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# Differentiation With Shared Features And Cannibalization Of Information Goods

Xueqi Wei

*Fudan University*, [weixueqi@fudan.edu.cn](mailto:weixueqi@fudan.edu.cn)

Zhe Qu

*Fudan University*, [quz@fudan.edu.cn](mailto:quz@fudan.edu.cn)

Zhaoran Xu

*Fudan University*, [xuzhaoran@163.com](mailto:xuzhaoran@163.com)

Lihua Huang

*Fudan University*, [lhhuang@fudan.edu.cn](mailto:lhhuang@fudan.edu.cn)

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## DIFFERENTIATION WITH SHARED FEATURES AND CANNIBALIZATION OF INFORMATION GOODS

Xueqi (David) Wei, School of Management, Fudan University, Shanghai, P.R. China,  
weixueqi@fudan.edu.cn

Zhe Qu, School of Management, Fudan University, Shanghai, P.R. China, quz@fudan.edu.cn

Zhaoran Xu, School of Management, Fudan University, Shanghai, P.R. China,  
xuzhaoran@163.com

Lihua Huang, School of Management, Fudan University, Shanghai, P.R. China, lhhuang@  
fudan.edu.cn

### Abstract

*Large sunk cost of development, negligible cost of reproduction and distribution and substantial economies of scale make information goods distinct from industry goods. In this paper, we analyze versioning strategies of horizontally differentiated information goods with shared feature sets, discrete hierarchical groups and continuous individual consumer tastes. Based on our modelling results, when cannibalization is considered among different market segments, it is always sub-optimal to differentiate information goods if market is not fully differentiated or characteristics of the information goods are not specifically designed to relate to certain market segments.*

*Keywords: Product Line Design, Versioning Strategies, Information Goods, Cannibalization*

# 1 INTRODUCTION

Information goods such as computer software, online services, online content and digitalized music, movies and books have become an indispensable part of our life. The greatest distinction between information goods and physical goods is reproduction costs where the former incurs large sunk costs of development but negligible costs of reproduction and distribution. Broad adoption of e-commerce, secure and convenient online payments and high-speed Internet connections have greatly lowered transaction costs and made information goods more appealing. In addition to production costs, several other features make information goods different from other products: due to developments in software engineering, characteristics of information goods can be easily recombined to generate different versions (Varian 1998). Typical versioning examples include Microsoft Windows series (XP, Vista and 7), Norton anti-virus software, SAS and Matlab packages, among others.

Although it is technically possible for firms to generate a "super-version" which contains all the characteristics in their product line and then degrade it to generate vertically differentiated versions, many firms still choose to differentiate their products horizontally whenever possible. Indeed, previous research has shown that a monopolist offering vertically differentiated versions is optimal only under some restrictive conditions (Wu, Chen and Anandalingam 2003, Chen and Seshadri 2007, Bhargava and Choudhary 2008). In this work, we treat vertical differentiation as a special case of horizontal differentiation, and model the interaction between different market segments showing how and when monopoly versioning is optimal.

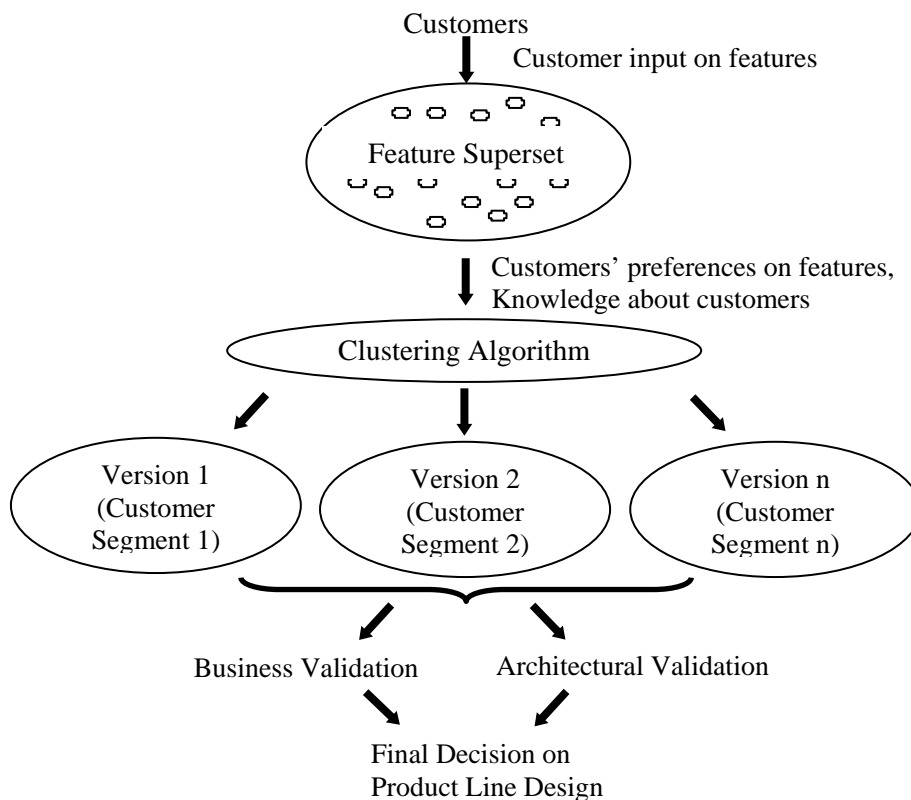


Figure 1. Overview of the Complete Product Line Design Approach

A complete versioning solution includes both technical and business validations, as illustrated in Figure 1 (Ullah and Wei 2010). In this paper we only focus on the business side, assuming that all the technical problems have been solved. The information goods monopolist is free to choose various combinations of features to generate different versions for different consumer segments.

Essential to our model is the definition of an individual consumer taste for quality, and a group taste that is correlated with individual tastes. In the real world, we normally observe that consumers with similar preference for certain products are aggregated in groups, which is also regarded as market segments. We find that if there is only one group, then the classic result of no versioning - that is, a single version - found by others, holds. For multiple groups and horizontally differentiated information goods we provide an intuitive condition that results in no cross-purchasing, and consequently a monopolist offers a separate version for each group. Relaxing the no cross-purchasing condition, we find that versioning can still be optimal with the monopolist squeezing lower-taste groups in favor of higher taste and more profitable groups.

The rest of the paper is organized as follows. We set up our notation and assumptions in Section 2 and analyze the optimization model of an information good monopolist when there are multiple groups with horizontally differentiated goods in Section 3. Discussion and future research are included in Section 4.

## 2 MODELING

Following the hedonic hypothesis that “goods are valued for their utility-bearing attributes or characteristics” (Rosen 1974), we define information goods as a set of characteristics. We allow for  $M$  characteristics,  $\mathcal{X} = \{x_1, x_2, \dots, x_M\}$ , and each good contains a subset of these characteristics, for example,  $\mathcal{X} \supseteq \{X_1, X_2, \dots, X_I\}$  where there are  $I$  possible information goods. Quality is denoted by  $q$  where  $q \in [0, +\infty)$ . We assume that complexity of information goods does not jeopardize their quality levels and that unused characteristics can be freely disposed of or ignored in use. In other words, the quality of information goods are solely determined by the set of characteristics they include, and more characteristics are better. This is our first assumption.

**Assumption 1** For two information goods  $X_i$  and  $X_j$ , if  $X_i \subseteq X_j$ , then  $q_i \leq q_j$ .

If an information good contains all the characteristics of another good and more, then we call it “vertical differentiation”. If two information goods do not include each other, then we call it “horizontal differentiation”. Our Assumption 1 indicates that quality can be compared between vertically differentiated goods. For horizontally differentiated goods, quality cannot be compared directly. As in most prior research, we take consumers to be heterogeneous and continuously distributed in their individual taste for quality. We denote the individual consumer taste as  $\theta$  which belongs to  $[\theta_0, \theta_N]$ . We assume that  $\theta$  has density and cumulative density functions  $f(\theta)$  and  $F(\theta)$ , so that consumers are normalized with a unit population. The density is strictly positive over its support and continuously differentiable. Following Bhargava and Choudhary (2001), Jing (2002) and Sundararajan (2004), we make the following assumption about the distribution of consumer taste:

$$\varphi(\theta) = \frac{1 - F(\theta)}{f(\theta)}, \text{ is non-increasing in } \theta.$$

**Assumption 2** The reciprocal of the hazard function,

This assumption is satisfied by common distributions such as the uniform, normal, logistic, chi-squared, exponential, and Laplace distributions, and any distribution with increasing density (Bhargava and Choudhary, 2001).

Essential to our model, we define a second feature that determines an individual's taste for quality: a group taste. Consumers are divided into groups and these groups are correlated with individual tastes which in turn define segments. Consumers with individual taste in segment  $[\theta_{n-1}, \theta_n)$  belong to group  $n$ ,  $n \in \{1, 2, \dots, N\}$ . Consumers in the same group  $n$  share the same group taste  $k_n$  and higher groups have greater tastes for quality, which means  $k_{n+1} > k_n$ . We represent the taste for quality as a product of the individual and group taste so that it can be represented by  $k_n \theta$ . Without a great loss of generality (as we can rescale  $q$ ), we assume a multiplicative relationship in the consumers' willingness to pay  $U(q, \theta, k_n)$  between taste  $k_n \theta$  and quality  $q$ . This is our third assumption.

**Assumption 3** The utility function of consumers in group  $n$  who purchase information good with quality  $q$  is expressed as  $U(q, \theta, k_n) = k_n \theta q$ ,  $n \in \{1, 2, \dots, N\}$ ,  $\theta \in [\theta_{n-1}, \theta_n)$ .

To provide a separate version for certain consumers may incur additional costs which we refer to as "versioning costs". Versioning costs could include additional development, marketing and managerial costs. Technology development such as software engineering has greatly lowered additional development costs for versioning and broad adoption of e-commerce has minimized additional marketing and managerial costs for providing an extra version. In this paper, we assume that versioning costs are zero after the highest quality information goods have been produced.

Following the individual-rationality constraint (Sundararajan 2004), in segment  $n$  where the consumer only chooses between purchasing the good designed for their segment and not purchasing, we define  $\tilde{\theta}_n$  as the indifferent consumer and the price assignment is

$$p_n = U(q_n, \tilde{\theta}_n, k_n) \tag{1}$$

Following the incentive-compatibility constraint (Sundararajan 2004), in segment  $n$  where the consumer chooses between purchasing the good designed for their segment  $n$  and a good designed for another segment  $i$ , we define  $\tilde{\theta}_n$  as the indifferent consumer and the price assignment is

$$p_n = p_i + U(q_n, \tilde{\theta}_n, k_n) - U(q_i, \tilde{\theta}_n, k_n) \tag{2}$$

In this formulation, the profit maximization problem for a monopolist that serves all  $N$  segments

$$\text{is } \max_{\tilde{\theta}_1, \dots, \tilde{\theta}_N} \Pi(\tilde{\theta}_1, \dots, \tilde{\theta}_N) = \max_{\tilde{\theta}_1, \dots, \tilde{\theta}_N} \left\{ \sum_{n=1}^N p_n [F(\theta_n) - F(\tilde{\theta}_n)] \right\} \quad \tilde{\theta}_n \in [\theta_{n-1}, \theta_n)$$

### 3 VERSIONING STRATEGIES WITH CROSS-PURCHASE

When there is no group taste parameter to differentiate different market segments (e.g. there is only one segment in the market), previous research (Bhargava and Choudhary 2001, Jones and Mendelson 2005, Jing 2002 and Wu, Chen and Anandalingam 2003) shows that it is not optimal to version information goods. Using our formulation we also replicate their findings.

Now we extend our basic model to include group tastes for different segments. For a horizontally differentiated market, consumers from different groups derive value from a shared set of characteristics of the information good, while other characteristics can be tailored to provide value for different groups. We use  $X^a$  to denote the shared characteristics and  $q^a$  as the quality index for  $X^a$ . Based on the product line engineering, different versions within a product line normally share a common, managed set of characteristics (Birk, Heller, John, von der Maben, Muller and Schmid,

2003). For simplicity, we assume that  $X_a$  is the only set of characteristics shared by the different goods in the product line, that is  $X_a = X_i \cap X_j, \forall i \neq j$ . As a result we have the following utility function

$$U(q_i, \theta, k_n) = \begin{cases} k_n \theta q_i, & \text{if } n = i; \\ k_n \theta q_a, & \text{if } n \neq i; \end{cases}$$

which means if a consumer from group  $n$  purchases the information good tailored for group  $n$ , then the consumer receives utility  $k_n \theta q_n$ . Otherwise, if a consumer purchases the “wrong” information good (one tailored for another group), the consumer only gets utility from the shared characteristics,  $k_n \theta q_a$ . Therefore, our definition of horizontal differentiation is this form where the additional characteristics that each group values are mutually exclusive.

To avoid cross-purchase, which in this case means avoiding consumers preferring the “wrong” information good, the following conditions apply, which means as far as the highest group does not cross-purchase, then cross-purchase can be safely avoided.

$$\frac{q_a}{q_n} \leq \frac{k_n \theta_n^*}{k_N \theta_N^*}, \forall n \in \{1, 2, \dots, N-1\}$$

where  $\theta_n^*$  is the indifferent consumer when the monopolist maximizes profit in segment  $n$  only.

When there is no cross-purchase, each consumer groups can be safely treated as an independent market segment and it is straightforward that the monopolist provides each segment one version which is tailored for it.

Now we analyze the conditions where there is cross-purchase. Generally, for customer group  $i$ , if we

have  $\frac{q_a}{q_i} > \frac{k_i \theta_i^*}{k_j \theta_j^*}, 1 \leq i < j \leq N$ , which means  $\theta_j^*$  gets more value from  $q_a$  than  $\theta_j^*$  gets from  $q_i$ ,

then there is potential threat for part of market segment  $j$  who will purchase good  $X_i$  instead of  $X_j$ .

So how does the producer deal with this problem? To better address this problem, we further assume

$$\lambda = \frac{q_a}{q_1} = \frac{q_a}{q_2} = \dots = \frac{q_a}{q_N}$$

, which means the comparable quality of the different versions offered for

each market segment is the same. Now we can see that if  $\frac{k_1 \theta_1^*}{k_N \theta_N^*} < \lambda \leq \frac{k_1 \theta_1^*}{k_{N-1} \theta_{N-1}^*}$ , then cross purchasing only occurs between market segment 1 and market segment  $N$  (Since market  $N-1$  are prevented from cross purchasing, all the lower market segments are also prevented from purchasing goods designed for segment 1). Here we limit the interaction within two market segments to better illustrate the interactions. Results from the analysis of market 1 and  $N$  can be generalized to the analysis of any two market segments  $i$  and  $j$ .

Under the threat of cross purchasing between market segment 1 and market segment  $N$ , the information good producer will now change the price constraints in both market segments  $N$  and 1.

We denote  $\tilde{\theta}_N$  the indifferent type for market segment  $N$  who is indifferent between buying good

$X_N$  and  $X_1$  and  $\tilde{\theta}_1$  the indifferent type for market segment 1 who is indifferent between buying good  $X_1$  and not buying. Then the price constraints are as follow:

$$p_1 = k_1 \tilde{\theta}_1 q_1, \quad \tilde{\theta}_1 \in [\theta_0, \theta_1) \tag{3}$$

and

$$k_N \tilde{\theta}_N q_N - p_N = k_N \tilde{\theta}_N q_a - p_1, \quad \text{for } \tilde{\theta}_1 \in [\theta_{N-1}, \theta_N) \tag{4}$$

In the market segment  $N$ , there is another indifferent type which we denote as customer type  $\theta'_N$ , who is indifferent between buying  $X_1$  and not buying. And we have the following additional relationship

$$k_N \theta'_N q_a = k_1 \tilde{\theta}_1 q_1, \quad \text{for } \theta'_N \in [\theta_{N-1}, \tilde{\theta}_N] \tag{5}$$

Based on the constraints of  $\theta'_N$ , we have  $\theta'_N = \max\{\frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a}, \theta_{n-1}\}$  since  $\theta'_N \leq \tilde{\theta}_N$  can always be satisfied. Here we have three possible customer groups. Customers in  $[\tilde{\theta}_1, \theta_1]$  who buy  $X_1$ , customers in  $[\theta'_N, \tilde{\theta}_N]$  who buy  $X_1$  and customers in  $[\tilde{\theta}_N, \theta_N]$  who buy  $X_N$ . Customers in  $[\theta'_N, \tilde{\theta}_N]$  are market

encroachment of good  $X_1$  in market for  $X_N$ . Note that in this situation,  $q_1 = q_N = \frac{q_a}{\lambda}$ . Substitute the same price relationship equations (3) and (4) into the profit maximization model, we get:

$$\max_{\tilde{\theta}_N, \tilde{\theta}_1} \{ \Pi(\tilde{\theta}_N, \tilde{\theta}_1) = k_1 \tilde{\theta}_1 \frac{q_a}{\lambda} (F(\theta_1) - F(\tilde{\theta}_1)) + 1 - F(\theta'_N) + k_N \tilde{\theta}_N q_a \frac{1-\lambda}{\lambda} (1 - F(\tilde{\theta}_N)) \}$$

Subject to

$$\tilde{\theta}_1 \in [\theta_0, \theta_1), \quad \tilde{\theta}_N \in [\theta_{N-1}, \theta_N], \quad \theta'_N = \max\{\frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a}, \theta_{N-1}\}$$

$$\tilde{\theta}_N^* = \frac{1 - F(\tilde{\theta}_N^*)}{f(\tilde{\theta}_N^*)}$$

From the first order conditions with respect to  $\tilde{\theta}_N$ , we have,

Solve the above equation we get  $\tilde{\theta}_N^* = \theta_N^*$ , which means the market share for good  $X_N$  is the same as without the threat of good  $X_1$ . However, the profit of good  $X_N$  decreases because the price has to be lowered to maintain the same market share.

Now we come to the market share for good  $X_1$  in market segment 1 and there are two situations.

1. If market segment  $N$  is already covered by  $X_N$ , or if we have  $\frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a} \leq \theta_{N-1}$ , which means market segment  $N$  is jointly covered by  $X_N$  and  $X_1$ , then we have  $\theta'_N = \theta_{n-1}$ . The first order condition with respect to  $\tilde{\theta}_1$  is:

$$\tilde{\theta}_1^* = \frac{F(\theta_1) - F(\tilde{\theta}_1^*) + 1 - F(\theta_{N-1})}{f(\tilde{\theta}_1^*)}$$

Since  $\frac{F(\theta_1) - F(\theta) + 1 - F(\theta_{N-1})}{f(\theta)} > \frac{F(\theta_1) - F(\theta)}{f(\theta)}$ , we get  $\tilde{\theta}_1^* > \theta_1^*$ . Note that in this case, market segment  $N$  is covered. It can be covered by good  $X_N$  alone or by both  $X_N$  and  $X_1$ .

2. If market segment  $N$  is not covered. We have  $\theta_{N-1} < \frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a} < \theta_N^*$ . Then we get  $\theta'_N = \frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a}$ .

The first order conditions with respect to  $\tilde{\theta}_1$  is:

$$\tilde{\theta}_1^* = \frac{F(\theta_1) - F(\tilde{\theta}_1^*) + 1 - F(\theta'_N)}{f(\tilde{\theta}_1^*) + f(\theta'_N) \frac{k_1}{k_N \lambda}}$$

Since function  $\frac{1 - F(\theta)}{f(\theta)}$  is non-increasing, we have,

$$\frac{1 - F(\theta'_N)}{f(\theta'_N) \frac{k_1}{k_N \lambda}} \geq \frac{k_N \lambda}{k_1} \frac{1 - F(\theta_N^*)}{f(\theta_N^*)} = \frac{k_N}{k_1} \lambda \theta_N^* > \frac{k_N}{k_1} \theta_N^* \frac{k_1 \theta_1^*}{k_N \theta_N^*} = \theta_1^*$$

And  $\theta_1^*$  is the solution for  $\theta = \frac{F(\theta_1) - F(\theta)}{f(\theta)}$ . So we have  $\tilde{\theta}_1^* > \theta_1^*$ .

So under both conditions we have  $\tilde{\theta}_1^* > \theta_1^*$ , which means the producer shrinks its market share for good  $X_1$  in segment 1 to maximize its overall profit. And the higher  $\tilde{\theta}_1^*$  can also make the price of good  $X_1$  and  $X_N$  relatively higher.

And we can expect that with the increase of  $\lambda$ , cross purchasing happens between market segment 1 and  $N-1$ . There will be more incentive for firm to increase  $\tilde{\theta}_1^*$ , and finally it will reach the point that  $\tilde{\theta}_1^* \geq \theta_2$ . Then firm finds it better to close its sales for goods  $X_1$  in market segment 1 to maintain the high profit in its high-end market segments. When  $\lambda$  is close to one, most of the low-end markets are closed and only a few high-end markets retain.

We generalize the analysis above to develop the following theorem of versioning strategies:

**Theorem 1**

1. If there is only one consumer group, then it is not optimal to version information goods.
2. With multiple consumer groups, if there is no threat of cross-purchasing, then the monopolist to provide each segment with one version which is tailored for it.
3. For market with multiple groups and differentiated goods with shared characteristics, if there is threat of cross-purchase, the monopolist retains the market share of version designed for the high-end market in its own market segment while shrinking the market share of the low-end market until it is totally closed.



#### 4 DISCUSSIONS AND EXTENSIONS

There is interesting comparison if we treat market segment 1 and  $N$  separately. Without considering profit from market segment 1 (we may suppose market segment 1 and market segment  $N$  are managed separately), the profit maximization problem takes the following form where we denote  $\Pi_N$  the profit for market segment  $N$

$$\max_{\tilde{\theta}_N} \{ \Pi_N(\tilde{\theta}_N) = (k_N \tilde{\theta}_N q_a \frac{1-\lambda}{\lambda} + k_1 \tilde{\theta}_1 \frac{q_a}{\lambda})(1 - F(\tilde{\theta}_N)) \} \quad \tilde{\theta}_N \in [\theta_{N-1}, \theta_N]$$

The first order condition is:

$$\tilde{\theta}_N = \frac{1 - F(\tilde{\theta}_N)}{f(\tilde{\theta}_N)} - \frac{k_1 \tilde{\theta}_1}{k_N(1-\lambda)}$$

We can see that if market segment  $N$  is not covered without threat of cross purchasing ( $\theta_N^* > \theta_{N-1}$ ), then we can always have  $\tilde{\theta}_N^* > \theta_N^*$ . It means the producer has incentive to expand its market share in the high-end market under threat of cross purchasing. The reason why the producer retains its market share in its high-end market while considering the profit in both market is because firm can get compensation from the sales of  $X_1$  in market segment  $N$ .

The profit maximizing problem for segment 1 is:

$$\max_{\tilde{\theta}_1} \{ \Pi_1(\tilde{\theta}_1) = k_1 \tilde{\theta}_1 \frac{q_a}{\lambda} (F(\theta_1) - F(\tilde{\theta}_1) + F(\tilde{\theta}_N^*) - F(\theta'_N)) \}$$

$$\tilde{\theta}_1 \in [\theta_0, \theta_1], \quad \theta'_N = \max \left\{ \frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a}, \theta_{N-1} \right\}$$

There are three situations that can result:

1. If market segment  $N$  is already covered by  $X_N$ , then we have  $\theta'_N = \tilde{\theta}_N^* = \theta_{N-1}$ . The first order conditions with respect to  $\tilde{\theta}_1$  is:

$$\tilde{\theta}_1^* = \frac{F(\theta_1) - F(\tilde{\theta}_1^*)}{f(\tilde{\theta}_1^*)}$$

Obviously we have  $\tilde{\theta}_1^* = \theta_1^*$ , which means if segment  $N$  is already covered by good  $X_N$ , then there is no incentive for segment 1 to change its optimal arrangement.

2. If market segment  $N$  is not covered by good  $X_N$ , but it is jointly covered by goods  $X_N$  and  $X_1$ , we have  $\theta'_N = \theta_{N-1} < \tilde{\theta}_N^*$ . The first order conditions with respect to  $\tilde{\theta}_1$  is:

$$\tilde{\theta}_1^* = \frac{F(\theta_1) - F(\tilde{\theta}_1^*) + F(\tilde{\theta}_N^*) - F(\theta_{N-1})}{f(\tilde{\theta}_1^*)}$$

Since  $F(\tilde{\theta}_N^*) - F(\theta_{N-1}) > 0$ , we get  $\tilde{\theta}_1^* > \theta_1^*$ . It means in this situation, segment 1 shrinks in its own market segment while encroaching on segment  $N$ .

3. If market segment  $N$  is not covered by good  $X_N$ , and it is also not covered by both goods  $X_N$  and  $X_1$ , we have  $\theta_{N-1} < \frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a} < \theta_N^*$ . Then we get  $\theta'_N = \frac{k_1 q_1 \tilde{\theta}_1}{k_N q_a}$ . The first order conditions with respect to  $\tilde{\theta}_1$  is:

$$\tilde{\theta}_1^* = \frac{F(\theta_1) - F(\tilde{\theta}_1^*) + F(\tilde{\theta}_N^*) - F(\theta'_N)}{f(\tilde{\theta}_1^*) + f(\theta'_N) \frac{k_1}{k_N \lambda}}$$

In this condition it is uncertain whether market share of good  $X_1$  in segment 1 expands or shrinks. It will depend on the relative value of  $\lambda$ ,  $k_1$  and  $k_N$ . We use the following numerical example to show this.

**A Numerical Example.**

In a situation where there are only two segments, we make  $\theta_0 = 0, \theta_1 = 0.125, \theta_2 = 1$ . Customers are uniformly distributed so that  $F(\theta) = \theta, f(\theta) = 1$ . We can easily get  $\theta_1^* = 0.063$  and  $\theta_2^* = 0.5$ .

If  $\lambda = 0.125, k_1 = 1$  and  $k_2 = 2$ , we can calculate that  $\tilde{\theta}_1^* = 0.061 < \theta_1^*, \tilde{\theta}_2^* = 0.483 < \theta_2^*$  and  $\theta'_2 = 0.243$ . All constraints are satisfied.

If  $\lambda = 0.25, k_1 = 1$  and  $k_2 = 2$ , we can calculate that  $\tilde{\theta}_1^* = 0.099 > \theta_1^*, \tilde{\theta}_2^* = 0.467 < \theta_2^*$  and  $\theta'_2 = 0.197$ . All constraints are satisfied.

Segment j	Optimal $\theta$	Separately	Jointly
Covered by $X_j$	$\theta_i^*$	Same	Increase
	$\theta_j^*$	Same	Same
Covered by $X_j$ and $X_i$	$\theta_i^*$	Increase	Increase
	$\theta_j^*$	Decrease	Same
Not Covered	$\theta_i^*$	Uncertain	Increase
	$\theta_j^*$	Decrease	Same

Table 2 Market Encroachment between Market Segments  $i$  and  $j$  ( $i < j$ )

**Note:**

Increase means shrinkage of market share in the market segment;

Decrease means expansion of market share in the market segment.

There are two extreme situations for product with shared characteristics. One is that the common quality  $q_a$  is zero, which is the perfect quality differentiation situation we discussed in the previous section. The other extreme is that the special quality is zero, which means  $q_h = q_a$ , customers in different groups value all the characteristics of the information good, although at different utility level, which returns to the vertical differentiation model.

## 5 CONCLUSION

In this paper we investigated conditions that determine when an information goods monopolist chooses to implement versioning strategies. We showed that versioning strategies are implemented only when different groups of consumers can be clearly defined. In other words, versioning cannot be used to segment a market; rather, versioning strategies must fit the existing market segments. Our optimal versioning strategies are in accordance with Shapiro and Varian's (1999) suggestion that versions should be designed to accentuate the differences between groups in their tastes. We demonstrated that in a horizontally differentiated market, if there is no cross-purchase, then it is optimal to provide one version for each segment. Otherwise, the monopolist shrinks the market in the lower-end segment to protect profits in the higher-end segments.

Our contribution lies in two aspects. First, although most of the previous research (Bhargava and Choudhary 2001, 2008, Jones and Mendelson 2008, Jing 2002 and Wu, Chen and Anandalingam 2003) focuses on vertical differentiation, we treat information goods as a combination of characteristics so that we link horizontal differentiation with vertical differentiation. In our model, we made a transition from horizontal differentiation to vertical differentiation and showed how versioning strategies change during the transition. Second, we introduced a group taste to successfully explain the existence of multiple versions. Much of the previous research (Bhargava and Choudhary 2001, Jones and Mendelson 2005) using linear utility without group tastes found only one version is optimal.

There are several limitations in our modeling framework. Our modeling results are based on assumptions such as linear utility and a positive relationship between group taste and individual taste. In addition, the introduction of hierarchical characteristics explains versioning in vertical differentiation, but we recognize that it is a special preference structure. Future research may relax some of these assumptions, and can address additional issues.

In addition, our paper studies monopoly versioning strategies. Although real world examples show that many information goods markets are "winner-take-all" markets where only one provider dominates, we expect that competition (Jones and Mendelson 2011, Wei and Nault 2006) has the potential to make a significant difference in these strategies.

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