Selling or Renting: Competition of Electronic Book Retailers

ABSTRACT

Online e-book retailers used to sell e-books directly to consumers. Motivated by the successful subscription/renting programs by other operators of information goods such as video stream and TV (e.g. Netflix.com), many e-book retailers have recently introduced their subscription-based program. This study presents an economic approach to the analysis of the competition between an e-book retailer using selling method (EBS retailer) and an e-book retailer using subscription/renting method (EBR retailer). We derive the equilibrium outcomes and analyze the factors that affect the equilibrium outcomes under both scenarios of complete and incomplete information. Our results suggest that larger difference between the EBS retailer and the EBR retailer leads to higher prices and an increased service level for EBR retailer. We find that factors such as quality of e-book subscription program, the EBR retailer's variable cost of service operation and usage rate will also affect equilibrium prices. Under information asymmetry, we show that the EBS retailer can adjust his price based on his estimation of the EBR retailer's strategy. We extend the model by incorporating factors such as value depreciation and hybrid pricing model, and most of our results will hold.

Keywords: E-book, information goods, subscription model, price competition

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1. INTRODUCTION

Subscription model (also known as leasing, or renting model) becomes mainstream phenomenon in recent years among retailers of information goods and services whose content are consumed in digital format (Rosenblatt 2015). Several well-known examples are the online video streaming services (e.g. Netflix.com), online music (e.g. Spotify.com), software as a service (e.g. Salesforce.com), and online storage services (e.g. Dropbox. com). Under the subscription model, users rent information goods or services from the retailers by paying periodic subscription fee rather than buying the perpetual ownership. For example, Netflix consumers have access to thousands of movies and TV shows online with a monthly fee ranging from $7.99 to $11.99[1].

Recently, e-book retailers started embracing the subscription/renting model. Oyster started its e-book subscription program in September 2013. Working with more than 1600 publishers, its program Oyster Unlimited allows a registered member to rent from more than one million books it stores in its library for $9.95 a month (Harvey 2014)[2]. Unlike traditional library, there is no due date for the e-books borrowed under the subscription/renting program. However, this doesn't mean consumers can own the e-books they borrow. If a consumer cancels the subscription service, he or she can no longer access the titles saved before. Several e-book retailers quickly followed the trend. Scribd introduced a similar e-book subscription program in October 2013, allowing its members to have unlimited access to Scribd's library of e-books. Scribd added audio books into the program in November 2014 and comics in February 2015 to make the subscription program more attractive to consumers[3]. The giant online book retailer Amazon unveiled its e-books subscription program Kindle Unlimited in July 2014.[4] After signing up for this service, members of this program can have access of more than one million books including self-published e-books, and audiobooks on multiple reading devices with a flat monthly fee. A clever feature of Kindle Unlimited is that Amazon's voice technology enables its members to switch between listening to the audiobook version and reading the e-book version (Alter 2014). Therefore, a member can read the e-book at his free time and continue listening to the book when doing other work. Table 1 below summarizes current major e-book retailers using subscription model.

[1] www.netflix.com

[2] https://www.oysterbooks.com/help/about

[3] https://www.scribd.com/about

[4] http://www.amazon.com/gp/feature.html?docId=1002872331

Table 1. Summary of Major Retailers Offering E-book Subscription Services

	Kindle Unlimited	Oyster	Scribd
Price	$9.99 per month	$9.95 per month	$8.99 per month
Free trial (?)	30 days	30 days	14 days
App availability	Kindle devices, Android, iOS, Windows Phone and BlackBerry	Android, iOS and Kindle Fire	Android, iOS and Kindle Fire
Types of content	Audiobooks and e-books	E-books	Audiobooks, e-books, comics and PDFs
Size	1,000,000+	1,000,000+	1,000,000+

Recourse: CNET.com Amazon Kindle vs. Oyster vs. Scribd[5]

There are few reasons that e-book retailers are quickly adopting e-book subscription/renting model. First, success of companies such as Netflix (more than $6.7 billion revenue in 2015)[6] shows that subscription model becomes popular among consumers. Eric Stromberg, the chief executive of Oyster, said more people will accept the subscription model, just like they do with movie or music (Alter 2014). If the consume-all-you-can model works for online videos and music, why not mirror Netflix's model on e-books? Second, technology advancements, especially the e-book technologies have made e-book renting a feasible option for retailers. Books used to be in physical format only and can only be rent from libraries of the local community. Now retailers can distribute e-books instantly to a large number of readers over Internet without worrying about losing the procession of the e-books. For example, members of the subscription program cannot resell or rent again the e-books they get from the program. In addition, e-book reading becomes a much more pleasant experience on specific e-book reading devices such as Amazon Kindle and smart phones such as iPhone. Thus, e-book renting is an appealing choice for those heavy e-book readers. Third, e-book subscription programs are bolstered with partnership of publishers. For example, Oyster Unlimited has titles from more than 1600 publishers, including *Big Five* publishers such as HarperCollins, Simon & Schuster, and Macmillan Publishers (Harvey 2014). Amazon's Kindle Unlimited program also partners with publishers to incorporate popular titles such as "the Capital in the Twenty-First Century" and the entire "Harry Porter" series (Wood 2014), which makes the program attractive to e-book readers. In fact, some publishers such as HarperCollins think that the trend of books-by-subscription is inevitable for book industry (Brustein 2014). They also consider the e-book subscription programs as an opportunity to capture potential consumers for upcoming new books after they rent and read e-books from the same authors (Wood 2014).

Retailers' start embracing e-book renting model might portend significant changes in the e-book industry. From the aspect of economics, there will be a new type of competition between retailers of homogenous information goods (e-books)

[5] http://www.cnet.com/how-to/amazon-kindle-unlimited-vs-scribd-vs-oyster-e-book-subscriptions/

[6] http://www.google.com/finance

through different pricing models: the e-book retailer using selling model (EBS) and the e-book retailer using renting model (EBR). Obviously, this new phenomena asks the retailers to develop their own strategies in addition to those conventional ones of information goods such as the revenue strategy such as advertising (Fan et al. 2007), the product strategy such as bundling (Akcura and Altinkemer 2010), and marketing strategy such as sampling (Hu et al. 2010). However, there is a lack of rigorous research investigating the competition of e-book retailers due to different pricing models, and there are also no best business practices in the online publishing industry. In this study, we strive to close the gap by using an economic model to investigate the e-book subscription model and analyze the competition between EBS and EBR retailers in the market of e-books. To be more specific, we want to answer the following questions: (1) What are the optimal pricing strategies of both EBS retailer and EBR retailer? (2) How do factors such as variable cost of EBR retailer's service operation, quality of e-book subscription program, and the usage rate affect the retailers' pricing or service level? (3) Are there any differences between the scenarios of complete and incomplete information competition?

Using a two-stage game theory model, we aim to make an exploratory study on the competition between the EBS retailer and EBR retailer under both complete and incomplete information scenario. Our results suggest that larger difference between the EBS retailer and the EBR retailer leads to higher prices and an increased service level for EBR retailer. We also find that factors such as variable cost of EBR retailer's service operation, the quality of e-book subscription program, and the usage rate will play an important role in its strategy in the market. Under information asymmetry, we show that an EBS retailer can adjust his price based on his estimation of the EBR retailer's price. Most of our analysis results will hold when we incorporate factors such as value depreciation and hybrid pricing model into consideration. The publishing industry is experiencing a rapid and fundamental transformation with the quick development of e-books. Our research is expected to provide important managerial insights and operational policies for e-book retailers to effectively manage the competition and to maximize their revenue.

The rest of the paper is organized as follows. Section 2 contains a literature review of relevant research. In Section 3, we propose our research model of competition between EBS and EBR retailers in both complete information scenario and incomplete information scenario. For both scenarios, we study the EBS and the EBR retailers' pricing strategies and the EBR retailer's service level at equilibrium. We discuss model extensions when incorporating factors such as value depreciation and hybrid pricing model in section 4. The paper concludes in section 5 with research implications and directions for future research studies.

2. LITERATURE REVIEW

Our research is related to the literature on competition games of firms using different pricing methods for homogenous or similar products. Researchers have been engaged in a long standing debate as to which is better for companies: sell or subscribe/rent their products or services. Stokey (1981) and Bulow (1982) argued that a monopolist of durable goods will earn more profit by adopting renting model rather than selling model. However, other research showed that selling model for durable goods retailers is still viable under certain conditions. For example, Desai and Purohit (1998) claimed that a monopoly will benefit from selling if the depreciation rate is significantly higher for sold items than leased items. They also found that a combined strategy of selling and leasing is optimal if the depreciable rates for sold items and leased items are different.

In our research we study e-books which in a broad sense can been seen as one type for information goods rather than physical goods. In prior research on pricing methods of information goods and services, Jain and Kannan (2002) examined three types of pricing schemes of information access services, including connect time-based pricing, flat-rate pricing and subscription-based pricing. They found out that the online servers' choice of pricing methods is influenced by consumer's expertise and their valuation of the information. Choudhary (2007) studied software vendor's upgrading decision and showed that the SaaS (software-as-a-service) subscription model helps motivate vendor to increase quality and gain more profits. Zhang and Seidman (2010) examined the optimal pricing for a software vendor. After comparing the license model, the subscription model, and the hybrid approach, they suggested that the software vendor should provide both the license model and subscription model when the network effect is strong. Lyons et al. (2012) found that there are three major pricing plans for online services, one-time fixed fee, periodical fee plan, and a fee-for-services schedule. They then developed a model to predict rational consumers' choice and how a monopoly service provider can design his service offerings and the pricing plans. What distinguishes our study are the following: (1) Previous research mainly studies a monopoly company's decision on which pricing method to choose. Our study focuses on the competition scenario and the competing retailers' strategies when they come to different pricing model (selling versus renting). In our model, consumers' use of the products or the services is affected by the consumers' uncertainty cost of the two different pricing methods, which is different from previous research contexts such as physical goods. (2) We also extend our model to the incomplete information scenario and analyze how factors such as EBR retailer's variable cost of service, quality of e-book subscription program and customer usage rate affect retailers' pricing strategies.

Our research also contributes to the literature of online publishing industry. Before the emergence of the Internet, conventional distribution and consumption of reading is mainly based on physical books. The rapid development of information technologies makes it possible for book retailers to sell and distribute both physical books and e-books at the same time. One popular topic of prior studies is the influence of e-books' entering into the market on print books, especially the cannibalization of e-books sales on print books sales. For example, Hu and Smith (2011) working paper "The Impact of Ebook Distribution on Print Sales: Analysis of a Natural Experiment" studied the influence of e-books sales on print book sales using Amazon's sales data when it stopped releasing e-book version of new print books for six months. They showed that the delay of releasing e-books has not significantly changed the print book sales. However, they found that such delay seemed to have caused a significant drop in the sales of e-books and the total sales. Bounie et al. (2012) working paper "Superstars and outsiders in online markets: An empirical analysis of electronic books" studied the cannibalization of e-books sales on print books sales using data of best sellers in Amazon from November 2007 to July 2011. Their findings showed that the cannibalization effect of e-books on print book sales is more likely to occur in best sellers written by famous writers. Other topics in this literature include the impact of an e-book retailer's entering into the market, market asymmetry and the technology advancement (Jiang and Katsamakas 2014), consumers' attitude and preference toward e-books and print books (Chao et al. 2013), etc.

Our research differs from the previous studies of the online publishing industry in that it focuses on the competition of e-book retailers using different pricing models (selling versus subscription/renting). This is a new phenomenon in the online publishing industry and is different from the competition over retailers of information goods who mainly differ in quality of products and services or brand recognition. Our study expands the research on e-books which often focused on issues such as digital rights of e-books (Oestreicher-Singer and Sundararajan 2010 working paper "Are digital rights valuable? Theory and evidence from eBook pricing"), pricing models in e-book market (Kannan et al. 2010, Hao and Fan 2014), people's DIY publication of e-books (Fox and Patterson 2015), and the influence of e-book on book supply chain market (Li et al. 2015). While those prior studies also exam e-books retailers' pricing strategy, they haven't explored the problem from the aspect our paper has taken. Previous research has illustrated the advantages of online distribution compared with traditional channels (Dewan et al. 2000). However, the competition we are interested in is between different pricing methods in the consumption stage in the e-book market rather than between different distribution channels in the distribution stage such as online and off-line channels.

3. MODEL

We develop a game theory model of competition between two e-book retailers: Retailer one who sells e-books to consumers (EBS retailer) and retailer two who provides subscription service for e-book consumers (EBR retailer). We denote a representative e-book retail price of EBS by p_1, and that the price for EBR's subscription service by p_2. The representative price is often used in the literature to represent the different prices of a variety of products in the same genre (Hao and Fan 2014). We assume that consumers have different levels of uncertainty costs of accessing e-books. Since books are generally considered as experience goods, consumers usually can only decide whether the book has met the expectation after they finish reading. We denote the consumers' cost due to uncertainty from EBS retailer as c_1 and the consumers' cost due to uncertainty from EBR retailer as c_2. We assume $c_1 > c_2$, which implies that consumers buying e-books will have a higher uncertainty cost compared with those renting e-books. The rationale of making such assumption comes from the features of two different models. For the consumers of the EBS retailer, they usually cannot return the book after they find that they have not enjoyed reading it. On the other hand, consumers of the EBR retailer usually have a larger selection of e-books in its library to choose from (a catalog of more than one million books for the three major e-book subscription program in Table 1), and can quickly change the e-books they don't like for the ones they are more interested in. We assume that consumers have heterogeneous sensitivity ω to the cost of uncertainty.

In **our** research setting, customers make their decision on which retailer they want to get e-books based on their utilities. We assume that the customers' valuation of v for e-books is large enough to cover the whole market. Suppose that a customer's utility is $u_1 = v - p_1 - \omega c_1$ for getting e-books from the EBS retailer and $u_2 = v - \alpha p_2 - \omega c_2$ for getting e-books from the EBR retailer, where α ($0 < \alpha < 1$) refers to the expected discounted factor for the subscription fee for one representative e-book. A lower value in α indicates that the subscription service is frequently used and for each representative e-book the discounted cost is low (companies can estimate α based on historical consumption records). Therefore, the discounted factor actually can serve as an index of quality of the e-book subscription program, with a lower value of α implying a higher quality of the program. The parameters and decision variables in our model are presented in Table 2.

Table 2. Decision Variables and Parameters

Decision variables		Parameters	
p_1	Price of a representative e-book from EBS retailer	c_1	Consumers' cost due to uncertainty of EBS retailer
p_2	Price of subscription service from EBR retailer	c_2	Consumers' cost due to uncertainty of EBR retailer
Z	Service level from EBR retailer	α	Discount factor of subscription service cost on a representative e-book
		β_1	Coefficient of variable cost of service operation for EBR retailer
		r	Usage rate

We started our analysis by computing the demand of e-books from both EBS and the EBR retailers. Here, we assume that there are demands for both EBS retailer and EBR retailer, which makes the competition between the two retailers possible. We suppose a consumer is indifferent between the two e-book retailers if $u_1 = u_2$, or say, $v - p_1 - \omega c_1 = v - \alpha p_2 - \omega c_2$. Solving this equation leads to $\omega^* = \frac{\alpha p_2 - p_1}{c_1 - c_2}$, which is the indifferent point for consumers for both retailers. When $\omega < \omega^*$, the consumers will choose to buy e-books from EBS retailer because $u_1 > u_2$. When $\omega > \omega^*$, the consumers will choose to rent e-books from EBR retailer because $u_1 < u_2$ (please see the demand segmentation of consumers in Figure 1).

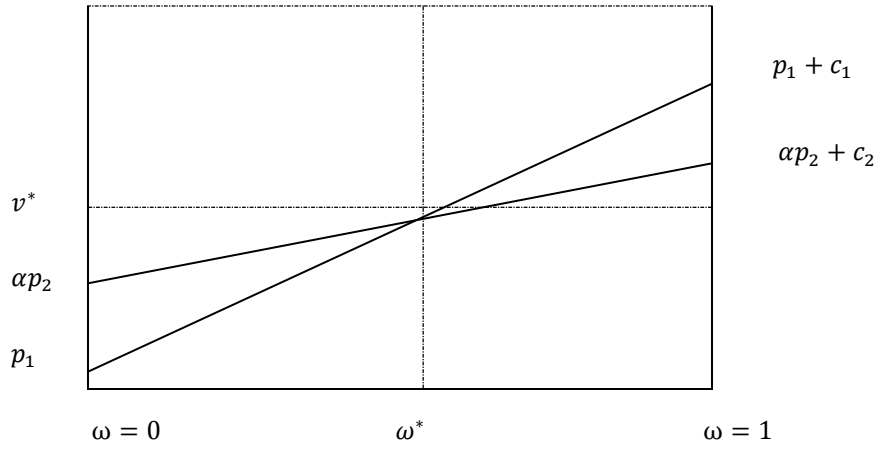

Fig. 1. Demand for E-books

Based on Figure 1, we are able to find demand for the two types of e-books retailers using sensitivity of cost of uncertainty as an index:

(1) The demand for EBS retailer is:

$$D_1 = \omega^* = \frac{\alpha p_2 - p_1}{c_1 - c_2}$$

(2) The demand for EPR retailer is:

$$D_2 = 1 - \omega^* = 1 - \frac{\alpha p_2 - p_1}{c_1 - c_2}$$

Consistent with the assumption of zero marginal cost of information good in the literature (Fan et al. 2007), the profit function for EBS retailer is:

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

For the EBR retailer, we need to consider the cost of service operation to satisfy his consumers. For example, EBR subscription program members usually expect to have quick access to the e-book library and promptly find what they want. In addition, similar to public library services, EBR subscription program allows members to borrow and return multiple e-books from time to time. To keep the guaranteed service level, EBR retailer needs to invest in and maintain the system to avoid consumers' complaints such as low download speed, high rate of transfer failure, long waiting time, and the difficulty of getting help when using the subscription program. All of these costs can be combined into service operation cost. For simplicity, we denote this cost in the linear form $f(z) = \beta_0 + \beta_1 z$ where z refers to the service level. The higher the service level is, the higher the service operation cost will be. Therefore, the EBR retailer wants to find optimal service level to maximize his revenue.

Thus, the profit function of company two is

$$\pi_2 = D_2 p_2 - \beta_0 - \beta_1 z = \left(1 - \frac{\alpha p_2 - p_1}{c_1 - c_2}\right) p_2 - \beta_0 - \beta_1 z$$

In our paper, we establish a game theory model for competition between EBS and EBR retailers. Consistent with previous literature (Desai and Purohit 2009, Zhang and the Seidman 2010), we model the game in two stages. In stage one, both EBS and the EBR retailers simultaneously set their prices. In stage two, the EBR retailer chooses the service level. The rational here is that prices of e-books and e-book subscription program are visible to consumers immediately and frequent changes of these prices may bring negative effect such as discouraging current and potential consumers. On the other hand, the EBR retailer's service level is an internal decision and can be adjusted based on market response of competition.

3.1 Competition under the Scenario of Complete Information

In the competition under the scenario of complete information, we assume that both EBS and EBR retailers set the price simultaneously in the first stage and the EBR retailer 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 the following

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

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

where r refers to the rate of consumers using the subscription/renting service, $0 < r < 1$.

For any given demand, it is straight that the solution is $z = rD_2$. Substituting the equation back into EBS and EBR retailer's profit functions, we can solve the equilibrium prices for both retailers and the service level for the EBR retailer. The results are summarized in Proposition 1.

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

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

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

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

Please see the Appendix for proof.

Our next two propositions present the impact of factors such as EBR retailer's variable cost of service operation, quality of subscription program, and the usage rate on the equilibrium outcome in Proposition 1.

Proposition 2. *The optimal prices for both EBS and EBR retailers will increase with the difference of consumers' uncertainty cost between the two retailers, the usage rate, and the variable cost of service operation. Please see the Appendix for proof.*

From the results of Proposition 2, we find that the equilibrium prices for both EBS and EBR retailers will increase in their difference in terms of the consumers' uncertainty cost ($c_1 - c_2$). In another word, the larger the difference of cost of uncertainty between EBS and the EBR retailers, the higher prices they can charge at equilibrium. This result is consistent with the literature which shows that higher level differentiation will lead to lower level of competition and higher equilibrium prices (Fan et al. 2009). In the online book industry, the e-book subscription program helps EBR retailers to effectively differentiate their service from EBS retailers by lowering the readers' uncertainty cost, which helps reduce price competition in this case. Our finding might explain why EBR retailers such as Scribd and Amazon continue to collaborate with publishers to expand their library size and incorporate audiobooks in their subscription programs. These efforts help further reduce the

cost of uncertainty of their programs to potential consumers and consequently make a more distinct differentiation between EBS and EBR retailers.

We also find that EBR retailer's equilibrium prices increase in usage rate (r) and variable cost of service operation (β_1), and decreases in the discount factor (α). This is intuitive because both usage rate and variable cost of service operation contribute to the marginal cost of the EBR retailer. Naturally, a higher marginal cost leads to a higher equilibrium price for the EBR retailer. As for the discount factor, a lower value implies that the e-book subscription program has a relatively high quality, which enables the EBR retailer to take advantage of this popularity and charge a higher price. The managerial insight here is that the EBR retailer needs to continue to improve the quality of its subscription program such as creating a better managed e-book catalog, developing advanced search function, and designing user-friendly interface. For example, we realize that one common comment from users of Amazon Kindle unlimited program is that its poorly designed interface of both the website and software application makes it difficult to search e-books (Wood 2014). Therefore, Amazon needs to improve the interface of its e-book subscription program to meet consumers' expectation.

Proposition 3. *The optimal service level for the EBR retailer will increase in the difference of consumers' uncertainty cost between retailers and the variable cost of service operation. However, the effect of usage rate remains uncertain. Please see the Appendix for proof.*

Proposition 3 results show that as the gap of consumers' uncertainty cost ($c_1 - c_2$) between EBS and EBR retailer becomes large; it is beneficial for the EBR retailer to increase the optimal service level. This result suggests that when the differential effect between EBS and EBR retailers becomes more significant, the EBR retailer should take the chance to attract potential consumers and to keep the current consumers by investing to keep a high level of service. The managerial insight of our finding is that the EBR retailer in this case needs to improve its service by reducing consumers' waiting time, facilitating consumers' downloading and returning e-books, and answering their questions when using its subscription program. We also find that a higher variable cost of service operation (β_1) will lower EBR retailer's optimal service level. An inspection of the EBR retailer's profit and cost function reflects that as the cost of service operation goes up, EBR retailer needs to reduce the service level to guarantee the smooth operation of the business. Another interesting finding in Proposition 3 is that the impact of usage rate (r) is uncertain. On one hand, a higher usage rate requires a higher level of service to keep the business operation going on properly. On the other hand, the EBR retailer might not be able to afford the cost to support a higher usage rate and has to lower the level of service.

3.2 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 EBS retailer has incomplete information on the EBR retailer's internal information: the variable cost of service operation. Different from the setting the previous subsection, he can only estimate that the EBR retailer's cost is β_{1H} with probability γ, and 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. We assume that the EBR retailer will choose either a high variable cost or a low variable cost. When choosing the high variable cost, the EBR retailer has a profit function $\pi_2^H = D_2^H p_2^H - \beta_0 - \beta_1^H z$, where p_2^H and z are its pricing and service level decisions. Similarly, when choosing the low variable cost, the EBR retailer has a profit function $\pi_2^L = D_2^L p_2^L - \beta_0 - \beta_1^L z$, where p_2^L and z are its pricing and service level decisions. We follow the same game structure and assume that EBS retailer wants to maximize its profit by choosing the optimal price. In another word, the EBS retailer's objective function is as follows:

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

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

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

Proposition 4. *The solution to the Bayes Nash Equilibrium of the EBS and the EBR e-book retailers under the scenario of information asymmetry is as follows:*

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

$$p_2^{H*} = \frac{1}{6\alpha}[4(c_1 - c_2) + (3+\gamma)\beta_1^H r + (1-\gamma)\beta_1^L r]$$

$$p_2^{L*} = \frac{1}{6\alpha}[4(c_1 - c_2) + \gamma\beta_1^H r + (4-\gamma)\beta_1^L r]$$

$$\mathrm{z}_H{}^* = \left(\frac{r}{c_1 - c_2}\right)\frac{1}{6}[4(c_1 - c_2) + (-3+\gamma)\beta_1^H r + (1\ -\gamma)\beta_1^L r]$$

$$\mathrm{z}_L{}^* = \left(\frac{r}{c_1 - c_2}\right)\frac{1}{6}[4(c_1 - c_2) + \beta_1^H r - (2+\gamma)\beta_1^L r]$$

Please see the Appendix for proof.

From the results of Proposition 4, we can see that at the equilibrium of the scenario of incomplete information, the EBS retailer's optimal price under competition can be either higher or lower than his price in the complete information scenario. Therefore, for the EBS retailer to compete effectively in the market, he needs to have accurate estimation. For

example, when his estimation is $\gamma\beta_1^H + (1-\gamma)\beta_1^L > \beta_1$, our finding suggests that under the scenario of information asymmetry the EBS retailer should increase the price of their e-books. This is because that since there is a high chance that the EBR retailer will have a higher variable cost of service operation, the EBS retailer should take a similar action to compete with the EBR retailer and maximize his revenue. This result might explain that the EBS retailers have developed individual pricing strategies based on their own estimation towards the entering of EBR retailers into the e-book market.

4. MODEL EXTENSION

In our preceding analysis, we have made a few simplifying assumptions. In this section, we explore how our results will be affected if we relax some of these assumptions.

4.1 Depreciation of E-book Value

In our analysis in the previous section, we assumed that there is no depreciation of the e-book value. Nevertheless, information goods including e-books might depreciate in value over time. To model this effect, we can add a depreciation factor to the utility function of both EBS and EBR retailers' consumers (a larger value of the depreciate factor implying slower depreciation). For EBS retailer's consumers, their utility function is $u_1 = \delta_1 v - p_1 - \omega c_1$. For EBR retailer's consumers, their utility function is $u_2 = \delta_2 v - \alpha p_2 - \omega c_2$. When the depreciation factors are the same $\delta_1 = \delta_2$, they will cancel out. Therefore, the prices at equilibrium remain the same, and our prior analysis results in the previous section will hold. In practice, however, we noticed that the e-book depreciation effect is less significant for the EBR consumers ($\delta_1 < \delta_2$) because they have access to a large library thorough the subscription program and can always exchange the books they currently have with the books they are more interested in. Based on the above assumption of different depreciation level of e-books, we get the following proposition.

Proposition 5. *When consumers have different level of e-book value depreciation, the EBS retailer's optimal price and EBR retailer's optimal price and the service level p_1^*, p_2^* and z^* are as follows:*

$$p_1^* = \frac{c_1 - c_2 + \beta_1 r + (\delta_1 - \delta_2)v}{3}$$

$$p_2^* = \frac{2(c_1 - c_2 + \beta_1 r) - (\delta_1 - \delta_2)v}{3\alpha}$$

$$z^* = \frac{r(c_1 - c_2 - \beta_1 r) - (\delta_1 - \delta_2)v}{3(c_1 - c_2)}$$

Please see the Appendix for proof.

Our analysis on Proposition 5 results focuses on the impacts of depreciation factors. Proposition 5 illustrates that a wider difference of depreciation factors will have different effect on the e-book retailers. For the EBS retailer, the larger the difference, the lower the equilibrium price will be. However, for the EBR retailer, a wider gap in depreciation factors will help him to increase the e-book subscription program price with a lower service level. This is because when the e-book consumers expect that the EBS retailer's e-books will depreciate faster, the EBS retailer is under pressure to drop the price to keep its consumers. Meanwhile, the EBR retailer is likely to take the advantage of the slow depreciation by charging a higher price while keeping a low service level to maximize his revenue. Our findings on of the major factors of the EBR retailer's subscription/renting program remain the same under the equilibrium outcome of proposition 5.

4.2 Hybrid Pricing Model

In the previous section, we focus on the scenario that one EBS retailer using selling model and another EBR retailer using subscription model. This setup helps us focus on the competition of e-book retailers due to different pricing methods while avoiding over-complexity of the model. In practice, we do see e-book retailers such as Amazon using a combination of both selling and subscription models. The competition between Amazon and another EBS retailer then can be divided into two segments: 1) competition between Amazon's subscription model and the EBS retailer's selling model, which is similar to the case discussed in the previous section, and 2) competition between two retailers' selling-based e-books programs. The second type of competition between the two retailers follows a typical example of Bertrand competition. Prior research suggests that this will lead the prices of both retailers' selling programs to zero (Lin et al., 2012). Since the two segments of market competition are separate, our major findings remained unchanged as in the first segment of competition.

5. CONCLUSION

Motivated by success of retailers of other information goods such as online video stream services (e.g. Netflix.com) and online music services (e.g. Spotify.com), e-book retailers recently are embracing the subscription model. This strategic decision is crucial because it brings a new type of competition between retailers using different pricing models into the industry. Using a two-stage game theory model, we study in this paper the competition between an EBS retailer who sells e-books and an EBR retailer who provides e-book subscription services. 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 increases in the gap of cost of uncertainty of consumers' reading e-books between the two retailers, the EBR retailer's variable cost of service operation, and the usage rate. Our results also suggest that for the EBR retailer, the

optimal service level increases in the gap of cost of uncertainty, but decreases in the variable of cost of service operation. Additionally, we find that a higher quality of e-book subscription program helps to reduce price competition. We also find that the impact of information asymmetry on EBS retailer depends on his estimation of EBR retailer's expected variable cost of service operation.

Our study contributes to the prior research in the following three aspects: First, our study enriches the e-commerce literature by exploring the e-book retailers' subscription-based model, which is quite different from the selling model e-book retailers widely used before. This is a new type of competition of retailers, and is fairly different from the competition due to different level of products' quality and the brand recognition. EBR retailers might want to differentiate from EBS retailers by reducing the cost of uncertainty of e-book readers. Second, we analyze how factors such as the EBR retailer's variable cost of service operation, the quality of e-book subscription program, and usage rate affect the retailers' decision of pricing and the service level. Third, our paper explores both the competition of complete and incomplete information setting. Exploring both these two settings gives us richer insights to examine the impact of the e-book subscription-based program. For example, whether EBR retailer can take advantage of the incomplete information setting, in light of our research results, depends on its expectation/judgement of EBS retailers pricing strategy. Retailers can benefit from this study by determining their pricing method and the corresponding pricing strategy.

Our research provides important managerial implications to both EBS and EBR e-book retailers in the following three ways. First, the EBR retailer can reduce the intensity of pricing competition by further differentiating with the EBS retailer. Therefore, EBR retailer's subscription programs need to enlarge their sizes and provide more attractive e-books (including audiobooks) to consumers. Second, EBR retailer needs to further improve the quality of their subscription programs and decrease the variable cost of service operation. To compete effectively in the market, they need to invest in developing advanced search functions, designing more user-friendly interfaces for their software applications, and improving their service quality by reducing users' waiting time and facilitating readers' using the service. These efforts will not only help improve consumers' satisfaction, but also benefit the EBR retailers with a higher price. Third, the EBS retailer under incomplete information scenario can adjust his price based on his accurate estimation of EBR retailer's variable cost of service operation. Thus, EBS retailer is able to modify his strategy in a dynamic market which changes rapidly from time to time. Although our research is particularly relevant to the e-book industry, it can be extended to other types of information goods with different pricing models such as digital newspaper, magazine and music, etc.

This research has several limitations. First, we focus on the competition of e-book sales in the publishing industry. In practice, most of retailers sell both print books and e-books. The pricing strategy of e-books, either for sale or for lease, might influence their print book sales too. Second, we assume that both retailers fix price in the same stage. Future research can investigate the scenarios in which retailers set prices in different stages. It will be interesting to investigate the EBR retailer's behavior after he observes his competitor's pricing in these settings. Third, we only consider the e-book retailers' strategies in the model. For future research, incorporating other important participants in the publishing industry such as publishers can also be an interesting extension of this paper. For example, what factors will influence publishers' decision of whether to join the subscription program on not. In addition, researchers might study whether the timing of releasing e-books into the program will help alleviate the publishers' worry on cannibalization effect.

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APPENDIX

Proof of Proposition 1

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

For EBS: $\pi_1 = \left(\frac{\alpha p_2 - p_1}{c_1 - c_2}\right) p_1$

For EBR: $\pi_2 = \left(1 - \frac{\alpha p_2 - p_1}{c_1 - c_2}\right) p_2 - \beta_0 - \beta_1 r \left(1 - \frac{\alpha p_2 - p_1}{c_1 - c_2}\right)$

Then we take the first-order conditions (FOC) of both profit functions

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

The second order conditions (SOC) for both functions show negative results.

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

We get $p_1^* = \frac{c_1 - c_2 + \beta_1 r}{3}$, $p_2^* = \frac{2(c_1 - c_2 + \beta_1 r)}{3\alpha}$, and $z^* = \frac{r(c_1 - c_2 - \beta_1 r)}{3(c_1 - c_2)}$

Proof of Proposition 2

The comparative static for the equilibrium results in Proposition 1 shows the following

Let $\Delta c = c_1 - c_2$, $\frac{\partial p_1}{\partial \Delta c} = \frac{1}{3}$, $\frac{\partial p_1}{\partial \beta_1} = \frac{r}{3} > 0$, $\frac{\partial p_1}{\partial r} = \frac{\beta_1}{3} > 0$

Let $\Delta c = c_1 - c_2$, $\frac{\partial p_2}{\partial \Delta c} = \frac{2}{3\alpha}$, $\frac{\partial p_2}{\partial \beta_1} = \frac{2r}{3\alpha} > 0$, $\frac{\partial p_2}{\partial r} = \frac{2\beta_1}{3\alpha} > 0$, $\frac{\partial p_2}{\partial \alpha} = -\frac{2(c_1 - c_2 + \beta_1 r)}{3} < 0$

Proof of Proposition 3

The comparative static for the equilibrium results in Proposition 1 shows the following

Let $\Delta c = c_1 - c_2$, $\frac{\partial z}{\partial \Delta c} = \frac{\beta_1 r^2}{3} > 0$, $\frac{\partial z}{\partial \beta_1} = -\frac{r^2}{3(c_1 - c_2)} < 0$, $\frac{\partial z}{\partial r} = \frac{c_1 - c_2 - 2\beta_1 r}{3(c_1 - c_2)}$

Proof of Proposition 4

Similar to the proof of Proposition 1, we first get the profit function for the EBS retailer and for the EBR retailer with both high cost strategy and low cost strategy:

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

$$\pi_2^H = \left(1 - \frac{\alpha p_2^H - p_1}{c_1 - c_2}\right) p_2^H - \beta_0 - \beta_1^H r \left(1 - \frac{\alpha p_2^H - p_1}{c_1 - c_2}\right)$$

$$\pi_2^L = \left(1 - \frac{\alpha p_2^L - p_1}{c_1 - c_2}\right) p_2^L - \beta_0 - \beta_1^L r \left(1 - \frac{\alpha p_2^L - p_1}{c_1 - c_2}\right)$$

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

Proof of Proposition 5

Similar to the proof of Proposition 1, we first get the profit function for the EBS retailer and for the EBR retailer.

For EBS: $\pi_1 = \left(\frac{\alpha p_2 - p_1 + (\delta_1 - \delta_2)v}{c_1 - c_2}\right) p_1$

For EBR: $\pi_2 = \left(1 - \frac{\alpha p_2 - p_1 + (\delta_1 - \delta_2)v}{c_1 - c_2}\right) p_2 - \beta_0 - \beta_1 r \left(1 - \frac{\alpha p_2 - p_1 + (\delta_1 - \delta_2)v}{c_1 - c_2}\right)$

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

$$\begin{cases} \dfrac{\partial \pi_1}{\partial p_1} = \dfrac{\alpha p_2 - 2p_1 + (\delta_1 - \delta_2)v}{c_1 - c_2} = 0 \\ \dfrac{\partial \pi_2}{\partial p_2} = \dfrac{\alpha(c_1 - c_2 + p_1 - 2\alpha p_2 + \beta_1 r - (\delta_1 - \delta_2)v\,)}{c_1 - c_2} = 0 \end{cases}$$

The second order conditions (SOC) for both functions show negative results.

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

We get $p_1^* = \frac{c_1 - c_2 + \beta_1 r + (\delta_1 - \delta_2)v}{3}$, $p_2^* = \frac{2(c_1 - c_2 + \beta_1 r) - (\delta_1 - \delta_2)v}{3\alpha}$, and $z^* = \frac{r(c_1 - c_2 - \beta_1 r) - (\delta_1 - \delta_2)v}{3(c_1 - c_2)}$