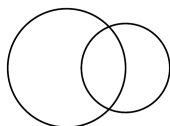


Competition With Captive Customers

Mark Armstrong & John Vickers

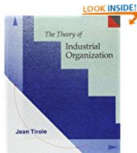
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- “Captive” customers can only buy from a particular seller; others consider several sellers and choose cheapest one
- Interpretations:
 - consumers differ in awareness of sellers (Varian, Burdett & Judd, etc.)
 - horizontal differentiation, where only subset of consumers find a seller’s product suitable
 - chain stores face competition in some locations but not others
 - consumers differ in default bias or willingness to switch supplier
 - consumers differ in ability to compare deals, and confused consumers buy randomly (Piccione & Spiegler 2012, Chioveanu & Zhou 2013)
 - advertising as shifter of awareness (Honka et al 2017)

- Uniform pricing:
 - a seller must charge the same price to all its customers
 - Here, Bertrand competition typically involves mixed strategies (inter-firm price dispersion)
- Price discrimination:
 - a seller knows whether a consumer is captive or not, and can price accordingly
 - e.g., a customer who calls her existing supplier to say she's considering switching may be offered a “special discount”, while inert consumers remain on the “standard tariff”
 - Bertrand competition then involves pure strategies (but with intra-firm price dispersion)
 - paper also studies an extension where sellers see a noisy signal of whether customer is captive
 - current policy issue is whether to ban this form of price discrimination

Price dispersion online



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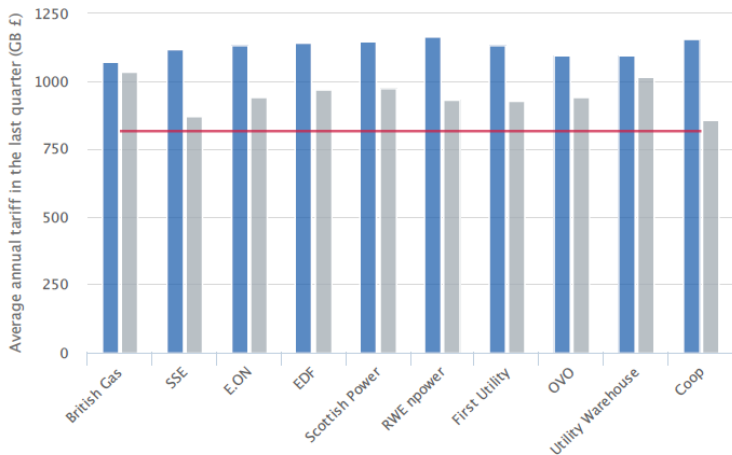
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Price discrimination by energy firms in UK

Average tariff prices by supplier: Standard variable vs cheapest available tariffs (GB)



■ Supplier's average annual standard variable tariff

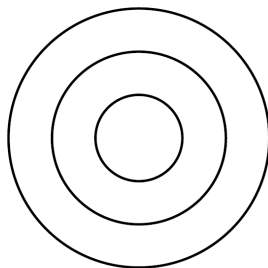
■ Supplier's cheapest annual average tariff

— Market cheapest annual average tariff

- n sellers with costless production
 - exogenous fraction of consumers aware of any given subset $S \subset \{1, \dots, n\}$ of sellers
 - consumer buys from seller she sees with the lowest price and has demand function $q(p)$
 - profit function $\pi(p) \equiv pq(p)$ single-peaked up to monopoly price p^*
- General features of equilibrium with uniform pricing:
 - equilibrium exists (Dasgupta & Maskin 1986)
 - each firm's profit is at least equal to the number of its captive customers times $\pi(p^*)$
 - if a price is sometimes chosen, at least two firms sometimes choose it
 - there are no gaps in the set of prices sometimes chosen: if p_0 is minimum price ever chosen, all prices $[p_0, p^*]$ are sometimes chosen
 - duopoly is special: firms have same price support which is an interval

Particular patterns of awareness

- Duopoly [Narasimhan 1988]
- Consumers either know all sellers or one random seller [Varian 1980]
- Symmetric sellers [Burdett & Judd 1983]
- Independent reach [Butters 1977, Ireland 1993, McAfee 1994]
- Nested reach:

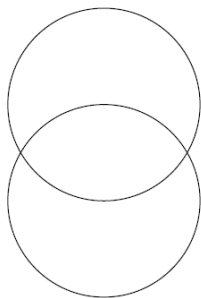


Talk addresses two issues

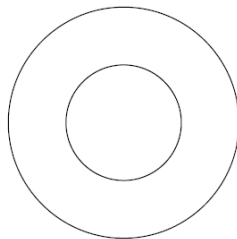
- Price discrimination in duopoly
- Uniform pricing with more than two sellers:
 - rich possibilities depending on patterns of competition
 - “perverse” effects of entry possible
- (Longer talk would relate to Bertrand-Edgeworth competition with capacity constraints)

The impact of price discrimination

- Consider a duopoly market



symmetric reach



nested reach

- Left-hand picture has equal numbers of captives
- In right-hand picture the smaller seller has no captives
 - e.g., smaller seller is an entrant who is able to serve those customers of the incumbent with low switching costs

The impact of price discrimination

- Price discrimination:
 - contested consumers get competitive price $p = 0$
 - captive consumers get monopoly price $p = p^*$
 - each seller obtains its captive profit
- Uniform pricing:
 - both sellers choose price in interval $[p_0, p^*]$
 - larger seller obtains its captive profit
 - smaller seller obtains more than its captive profit
- Comparison:
 - industry profit lower with discrimination (equal if market symmetric)
 - distribution of profit across consumers is more dispersed with discrimination (a mean-preserving spread if market symmetric)
 - a ban on discrimination helps captive customers and harms contested customers, but overall impact?

The impact of price discrimination

- Useful perspective is “expected utility theory”
 - regard a consumer’s surplus $v(\pi)$ as a (decreasing) function of the profit π she generates
 - “competition in utility space” [Armstrong & Vickers 2001]
 - $v(\pi)$ is *concave* if elasticity $-pq'(p)/q(p)$ increases with price
 - unit demand [$q(p) \equiv 1$ if $p \leq 1$] corresponds to “risk neutrality”
- In symmetric market, distribution of profit has same mean but greater dispersion with discrimination
 - so consumers in aggregate are harmed by discrimination
 - (they are indifferent with unit demand)
- In asymmetric market, distribution of profit has lower mean with discrimination
 - so with unit demand consumers benefit from discrimination
 - under mild conditions [eg., $q(p)$ log-concave] with nested configuration consumers benefit from discrimination

- For simplicity assume unit demand [$q(p) \equiv 1$ if $p \leq 1$]
 - makes little difference to equilibrium strategies, but makes welfare analysis [too] easy
- We describe a few interesting equilibria:
 - independent reach
 - nested reach
 - “perverse” entry
- Then solve triopoly market

Independent reach

- Firm $i = 1, \dots, n$ is seen by *independent* fraction σ_i of consumers
 - Ireland 1993, McAfee 1994
- Suppose firm j uses CDF $F_j(p)$ for its price
 - firm i 's demand with price p is

$$\sigma_i \prod_{j \neq i} [1 - \sigma_j F_j(p)]$$

- if π_i is firm i 's profit, for a price in firm i 's support we require

$$p \times \sigma_i \prod_{j \neq i} [1 - \sigma_j F_j(p)] = \pi_i$$

- This system is easily solved:
 - each firm chooses price from an interval
 - all firms have the same minimum price p_0
 - so profit of firm i is $\sigma_i \times p_0$
 - maximum price is lower for smaller firms

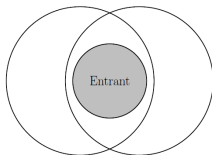
- Independent reach scenario is easy to analyze, despite asymmetry
 - explicit formulas for industry profit, total welfare and consumer surplus
 - e.g., if firm n is largest, consumer surplus in equilibrium is

$$1 - \left(1 + \sum_{i=1}^{n-1} \sigma_i\right) \prod_{i=1}^{n-1} (1 - \sigma_i)$$

- [akin to the “Herfindahl index” in Cournot oligopoly]
- Consider entry by a new firm, also with independent reach
 - expands total reach and so boosts total welfare
 - reduces minimum price p_0 and so impact on incumbents is negative
 - necessarily boosts consumer surplus

- Radical departure from independence is nested reach
 - a smaller firm's reach lies *inside* a larger firm's reach
 - only the largest firm has any captive customers
- Example: $n \geq 3$ sellers with nested reach, where seller $i = 1, \dots, n$ reaches i consumers
 - equilibrium takes the form of “overlapping duopoly”
 - threshold prices $p_1 < \dots < p_{n-1} < p_n = 1$ such that only firms 1 and 2 choose prices in $[p_1, p_2]$, only 2 and 3 choose prices in $[p_2, p_3]$, ..., only firms $n - 1$ and n choose prices in $[p_{n-1}, 1]$
 - $p_{i+1} = p_i + p_{i-1}$, so threshold prices proportional to Fibonacci sequence
 - profit of firm i is p_i
 - small firms only choose low prices, large firms only choose high prices

“Perverse” impact of entry into contested market



- Suppose a third firm enters a symmetric duopoly market, which is considered only by the contested consumers
 - a natural scenario with the “switching cost” interpretation
- The number of captives and total reach is unchanged
 - minimum price p_0 unchanged
 - total profit rises and consumers in aggregate are *harmed* by entry
 - captive consumers surely harmed, as entry induces incumbents to focus more on their captive consumers
 - but even the contested consumers can be harmed

- Independent and nested cases have firms in obvious “order”
 - firms with large reach also have high proportion of captive customers
- But, say, a “niche” firm might have limited reach and high proportion of captives
- General solution seems unavailable
- We have solved the model with triopoly
 - solution depends on the seven parameters in the Venn diagram
 - equilibria take just three forms

- Solution depends on the parameters:

$$t_i = \Pr\{\text{see at least } i\} \times \Pr\{\text{see at least } j \text{ and } k\}$$

- with independent reach $t_1 = t_2 = t_3 = \sigma_1\sigma_2\sigma_3$
- with nested reach largest firm has a larger t_i than others
- If t_i close together equilibrium looks like independent case:
 - “3 then 2”: all firms have same minimum price, then one firm drops out
- If t_i moderately different:
 - “3 then 2 then 2”: all firms have same minimum price, one firm prices in the whole range, one firm only prices low, and one firm has disconnected support and does not choose intermediate prices
- If t_i far apart:
 - “2 then 2”, or overlapping duopoly: one firm prices throughout whole range, one firm only prices low, and one firm only prices high

Concluding themes

- Competitive outcomes depend not only on the number and sizes of firms, but also on the *patterns* of their interactions with customers
- Effects of entry may be non-standard
- Natural forms of price discrimination induce “mean-preserving spread”
- “Risk averse” consumers are then harmed if firms are symmetric (but not in general)