Regulation and Competition with Captive Customers

John Vickers

Zeeman Lecture
RPI Annual Conference
Oxford, 24 September 2018
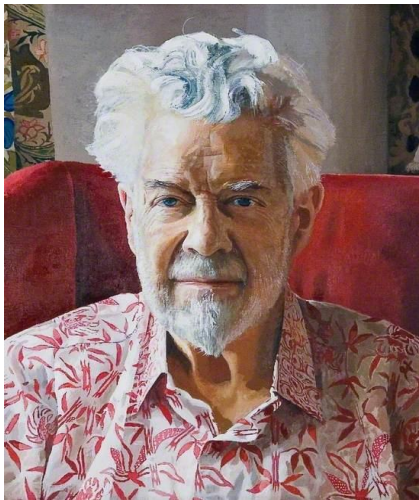
Privatization

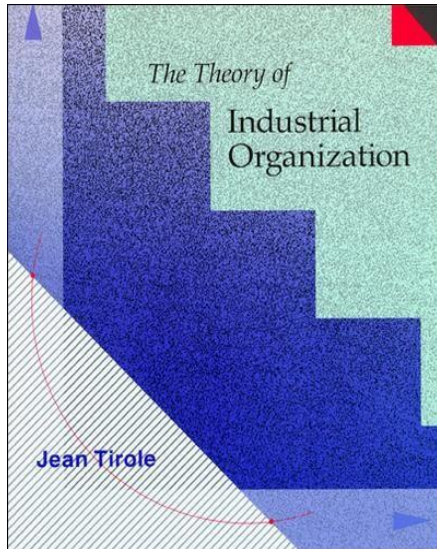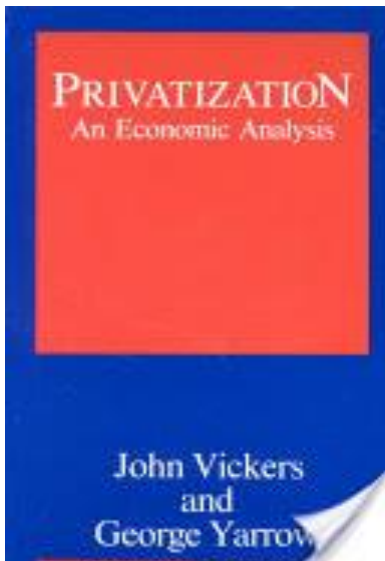Monopoly Regulation
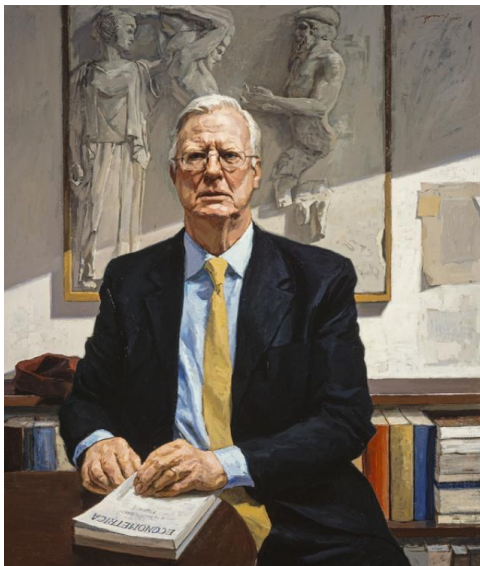
Competition Policy

Consumer Policy

Jim Mirrlees (1936-2018)

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"I followed the main principle for academic success: get a good co-author (and also the second: get another)"
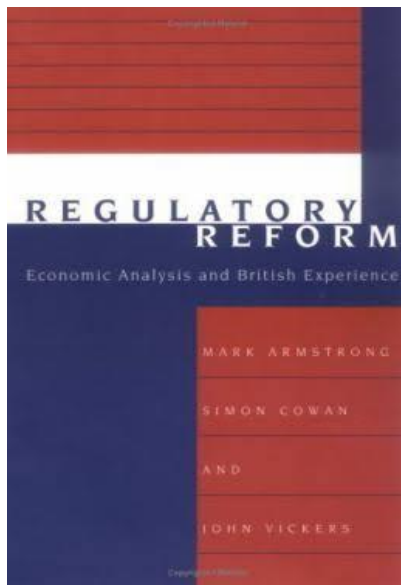
- Consumer protection and the incentive to become informed (with Jidong Zhou)
- Prominence and consumer search (ditto)
- Competitive nonlinear pricing and bundling
- A model of delegated project choice
- Consumer protection and contingent charges
- Which demand systems can be generated by discrete choice?
- Multiproduct pricing made simple

- Competition with captive customers

Competition With Captive Customers

Mark Armstrong & John Vickers

Summer 2018
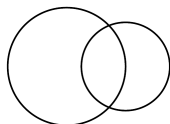
- "Captive" customers only consider a particular seller; others consider several sellers and choose cheapest one
- Interpretations:
  - consumers differ in awareness of sellers (Varian, Burdett & Judd, etc.)
  - horizontal differentiation, where only subset of consumers find a seller's product suitable
  - chain stores face local 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)

Pricing regimes

- Uniform pricing:
    - a seller must charge the same price to all its customers
    - Bertrand competition typically involves mixed strategies (inter-firm price dispersion)

- Price discrimination:
    - assumption is 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 default tariff
    - or chain store sets higher prices in markets with limited local competition
    - Bertrand competition then involves pure strategies (but with intra-firm price dispersion)
    - current policy issue is whether to ban this form of price discrimination in energy and related markets
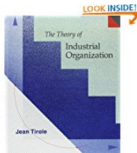
The Theory of Industrial Organization (MIT Press) (Hardcover)
by Jean Tirole

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Price discrimination by energy firms in UK

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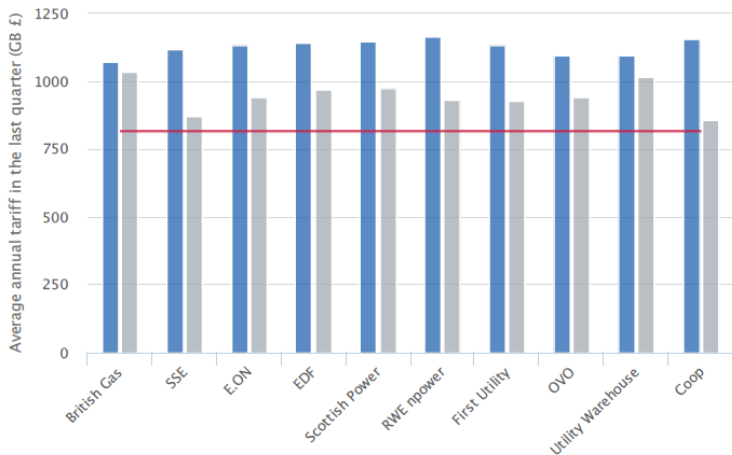
A framework

- n sellers with costless production
  - exogenous fraction of consumers consider the set $S \subset \{1, ..., n\}$ of sellers for their purchase
  - consumer buys from seller she considers with the lowest price and has demand function $q(p)$, same for all consumers
  - 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:
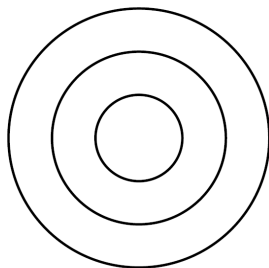
Talk addresses two issues

- Price discrimination in duopoly
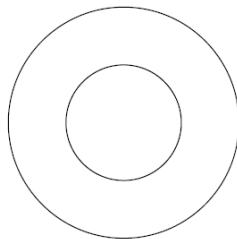- Uniform pricing with more than two sellers

The impact of price discrimination

- Consider a duopoly market
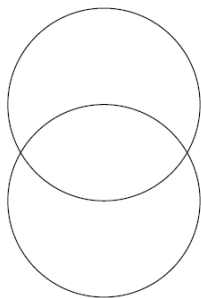
symmetric reach   nested reach

- 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

Uniform pricing with more sellers

- 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 $i = 1, ..., n$ 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 firms with smaller σ_i

Independent reach

- 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

Nested reach

- 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 $i = 1, ..., n$ reaches i consumers
  - equilibrium takes the form of "overlapping duopoly"
  - threshold prices $p_1 < ... < p_{n-1} < p_n = 1$ 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
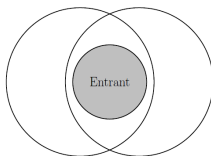
- Suppose a third firm enters a symmetric duopoly market, which is considered only by the contested consumers
  - a natural scenario if "savvy" consumers consider the entrant, and these are the consumers who already consider both incumbents
- The number of captives and total reach is unchanged
  - minimum 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

Triopoly

- 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 also a 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

Triopoly

- 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 other two

- 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 form of price discrimination induce "mean-preserving spread" in distribution of profit across consumers
- "Risk averse" consumers are then harmed if firms are symmetric (but not in general)