Industrial Organization

Nonlinear pricing and exclusion

Laurent Linnemer

CREST (LEI)

2014/15
Introduction

Dominant firm and exclusion

The Dominant Firm

Incumbent I

The Rival

Competitor E

The Buyer

A large retailer B
Introduction

Dominant firm and exclusion

The Dominant Firm moves first

Incumbent \( I \)

The Buyer moves first

A large retailer \( B \)

Nonlinear pricing:
- Rebates
- Market-share rebates

Uncertainty about

The Rival

Competition \( E \)

\[ BI \text{ pair} \]

\[ T(q_E, q_I) \text{ } T(q_I) \]
Introduction

Dominant firm and exclusion

The Dominant Firm
moves first

Incumbent I

The Rival
moves second

Competitor E

The Buyer
moves second

A large retailer B

Nonlinear pricing:
Rebates
Market-share rebates

BO
$T(q_E, q_I)$
$T(q_I)$
Comparing
Introduction

Dominant firm and exclusion

The Dominant Firm
moves first

Incumbent I

The Buyer
moves first and second

A large retailer B

Nonlinear pricing:
Rebates
Market-share rebates

The Rival
moves second
partial or total exclusion

Tries to match the rebates of I

Competitor E
Landmark antitrust cases

The Dominant Firm

British Airways

The Rival

Virgin

The Buyer

Travel Agents

European Case 1999: €6.8 millions
US Case 1999: not guilty
Landmark antitrust cases

European Case 2001: €19.76 millions
Landmark antitrust cases

The Dominant Firm

Tomra
Reverse Vending Machines

The Rival

Prokent

European Case 2006: €24 millions

The Buyer

Supermarkets ...
Landmark antitrust cases

European Case 2009: €1.06 billion

US Case 2009: settlement $1.25 billion
Theories of harm?

Predation?

- Hard to convince judges (and economists)
- Likely to be rare in practice

In this class: Static scenario of exclusion

- link the shape of price-quantity schedules to demand behavior and exclusionary strategy
- relate the nonlinearities to uncertainty about rival characteristics
Two types of models on exclusion

Naked exclusion (complete information)

- Rasmusen, Ramseyer, and Wiley (1991)
- Segal and Whinston (2000)
- DeGraba (2013)

Rent shifting (incomplete information)

- Aghion and Bolton (1987)
- Marx and Shaffer (1999) (complete info)
- Choné and Linnemer (2014a)
- Choné and Linnemer (2014b)
Citations for Aghion and Bolton (1987)
“Contracts as a barrier to entry” 1987-November 2014: 238 citations
Contracts as a barrier to entry
Aghion and Bolton (1987)

Three players: one buyer, two sellers

- Buyer: needs 1 unit, valued at 1
- Dominant firm: cost $0 < c_I < 1$
- Entrant: cost $c_E \in [0, 1]$ distribution $F(.)$, $f(.)$.

Welfare

- $1 - c_I$ if $I$ is the seller
- $1 - c_E$ if $E$ is the seller

Timing

- $B$ and $I$ sign a contract (commitment) before $c_E$ is known
- $B$ and $E$ learn $c_E$ and bargain
Contracts as a barrier to entry
Aghion and Bolton (1987)

The dominant firm makes a take it or leave it offer

\[ T = \begin{cases} 
  P & \text{if } q_I = 1 \\
  P_0 & \text{if } q_I = 0 
\end{cases} \]

- \( P \) regular price
- \( P_0 \) stipulated damage for breach of contract
Aghion and Bolton (1987)
Equilibrium

Choice of $B$ and $E$ for given $P$, $P_0$, and $c_E$

- Surplus for $B - E$ if $B$ buys from $E$: $1 - c_E - P_0$
- Surplus for $B - E$ if $B$ buys from $I$: $1 - P$
- $B$ buys from $E$ iff $1 - c_E - P_0 > 1 - P$
- $B$ buys from $E$ iff $P - P_0 > c_E$
- If $E$ has all the bargaining power: $P_E = P - P_0$

By choosing $\Delta = P - P_0$ the pair $B - I$ controls entry
Choice of $\Delta$ to maximize $B - I$ profits?
Aghion and Bolton (1987)

Equilibrium

Choice of $\Delta$ to maximize $B - I$ profits

$$F(\Delta)(1 - \Delta) + (1 - F(\Delta))(1 - c_i)$$

f.o.c. is:

$$c_i - \Delta = F(\Delta)/f(\Delta)$$

Assumptions

- $F/f$ is ↗
- $F(0)/f(0) = 0$

A unique solution denoted $\Delta^*$

- Main property: $0 < \Delta^* < c_i$ inefficient exclusion
- Example: $c_E$ uniformly distributed over $[0, 1]$
- Then $\Delta^* = c_i/2$
Aghion and Bolton (1987)
Split of the profit between $I$ and $B$

Individual profits

- $\Pi_I = F(\Delta)P_0 + (1 - F(\Delta))(P - c_I) = P - c_I - F(\Delta)(\Delta - c_I)$
- $\Pi_B = F(\Delta)(1 - \Delta - P_0) + (1 - F(\Delta))(1 - P) = 1 - P$
- constraint: $\Delta = \Delta^*$

$P$ is used to split the profit between $B$ and $I$
and $P_0$ is such that $P - P_0 = \Delta^*$
Discussion

In Aghion and Bolton the focus is on the stipulated damages but

\[
T = \begin{cases} 
  P & \text{if } q_I = 1 \text{ (and } q_E = 0) \\
  P_0 & \text{if } q_I = 0 \text{ (and } q_E = 1) 
\end{cases}
\]

equivalent to

\[
T = P_0 + (P - P_0)q_I
\]

Three interpretations

- stipulated damages
- two-part tariff (with price below marginal cost)
- exclusivity offer

Also not clear if the price schedule is of the form

\[
T(q_I) \text{ or } T(q_E, q_I)
\]
Nonlinear pricing and exclusion
Choné and Linnemer (2014a)

A general model

- Same timing and uncertainty as Aghion Bolton
- Continuous quantity choice
- Differentiated goods
- Disposal costs

Three types of price schedule

- Conditional: \( T(q_E, q_I) \)
- Non conditional: \( T(q_I) \)
- Exclusivity: \( (T(q_I) \text{ and } T^x(q_I)) \)
Nonlinear pricing and exclusion

The model

Utility of $B$: $V(q_E, q_I) =$

$$\max_{x_E \leq q_E, x_I \leq q_I} v_E x_E + v_I x_I - h(x_E, x_I) - \gamma(q_E - x_E) - \gamma(q_I - x_I).$$

where $h$ is a convex function, $\partial h/\partial x_E(0, 0) = \partial h/\partial x_I(0, 0) = 0$

$\partial^2 h/\partial x_E \partial x_I > 0$; exple: $h(x_E, x_I) = x_E^2/2 + x_I^2/2 + \sigma x_E x_I$, $0 \leq \sigma < 1$

Total Welfare when $x = q$ (no disposal)

$W(q_E, q_I) = V(q_E, q_I; v_E) - c_E q_E - c_I q_I$

Key parameters:

- Surplus: $\omega_E = v_E - c_E$ and $\omega_I = v_I - c_I$
- Conditionally efficient quantities: $q_E^*(q_I; \omega_E)$ and $q_I^*(q_E; \omega_I)$
Preferences of the Buyer

\[ q_I = v_I + \gamma - \sigma q_E \]

No disposal

Some units of good I are disposed of

Some units of each good are disposed of

Some units of good E are disposed of

\[ q^*_I(q_E; \omega_I) \]

\[ q^*_E(q_I; \omega_E) \]

\[ W = \text{cst} \]

\[ q^*_I \]

\[ q^*_E \]

\[ q_E = v_E + \gamma - \sigma q_I \]
Last stages (complete information)

Choices of $q_I$ and $q_E$ by B and E

Given $T = T(q_E, q_I)$ or $T(q_I)$

$$S_{BE} = \max_{q_E, q_I} V(q_E, q_I) - T - c_E q_E,$$

Key observations:

- If $T = T(q_I)$, then $q_E = q_E^*(q_I; \omega_E)$
- If $T = T(q_E, q_I) = P(q_E) + c_I q_I$, then $q_I = q_I^*(q_E; \omega_I)$
Last stages (complete information)

Split of the surplus between B and E

Outside options
0 and $U_B^0 = \max_{q_I \geq 0} V(0, q_I) - T(0, q_I)$

Surplus
$\Delta S_{BE} = S_{BE} - U_B^0$

Split
$\Pi_E = \beta \Delta S_{BE}$
$\Pi_B = (1 - \beta) \Delta S_{BE} + U_B^0$
Negotiation between B and I
At this stage: incomplete information

\[ B \text{ and } I \text{ max their joint expected profit} \]
\[ \mathbb{E}_{c_E, v_E} \Pi_{BI} = \mathbb{E}_{c_E, v_E} \left\{ W(q_E, q_I; c_E, v_E) - \Pi_E \right\} \]

Two inefficiencies

1. Ex post inefficiency
\[ q_I \neq q_I^*(q_E; \theta_E) \]

2. Inefficient foreclosure
- Complete when \( q_E = 0 < q_E^* \)
- Partial when \( 0 < q_E < q_E^* \)
Buyer Opportunism
Take the rebates and run!

Why would the Buyer pay more for less units?
Buyer Opportunism

Pricing should take disposal costs into account
Buyer Opportunism
Optimality result

Proposition
At the second-best optimum, the buyer consumes all units (of both goods) she has purchased.

- Good E: BI have nothing to gain from pushing B to purchase too much
- Good I: A matter of credibility $\Rightarrow \partial T / \partial q_I \geq -\gamma$
Conditional price-quantity schedule $T(q_E, q_I)$

Rewriting the program of $B$ and $I$ who can control both $q_E$ and $q_I$

Notations

- $F$ distribution of $\omega_E$ on $[\omega_E, \bar{\omega}_E]$
- $f$ continuous density function
- The hazard rate $f/(1 - F)$ is $\nearrow$ in $\omega_E$.

Surplus created by $B$ and $E$

$$\Delta S_{BE}(\omega_E) = \max_{q_E, q_I \geq 0} \omega_E q_E + v_I q_I - h(q_E, q_I) - T(q_E, q_I) - U_B^0$$

$$\Rightarrow \frac{\partial \Delta S_{BE}}{\partial \omega_E} = q_E(\omega_E) \text{ then using } \Pi_E = \beta \Delta S_{BE} \Rightarrow$$

$$\int_{\omega_E}^{\bar{\omega}_E} \Pi_E(\omega_E) f(\omega_E) d\omega_E = \Pi_E(\omega_E) + \beta \int_{\omega_E}^{\bar{\omega}_E} q_E(\omega_E)[1 - F(\omega_E)] d\omega_E$$
Conditional price-quantity schedule $T(q_E, q_I)$

Rewriting the program of $B$ and $I$ who can control both $q_E$ and $q_I$

Virtual surplus

$\mathbb{E}_{\omega_E} \Pi_{BI} = \mathbb{E}_{\omega_E} S^\gamma(q_E, q_I; \omega) - \Pi_E(\omega_E)$ with

$$S^\gamma(q_E, q_I; \omega) = \omega_E q_E + \omega_I q_I - h(q_E, q_I) - \beta q_E \frac{1 - F(\omega_E)}{f(\omega_E)}$$

Pointwise Maximization of $S^\gamma(q_E, q_I; \omega_E)$

- $\omega_E - \frac{\partial h}{\partial q_E}(q_E^c, q_I^c) \leq \beta \frac{1 - F(\omega_E)}{f(\omega_E)}$
- $\frac{\partial h}{\partial q_I}(q_E^c, q_I^c) = \omega_I$
- $\Rightarrow q_I$ is conditionally efficient, $q_I = q_I^*(q_E)$
Some units of good I are disposed of

Some units of each good are disposed of

Some units of good E are disposed of

\[ q_I = v_I + \gamma - \sigma q_E \]

\[ q_E = v_E + \gamma - \sigma q_I \]
Conditional schedule \( T(q_E, q_I) \)

Proposition

1. *B and I agree on* \( T = P(q_E) + c_I q_I \) *with* \( P'' < 0 \) *and*

\[
P'(q_E) = \beta (1 - F(\omega_E))/f(\omega_E)
\]

2. \( \forall \omega_E, q^c_E \leq q^{**}_E \). *The quantity purchased from the incumbent firm,* \( q^c_I = q^*_I(q^c_E; \omega_E) \), *is efficient given* \( q^c_E \) *and distorted upwards relative to* \( q^{**}_I \).

3. *The magnitude of the disposal costs,* \( \gamma \), *does not affect the buyer's supply policy or the price quantity schedule* \( T(q_E, q_I) \).

Remark: No market share rebates (suboptimal)
Unconditional price-quantity schedule $T(q_I)$

Rewriting the program of $B$ and $I$

The key: $q_E$ is conditionally efficient

- $B$ and $I$ can control $q_E$ only through $q_I$
- $\Rightarrow q_E = q_E^*(q_I; \omega_E)$

Surplus created by $B$ and $E$

$$\Delta S_{BE}(\omega_E) = \max_{q_I \geq 0} \omega_E q_E^*(q_I; \omega_E) + v_I q_I - h(q_E^*(q_I; \omega_E), q_I) - T(q_I) - U_B^0$$

$$\Rightarrow \frac{\partial \Delta S_{BE}}{\partial \omega_E} = q_E^*(q_I; \omega_E)$$

then using $\Pi_E = \beta \Delta S_{BE} \Rightarrow$

$$\int_{\omega_E} \Pi_E(\omega_E)f(\omega_E) d\omega_E =$$

$$\Pi_E(\omega_E) + \beta \int_{\omega_E} q_E^*(q_I; \omega_E)[1 - F(\omega_E)] d\omega_E$$
Unconditional schedule $T(q_I)$

Rewriting the program of $B$ and $I$

Virtual surplus

$$\tilde{S}^v(q_I; \omega_E) = S^v(q^*_E(q_I; \omega_E), q_I; \omega_E) =$$

$$\omega_E q^*_E(q_I; \omega_E) + \omega_I q_I - h(q^*_E(q_I; \omega_E), q_I) - \beta q^*_E(q_I; \omega_E) \frac{1-F(\omega_E)}{f(\omega_E)}$$

Pointwise Maximization of $S^v(q^*_E(q_I; \omega_E), q_I; \omega_E)$

Technical requirements for equilibria à la Martimort-Stole 2009

- Assumption: quasi-concavity of $\tilde{S}^v(q_I; \omega_E)$ in $q_I$
- Assumption: $\partial^2 S^v / \partial q_I \partial \omega_E < 0$
Unconditional schedule $T(q_I)$

Proposition

- $q^u_E = q^*_{E}(q^u_I; \omega_E) \leq q^{**}_E$ and $q^u_I \geq q^{**}_I$
- When $\gamma$ is large, the possibility of buyer opportunism does not constrain pricing policy and $(q^u_E, q^u_I)$ such that
  - $\omega_I - \frac{\partial h}{\partial q_I}(q^u_E, q^u_I) = \beta \frac{1-F(\omega_E)}{f(\omega_E)} \frac{\partial q^*_E}{\partial q_I}$
  - $-\gamma < T' \leq c_I$
- When $\gamma$ is small, $T' = -\gamma$
- $(q^u_E, q^u_I)$ is efficient if goods are independent (or $\beta = 0$)
- $(q^u_E, q^u_I) \rightarrow$ the efficient allocation as $\gamma \rightarrow -c_I$
Unconditional schedule $T(q_I)$

Proposition

- $T(q_I)$ concave if $q_E^*$ not too convex in $q_I$ (true in the quadratic case)
- $T'(q_I^u(\omega_E)) = \max \left( c_I + \frac{1-F(\omega_E)}{f(\omega_E)} \frac{\partial q_E^*}{\partial q_I}, -\gamma \right) < c_I$
Comparing $T(q_E, q_I)$, $T(q_I)$, and $(T, T^x)$

Equilibrium quantities of good $E$ under each type of price schedule
Comparing $T(q_E, q_I)$, $T(q_I)$, and $(T, T^x)$

Equilibrium quantities of good $I$ under each type of price schedule
Comparing $T(q_E, q_I), T(q_I)$, and $(T, T^x)$

Buyer opportunism in regimes $u$ and $x$: $q_I$ is above $q_i^*(q_E; \omega_I)$
Comparing $T(q_E, q_I)$, $T(q_I)$, and $(T, T^x)$

Price-quantity schedules in the three regimes
Comparing \( T(q_E, q_I), T(q_I), \) and \( (T, T^x) \)

Welfare at the first-best and second-best allocations