Vertical Foreclosure with Multiple Integrated Firms

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Introduction: Market Structure

**Question:** Will firm $d$ receive an upstream offer, or will it be completely foreclosed?
Introduction: Industry examples

- **Mobile telephony industry**: Mobile Network Operators (MNOs) vs. Mobile Virtual Network Operators (MVNOs). In some countries MNOs provide access to MVNOs (Denmark, England, Sweden); in others they don’t (Italy, Hungary, Poland, Spain).

- **Broadband industry**: facility-based firms (e.g., Orange, Neuf-Cegetel) vs. service-based firms (e.g., Darty). A wholesale broadband market has emerged in some countries (France, UK); in others, it has not (Germany).

- **Market for Polyethylene**: (see Arora, Fosfuri and Gambardella (2004)) Integrated firms Dow Chemicals and Exxon have their own metallocene technology. They use it to produce polyethylene. They also license it to unintegrated downstream firms (e.g., BASF, Fina).

- **3D video game engines**: Epic Games and Valve Corporation have developed their own 3D engines. They use it to produce their own games (e.g., Gears of War, Team Fortress II) . . .

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Introduction

Incentives of a vertically integrated structure to supply an essential input to a downstream competitor?

If integrated firm is an upstream monopolist:

- Decision to supply trades off *upstream profits* vs. *cannibalization*.
- Complete foreclosure (total squeeze) if downstream products perfect substitutes, and the entrant is less efficient than the incumbent.
- Partial foreclosure (input price > marginal cost) if downstream products differentiated, and the entrant is sufficiently efficient.

What if there are several vertically integrated firms?
Introduction: Our contribution

Write a general model to disentangle the different effects (not done in the literature).

- Upstream profit effect
- Cannibalization effect
- Reaction effect (other integrated firms react to entry)
- Softening effect (upstream supplier becomes a fat cat)

Stress the role of downstream strategic interactions → Price vs. quantity competition, strategic complementarity vs. substitutability.

Under (downstream) Cournot competition: General conditions under which complete foreclosure does not arise.

Under (downstream) Price competition: No general results.

- We propose a consistent linear demand system to deal with complete foreclosure and cannibalization effects.
- Comparative statics → Determinants of complete foreclosure.
- Surprisingly, more input differentiation leads to less complete foreclosure
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Introduction: Literature

**One-way access pricing:**

**Vertical foreclosure:**
→ At most one vertically integrated firm in their frameworks.

**Papers w/ several integrated firms:**
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Papers w/ several integrated firms:
General framework

Two (identical) vertically integrated firms 1 and 2:
- Produce an input at constant marginal cost $c_u$.
- 1 unit of input → 1 unit of final product.
  Inputs may or may not be differentiated.

One potential downstream entrant 3:
- Must purchase the input from either integrated firm.

Timing:
1. Integrated firms make upstream (linear) offers $a_1$ and $a_2$.
   The entrant can accept at most one offer.
2. Downstream competition with differentiated products.

Is there a subgame-perfect equilibrium in which neither integrated firm supplies the input?
We do not try to characterize all equilibria (see Bourreau, Hombert, Pouyet and Schutz, 2008).
General framework

- Start from duopoly between integrated firms 1 and 2. Incentives of, say, firm 1 to supply the input to the entrant at (linear) price $a$?
- Downstream competition in price $\rightarrow q_i(p_1, p_2, p_3)$ . . .
- . . . or in quantity $\rightarrow p_i(q_1, q_2, q_3)$
- Profits ($q_3 =$ or $> 0$):

\[
\begin{align*}
\pi_1 &= (p_1 - c_u - c)q_1 + (a - c)q_3 \\
\pi_2 &= (p_2 - c_u - c)q_2 \\
\pi_3 &= (p_3 - a - c_3)q_3
\end{align*}
\]
Quantity competition

- If entrant squeezed, downstream equilibrium conditions:

\[
\frac{\partial \pi_1}{\partial q_1} = (p_1 - c_u - c) + \frac{\partial p_1}{\partial q_1} q_1 = 0 \\
\frac{\partial \pi_2}{\partial q_2} = (p_2 - c_u - c) + \frac{\partial p_2}{\partial q_2} q_2 = 0 \\
q_3 = 0
\]

- If entrant supplied, downstream equilibrium conditions:

\[
\frac{\partial \pi_1}{\partial q_1} = (p_1 - c_u - c) + \frac{\partial p_1}{\partial q_1} q_1 = 0 \\
\frac{\partial \pi_2}{\partial q_2} = (p_2 - c_u - c) + \frac{\partial p_2}{\partial q_2} q_2 = 0 \\
\frac{\partial \pi_3}{\partial q_3} = (p_3 - a - c_3) + \frac{\partial p_3}{\partial q_3} q_3 = 0
\]
Effects on firm 1’s profit:

1. **Upstream profit effect** – Firm 1 gets upstream profits. $\pi_1 \uparrow$
2. **Cannibalization effect** – Firm 3 cannibalizes firm 1’s demand. $\pi_1 \downarrow$
   - Includes strategic effect.
3. **Reaction effect** – Firm 2 reacts to the entry of firm 3. $\pi_1 \uparrow (\downarrow)$ if strategic substitutability (complementarity)
   - Not present when only 1 integrated firm.
   - The no-complete-foreclosure result may not hold.
Quantity competition

**Proposition.** If (i) downstream competition is in quantity, (ii) quantities are strategic substitutes and (iii) the entrant is not too inefficient, then the entrant is supplied on the upstream market.

Proof:
Denote $q_i(a)$ the equilibrium quantities when the upstream price is $a$. Let $q^D_1$ the equilibrium quantities under duopoly. Let $\bar{a}$, s.t. $q_3(a) = 0$ iff $a \geq \bar{a}$. By Assumption (iii), $\bar{a} \geq p_1(q^D_1, q^D_2, 0) - c$.

\[
\left. \frac{d\pi_1}{da} \right|_{a=\bar{a}} = q_3 + q_1 \frac{\partial p_1}{\partial q_2} \frac{dq_2}{da} + \left( \frac{\partial p_1}{\partial q_3} q_1 + a - c_u \right) \frac{dq_3}{da} < q_1 \frac{\partial p_1}{\partial q_2} \frac{dq_2}{da} + \left( \frac{\partial p_1}{\partial q_3} q_1 + a - c_u \right) \frac{dq_3}{da} < q_1 \frac{\partial p_1}{\partial q_2} \frac{dq_2}{da} + (a - (p_1 - c)) \frac{dq_3}{da} < 0.
\]
Price competition

- If entrant squeezed, downstream equilibrium conditions:
  \[
  \frac{\partial \pi_1}{\partial p_1} = q_1 + (p_1 - c_u - c) \frac{\partial q_1}{\partial p_1} = 0 \\
  \frac{\partial \pi_2}{\partial p_2} = q_2 + (p_2 - c_u - c) \frac{\partial q_2}{\partial p_2} = 0 \\
  p_3 = +\infty
  \]

- If entrant supplied, downstream equilibrium conditions:
  \[
  \frac{\partial \pi_1}{\partial p_1} = q_1 + (p_1 - c_u - c) \frac{\partial q_1}{\partial p_1} + (a - c) \frac{\partial q_3}{\partial p_1} = 0 \\
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3. **Reaction effect** – Firm 2 reacts to the entry of firm 3. $\pi_1 \downarrow (\uparrow)$ if strategic complementarity (substitutability)
   - Specific to the multiple integrated firms case.
4. **Softening effect** – Firm 1 is less aggressive on the downstream market to preserve its upstream profit, which triggers a reaction of firm 2 (fat cat effect). $\pi_1 \uparrow (\downarrow)$ if strategic complementarity (substitutability)
   - Specific to the multiple integrated firms case with downstream price competition.
Input differentiation and entrant’s efficiency

**Input differentiation**: if inputs are differentiated, the retailer cannibalizes more its supplier’s product.

Using specific demands functions, Ordover and Shaffer (2007) predict that more input differentiation leads to more complete foreclosure. Yet, more input differentiation

- Strengthens the cannibalization effect ⇒ Foreclosure more likely
- Reduces the reaction effect ⇒ Foreclosure less likely if strategic complementarity
- Strengthens the softening effect ⇒ Foreclosure less likely if strategic complementarity

⇒ Overall effect is actually ambiguous.

Besides, Ordover and Shaffer (2008)’s demand specification is problematic (more on this later).

Impact of entrant’s efficiency is also ambiguous.
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Linear specification

What's wrong with Ordover and Shaffer (2008)?

Downstream demand functions:

- Duopoly: \( q_{i\, \text{duo}}(p_1, p_2) = \frac{1}{2} [1 - p_i - \gamma (p_i - \sum_{j=1}^{2} \frac{1}{2} p_j)] \)
- Triopoly with firm 1 upstream supplier:
  \( q_{i\, \text{trio}}(p_1, p_2, p_3) = s_i [1 - p_i - \gamma (p_i - \sum_{j=1}^{3} s_j p_j)] \)

\( s_i \) firm \( i \)'s "baseline share": \( \sum_{i=1}^{3} s_i = 1 \). Take \( s_3 \) as given:

- "Proportional cannibalization": \( s_1 = \frac{1}{2} (1 - s_3) \) \( s_2 = \frac{1}{2} (1 - s_3) \)
- "Disproportional cannibalization" of own-supplier: \( s_1 = \frac{1}{2} - s_3 \) \( s_2 = \frac{1}{2} \)

Main result: Foreclosure of entrant if and only if disproportional cannibalization.

Problem:

- Start from a duopoly with \( p_1 = p_2 = p \) and assume that firm 3 enters with \( p_3 > p \).

  \( \Rightarrow \) Market size decreases:
  \( \sum_{i=1}^{3} q_{i\, \text{trio}}(p, p, p_3) = 1 - ((s_1 + s_2)p + s_3 p_3) < 1 - p = \sum_{i=1}^{2} q_{i\, \text{duo}}(p, p) \)

- Demand is "increasing"!
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  $\Rightarrow$ Market size decreases:
  
  $\sum_{i=1}^{3} q_{i, \text{trio}}(p, p, p_3) = 1 - ((s_1 + s_2)p + s_3p_3) < 1 - p = \sum_{i=1}^{2} q_{i, \text{duo}}(p, p)$

- Demand is “increasing”!
We look for linear demand systems $q_{i}^{\text{duo}}(p_1, p_2)$ and $q_{i}^{\text{trio}}(p_1, p_2, p_3)$ that satisfy:

1. Demands are derived from a representative consumer with quadratic utility $U(q_1, q_2, q_3)$.
2. Integrated firms are symmetric in duopoly: $q_{1}^{\text{duo}}(p_1, p_2) = q_{2}^{\text{duo}}(p_2, p_1)$.
3. Duopoly is the limit case of triopoly: $q_{3}^{\text{trio}}(p_1, p_2, p_3) = 0 \Rightarrow q_{i}^{\text{trio}}(p_1, p_2, p_3) = q_{i}^{\text{duo}}(p_1, p_2), i = 1, 2$. 
Proposition. Such demand systems are of the form (up to a normalization):

\[
q_{1}^{\text{trio}}(p_1, p_2, p_3) = 1 - p_1 + \sigma p_2 - \frac{\beta_1}{\beta_3} q_3^{\text{trio}}(p_1, p_2, p_3)
\]

\[
q_{2}^{\text{trio}}(p_1, p_2, p_3) = 1 - p_2 + \sigma p_1 - \frac{\beta_2}{\beta_3} q_3^{\text{trio}}(p_1, p_2, p_3)
\]

\[
q_{3}^{\text{trio}}(p_1, p_2, p_3) = \max\{K - \beta_3 p_3 + \beta_1 p_1 + \beta_2 p_2, 0\}
\]

Proportional cannibalization (or homogenous inputs): $\beta_1 = \beta_2$.
Disproportional own-supplier cannibalization (or differentiated inputs): $\beta_1 > \beta_2$. 
Linear specification

Benchmark for comparative statics:
Cost parameters:
- All firms have the same downstream marginal cost: \( c = c_3 \)

Demand parameters:
- \( \sigma, \beta_1, \beta_2 \) and \( \beta_3 \) such that \( \partial q^\text{trio}_1 / \partial p_1 = \partial q^\text{trio}_2 / \partial p_2 = \partial q^\text{trio}_3 / \partial p_3 \) and \( \partial q^\text{trio}_1 / \partial p_2 = \partial q^\text{trio}_1 / \partial p_3 = \partial q^\text{trio}_2 / \partial p_3 \).
- \( K \) such that firm 1 is indifferent between supplying firm 3 or not (unique).
Linear specification

Look whether a small variation of parameters creates foreclosure:

- There exists a threshold $\bar{\sigma}$ such that:
  - More input differentiation ($\Delta \beta_1 = -\Delta \beta_2 > 0$) prevents complete foreclosure if $\sigma > \bar{\sigma}$.
  - More input differentiation ($\Delta \beta_1 = -\Delta \beta_2 > 0$) generates complete foreclosure if $\sigma < \bar{\sigma}$.

- More efficient entrant ($\Delta c_3 < 0$) $\Rightarrow$ No foreclosure
- Tighter downstream competition ($\Delta \sigma > 0$) $\Rightarrow$ Foreclosure
  - Tension upstream vs. downstream competitiveness
Conclusion

We have developed a model to analyze the incentives for complete foreclosure. The decision to supply trades off four (three) effects:

- Upstream profit effect
- Cannibalization effect
- Reaction effect
- Softening effect (only w/ price competition)

Under Cournot competition + strategic substitutability, no foreclosure. Under price competition, no general results. → we have derived a consistent demand system to compute comparative statics. Surprisingly, more input differentiation could lead to less complete foreclosure.