - T - tq_i(t) \geq 0$

$\Rightarrow$ aggregate consumer surplus:

$$CS = \sum_{j=1}^{n} (v_j(t) - T - tq_j(t)) \quad \forall j \text{ s.t.}$$

$$v_j(t) - T - tq_j \geq 0$$

With one consumer type, $T = F/n$, $t = c$.

Laffont-Tirole, chs I-2

What if have incomplete information?