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iPhone or Kindle: Competition of Electronic Books Sales

Li Chen
University of Connecticut, lchen@business.uconn.edu

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Li Chen
University of Connecticut
lchen@business.uconn.edu

ABSTRACT

With the technical development of the reading equipment, e-books have witnessed a gradual and steady increase in sales in recent years. Last year, smart phones announced to be able to perform additional functions as e-book reading devices, making it possible for retailers selling e-books for smart phones (SPR) such as iPhone to differentiate with those selling e-books for specific reading equipment (SER) such as Amazon Kindle. We develop a game theory model to examine the competition between SER and SPR retailers. We derive the equilibrium price and analyze the factors that affect equilibrium outcomes under both scenarios of complete and incomplete information. Our results suggest that reduced cost due to inconvenience of reading e-books over iPhone lowers equilibrium prices, and reduced cost of specific reading equipment leads to more intense price competition. Under information asymmetry, we show that SER retailers will increase the price at equilibrium.

Keywords

E-book, information goods, game theory, price competition

INTRODUCTION

Recently, the publishing industry has experienced a successive decrease of revenue together with a grim forecast for the near future. According to Association of American Publishers (AAP), book sales drop 2.4% in year 2008. However, e-books have witnessed an outgrowth in sales. According to the Association of American Publishers (AAP), in November 2008, "e-book sales jumped up by 108.3 percent for the month ($5.1 million), reflecting an increase of 63.8 percent for the year". In fact, e-books have seen a steady growth in these years. According to the International Digital Publishing Forum, e-book wholesale revenue has reached almost 14 million in the third quarter of 2008, almost an increase of 75% compared with the same period of 2007 (see Figure 1).

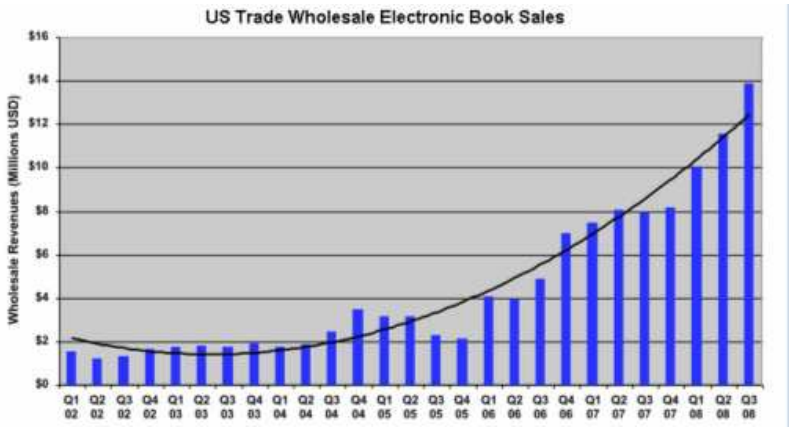

Figure 1. US Trade Wholesale E-book Sales

A couple of reasons may explain the gradual but steady development of e-book sales. First, technology advancements, especially that of new reading equipment for e-books such as Amazon Kindle and Sony e-book reader, make it possible for a higher level of reading comfort. For example, high-definition technologies have made reading a more enjoyable experience, and broadband technologies have turned downloading e-books into an easy job. In addition, newly developed equipments such as Amazon Kindle are capable of storing a large number of e-books, which relaxes the constraint of e-book storage. Second, selling e-books provides an additional revenue source for book retailers. Retailers typically need to face high fixed costs in obtaining published books, such as the copyright expenses charged by publishers and/or authors. However, once the books are transformed into digital format, the marginal distribution costs are extremely low. Thus, any additional way that can help increase revenue such as distributing published books in e-book format will be a big plus. Third, publishing e-books provides a lower barrier for independent writers to build reputation and distribute their work as self-publishers.

Last year, smart phones such as iPhone, announce that they can involve new software to perform additional functions as e-book reading devices, providing an alternative for e-book readers. For example, beginning July 14, 2008, Lexcycle Stanza, a software program for reading e-books, digital newspapers, and other digital publications, was available for users of Apple iPhone and iPod Touch. Lexcycle Stanza enables electronic books and articles to be displayed in an easy-to-read (and adjustable) format and allows pages being turned with the flick of a thumb. Up till now, the software has supported a variety of e-book formats including Mobipocket, PalmDoc, HTML and PDF. In addition, Stanza allows users to manage a library of books through a customizable reading interface on iPhone and iPod Touch. Right now, the list of Stanza's partners includes many online e-books such as BooksOnBoard, Fictionwise, and Smashwords and continues to increase. On those websites, consumers can purchase e-books and download them wirelessly on their iPhones.

The appearance of smart phones as e-book reading devices may lead to an enormous change of the industry. Compared with previous e-book readers such as Amazon Kindle and Sony e-book readers, the distribution channel of smart phone has the following advantages: First of all, phones are routine equipment for millions of people. One typical example of smart phones is iPhone, the total sale of which reached 13 million in the forth quarter of 2008. Therefore, consumers purchasing e-books for smart phone do not need to purchase specific equipments for e-book reading, especially for those people who are unwilling to carry a lot of items. Second, although the price is similar for newly released books for both smart phones such as iPhone and specific reading equipment such as Amazon Kindle, it is relatively cheaper for royalty-free classical books on iPhone which usually cost just 99 cents or even less for each. Finally, for those independent publishers, the large population of iPhone users is surely much more attractive compared with that of readers using specific e-book reading equipments (see Table 1 for a brief comparison of smart phone, Amazon Kindle and Sony e-book readers). However, we assume that the trade-off of reading e-books on smart phone will incur a lower level of reading comfort, or say a higher inconvenience even if the content of books have little difference compared with the e-books for specific reading equipment

Smart Phone	**Amazon Kindle**	**Sony e-book Reader**
		
More than 13 million iPhone alone till the forth quarter 2008**	Around 380,000*	Around 300,000*

Table 1. Comparison of E-book Reading Equipment

*The sales figures are estimates in Kharif
** The sales figure is from Wikipedia http://en.wikipedia.org/wiki/Iphone

In our opinion, the entry of smart phones such as iPhone will lead to new competition in the e-book industry. With smart phones, there are two types of retailers for e-book industry: retailers selling e-books for specific reading equipment (SRP) and retailers selling e-books for smart phone. Essentially, this is a competition between retailers who sell homogenous information goods (e-books) but for different ultimate consumption devices. Although it is important for companies to derive their strategies under competition, few research have investigate competition of e-books due to different reading devices. In this research, we aim to make an exploratory study on the pricing strategies of retailers under this competition scenario. In specific, we want to answer the following questions:
(1) What is the optimal price of both types of retailers in selling e-books?
(2) Are there any differences in the scenario of complete and incomplete information competition?

LITERATURE REVIEW

In this paper, we use e-books as our research subject. Different from many recent research studying e-books from the aspect of copyright and education (Shiratuddin 2005; Srisaard 2005), our paper is based on e-books' properties as information goods. In a broad sense, e-books can been seen as one type of information goods whose content consumed in digital format such as digital music, videos, and software products (Asvanund, Clay, Krishnan, and Smith 2004; Fan, Kumar, and Whinston 2009). Because of information goods' unique property of digitalized content, related issues are frequently studied such as the sharing of information goods (Asvanund et al. 2004), the bundling of information goods (Geng, Stinchcombe, and Whinston 2005) and the sampling of information goods (Wang and Zhang 2007). In our paper, we examine the issue of competition of retailers of e-books based on different consumption devices (SER and SPR). Before the emergence of the Internet, conventional distribution and consumption of reading is based on physical books. The Internet makes it possible for book retailers selling and distributing physical books and e-books. Previous research has illustrated the advantages of online distribution compared with traditional channels (Dewan, Freimer, and Seidmann 2000). However, the competition we are interested in is on the consumption stage rather than the distribution stage. Here, we examine the competition where there are two different e-books due to the reading device of them, which is new to the industry of e-books.

Our research is related to the literature on competition games of firms selling homogenous and similar products. In our research context, there are two competing firms who sell e-books with the same content but through different consuming equipment. Previous research in economics often applies Hotelling's approach to model competition, which assumes that consumers' valuation lies on a continuous base. In the research of competition information goods sales, Bakos and Brynjolfsson (2000) discuss several different types of competition, including upstream and downstream, and bundler and single information good (Bhargava and Choudhary 2008). Another research stream related to our work is optimal pricing of information goods. Chen and Seshadri (2007) find optimal pricing strategies for a seller who faces heterogeneous customers in both marginal willingness to pay and chances of getting information goods other than the seller. Sundararajan (2004) investigate strategies of optimal pricing for information goods under the scenario of incomplete information.

What distinguishes our work are the follows: (1) We focus on pricing strategies of firms selling e-books whose competitions are based on two different consumption devices of information goods. The distinct property of competition in our research context is that the quality of the products, e-books are in some senses determined by the reading equipment of consumers, which is different from previous research contexts such as physical goods. (2) We extend our model to the incomplete information scenario and analyze how factors such as inconvenience cost, cost of specific reading equipment and customer keeping ratio affect companies pricing strategies. Our research is relevant to the e-book industry which is experiencing a rapid and fundamental transformation, and provides important managerial implications for firms to effectively manage the competition to maximize their revenue. The research discussed above ranges over different aspects of our study, however, to the best of our knowledge, the issue of competition based on two different consumption devices of homogeneous information goods, especially e-books, has not been studies before.

MODEL

We develop a game theory model of e-books sales under competition between two companies: Company one who sells e-books that need specific e-book reading equipment (SER) to read and company two who sells e-books that need smart phone (SPR) to read. The parameters and decision variables in our model are presented in Table 2 which will be further explained in this section.

Decision variables		Parameters	
p_1	Price of e-book from SER retailer	c_1	Cost due to inconvenience of SER retailer
p_2	Price of e-book from SPR retailer	c_2	Cost due to inconvenience of SPR retailer
z	Customer-keeping level	c_e	Cost of specific reading equipment
		α	Discount factor of equipment cost
		β_1	Coefficient of variable cost of SPR retailer
		r	Customer kept ratio

Table 2. Decision Variables and Parameters

In our research setting, customers make their decision of which company they want to buy e-books from based on their utilities. We assume that the e-books offered by both companies have little difference in terms of content, but have certain level of quality difference in terms of reading comfort, or say inconvenience. We denote the cost due to inconvenience when reading through specific reading equipment such as Amazon Kindle as c_1 and the cost due to inconvenience of reading smart phones such as iPhone as c_2. We suppose $c_1 < c_2$, which implies that the customers will lose more convenience reading e-books on smart phones such as iPhone compared with reading e-books on specific reading equipments such as Amazon Kindle. The rationale of making such assumption comes from the features of two different equipments. Compared with iPhone, Kindle has a larger reading screen, delivers higher-contrast letters on an off-white background, and resembles more like real book page.

We assume that consumers have heterogeneous sensitivity ϖ to such cost due to inconvenience. This technique of modeling competition is consistent with the literature (Fan et al. 2009). We also assume that the customers share a homogeneous valuation of v for e-books. In addition, as mentioned earlier in the Introduction Section, consumers who want to get an e-book from SER retailer needs to purchase a specific e-book reader with the cost c_e. The reason we assume that consumers will not purchase an iPhone special for e-book reading is that smart phone is most often used for making calls and sending short messages. The utility of reading e-books on iPhone only consists a small portion of the total utility of using smart phones. We also have not involved in bundling reading equipment with e-books sales because it is not common in real business practice that one consumer will get a reading equipment for free or together with purchase of an e-book.

In our model, customers choose to purchase e-books from one of the two retailers based on their personal preference of price and sensibility of the cost due to inconvenience. Suppose that a customer's utility is $u_1 = v - p_1 - \alpha c_e - \varpi c_1$ for purchasing e-books from SER retailer and $u_2 = v - p_2 - \varpi c_2$ for purchasing e-books from SPR retailer. The constant $\alpha, \quad 0 < \alpha < 1$ refers to the expected discounted factor for the cost of reading equipment on each e-book. A higher value in α implies that the equipment is not often used and for each e-book the discounted cost of using the equipment is high while a lower value in α implies that the equipment is frequently used and for each e-book the discounted cost is low (companies can estimate α based on historical consumption records).

We assume that a customer is indifferent between the two e-book providers if $u_1 = u_2$, or say, $v - p_1 - \alpha c_e - \varpi c_1 = v - p_2 - \varpi c_2$. Solving this equation leads to $\varpi^* = \dfrac{p_1 + \alpha c_e - p_2}{c_2 - c_1}$, which is the indifferent point for customers. When $\varpi > \varpi^*$, the customers will choose to buy books from SER retailer because $u_1 > u_2$. When $\varpi < \varpi^*$, the customers will choose to buy books from SPR retailer because $u_1 < u_2$ (see Figure 2).

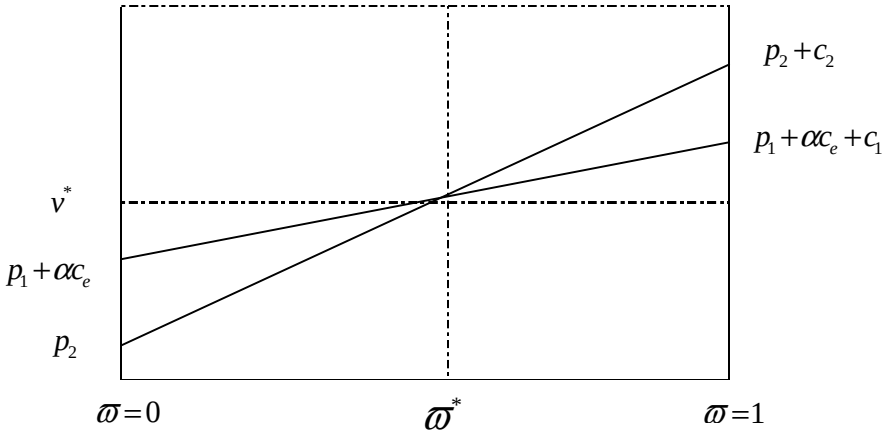

Figure 2. Demand for E-books

Here, we assume that there are demands for both iPhone-based e-books and Kindle-based e-books. As shown in Figure 2, when $v = v^*$, $\varpi = \varpi^*$, $u_1 = v^* - p_1 - \alpha c_e - \varpi^* c_1 = 0$ and $u_2 = v^* - p_2 - \varpi^* c_2 = 0$. Therefore, it is straight forward to find the value of $v^* = \frac{p_1 c_2 + \alpha c_e c_2 - p_2 c_1}{c_2 - c_1}$. As shown in Figure 2, consumers with low sensitivity to cost due to inconvenience $\varpi \in \left[0 \quad \varpi^*\right]$ will choose SPR retailers while consumers with high sensitivity to cost due to inconvenience $\varpi \in \left[\varpi^* \quad 1\right]$ will choose SER retailers. Thus, we find demand for the two types of e-books retailers using sensitivity as an index:

(1) The demand for company one is:

$$D_1 = 1 - \varpi^* = 1 - \frac{p_1 + \alpha c_e - p_2}{c_2 - c_1}$$

(2) The demand for company two is:

$$D_2 = \varpi^* = \frac{p_1 + \alpha c_e - p_2}{c_2 - c_1}$$

Consistent with the assumption of zero marginal cost of information good, the profit function for company one is:

$$\pi_1 = D_1 p_1 = \left(1 - \frac{p_1 + \alpha c_e - p_2}{c_2 - c_1}\right) p_1$$

For company two (SPR retailers), we need to consider the additional cost of keeping customers. Since SPR retailers do not directly distribute e-books to consumers, they need to use the network of communication companies such as AT&T who are also responsible for various type of services such as phone calls (both incoming and outgoing), short messages, other digital content such as images. Therefore, the higher level SPR retailers want to keep their customers to avoid complaints such as low download speed and high rate of transfer failure, the higher the maintenance cost. For simplicity, we denote this cost $f(z)$ in the linear form of level of keeping customers, $f(z) = \beta_0 + \beta_1 z$, where z is the level of keeping customers. The higher the level of keeping customers is, the higher the maintenance cost.

Thus, the profit function of company two is

$$\pi_2 = D_2 p_2 - \beta_0 - \beta_1 z$$

subject to $\frac{z}{D_2} \geq r$, which means that the customer-keeping ratio needs to be no less than r, $0 < r < 1$.

In our paper, we establish a game theory model for competition between SER and SPR retailers. Consistent with previous literature (Fan et al. 2009), we model the game in two stages. In stage one, both companies simultaneously set their prices. In stage two, the company that distributes e-books over smart phones chooses the customer keeping level. The rational here is that prices of e-books are visible to consumers immediately and frequent change of prices may bring negative effect to retailers such as discouraging current and potential consumers. On the other hand, the customer keeping level is in some senses an internal decision and can be adjusted based on market response of competition.

Competition under the Scenario of Complete Information

In the competition under the scenario of complete information, we assume that both companies set the price simultaneously in the first stage and the company selling e-books through iPhone sets up the service level in the second stage. Using backward induction, we solve the second stage first. Since we assume that price and demand are given in the second stage, the problem can be simplified to

$$\underset{z}{Min} \quad \beta_0 + \beta_1 z$$

subject to $\frac{z}{D_2} \geq r$

For any given demand, it is straight that the solution is $z = rD_2$. Substituting the equation back into SER and SPR retailer's profit functions, we can solve the equilibrium for the price competition game. The results are summarized in Proposition 1.

Proposition 1. The SER retailer's optimal price and SPR retailer's optimal price and the service level establish a Nash equilibrium, with p_1^*, p_2^* and z^* given as follows:

$$p_1^* = \frac{2c_2 - 2c_1 - \alpha c_e + \beta_1 r}{3}$$

$$p_2^* = \frac{c_2 - c_1 + \alpha c_e + 2\beta_1 r}{3}$$

$$z^* = \frac{r}{3(c_2 - c_1)}(c_2 - c_1 + \alpha c_e - \beta_1 r)$$

For brevity, the proof is relegated to the Appendix. The comparative static for the equilibrium results is presented in Table 3.

Variables	c_1	c_2	α	c_e	β_1	r
p_1^*	-	+	-	-	+	+
p_2^*	-	+	+	+	+	+
z^*	?	?	-	-	-	-

Table 3. Comparative Statics Results

* + increase; - decrease; n/a, no effect, ? no closed-form solution

We first examine the equilibrium prices. We find that the equilibrium prices of e-books for both SER and SPR retailers will decrease when the cost due to inconvenience of reading e-books from SER retailers (c_1) and/or from SPR retailers (c_2) increases. This result suggests that when consumers who use smart phone incur lower cost due to inconvenience, then the equilibrium price of both the e-books sold by SER and SPR e-book retailers will go down accordingly. In another word, the market price will decrease as the technology related to smart phone e-book reader improves and reading e-books on smart phones such as iPhone is less significantly different from reading e-books on specific reading equipments. We also find out that when the price of equipment (c_e) decreases, the price of SER e-books will increase and the price of SPR e-books will decrease. This result implies that as the equipment goes cheaper, the SER retailer will take this advantage and charges higher price on e-books, but the SPR retailer needs to lower the price to remain competitive. Previous literature suggests that distinct differentiation may lead to reduced price competition. In some sense, our finding is consistent with this result since a lower cost of e-book reading equipment refers to a less distinct differentiation. In addition, our results show that equilibrium prices also increase in customer-keeping ratio (r) and variable cost of service (β_1) of the SPR retailer. This is intuitive because both customer-keeping ratio and variable cost of service contributes to the marginal cost of SRP retailers. Naturally, a higher marginal cost leads to a higher equilibrium price for SPR retailers.

As for the optimal customer-keeping level, comparative statics results suggest that a higher customer-keeping ratio (r) or a higher variable cost of service (β_1) will lead to a lower level of SPR retailer's customer keeping level. An inspection of the SPR retailer's profit and cost function suggests that as the cost for IT capacity goes up and service level goes up, SPR retailer need to lower the customer-keeping level expectation to guarantee the smooth operation of the business. An interesting finding is that as the SER equipment price and usage ratio goes up, it is optimal for SPR to decrease the customer-keeping level expectation. This result may imply that when the differential effect in price is not significant, there is risk for SPR retailers to invest to keep a high level of customer-keeping expectation.

Competition under the Scenario of Incomplete Information

We extend the analysis in the previous subsection and analyze the game under the scenario of incomplete information, or say information asymmetry. We assume that the SER retailer has incomplete information of SPR retailer's cost function that the SPR retailer's variable cost for customer-keeping is β_{1H} with probability γ, and is β_{1L} with probability $1-\gamma$, where $\beta_{1L} < \beta_{1H}$. This setup leads to a Bayesian game which is frequently used in models of incomplete information. Assume that SPR retailer will choose either a high price or a low price. When it chooses high price strategy, its profit function is $\pi_2^H = D_2^H p_2^H - \beta_0 - \beta_1^H z$, and when it chooses low price strategy, its profit function is $\pi_2^L = D_2^L p_2^L - \beta_0 - \beta_1^L z$.

We follow the same game structure in the previous subsection and we assume that SER retailer wants to maximize its profit by choosing the optimal price. In another word, the SER retailer's objective function is as follows:

$$\underset{p1}{Max} \quad \pi_1 = D_1^H p_1 \gamma + D_1^L p_1 (1-\gamma)$$

where D_1^H and D_1^L refers to the demand of the SER retailer as a function of price of both retailers.

Solving the above game of incomplete information, we have the following result:

Proposition 2. The solution to the Bayes Nash Equilibrium of the SER and the SPR e-book retailers is as follows:

$$p_1^* = \frac{2}{3}\left[\left(c_2 - c_1 - \frac{1}{2}\alpha c_e\right) + \frac{\gamma}{2}\beta_1^H r - \frac{\gamma}{2}\beta_1^L r + \frac{1}{2}\beta_1^L r\right]$$

$$p_2^{H*} = \frac{1}{3}\left[\left(c_2 - c_1 + \alpha c_e\right) + \frac{\gamma}{2}\beta_1^H r + \frac{3}{2}\beta_1^H r - \frac{\gamma}{2}\beta_1^L r + \frac{1}{2}\beta_1^L r\right]$$

$$p_2^{L*} = \frac{1}{3}[(c_2 - c_1 + \alpha c_e) + \frac{\gamma}{2}\beta_1^H r - \frac{\gamma}{2}\beta_1^L r + 2\beta_1^L r]$$

$$z_H^{\ *} = \left(\frac{r}{c_2 - c_1}\right)\frac{1}{3}\left[(c_2 - c_1 + \alpha c_e) + \frac{\gamma}{2}\beta_1^H r - \frac{3}{2}\beta_1^H r - \frac{\gamma}{2}\beta_1^L r + \frac{1}{2}\beta_1^L r\right]$$

$$z_L^{\ *} = \left(\frac{r}{c_2 - c_1}\right)\frac{1}{3}\left[(c_2 - c_1 + \alpha c_e) + \frac{\gamma}{2}\beta_1^H r - \frac{\gamma}{2}\beta_1^L r - \beta_1^L r\right]$$

We can see that at the equilibrium of the scenario of incomplete information, the SER retailer's optimal price under competition will be higher than the scenario of complete information because $p_1^{incomplete} - p_1^{complete} = \frac{\gamma}{3}\left(\beta_1^H r - \beta_1^L r\right) > 0$.

This result reveals that under the scenario of information asymmetry, SER retailers will tend to increase the price of their e-books. One explanation is that since there is uncertainty in the strategies SPR retailers will take, charging a higher price helps SER retailers to differentiate themselves with SER retailers and capture potential customers.

CONCLUSION

The introduction of smart phone in this industry may bring a significant transformation to the whole industry. This research uses a game theory approach to examine competition brought by this issue. We distinguish our research by modeling the competition as a two-stage game between two retailers who differentiate with each other by selling e-books for different reading devices: Smart phones such as iPhone or special equipment such as Amazon Kindle. We derive the equilibrium price and analyze the factors that affect equilibrium prices under both scenarios of complete and incomplete information. Our results suggest that equilibrium prices decrease in cost due to inconvenience of reading e-books. We also find that reduced cost of specific reading equipment and information asymmetry leads to more intense price competition.

Our research provides important managerial implications to retailers of information goods. First, under competition of homogenous goods but on different consumption devices, a company who wants to lower the intensity of competition needs to narrow the difference of reading experience of consumers through different reading equipment. Second, retailers under incomplete information are likely to differentiate with his or her competitors by prices. Although our research is particularly relevant to the e-book industry, it can be extended to other types of information goods on different equipments such as playing digital music or videos through either Apple iTouch or PDA.

This research has several limitations. First, we assume that both companies fix price in the same stage. In reality, companies can take the strategy of waiting to see their competitor's behavior before they set their prices. Second, we only consider the scenario in which the companies sell either e-books for smart phones such as iPhone or e-books for specific reading equipment such as Kindle. For future research, it will be interesting to investigate scenarios of competition where companies sell both e-books for smart phone and e-books for specific reading equipment. We also observe that there are new models of selling e-books online, such as providing a free first chapter to customers. Investigation on those new business models can also be an interesting extension of this paper. For example, Kindle recently has announced a reader application for iPhones, which makes Amazon a seller of both Kindle-based e-books and smart phone-based e-books. In that scenario, we will have competition between sellers of both type of e-books and cannibalization is going to be an issue.

APPENDIX

Proof of Proposition 1

We first get the profit function for both the SER and the SPR e-book retailers as follows:

$$\pi_1 = \frac{c_2 - c_1 + p_2 - p_1 - \alpha c_e}{c_2 - c_1}$$

$$\pi_2 = \left(p_2 - \beta_1 r\right)\left(\frac{p_1 + \alpha c_e - p_2}{c_2 - c_1}\right) - \beta_0$$

Then we take the first-order condition of both profit functions

$$\begin{cases} \dfrac{\partial \pi_1}{\partial p_1} = \dfrac{c_2 - c_1 + p_2 - 2p_1 - \alpha c_e}{c_2 - c_1} = 0 \\ \dfrac{\partial \pi_2}{\partial p_2} = \dfrac{p_1 + \alpha c_e - 2p_2}{c_2 - c_1} + \dfrac{\beta_1 r}{c_2 - c_1} = 0 \end{cases}$$

The last step is to solve the previous equations simultaneously to get the optimal solutions of prices and find the optimal result of z accordingly.

Proof of Proposition 2

Similar to the proof of Proposition 1, we first get the profit function for the SER retailer, the SPR retailer with high price strategy and low price strategy:

$$\pi_1 = D_1^H p_1 \gamma + D_1^L p_1 (1-\gamma) = \frac{p_1 \gamma (c_2 - c_1 + p_2^H - p_1 - \alpha c_e)}{c_2 - c_1} + \frac{p_1 (1-\gamma)(c_2 - c_1 + p_2^L - p_1 - \alpha c_e)}{c_2 - c_1}$$

$$\pi_2^H = \left(p_2^H - \beta_1^H r\right)\left(\frac{p_1 + \alpha c_e - p_2^H}{c_2 - c_1}\right)$$

$$\pi_2^L = \left(p_2^L - \beta_1^L r\right)\left(\frac{p_1 + \alpha c_e - p_2^L}{c_2 - c_1}\right)$$

Then, we obtain the first order conditions of the previous profit functions and solve them simultaneously to get the solutions.

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