Product Differentiation, Store Differentiation, and Assortment Depth
1. Introduction

**Purpose** - How the equilibrium depth of the product assortment is determined across categories that vary in the degree of differentiation and across retail environments that vary in the degree of store differentiation.

Product Differentiation

Store Differentiation

Assortment
1. Introduction

Product Differentiation

Distinguish a product to make it more attractive to a particular target market

Differentiate from competitors’ products

Three types of product differentiation

1. Simple
2. Horizontal
3. Vertical
1. Introduction

Store Differentiation

Distinguish a store to make it more attractive
Differentiate from competitors’ stores
Differentiated by

Product price
Proximity to consumer
The number of products
Store interior, etc
1. Introduction

Assortment

Width - Number of different lines offered

Depth - Number of items in line

Product line

A group of closely related products

Product item

Identified by a different brand name, number, price, size, color, or one of many other attribute
1. Introduction

Assortment

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<thead>
<tr>
<th>Perfumed Soap</th>
<th>Shampoo</th>
<th>Hand Cream</th>
<th>Toothpaste</th>
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<tr>
<td>Toccara</td>
<td>New Vitality</td>
<td>Rich Moisture</td>
<td>Twice Bright</td>
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<td>Naturally Gentle</td>
<td>Vita-Moist</td>
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<td>Foxfire</td>
<td>Keep Clear</td>
<td>Care Deeply</td>
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<td>Candid</td>
<td>Clean &amp; Lively</td>
<td>Fresh Takes</td>
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<td>Body Bonus</td>
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<td>Roses, Roses</td>
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<td>Wild Jasmine</td>
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</table>
2. Assortment depth and category sales

Degree of differentiation
   Positive relationship in highly differentiation
   Negative relationship in less differentiation

Retail margin
   More differentiated, wider retail margins
   Category sales rise with assortment depth
2. Assortment depth and category sales

Cannibalization

New variants cannibalize a portion of their sales from existing variants

More costly when retail margins are wider

More differentiated, larger impact on category demand

Profit per variant falls with assortment depth

This effects dominates, retailers increase product differentiation by reducing assortment depth
3. Assortment depth and Product differentiation

Inverted U-shaped pattern

Survival rate of category demand

Reduction in profit per variants

\[
\frac{\partial \pi(p,v)}{\partial u} = (1 - e_v)(p - c)x(p,v) - F = 0 \quad \ldots \quad (1)
\]

As profit per variant declines, introducing new variants ceases to be worthwhile
3. Assortment depth and Product differentiation

Dashed line: survival rate
Solid line: profit per variant
4. Assortment depth and Store differentiation

A model of store differentiation

N retailers located on a circle of unit length
Consumers are distributed uniformly around the circle
No retail location is superior to any other location
Consumers compare only the assortment depths and prices to decide where to shop
4. Assortment depth and Store differentiation

The cost of switching between retailers increases

(i) Lower $n$

A smaller number of retailers in the market
Price ↑, assortment depth ↑

(ii) Higher $t$

The transaction cost of traveling to a rival retailer becomes larger
Increase loyalty
Price ↑, assortment depth ↓
4. Assortment depth and Store differentiation

Total retailer profit

\[
\prod (p, v; \bar{p}, \bar{v}) = 2\delta^*(p, v; \bar{p}, \bar{v}) \pi(p, v) - vF \quad \ldots \ldots (2)
\]

Differentiation with respect to \( p \)

\[
\frac{\pi(p, v) du(p, v)}{t \cdot \frac{\partial \pi(p, v)}{\partial p_i}} + 2\delta^*(p, v; \bar{p}, \bar{v}) \frac{\partial \pi(p, v)}{\partial p_i} = 0 \quad \ldots \ldots (3)
\]

Effect into an inter-retailer margin

Effect into an intra-retailer margin
4. Assortment depth and Store differentiation

Effect of a price increase on

Inter-retailer margin
  The role of prices in determining market share

Intra-retailer margin
  The role of the prices in augmenting profit per customer
4. Assortment depth and Store differentiation

\[ \frac{\pi(p, v)}{t} \frac{\partial u(p, v)}{\partial p_i} + 2\delta^*(p, v; \bar{p}, \bar{v}) \frac{\partial \pi(p, v)}{\partial p_i} = 0 \] ...... (3)

Opposing signs

A strengthening of effects on the intra-retailer margin has similar implications for retail prices as a weakening of effects on the inter-retailer margin
4. Assortment depth and Store differentiation

An increase in consumer switching costs raises retail prices by

(i) higher t

The development of greater consumer loyalty
Hard to attract customers from other retailers
Hard to do selective discount

→ Price increase
4. Assortment depth and Store differentiation

An increase in consumer switching costs raises retail prices by

(ii) lower $n$

The closure of existing retailers

More customers are allocated

Strengthen monopoly pricing incentive

→ Price increase
4. Assortment depth and Store differentiation

Differentiation with respect to $v$

$$\frac{\pi(p, v)}{t} \frac{\partial u(p, v)}{\partial v} + 2\delta^*(p, v; \bar{p}, \bar{v}) \frac{\partial \pi(p, v)}{\partial v} - F = 0 \quad \ldots \ldots (4)$$

Inter-retailer

Assortment depth ↑, attracts new customers

Intra-retailer

Assortment depth ↑, raises retail profit per customer

Positive effects on both terms.
4. Assortment depth and Store differentiation

Equilibrium price, equilibrium assortment depth
→ Determined by the simultaneous solution of equation (3), (4)
5. Store and Product Differentiation

Elasticity with respect to assortment depth \( (e_v) \)

Degree to which new variants cannibalize their demand from the demand for existing variants as the assortment deepens.

\( e_v = 0 \rightarrow \) demand is independent of assortment depth.

\( e_v = 1 \rightarrow \) total category demand remains constant.

\( \theta = \) degree of product differentiation

\( \theta \downarrow, \) differentiation \( \uparrow \)
5. Store and Product Differentiation

As $\theta \downarrow$, $e_v \downarrow$

Then differentiation $\uparrow$, profit level $\uparrow$?

→ No

Category profitability depends on the opportunity cost of cannibalization, not on the level.

Cannibalizing sales from existing variants is more costly when retail margins are wide.
5. Store and Product Differentiation

The Monopoly Outcome

\[
\frac{\partial \pi(p,v)}{\partial p_i} = x(p,v) \left( 1 - \left( \frac{p - c}{p} \right) e_p \right) = 0 \quad \text{...... (5)}
\]

Since \( e_p \) increases with \( \theta \)
- Equilibrium price ↑, Differentiation level ↑
- Equilibrium price ↓, Differentiation level ↓
5. Store and Product Differentiation

The Monopoly Outcome

\[
\frac{\partial \pi(p, v)}{\partial v} = (p - c)x(p, v)(1 - e_v) - F = 0 \quad \ldots \quad (6)
\]

As assortment depth ↑,
Profit of \((p - c)x(p, v)\) from new variants ↑
Cannibalizes \(e_v(p - c)x(p, v)\) in profit from existing variants
5. Store and Product Differentiation

As retail margins widen and the level of sales per variant falls, cannibalization becomes increasingly costly, and the equilibrium depth of the product assortment ultimately becomes shallower.

Ex) General Motors

   Too many types of cars
   → weak sales, cost inefficiencies
   “Deproliferation” strategy to reduce the number of car models in 1987
5. Store and Product Differentiation

Oligopoly Outcome

\[
\frac{(p - c)vx(p, v)}{t} = \frac{1}{n}\left[1 - \left(\frac{p - c}{p}\right)e_p\right] \quad \ldots\ldots (7)
\]

Effect into an inter-retailer margin

Effect into an intra-retailer margin

Opposing signs

Discount on category price from the monopoly level to acquire market share
5. Store and Product Differentiation

Oligopoly Outcome

\[(p - c)x(p,v) \left[ \left( \frac{1 - \theta}{\theta} \right) \frac{vpx(p,v)}{t} + \frac{1 - e_v}{n} \right] = F \quad \ldots \ldots (8)\]

- Effect into an inter-retailer margin
- Effect into an intra-retailer margin

Positive effect on both terms

- Attracts store traffic
- Facilitates greater category demand per customer
5. Store and Product Differentiation

\[ t \uparrow, \text{assortment depth} \downarrow \]
\[ \frac{1}{n} \uparrow, \text{assortment depth} \uparrow \]
6. The direction of future research

The degree of product differentiation in the category might depend on both the volume of sales per variant and the number of variants

Consider manufacturer decisions to add variants to their product lines

Consider the returns to jointly expanding assortment width and assortment depth
7. Summary

Assortment depth
  Degree of differentiation
    Positive / negative relationship
  Cannibalization
Product differentiation
  Inverted U-shaped pattern
Store differentiation
  Inter-retailer margin / Intra-retailer margin / Switching cost
Monopoly/Oligopoly outcome
References

정두근, “최적 구색 갖추기”

Lynch, Ross, Wray - “Introduction to marketing”

Evans Berman - “Marketing 4”

Michael Spence - “product differentiation and welfare”

Xavier Vives - “Oligopoly Pricing”

Steven C. Salop - “Monopolistic competition with outside goods”
Appendix

$u(p,v)$ is utility function

$$u(p,v) - \delta t = u(p,v) - t \left( \frac{1}{n} - \delta \right), \quad 0 \leq \delta \leq \frac{1}{n}$$

$$2t\delta = u(p,v) - u(p,v) + t \frac{1}{n}$$

$$\delta^*(p,v;p,v) = \frac{1}{2n} + \frac{1}{2t} \left[ u(p,v) - u(p,v) \right]$$

$$X_i(p,v;p,v) = \delta^*(p,v;p,v) x_i(p,v)$$

$$X(p,v;p,v) = \delta^*(p,v;p,v) \int_{i=0}^{v} x_i(p,v) di$$

$$\pi(p,v) = \int_{i=0}^{v} (p_i - c) x_i(p,v) di$$

t is distance between consumer and retailer
n is the number of retailers
p is a price of first retailer
v is the number of products of first retailer
\( \bar{p} \) is a price of second retailer
\( \bar{v} \) is the number of products of second retailer
\[ \Pi (p,v;\bar{p},\bar{v}) = 2\delta^* (p,v;\bar{p},\bar{v})\pi (p,v) - vF \]

\[ \Pi (p,v;\bar{p},\bar{v}) = \left[ \frac{1}{n} + \frac{1}{t} \left[ u(p,v) - u(\bar{p},\bar{v}) \right] \right] \pi (p,v) - vF \]

\[ \frac{\partial \Pi (p,v;\bar{p},\bar{v})}{\partial p_i} = \frac{\pi (p,v)}{t} \frac{\partial u(p,v)}{\partial p_i} + 2\delta^* (p,v;\bar{p},\bar{v}) \frac{\partial \pi (p,v)}{\partial p_i} = 0 \]

\[ \frac{\partial \Pi (p,v;\bar{p},\bar{v})}{\partial v} = \frac{\pi (p,v)}{t} \frac{\partial u(p,v)}{\partial v} + 2\delta^* (p,v;\bar{p},\bar{v}) \frac{\partial \pi (p,v)}{\partial v} - F = 0 \]