Oligopolistic Competition, Technology Innovation, and Multiproduct Firms

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Backgrounds

- Market structure in many industries is:
  - Oligopolistic competition
  - With multi-product firms

- Oligopolistic automobile market
  - GM, Ford, and Crysler

- Ready-to-eat breakfast cereal
  - Kellogg, General Mills, General Foods, and Quaker Oats
Limited theoretical backgrounds

• Two major contributions:
  – Endogenous product proliferation decision
  – Endogenous entry decision

• Existing literatures have some limitations:
  – Brander and Eaton (1984), exogenous product line size and the number of firms
  – Raubitscheck (1987), independent brand manager
  – Champsaur and Rochet (1989), analysis on a continuum
  – Anderson and de Palma (1992), shown only the existence of a Nash equilibrium
  – Baye et al. (1996), quantity competition
Major assumptions and concerns

• The compound constant elasticity of substitution (CES) model
  – Under the CES model, all existing products compete with one another and are equally good substitutes for one another.
  – Compound allows the firm-level heterogeneity.

• Endogenous product proliferation and firm entry decisions

• Firm products are identical, while the elasticity of inter-firm substitution may differ.

• In a symmetric equilibrium, it analyzes:
  – Product price
  – Number of products
  – Impact of the elasticity of substitution (across a firm’s own products and across different firms)
  – Product quality decision
Model (demand side)

- Consumer utility maximization

\[
\max_{x_{ij}} V(x_1, \ldots, x_N) = \left( \sum_{i=1}^{m} \left( \sum_{j=1}^{n_i} x_{ij}^\rho \right) ^{\frac{1}{\rho}} \right)^{\frac{1}{1-\alpha}}
\]

s.t. \( \sum_{i=1}^{m} \sum_{j=1}^{n_i} p_{ij} x_{ij} \leq Y. \)

\( m \), number of firms; \( n_i \), number of firm \( i \)'s products; \( x_{ij} \) and \( p_{ij} \), consumption and price of firm \( i \)'s product \( j \); \( \alpha \) and \( \rho \), are the substitution parameters; \( Y \), consumer budget.

- where price index is \( q_i = \left[ \sum_{j=1}^{n_i} p_{ij}^{1-\delta} \right]^{\frac{1}{1-\delta}} \) and \( q = \left[ \sum_{i=1}^{m} q_i^{1-\theta} \right]^{\frac{1}{1-\theta}} \).

- The demand function is:

\[
x_{ij} = \frac{\frac{1}{p_{ij}^{\delta} q_{i}^{1-\delta} q_{i}^{\theta} q^{1-\theta}} Y}{q_{i}^{\theta} q^{1-\theta}} \quad \text{(when } n_i = 1 \text{ and } m = 1, \ x_{ij} = \frac{Y}{p_{ij}}) \]

Model (supply side and game)

- Payoff function

\[ \pi_i = \sum_{k=1}^{n_i} (x_{ik}(p_{ik} - c) - f) \]

- Game
  - Players: competing \( m \) firms
  - Strategies: price \( p_i \) and proliferation level \( n_i \)
  - Payoffs: net profit \( \pi_i \)

  - Two stage game, proliferation level-first and price second
Major findings (2nd stage, price decision)

• **Proposition 1.** *In a symmetric equilibrium, an increase in the level of a firm’s proliferation raises the firm’s own prices and reduces other firms’ prices.*
  – Or:

\[
\frac{\partial p_i}{\partial n_i} > 0 \quad \text{and} \quad \frac{\partial p_j}{\partial n_i} < 0
\]

• Interpretation
  – The increase of the **proliferation level** raises the **market power**.
  – The increase of the **market power** elevates the **product price**.

  – The increase of the **product price** increases the **markup**.
  – The increase of the **markup** decreases the **competitor’s product price**.
Major findings (1\textsuperscript{st} stage, proliferation decision)

- Proposition 2. *The number of products produced by each firm increases as the marginal proliferation cost \( f \) decreases.* (…)
  - In a sense that:
    
    \[
    n = \frac{1}{f} \left[ \frac{Y}{(m - 1)\theta + 1} - k \right]
    \]

- Interpretation
  - Intuitive in a sense that the higher cost burdens firms.

- However, unknown influence of the proliferation cost increase on the product price.
  - As assumed symmetric firms, \( n_i = n \) and \( p_i = p \).
Other findings

• **Proposition 3.** (elasticity of substitution)
  - *The more the substitution is elastic across a firm’s own products, the smaller* $n_i$ *and the larger* $m$.
  - *The more the substitution is elastic across the different firms, the larger* $n_i$ *and the smaller* $m$.

• **Proposition 4.** (quality improvement, single product with multiple characteristics)
  - $x(i)$ denotes the product of firm $i$
  - $x(ij)$ denotes the $j$-th characteristic
  - The simplification $x(ij) = x$ provides $n(i)$ to denote the quality level
Conclusions

• Studied a competition of the symmetric multiproduct firms
  – Used the compound CES model
  – Symmetric implies each product in the market and the firms’
    strategies are identical

• Addressed that
  – An increase in the level of a firm’s proliferation raises the firm’s own
    prices and reduces other firms’ prices.
  – The number of products produced by each firm increases as the
    marginal proliferation cost $f$ decreases.