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Customer choices, charging policy and social welfare analysis in a duopoly music industry

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Abstract

The purpose of this paper is to explore the diversified billing models of duopoly players in the market, the interactive relationship between consumer preferences and brand awareness, and the implications of management policy. Using game theory to analyze competitive behavior in a duopoly music market and determined that brand value positively affects product pricing. Our results clearly find brand value is a positive factor in determining product pricing and when two companies provide slightly differentiated products, product pricing can be based on the quality of the products, and information is equally shared between the company and the consumers. In addition, consumer choice is primarily based on product pricing, followed by brand awareness and value.

Keywords: Music Industry, Charging Policy, Virtual Channels, Physical Channels, Game Theory

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Introduction and motivation

The Internet has drastically changed how people communicate, eliminating the gaps left between us by traditional means of communication in all areas of life, friendship, learning, the economy, and management. Internet users have increased substantially despite the bursting of the dot-com bubble in 2000. The rapid development of Internet technology has led to commerce that does not require a physical shop; with virtual channels used to conduct sales, explanations, and other transactions involving merchandise. In 2000 and 2001, person-to-person (P2P) technology became popular in Taiwan, with the launch of ezPeer and Kuso. This development led to a shift in music usage from physical to virtual channels. However, digital music sharing had not yet been authorized by record companies, leading to the decline of the traditional music market.

The rapid evolution of the online music industry and the application of information technology can be traced back to 1999 when Shawn Fanning founded Napster, an online music-sharing platform. The next 10 years of high-speed development brought about political, technological, market, and economic changes affecting many aspects of how music is obtained over the Internet and gradually creating a virtual online cluster for the music industry (Chang and Chou 2006). Upstream content providers, midstream manufacturers, and downstream manufacturers inadvertently formed a virtual online cluster because of consumer behavior. Record companies grant authorization to platform operators, who in turn have agreements with Web portals to gradually work toward vertical integration, thus reducing competition between content providers and midstream distributors of the same record company. Overheated competition between them is disadvantageous to the long-term sustainability of a record company (Lin, 2007).

Digital technology has rapidly transformed how music is marketed, shifting from push to pull strategies. Concurrently, public curiosity and public purchasing power for information technology products have increased, leading to constant changes in the rules and market structure of the Internet economy. Furthermore, integrating this new business model with the 4 Cs of marketing underscores the importance of the fair trade law (Hsu, 2004) and aids in innovating and developing virtual channels. Doing so also contributes to introducing emerging music industries and maintaining the competitive advantages of the music industry. The rapid changes in this environment motivated the present study, which explored the diversified billing models of duopoly players in the market, the interactive relationship between consumer preferences and brand awareness, and the implications of management policy.

Literature review

Competition among products is intense, and companies advertise new products in various manners to attract the attention of consumers. However, advertisements follow the same established approaches: (a) advertising media such as traditional media (e.g., newspapers, magazines, TV, radio, and direct marketing inserts in newspapers or bills) and Web media (e.g., e-mail, portal sites, and search engines), and (b) traditional advertising formats (e.g., print, non-print, experiential, and interactive) and website formats (e.g., banners, buttons, text, floating ads, pop-ups, media, and interstitials). Hence, it is crucial to determine the optimal advertising method for attracting consumer attention. Our study reviewed the literature on Web advertisements in digital product markets, the recent literature on two-sided markets and piracy, and the literature on moral judgment.

Piracy

Authors such as Conner and Rumelt (1991), Shy and Thisse (1999), and Peitz (2004) have argued that the unprotected software policy can be the optimal policy in the presence of a positive network effect. The policy can increase the profits of firms and lower the price of software. Moreover, the policy is an equilibrium policy for non-cooperative firms. Givon et al. (1995) used a diffusion model approach for estimating pirated software sales. Gayer and Shy (2003) developed a model in which the government directly taxes each hardware unit purchased by each software user and transfers the tax revenue collected on the hardware to the software firms. However, they argued that hardware taxation is inefficient. In addition, Lin and Lee (2006) showed that the level of social welfare is generally higher in the presence of software piracy and suggested that software firms must focus on increasing the basic utility difference between legal and illegal software. Yang, Wang, and Mourali(2015)develop an integrative model of music piracy and suggest that informational influence is the key underlying mechanism through which self-control affects unauthorized downloading. Huang (2005) used a conceptual model of sharing to investigate music file-sharing behavior from the perspectives of moral judgment, expertise, and social networking. The same model was used by Chen et al. (2008), who analyzed 834 samples of P2P users in Taiwan and found that moral reasoning moderated the relationships among fashion involvement, consumption value, and behavioral intention to download music.

Advertisements

We contribute to the literature on the Web advertisements of online digital products by introducing the option of setting advertisements. Previous analyses in the digital market literature have focused on the behavior of consumers or firms. Advertisements are crucial in the current context because record companies enter virtual channels to sell their music. Anderson and Coate (2005) found that lower

advertising levels and more programming are not necessarily socially desirable. Gabszewicz et al. (2004) verified that the program mixes of the channels do not converge when ad interruptions are costly for viewers, that niche strategies are less effective, and that the channel profiles become closer as advertising aversion becomes stronger. Zhou (2004) found that commercial breaks become more frequent toward the end of television programs or as the popularity of a television program increases. Hence, Gantman and Shy (2004) compared advertising equilibrium levels to socially optimal levels in the broadcasting industry and demonstrated that quality improvement is profitable for the advertising firms but not for the broadcasters. Peitz and Valletti (2008) compared the advertising intensity and programming content of competing media platforms and found that viewers strongly dislike advertising. Fan et al. (2007, 2008) reported that, as the advertisement revenue rate increases, the advertising level remains low and that, as digital video recorder technologies provide more convenience to consumers, media companies must increase, rather than reduce, revenue from advertising. Therefore, Lin and Li (2009) found that a duopolistic market position benefits the contextual advertising of channel firms and that acquisition becomes a prime strategy for revealing the value of contextual advertising.

Consumer Behavior and charging policy

About charging policy literatures, Peitz and Waelbroeck (2006) found that offer free online music downloads, in addition to improve the fit of consumer preferences and product type, and also help to increase the consumer's willing to pay. Liu and Chou (2006) used SEM (structural equation modeling) and suggested that the on-line music shops should provide more additional services to raise perceived value and increase purchasing intentions. In addition, they suggested the reasonable price for a song is 1 3.07 NT, i.e., the current price of 30 to 35 NT for a song is too high and should be adjusted. Chu and Lu (2007) used an empirical survey to test the hypotheses by SEM and collected data from a total of 302 online Taiwanese early adopters of online music. Their findings show that the perceived value of online music is a significant factor in predicting the purchaser intention of buying online music in Taiwan. Also, purchasers and potential purchasers differ in the determinants underlying the perceptions of value. Dong and Huang (2010) suggested that public transmission fee should be depended on the number of IOs(intermediary organizations), managing copyright, the economic standard of various countries, and the level of industrial development, and the single-charging-unit should be established. Chug (2014) found a positive temporal effect of self-oriented content usage (download) on other-oriented content usage (gift), based on behavioral orientation, and also a temporal interdependence between external (ringtone) and internal usage (mp3) based on types of content. The paper also finds that the fourth generation communications standard increases content usage in this mobile app.

Operation Strategy

Molteni (2003) asserted that downloading music is no longer the only form of consumption in a digital environment. Different consumption habits should be differentiated using artist selection and pricing strategy while predicting each new consumption model and preparing various strategies to manage the market environment. Paula, Krueger, and Beek (2006) analyzed a three year study (2003-2005) of the European online news and online music sectors. They suggested some predictions about what the future may hold for both these sectors. Chou (2006) considered two-sided markets in which a number of broadcast stations were financed through subscription and advertising revenue, whereas other broadcast stations were financed only through advertising revenue.

The piracy of digital products such as music has received increased attention in the literature. Most studies have focused on protection against piracy, advertising strategy, pricing policy, consumer behavior, and operation strategy in the music industry. However, no studies have analyzed how hybrid channels (entry channels and virtual channels) affect the profits of the digital-product companies by industry economics or e-economics. We developed a model in which a digital product company operates two channels of digital products to control the market share and profit margin.

Basic economic model construction

We used the model of spatial competition for the inside location game (Hotelling 1929) and solved the equilibrium by using sub-game perfect equilibrium and backward induction. Consumer purchases of musical products can be generalized into three categories: the purchase of physical products through physical channels, purchase of physical products through virtual channels, and purchase of virtual products through virtual channels.

Gayer and Shy (2003) analyzed consumer behavior in their discussion of digital products. They categorized their analysis into two forms of market models based on different types of consumer behavior. Free downloads, purchases from physical stores, and nonuse of digital products were grouped into the first market model. The second model comprised free downloads and purchases from physical stores. The differences in industry profits were then observed by comparing the two market models. Further study of this topic must clearly be conducted. Therefore, this paper is aimed at building upon the basic model constructed by Gayer and Shy (2003) to explore the present competitive strategies of the music industry in Taiwan, as well as the topic examined in this study.

The utility of each user indexed by t ($0 \leq t \leq 1$) can be specified as

$$TU_x \overset{def}{\equiv} \begin{cases} \beta s_E - \tau x + \gamma_E N_V & Physical\ \ digital\ \ products(PDP) \\ \beta s_V - \tau(1-x) + \gamma_V N_E & Virtual\ digital\ \ products(VDP) \\ 0 & Don't\ \ buy\ \ anything \end{cases} . \quad (1)$$

Changes in consumer behavior have created opportunities for the virtual channel market. Record companies have thus expanded their distribution channels on the basis of market changes, now maintaining both physical and virtual channels. In other words, companies now sell two types of product: (1) physical products such as cassettes, CDs, and DVDs, which are called physical digital products (PDPs), and (2) virtual products that are usable online but not downloadable are legally authorized and are known as virtual digital products (VDPs). Music user types are uniformly distributed on the interval [0, 1] (Rhee and Norton 2001). The location index number *x* is the widely used differentiation characteristic parameter of a consumer. Thus, consumers indexed by *x* toward 1 are interpreted as being those who gain the most benefit from buying a VDP, whereas consumers indexed by *x* toward 0 are interpreted as being those who gain the most benefit from buying a PDP. Each consumer uses a maximum of one unit of music. Hence, consumers have tree choices (Fig. 1): (a) no purchase, (b) buy a PDP and gain the valuation $\beta s_E - \tau x$, or (c) buy a VDP and gain the valuation $\beta s_V - \tau(1-x)$. Let the parameter β>0 denote a user's basic valuation from the PDP or VDP. A higher value of β indicates a service rendered that was more valuable. The parameters $\gamma \geq 0$, $N_V \geq 0$, and $N_E \geq 0$ represent the intensity of the effect of the network size (γ) from the number of users (*N*). Specifically, γ>0 indicates that higher use denotes higher user utility.

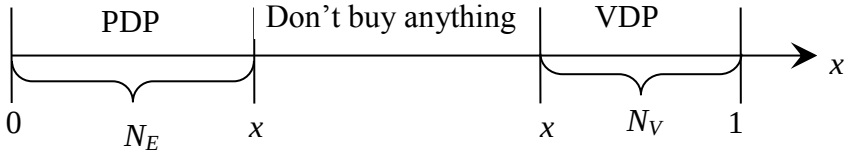

Fig. 1 Customer choices: the purchase of a PDP or VDP or no purchase

Shy (2001) defined the type of software package that the software industry should design for each operating system (or the basic functions that a software package should possess) and determined how many ATMs should be installed to improve customer convenience regarding cash withdrawals, fund transfers, bill payments, and other services. Similarly, the present study uses the parameter's' to represent types of product. The higher the value of 's', the more types of product and, correspondingly, the more choices available to consumers. By contrast, a lower value of 's' means fewer types of product and thus fewer choices for consumers. The parameter 'τ' measures the difference in the degree of recognition between downloaded products and products in physical shops.

Assume that record companies A and B both sell PDPs and VDPs. The companies form a duopoly with the ability to dictate the prices of digital products. They also

have the choice to provide the following. (1) free PDPs such as extended play (mid-length) albums, which are commonly released before a full album (to increase the popularity of the artist and sales performance when the full album is released); (2) free VDPs such as the free streaming of full-length tracks or 30-second excerpts; (3) chargeable PDPs; or (4) chargeable VDPs. Consumers, influenced by self-preferences, can select either PDPs or VDPs. Although there are only two companies selling two product types, the pricing strategies for the products and the brand awareness of each company influence consumer choice. This study uses P_{ij} to represent the set of prices for different products; $P_{ij}>0$ represents a chargeable product, whereas $P_{ij}=0$ represents a free or non-chargeable product. Two companies in a duopoly market start comparing prices, which leads to price competition. Furthermore, pricing strategy, brand awareness, or other factors affect whether consumers select PDPs or VDPs, which forms a utility function encompassing Eqs. 2 and 3:

$$U_t \overset{def}{\equiv} \begin{cases} \alpha_{AE} + \gamma n_{AE} - P_{AE} & Buy \quad PDP \quad from \quad \text{A} \\ \alpha_{BE} + \gamma n_{BE} - P_{BE} & Buy \quad PDP \quad from \quad \text{B} \end{cases} \tag{2}$$

$$\text{and } U_t \overset{def}{\equiv} \begin{cases} \alpha_{AV} + \gamma\left(\bar{n}_A - n_{AV}\right) - P_{AV} & Buy \quad VDP \quad from \quad A \\ \alpha_{BV} + \gamma\left(\bar{n}_B - n_{BV}\right) - P_{BV} & Buy \quad VDP \quad from \quad B \end{cases}. \tag{3}$$

Let the parameter γn represent the network effect of the user's size. The parameters $n_{AE}>0$, $n_{AV}>0$, $n_{BE}>0$, and $n_{BV}>0$ represent the user's size regarding the PDP or VDP from company A or B. Specifically, $\gamma>0$ indicates the network effect. Hence, $\alpha>0$ is a user's basic utility for the PDP or VDP provided by company A or B.

In addition, the consumer utility for the VDP diminishes as the number of Internet users or number of downloads increases, leading to a slowdown or breakdown in connection. In other words, once the number of users reaches a certain point, new users are crowded out. Here, we used $\bar{n}_A - n_{AV}$ and $\bar{n}_B - n_{BV}$ to represent the crowding-out problem on online platforms encountered by companies A and B, respectively. Because $\bar{n}_B$ represents the loading capacity of the number of Internet users, a crowding-out effect occurs when $n_{AV} > \bar{n}_A$ or $n_{BV} > \bar{n}_B$. When this occurs, an increase in the number of users induces a negative network effect.

Therefore, consumers who prefer a PDP buy from either company A or company B, leading to $N_E = n_{AE} + n_{BE}$. Otherwise, consumers who prefer a VDP buy from either company A or company B, leading to $N_V = n_{AV} + n_{BV}$.

Analysis of consumer behavior

Effect of preferences on consumer choice

Consumers are affected by their personal preferences when purchasing digital products, inducing them to make different choices. Thus, consumers either buy a certain type of product or make no purchase, as demonstrated in Eq. 1:

$$TU_x \overset{def}{\equiv} \begin{cases} \beta s_E - \tau x + \gamma_E N_V & Physical\ \ digital\ \ products(PDP) \\ \beta s_V - \tau(1-x) + \gamma_V N_E & Virtual\ digital\ \ products(VDP) \\ 0 & Don't\ \ buy\ \ anything \end{cases} \quad (1)$$

Let $\hat{x}_1$ denote the type of marginal user who is indifferent to "no purchase" and buying a PDP (i.e., $\beta s_E - \tau x + \gamma_E N_V = 0$ for a consumer $\hat{x}_1$).Otherwise, let $\hat{x}_2$ denote the type of marginal user who is indifferent to no purchase and buying a VDP (i.e., $\beta s_V - \tau(1-x) + \gamma_V N_E = 0$ for a consumer $\hat{x}_2$).We yield

$$\begin{cases} \tau \hat{x}_1 - \gamma_E N_V = \beta s_E \\ \tau(1-\hat{x}_2) - \gamma_V N_E = \beta s_V \end{cases} \quad where\ , N_V = 1-\hat{x}_2;\ N_E = \hat{x}_1 . \quad (4)$$

Solving simultaneously, we obtain

$$N_V = \frac{\beta(\gamma_V s_E + \tau s_V)}{\tau^2 - \gamma_V \gamma_E},\ \hat{x}_2 = 1 - \frac{\beta(\gamma_V s_E + \tau s_V)}{\tau^2 - \gamma_V \gamma_E},\ \text{and}\ N_E = \hat{x}_1 = \frac{\beta(\gamma_E s_V + \tau s_E)}{\tau^2 - \gamma_V \gamma_E} . \quad (5)$$

Advanced impact of brand awareness and pricing strategies on consumer choice

For consumers who prefer PDP products, there are currently only two companies providing such products, which mean that consumers seeking PDP scan purchase them only from company A or B, as demonstrated in Eq. 2:

$$U_t \overset{def}{\equiv} \begin{cases} \alpha_{AE} + \gamma n_{AE} - P_{AE} & Buy\ \ PDP\ \ from\ \ A \\ \alpha_{BE} + \gamma n_{BE} - P_{BE} & Buy\ \ PDP\ \ from\ \ B \end{cases} . \quad (2)$$

Let $\hat{t}_1$ denote the type of marginal user who is indifferent to buying PDPs from companies A and B. Simultaneously, n_{AE} ($n_{AE} = \hat{t}_1$) denotes the number of PDPs from company A, and n_{BE} ($n_{BE} = \hat{t}_2 - \hat{t}_1$) denotes the number of PDPs from company B, where $\hat{t}_2$ denotes the number of PDPs (i.e., $\alpha_{AE} + \gamma \hat{t}_1 - P_{AE} = \alpha_{BE} + \gamma(\hat{t}_2 - \hat{t}_1) - P_{BE}$). By substituting, we yield

$$\hat{t}_1 = \frac{\hat{t}_2}{2} + \frac{\alpha_{BE} - \alpha_{AE} + (P_{AE} - P_{BE})}{2\gamma},\ n_{AE} = \frac{A}{2} - \frac{D}{2\gamma} + \frac{P_{AE} - P_{BE}}{2\gamma},\ \text{and}\ n_{BE} = \frac{A}{2} + \frac{D}{2\gamma} - \frac{P_{AE} - P_{BE}}{2\gamma} , \quad (6)$$

where $A = \frac{\beta(\gamma_E s_V + \tau s_E)}{(\tau^2 - \gamma_V \gamma_E)}$ and $D = \alpha_{AE} - \alpha_{BE}$.

Similarly, for consumers who prefer VDP products, there are currently only two companies providing such products, as demonstrated in Eq.3:

$$U_t \overset{def}{\equiv} \begin{cases} \alpha_{AV} + \gamma(\bar{n}_A - n_{AV}) - P_{AV} & Buy\ \ VDP\ \ from\ \ A \\ \alpha_{BV} + \gamma(\bar{n}_B - n_{BV}) - P_{BV} & Buy\ \ VDP\ \ from\ \ B \end{cases} . \quad (3)$$

Let $\hat{t}_4$ denote the type of marginal user who is indifferent to buying VDPs from companies A and B. Simultaneously, n_{AV} ($n_{AV} = \hat{t}_4 - \hat{t}_3$) denotes the number of VDPs from company A, and n_{BV} ($n_{BV} = 1 - \hat{t}_4$) denotes the number of VDPs from company B. By substituting, we yield

$\hat{t}_4 = \frac{\hat{t}_3}{2} + \frac{\alpha_{AV} - \alpha_{BV} + \gamma(\bar{n}_A - \bar{n}_B + 1)}{2\gamma} + \frac{P_{BV} - P_{AV}}{2\gamma}$, $n_{AV} = \frac{B}{2} + \frac{C}{2\gamma} + \frac{P_{BV} - P_{AV}}{2\gamma}$, and

$n_{BV} = \frac{B}{2} - \frac{C}{2\gamma} - \frac{P_{BV} - P_{AV}}{2\gamma}$, where $B = \frac{\beta(\gamma_V s_E + \tau s_V)}{(\tau^2 - \gamma_V \gamma_E)}$ and $C = \alpha_{AV} - \alpha_{BV} + \gamma(\bar{n}_A - \bar{n}_B)$. (7)

Market analysis of pricing strategies

There are 16 possible pricing combinations that the two companies could adopt for the two types of product, with the two main strategies being (PDP, VDP) = (Chargeable, Non-chargeable) and (PDP, VDP) = (Chargeable, Chargeable). Initially, physical distribution channels were the main source of profit for the Taiwanese music industry. Therefore, to align with current conditions, this study was aimed at discussing four types of market model derived from pricing strategies set by two companies:

1. Type I market: Both companies adopt the same pricing strategies. Both companies adopt a chargeable pricing strategy for PDPs and a non-chargeable pricing strategy for VDPs.
2. Type II market: Both companies adopt different pricing strategies. Both companies adopt a chargeable pricing strategy for PDPs; however, only company B adopts a non-chargeable pricing strategy for VDPs.
3. Type III market: Both companies adopt different pricing strategies. Both companies adopt a chargeable pricing strategy for PDPs; however, only company A adopts a non-chargeable pricing strategy for VDPs.
4. Type IV market: Both companies adopt the same pricing strategies. Both companies adopt a chargeable pricing strategy for PDPs and VDPs.

Type I market

Under Type I, both companies adopt a non-chargeable pricing strategy for VDPs(i.e., $P_{AV} = 0$ and $P_{BV} = 0$). By substituting Eqs.5 and 6, the profit-maximizing P_{AE} and P_{BE} are derived by

$P_{AE} = \frac{D}{3} - \gamma A$ and $P_{BE} = -\frac{D}{3} - \gamma A$. (7)

Simultaneously, $n_{AE} = \frac{A}{2} - \frac{D}{6\gamma}$, $n_{AV} = \frac{B}{2} + \frac{C}{2\gamma}$, $n_{BE} = \frac{A}{2} + \frac{D}{6\gamma}$, and $n_{BV} = \frac{B}{2} - \frac{C}{2\gamma}$. (8)

Finally, we yield $\pi_A = -\frac{(3\gamma A - D)^2}{18\gamma}$, $\pi_B = -\frac{(3\gamma A - D)^2}{18\gamma} - \frac{2AD}{3}$, and $PS = -\gamma A^2 - \frac{D^2}{9\gamma}$. (9)

The results of Proposition 1 can be determined by examining Eqs. (8) and (9).

Proposition 1: (a) Companies A and B are competitors and form a duopoly market; each company has their own consumer group. Therefore, the equations indicating that $n_{AE} > 0$, $n_{BE} > 0$, $n_{AV} > 0$, and $n_{BV} > 0$ can only be established when $3\gamma A > D > \gamma A > 0$ and $\gamma B > C > 0$. (b) If D > 0, then $\alpha_{AE} > \alpha_{BE}$, implying that the consumer utility provided by company A is higher than that provided by company B. Thus, consumer utility is influenced not only by product quality but also by brand awareness. (c) Company A creates added value for their products through brand image and awareness, leading to a price difference in the PDPs ($P_{AE} > P_{BE}$). However, company A's PDPs obtain a lower market share than do the PDPs of company B ($n_{AE} < n_{BE}$), although company A has comparatively high profitability ($\pi_A > \pi_B$). (d) Compared with company B, company A shows a greater brand advantage regarding PDPs. Because of consumer empathy, consumers believe that company A's VDPs provide comparatively high utility. In addition, the VDPs provided by company A are free of charge. Thus, company A's VDPs have a comparatively large market share ($n_{AV} > n_{BV}$). (e) If $3\gamma A > D > \gamma A$, then $6\gamma A - 4D < 0$, indicating that the duopoly market and competition between the two brands of digital products are disadvantageous to the overall market ($PS < 0$).

Type II market

Under Type I conditions, both companies, in developing digital music platforms for selling VDPs, provide free VDPs to the consumer because of common consensus or competition. However, this arrangement is economically beneficial to neither company, nor to the overall industry. Therefore, sustainable growth and development are difficult to achieve under Type I conditions. Consequently, further correction and in-depth discussion regarding Types II and III must occur in the next two sections, respectively.

In the Type II market, company B adopts a non-chargeable pricing strategy for VDP (i.e., $P_{BV} = 0$). By substituting Eqs.5 and 6, the profit-maximizing P_{AE} , P_{BE} , and P_{AV} are derived by

$$P_{AE} = \frac{D}{3} - \gamma A, P_{BE} = -\frac{D}{3} - \gamma A, \text{ and } P_{AV} = \frac{\gamma B}{2} + \frac{C}{2}. \quad (10)$$

$$\text{Simultaneously, } n_{AE} = \frac{A}{2} - \frac{D}{6\gamma}, \; n_{AV} = \frac{B}{4} + \frac{C}{4\gamma}, \; n_{BE} = \frac{A}{2} + \frac{D}{6\gamma}, \text{ and } n_{BV} = \frac{3B}{4} - \frac{C}{4\gamma}. \quad (11)$$

$$\text{Thus, we yield } \pi_A = \frac{(\gamma B + C)^2}{8\gamma} - \frac{(3\gamma A - D)^2}{18\gamma}, \pi_B = -\frac{2AD}{3} - \frac{(3\gamma A - D)^2}{18\gamma}, \text{ and}$$

$$PS = \frac{(\gamma B + C)^2}{8\gamma} - \gamma A^2 - \frac{D^2}{9\gamma}. \quad (12)$$

The results of Proposition 2 can be inferred from Eqs. (11) and (12).

Proposition 2: (a) Companies A and B are competitors and form a duopoly market; each company has their own consumer group. Therefore, the equations indicating that $n_{AE} > 0$, $n_{BE} > 0$, $n_{AV} > 0$, and $n_{BV} > 0$ can only be established when $3\gamma A > D > \gamma A > 0$ and $\gamma B > C > 0$. (b) Under the condition of mutual competition, companies A and B adopt different pricing strategies. Compared with the products of company B, company A's products provide consumers with higher utility ($\alpha_{AE} > \alpha_{BE}$) and therefore are more expensive. (c) When consumers favor company A's PDPs, they also consider company A's VDPs to have high quality because of consumer empathy. However, consumers still prefer free products. Thus, the free VDPs provided by company B have a relatively large advantage in the market share ($\Delta n_V = n_{AV} - n_{BV} = (C - \gamma\beta)/2\gamma < 0$).

Type III market

In a Type III market, company A adopts a non-chargeable pricing strategy for VDPs(i.e., $P_{AV} = 0$). By substituting Eqs.5 and 6, the profit-maximizing P_{AE} , P_{BE} , and P_{BV} are derived by

$$P_{AE} = \frac{D}{3} - \gamma A,\ P_{BE} = -\frac{D}{3} - \gamma A, \text{ and } P_{BV} = \frac{\gamma B}{2} - \frac{C}{2}. \quad (13)$$

Simultaneously, $n_{AE} = \frac{A}{2} - \frac{D}{6\gamma}$, $n_{AV} = \frac{3B}{4} + \frac{C}{4\gamma}$, $n_{BE} = \frac{A}{2} + \frac{D}{6\gamma}$, and $n_{BV} = \frac{B}{4} - \frac{C}{4\gamma}$. (14)

Thus, we yield $\pi_A = -\frac{(3\gamma A - D)^2}{18\gamma}$, $\pi_B = \frac{(\gamma B - C)^2}{8\gamma} - \frac{(3\gamma A - D)^2}{18\gamma} - \frac{2AD}{3}$, and

$$PS = \frac{(\gamma B - C)^2}{8\gamma} - \gamma A^2 - \frac{D^2}{9\gamma}. \quad (15)$$

The results of Proposition 3 can be obtained by examining Eqs. (14) and (15).

Proposition 3: (a) Companies A and B are competitors and form a duopoly market; each company has their own customer group. Therefore, the equations indicating that $n_{AE} > 0$, $n_{BE} > 0$, $n_{AV} > 0$, and $n_{BV} > 0$ can only be established when $3\gamma A > D > \gamma A > 0$ and $\gamma B > C > 0$. (b) When $3\gamma A > D > 0$, then $\alpha_{AE} > \alpha_{BE} > 0$, indicating that company A's products provide consumers with higher utility than those of company B do ($\alpha_{AE} > \alpha_{BE}$). Therefore, company A sets higher prices for PDPs than company B does. However, company A does not acquire a correspondingly large market share. (3) Consumers evaluate company A's PDPs more favorably than those of company B; because of consumer empathy, they also prefer the VDPs provided by company A. In addition, the VDPs provided by company A are free, attracting more consumers to purchase this product ($n_{AV} > n_{BV}$).

Type IV market

In a Type IV market, both companies adopt a chargeable pricing strategy for VDPs. The profit-maximizing P_{AE}, P_{BE}, P_{AV}, and P_{BV} are derived by

$$P_{AE} = \frac{D}{3} - \gamma A,\ P_{AV} = \gamma B + \frac{C}{3},\ P_{BE} = -\frac{D}{3} - \gamma A, \text{ and } P_{BV} = \gamma B - \frac{C}{3}. \quad (16)$$

Simultaneously, we yield

$$n_{AE} = \frac{A}{2} - \frac{D}{6\gamma},\ n_{BE} = \frac{A}{2} + \frac{D}{6\gamma},\ n_{AV} = \frac{B}{2} + \frac{C}{6\gamma}, \text{ and } n_{BV} = \frac{B}{2} - \frac{C}{6\gamma}. \quad (17)$$

Thus, we yield

$$\pi_A = \frac{(3\gamma B - C)^2}{18\gamma} + \frac{2BC}{3} - \frac{(3\gamma A - D)^2}{18\gamma},\ \pi_B = \frac{(3\gamma B - C)^2}{18\gamma} - \frac{(3\gamma A - D)^2}{18\gamma} - \frac{2AD}{3}, \text{ and}$$

$$PS = \gamma B^2 + \frac{C^2}{9\gamma} - \gamma A^2 - \frac{D^2}{9\gamma}. \quad (18)$$

The results of Proposition 4 can be determined by examining Eqs. (17) and (18).

Proposition 4: (a) Companies A and B sell the same types of product; thus, they establish product prices based on the principle of profit maximization and attract their own consumers. The equations indicating that $n_{AE} > 0$, $n_{BE} > 0$, $n_{AV} > 0$, and $n_{BV} > 0$ can only be established when $3\gamma A > D > \gamma A > 0$ and $\gamma B > C > 0$. (b) Although consumers consider company A's PDPs to have high added value, their purchase intention is negatively influenced by the high prices of the products. Thus, despite providing high product quality or possessing brand awareness, company A cannot acquire a large market share in the PDP market ($n_{AE} < n_{BE}$). (c) Regarding VDPs, company A sets higher prices but still has more consumers than does company B ($n_{AV} > n_{BV}$). The reasons are as follows: (i) Consumers consider company A's PDPs to have high added value; however, they purchase VDPs for the sake of convenience (in other words, the consumers have brand loyalty toward company A). (ii) Consumers consider company A's VDPs to have high added value; although company A's VDPs are more expensive than are those of company B, the consumers' purchase intention is unaffected (indicating that brand awareness outweighs price difference). (iii) Because consumers exhibit brand preference and loyalty toward company A and evaluate company A's products more positively, they remain willing to purchase the product despite its high price (signifying that brand preference outweighs product prices).

Static analysis of the digital product market

This section analyzes how pricing strategies set by companies affect the four types of market conditions regarding market share, operational efficiency, overall industry, and overall social welfare.

Comparative analysis of market share

Companies A and B are competitors in a duopoly market and sell homogenous products. Regarding market share, when VDPs become chargeable, the effect of PDPs on market share is no significant. However, VDP market share is highly correlated with pricing.

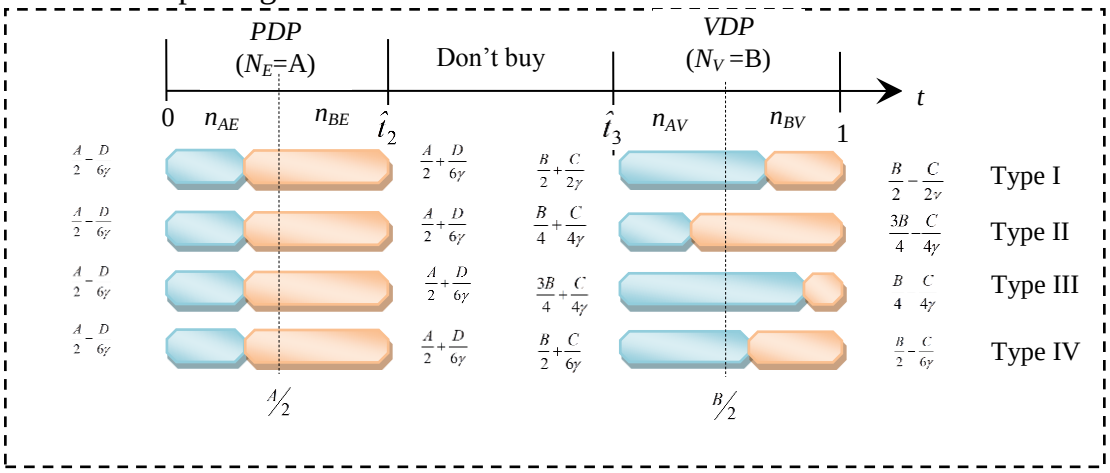

Fig.2 Comparison of market shares

The comparison of market share (Fig. 2) reveals the following findings.(1) Companies tend to differentiate themselves from competitors through value adding. In other words, companies appear not to engage in price competition. Thus, the pricing strategies of companies A and B are similar in Type I and IV markets, whereby both companies adopt either the same chargeable or non-chargeable pricing strategy. In situations in which products are chargeable by both companies, the effect on market conditions in a Type IV market is relatively no significant compared with that in a Type I market. (2) When competitors adopt different pricing strategies, the perceived value of the product is no longer the sole influencing factor for consumers. Types II and III indicate that market share is primarily affected by pricing, followed by the value of the product.

Comparative analysis of operational efficiency

The comparison of operational efficiency (Fig. 3) reveals the following findings.(1) If company A were to adopt the pricing strategy of company B, then company A would have a more competitive advantage and larger profit margin.(2) Profit maximization is the ultimate pursuit of companies; from this perspective, charging consumers for their purchases is fair. For company A, adopting a chargeable policy for VDPs is the optimal operational strategy regardless of what its competitors do. However, when γB>C, company A would benefit even more if its competitor were to

adopt a chargeable pricing strategy.(3)For company B, if γB>C and company A adopts a chargeable pricing strategy, then it is optimal to sell its products at no cost to the consumer. By contrast, if γB<C and company A adopts a chargeable pricing strategy, then it is more favorable to adopt the competitor's strategy.

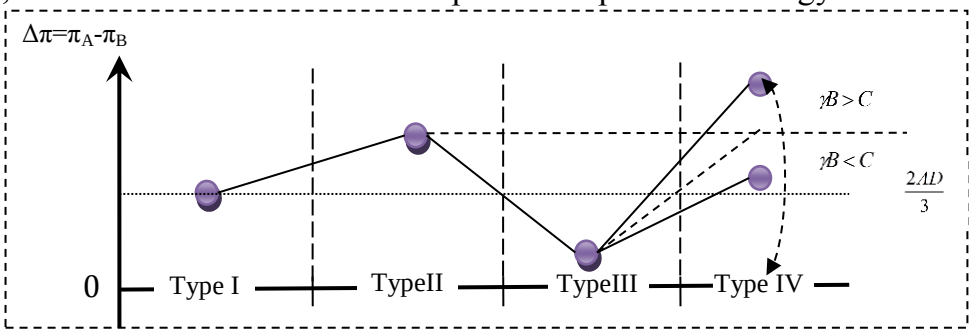

Fig. 3 Comparison of operational efficiency

When current products become unprofitable and new products face uncertainty, it is perhaps possible to strive for stronger competitiveness and survivability and to become the market leader. This situation creates an opportunity to work toward profitability amid competition and the building of brand awareness.

Industry analysis

The pursuit of sustainable development in an industry leads to competitive behavior. Competitive behavior, however, can affect the industry positively and serve as a source of growth for society. From the four types of market in this article, we can see that: (1)In competitive industries, the development of a new product that is highly popular among consumers must be complemented by a suitable pricing strategy. Providing the product for free leads to losses and does not make operational sense for companies. (2)In a price competition, reduced or exempted pricing by low-end (as perceived by consumers) companies can compensate for the misbalance of information between consumers and companies and prevent the formation of a lemon market (Gresham's law). Therefore, the conditions in Type II, whereby company A adopts a chargeable pricing strategy and company B adopts a non-chargeable strategy, are more beneficial to the overall industry than those of Type III, whereby company A adopts a non-chargeable pricing strategy and company B adopts a chargeable one. (3) Although Type II is more beneficial to the industry than Type III is, the non-chargeable pricing strategy adopted by B for VDPs in this market is detrimental to the company and leads to the eventual transformation of the market into Type IV. When the backdrop of a duopoly competition is considered, Type IV is the optimal model for the overall industry.

Social welfare analysis

Social welfare is aimed at increasing the overall standard of living and social perceptions. Thus, although the final conclusion does not always satisfy the expectations of both parties, it is nevertheless beneficial overall. The study results

revealed that social welfare and producer surplus are consistent with each other (i.e., $SW_4 > SW_2 > SW_3 > SW_1$).

Conclusion

With the prevalence of the Internet, companies encounter multiple challenges regarding the diversity of marketing channels and must adopt new growth techniques to achieve sustainable development. Thus, competitors' strategies regarding marketing, pricing, and distribution become critical considerations. In a market where short-term profitability is difficult, the ability to stay viable until profitability is achieved becomes a substantial challenge.

Consequently, the following conclusions are deduced from the study's theoretical model: (1)Brand value is a positive factor in determining product pricing, though it is not an absolute determining factor because the pricing strategy of competitors must also be considered. Low-end competitors using a penetration-pricing strategy (low or free initial-entry pricing) affects the market share of high-end competitors, though it also facilitates increasing the profitability of high-end brands. (2)When two companies provide slightly differentiated products, product pricing can be based on the quality of the products, and information is equally shared between the company and the consumers. Under such circumstances, the higher pricing of high-quality products and the lower pricing of low-quality ones fulfills the principle of fairness. (3)Consumer choice is primarily based on product pricing, followed by brand awareness and value. However, from the perspective of the overall industry and social welfare, it is optimal for both companies to adopt a chargeable pricing strategy. The considerable gap caused by free VDPs cannot be filled using the income earned from PDPs and is detrimental to the overall well-being of a company.

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