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Li Chen

Management, Fayetteville State University, Fayetteville, NC, United States., lchen@uncfsu.edu

Ruth King

Management, Fayetteville State University, Fayetteville, NC, United States., rking6@uncfsu.edu

Bee Yew

Management, Fayetteville State University, Fayetteville, NC, United States., byew@uncfsu.edu

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Analysis of eBook Lending: A Game-Theory Approach

Li Chen
Fayetteville State University
lchen@uncfsu.edu

Ruth C. King
Fayetteville State University
rking6@uncfsu.edu

Bee Yew
Fayetteville State University
byew@uncfsu.edu

ABSTRACT

Retailers have seen a steady and continuous increase in eBooks sales in recent years. A new strategy to further promote eBook sales is to provide eBook lending option. For example, Amazon.com allows Kindle eBook buyers to lend their eBooks for 14 days. The free eBook lending option will add additional utility to eBook buyers such as exchanging for other eBooks or reducing uncertainties of purchasing new books. However, such strategy might cannibalize the retailers' sales of print books. Using a game theory model, we explore whether the retailer will be better off to introduce the lending program. We derive the equilibrium price and identify the conditions under which the retailer can offer eBook lending option and generate more revenue.

Keywords

Electronic books, Lending, e-Commerce, Digital goods, Game theory.

INTRODUCTION

The Book publishing industry has been migrating to digitalization of contents and distributing them through online channels. While the sales of the publishing industry weaken in recent years, books in electronic/digital forms (eBooks) have seen a rapid and continuous increase in sales. According to Association of American Publishers (AAP), the US book publishing industry has experienced a 5.1% decline (from \$3,128.4 million in 2010 to \$2,967.5 million in 2011). However, eBook net sales in the first five months in 2011 have reached¹ \$473.1 million, an increase of 160.1% compared with the first five months of 2010. Figure 1 shows the trend of eBook sales from 2002 till the third quarter in 2010.

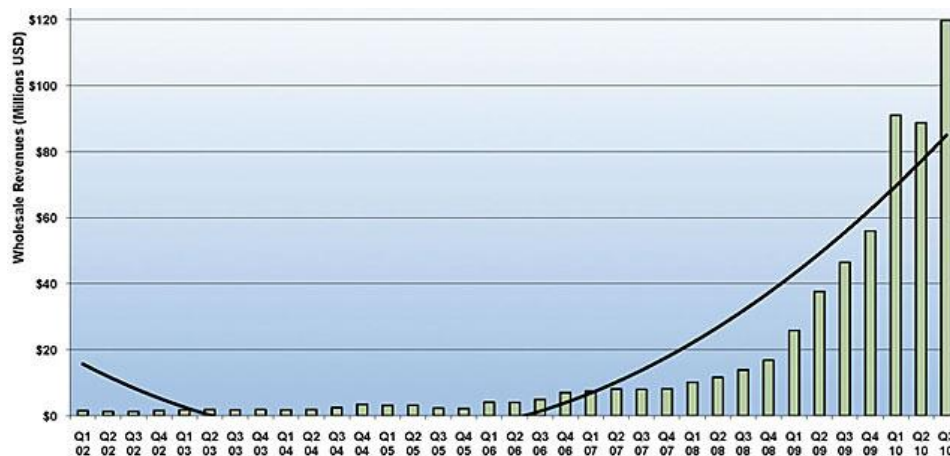


Figure 1. US Trade Wholesale E-book Sales

¹ <http://www.publishers.org/press/41/>

Meanwhile, the sales of eBooks by the online retailers have steadily surpassed the sales of physical books. For example, Amazon.com, a giant online book retailer, announced that its eBook sales had exceeded its physical books sales in May 2011. Two major reasons might help explain such growth. From the retailer's perspective, eBook, unlike print books, is a type of digital goods which allows retailers to mass-produce with extremely low marginal cost and can also be quickly distributed to a large number of consumers over online channels. From the consumer's perspective, the emergence of a myriad of smart reading equipment, such as Kindle, Nook and iPad, makes it more convenient for consumers to carry and read eBooks.

As the eBook market flourishes, competition escalates. Book retailers have to continuously develop new promotion and pricing strategy to stimulate eBook sales in the market. Recently, Amazon announced a 14-day eBook lending program to attract eBook buyers². According to Amazon, buyers of Kindle eBooks that are lendable are allowed to lend out their electronic books once for a period of 14 days. The borrower can read these books using Kindle or Kindle applications on other equipment such as PC, Mac, iPad, iPhone. However, the lender will not be able to read the Kindle book during the period when the book is lent out. Barnes & Noble's Nook had previously offered a similar program with its "LendMe" Technology.

The introduction of eBook lending program may change how consumers evaluate eBooks. In general, the additional eBook lending feature brings extra utility to buyers of eBooks. Compared with the situation where no such program is available, the current eBook buyers are able to exchange eBooks with other eBook readers for free for a period of time. This seems similar to the free trial of a software package provided by the software companies or a sample song provided by an online music retailer for consumers to listen. When consumers have an opportunity to read the eBook beforehand, they may decide to purchase it to keep, thus, increasing the sales of the physical books and eBooks. In addition, the benefit or utility resulted from the lending feature will increase as the buyers of the eBook increase. The more popular the book is, the higher the benefits. A large base of eBook buyers affords more eBooks to exchange and more sharing of reading experience and book reviews among readers. From the aspect of retailers, while offering eBook lending program has promising potential to increase eBooks demand, such strategy might have negative impact on the demand of physical books. When potential buyers are aware that they might be able to easily exchange eBooks with other eBook readers, they may choose to buy eBooks instead of physical books. In other words, the retailers might lose sales of print book sales because the eBook lending program "cannibalizes" the print books demand³.

In this paper, we explore the question whether it is strategically advantageous for retailers to offer the eBook lending option or to not offer the lending program so to avoid the negative "cannibalization" effect. Although we focus on eBooks, our research question is also relevant to other information goods such as digital magazine, movie and music. Specifically, our study addresses the following research questions: (1) Under what conditions can retailers generate higher revenue when offering eBook lending option? (2) What are the effects, and responding strategies of offering eBook lending option?

LITERATURE REVIEW

Our study focuses on examining whether eBook lending option will lead to cannibalization over print books under the scenario where a retailer is selling both print books and eBooks. Additionally, our study examines whether the additional consumer utility created by eBook lending option such as reducing uncertainty towards a new book will result in more eBook sales, thus, increase the retailers' profits that will compensate the loss of print book sales. There are three potential streams of research that may inform our current study.

The first one is the literature of multi-channel competition, especially the effect of cannibalization of digital goods (online channel) on physical goods (brick and mortar retailer channel). Deleersnyder et al. (2002) report that when electronic news is introduced, no significant influence is found on the physical newspaper sales. Similar insignificant results were found in the setting of physical music record sales (Biyalogorsky and Naik 2003) and in physical magazine sales (Simon and Kadiyali 2007). Recently, Danaher et al. (2011) showed that the online channel of iTunes did not significantly influence the physical DVD sales. Based on their results, our research focuses on whether additional utility (lending option) attached to the digital goods such as eBooks will also create insignificant cannibalization effect.

² <http://www.amazon.com/gp/help/customer/display.html?nodeId=200549320>

³ Another related issue is the replacement effect of eBooks demand on used print book market. Since our study focuses on the new print book market, we do not incorporate that in our analysis and discussion.

Another stream of literature to which our work is relevant can be found in software trial and digital goods sampling research. This line of research suggested that when consumer base expands, the resultant utility will increase which is based on the assertion of the "network effect" by Liebowitz and Margolis (1994). Cheng and Tang (2010) found that a monopoly company is more willing to offer free trial software when the network intensity is strong. Applying the concept the network effect, we speculate that the larger the consumer base, the higher utility eBook lending program will generate. Furthermore, research in digital goods sampling shows that free sampling can benefit the monopolistic seller even if the free samples are from third parties (Wang and Zhang 2009). Zhou and Duan (2011) studied the moderating effect of third-party information which includes reviews, sampling, and free-trials between internal word of mouth and sales. They found that while the third-party information positively influences the internal discussion, the free-sampling from the third party might cannibalize the future sales. eBook lending option is similar to the limited time software trial and digital goods sampling because the borrower of eBook can only keep it for a short period of time (e.g. 14 days) without accruing any costs. Thus, literature of free trial software and free digital goods sampling helps shed lights on our study of eBook lending be justified, not ragged.

The current online books sales research has basically focused on the issue of price differentiation of online book sales (Clay et al. 2002), the impact of online secondary market on new book sales (Ghose et al. 2006) and the entry of eBook seller under the condition of market asymmetries of print book and eBook markets (Jiang and Katsamakos 2010). However, our paper takes on a different aspect to address the effect of a retailer's introduction of an eBook lending program on the retailers' revenue and consumers' utility.

MODEL

We focus on the market in which a monopoly retailer sells both print books and eBooks. An eBook retailer might have a monopoly position because of an exclusive contract between the retailer and the publisher or between the retailer and book authors. The monopoly can also exist when the retailer has its unique channel presence such as Amazon Kindle or specific technological standards or formats. For example, the eBook lending program will be only available among Kindle eBooks. Another assumption we make for the retailers is that the price charged on print books p_r is higher than the price charged on eBooks p_e , $p_r > p_e$. This assumption comes from our observations that the prices of the new print books are in general higher than the prices of their eBook versions.

We make two assumptions for consumers' utility: (a) Consumers' utility of buying a print book is $\theta s_r - p_r$ and consumers' utility of buying an eBook is $\theta s_e - p_e - c$, where θ denotes the consumers' preference of a book following a uniform distribution over $[0, 1]$. The quality of print book is denoted as s_r and the quality of eBooks is denoted by s_e . Here, the quality of eBooks is broadly defined by features such as the reading convenience, the quality of eBook technology, etc. We denote c as the related cost of reading eBooks such as setting up eBook reading account, install eBook leading software, and an amortized cost of the expense on the reading equipment; (b) We assume $s_r - s_e > 0$ due to the fact that most readers are more familiar with print books, the comfortability level in reading print book is higher, etc.⁴ In addition, we assume that each consumer will choose one and only one of the followings: (1) Buy nothing, (2) Buy eBook, and (3) Buy print book. For simplicity we also assume that there are no repeated purchases for consumers. Table 1 summarizes the variables used in our model.

Notation	Definition
s_r, s_e	Quality of print books, quality of eBooks
p_r, p_e	Price of print books, price of eBooks
θ	Preference level of print books and eBooks
c	Related costs of reading eBooks
β	Coefficients of extra utility of eBook buyers

Table 1. Notation

⁴ In the long-run, the quality of print book might decrease because new books become used books with loss pages, marks, etc. Thus, our assumption might not be valid.

Case One: No eBooks Lending Case.

Case one serves as our benchmark scenario in which the retailer does not provide eBook lending option to consumers. Under this condition, the market is divided into three segmentations, one for each of consumers' choices (see Figure 2). Using different market segments for products with different quality levels is a frequently used framework in the literature (Cheng and Tang 2010, Jiang and Katsamakas 2010). The indifference point θ_1 refers to the point at which the utility of buying a print book is the same as buying an eBook: $\theta_1 = \frac{p_r - p_e - c}{s_r - s_e}$. Similarly, the indifference point θ_2 refers to the point at which the utility of buying an eBook is the same as buying nothing: $\theta_2 = \frac{p_e + c}{s_e}$. Thus, the demand of print books is $1 - \theta_1$ and the demand of eBook is $\theta_1 - \theta_2$.

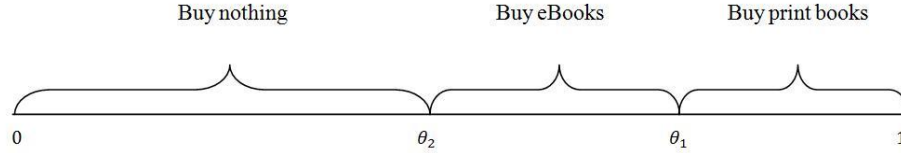


Figure 2. Market Segmentation with no eBook Lending

The retailers' goal is to maximize its revenue π which includes both the sales of physical books and the sales of eBooks.

$$\max_{p_e, p_r} \pi = (1 - \theta_1)p_r + (\theta_1 - \theta_2)p_e$$

Solving this optimization problem yields the following optimal prices for both eBook and print book: $p_r^* = \frac{s_r + c}{2}$ and $p_e^* = \frac{s_e}{2}$. Since $s_r + c > s_e$, $p_r^* > p_e^*$, which satisfy our previous assumption on the book prices. The revenue for the retailer who does not provide the free eBook lending program is $\pi^* = \frac{s_r(s_r - s_e) - c^2}{4(s_r - s_e)}$. This will serve as the benchmark for our next case.

Case Two: With eBook Lending Case

In this case, the retailer offers an eBook lending program which allows eBook buyers to lend their eBooks within a limited period of time. Consequently, the consumers' utility of buying an eBook will be affected. Consumers who purchase an eBook are able to lend the eBook in exchange for a new one. The eBook lending program also helps reduce consumers' uncertainty when they look to buy another book. Furthermore, the more a book is sought after, the higher utility the eBook lending option will bring to the eBook owners since it will be easier for them to find an exchange eBook. This phenomenon is similar to the network effect in the software free trial literature (Liebowitz and Margolis 1994). The market segmentation with the eBook lending program is shown in Figure 3. Note that although there are still three market segmentations, the demands of print books and eBooks will change due to the change of eBook buyers' utility.

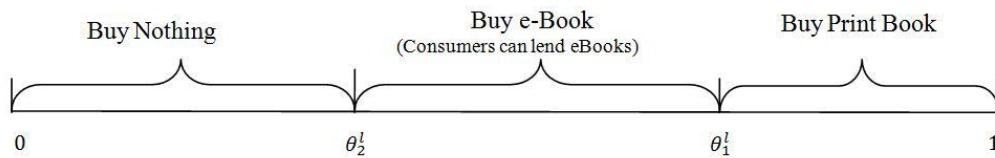


Figure 3. Market Segmentation with eBook Lending

We define the additional consumer utility from eBook lending option is $\beta(1 - \theta_2^l)$, which is linear with the consumer size in the market, $1 - \theta_2^l$. For the coefficient β , we first assume that $\beta < s_r - s_e$ which suggests that the

eBook lending option is not enough to cover the "quality" difference between print books and eBooks. We also assume $\beta < s_e/2$, which suggests that the effect of eBook lending is smaller than the effect of the quality of eBook, which is consistent with the fact that a reader's utility is mainly from reading the book. Thus, the utility of eBook consumers in this case is $\theta s_e - p_e - c + \beta(1 - \theta_2^l)$.

Following the similar approach in case one to compute the retailer's optimal revenue, we first determine two new indifference points using the following two equations: $\theta_1^l s_r - p_r^l = \theta_1^l s_e - p_e^l - c + \beta(1 - \theta_2^l)$, and $\theta_2^l s_e - p_e^l - c - \beta(1 - \theta_2^l) = 0$, where the superscript l refers to the case where the eBook lending option is available.

Solving these two equations together, we have $\theta_1^l = \frac{s_e(p_r^l - p_e^l - c) + \beta(s_e - p_r^l)}{(s_r - s_e)(s_e - \beta)}$ and $\theta_2^l = \frac{p_e^l + c - \beta}{(s_e - \beta)}$. Note that $0 < \theta_2^l < 1$. Thus, we have $c < s_e/2$. The demand for print book in this case is $1 - \theta_1^l$ and the demand of eBook in this case is $\theta_1^l - \theta_2^l$.

The retailer seeks to maximize its revenue by setting prices for both print books and eBooks:

$$\max_{p_r^l, p_e^l} \pi = (1 - \theta_1^l)p_r^l + (\theta_1^l - \theta_2^l)p_e^l$$

Lemma 1. When the retailer offers eBook lending option, the optimal price of the print book, the optimal price for the eBook and the retailer's optimal revenue at equilibrium are as follows:

$$p_r^{l,*} = \frac{(\beta^2 - (c + 2s_e - 2s_r) - 2s_e(s_r - s_e))s_r}{\beta^2 - 4(s_e - \beta)(s_r - s_e)}$$

$$p_e^{l,*} = \frac{\beta(c(s_e - 2s_r) - s_e(s_r - s_e)) + \beta^2 s_r - 2s_e(s_r - s_e)(s_e - c)}{\beta^2 - 4(s_e - \beta)(s_r - s_e)}$$

$$\pi^{l,*} = \frac{s_r(\beta(s_r - s_e + c) - s_e(s_r - s_e) - c^2)}{\beta^2 - 4(s_e - \beta)(s_r - s_e)}$$

Proof. Please see the Appendix.

DISCUSSION

In this section, we first discuss under what conditions the retailer can generate more revenue by offering the eBook lending option. We then discuss whether the introduction of eBook lending option do lead to the "cannibalization" effect on print books and the effect on the retailer's pricing strategy.

Now that we have calculated the retailer's optimal revenue in both case one (No eBook lending case) and case two (With eBook lending case), we are able to compute the revenue difference $\Delta\pi = \pi^{l,*} - \pi^*$.

Proposition 1. The retailer prefers to offer the free eBook lending option for a higher level of revenue when

$$2c < \beta < \frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}.$$

Proof. Please see the Appendix.

Proposition 1 illustrates the conditions that the retailer will realize more revenue when introducing eBook lending option: the coefficient β is greater than the lower threshold $2c$, and β is less than the upper threshold $\frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}$.

From the retailer's perspective, our results suggest that there is ample opportunity to offer the eBook lending option because the range of β can be widening.

For the lower threshold $2c$, the value of related cost of reading eBooks c is decreasing as the price of eBook reading equipment decreases, and eBook reading software and applications become more user-friendly and less challenging. For the upper threshold, the threshold value will increase when the quality difference of print books and eBooks $s_r - s_e$ decreases. Therefore, it seems that the condition of generating more revenue by introducing eBook lending program is easier to satisfy because the lower threshold will decrease while the upper threshold will increase, providing a wider range for β .

Our next proposition discusses whether eBook lending option creates "cannibalization effect" on the print book demand and its effect on both print book price and eBook price.

Proposition 2. When the retailer prefers to offer eBook lending option, part of the demand for its print books is cannibalized. However, the retailer is still able to realize higher revenue by charging a higher price for both its print books and eBooks.

Proof. Please see the Appendix.

Proposition 2 suggests that when the retailer offers the eBook lending option, the demand for its print books will be lower compared with the demand in the case of no eBook lending option, which shows the proof of "cannibalization effect". However, the retailer can neutralize such "cannibalization effect" by charging a higher price for both print book and eBook.

CONCLUSION

Our paper studies the effect of eBook lending option on print book sales and retailer's pricing strategy when introducing eBook lending option. While such promotional program can lead to a promising increase of eBook sales, it can cannibalize the print books sales. We contribute to the literature by examining the "cannibalization effect" from offering digital goods lending program, which is qualitatively different from prior research on physical and digital goods competition.

In this paper, we propose a game-theory model incorporating the effect of eBook lending program which was understudied in the previous literature of eBooks. We first derive the equilibrium prices for both cases: the case of no eBook lending option and the case of with eBook lending option. Our results suggest that without eBook lending, the equilibrium prices of both print book and eBook are lower than those in the case with eBook lending option. Our study also found that the trend to offer eBook lending option is in favor of the retailers. As the related cost of reading eBooks decreases and the quality gap of print books and eBooks becomes closer, the retailer will find it easier to satisfy the condition of offering eBook lending option for higher revenue. In addition, we found that the "cannibalization effect" did exist which is different from the current literature of "cannibalization" research. However, we also found that the retailer can still achieve profits by raising price for both print books and eBooks.

One possible extension to this paper is to study the impact of offering eBook lending option in the competition game setting such as in a duopoly setting. In the current market, monopoly might be difficult to achieve even for leading companies such as Amazon. It will be interesting to find out whether the option of offering digital goods lending will help companies achieve competitive advantage. Another interesting topic for future research is to examining the temporal effect of offering print book and eBook into market sequentially.

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APPENDIX

Due to the limits of the paper length, only brief proof is presented.

Proof of Lemma 1

Case Two: With eBook Lending

When the retailer offers the option of eBook lending, the revenue function is as follows:

$$\max_{p_r^l, p_e^l} \pi = (1 - \theta_1^l) p_r^l + (\theta_1^l - \theta_2^l) p_e^l$$

Based on the value of θ_1^l and θ_2^l , we have

$$\pi = \left(1 - \frac{s_e(p_r^l - p_e^l - c) + \beta(s_e - p_r^l)}{(s_r - s_e)(s_e - \beta)} \right) p_r^l + \left(\frac{s_e(p_r^l - p_e^l - c) + \beta(s_e - p_r^l)}{(s_r - s_e)(s_e - \beta)} - \frac{p_e^l + c - \beta}{(s_e - \beta)} \right) p_e^l$$

We first take the derivative on both p_r^l and p_e^l :

$$\frac{\partial \pi}{\partial p_r^l} = \frac{s_e(s_r - s_e + 2p_e^l - 2p_r^l + c) - \beta(s_r + p_e^l - p_r^l)}{(s_r - s_e)(s_e - \beta)} = 0$$

$$\frac{\partial \pi}{\partial p_e^l} = \frac{p_r^l}{s_r - s_e} + \frac{s_e p_r^l - s_e c - 2s_r p_e^l}{s_e(s_r - s_e)} = 0$$

Solving these two equations together, we get

$$p_r^{l,*} = \frac{(\beta^2 - (c + 2s_e - 2s_r) - 2s_e(s_r - s_e))s_r}{\beta^2 - 4(s_e - \beta)(s_r - s_e)}$$

$$p_e^{l,*} = \frac{\beta(c(s_e - 2s_r) - s_e(s_r - s_e)) + \beta^2 s_r - 2s_e(s_r - s_e)(s_e - c)}{\beta^2 - 4(s_e - \beta)(s_r - s_e)}$$

$$\pi^{l,*} = \frac{s_r(\beta(s_r - s_e + c) - s_e(s_r - s_e) - c^2)}{\beta^2 - 4(s_e - \beta)(s_r - s_e)}$$

Proof of Proposition 1

Based on the optimal revenue of the retailer in both cases, we are able to compute the difference $\Delta\pi = \pi^{l,*} - \pi^*$.

$$\Delta\pi = \frac{(\beta^2 - 4(s_e - \beta)(s_r - s_e))(c^2 - s_r(s_r - s_e)) - 4s_r(s_r - s_e)(\beta(s_r - s_e + c) - s_e(s_r - s_e) - c^2)}{4(s_r - s_e)(\beta^2 - 4(s_e - \beta)(s_r - s_e))}$$

Note that we need to make sure that there is positive demand for both print books and eBooks. Thus, we have the following two requirements:

Requirement (1): positive demand for print books, which is

$$\frac{2s_e(\beta(-s_r + s_e - c) + \beta(2s_r - s_e + c))}{\beta^2 - 4(s_e - \beta)(s_r - s_e)} > 0$$

Requirement (2): positive demand for eBooks, which is

$$\frac{s_r(2c - \beta)}{\beta^2 - 4(s_e - \beta)(s_r - s_e)} > 0$$

For the requirement (2), If $\beta < 2c$, then we need to have $\beta^2 - 4(s_e - \beta)(s_r - s_e) > 0$. However, since we assume $\beta < s_e/2$ and $\beta < s_r - s_e$, we have $\beta^2 - 4(s_e - \beta)(s_r - s_e) < 0$, which is conflicting to the expected result.

If $\beta > 2c$, we need to have $\beta^2 - 4(s_e - \beta)(s_r - s_e) < 0$.

For the requirement (1), we need to have $\beta < \frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}$. Thus, if $2c < \frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}$, we are able to identify the condition that $2c < \beta < \frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}$ which is true when $c < \beta/2$.

Since $2c < \beta < \frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}$ also satisfy the requirement that the difference of revenue $\Delta\pi > 0$, we claim that the retailer should offer the eBook lending option when this condition $2c < \beta < \frac{2s_e(s_r - s_e + c)}{2s_r - s_e + c}$ is satisfied.

Proof of Proposition 2.

For the price and demand change in the presence of eBook lending option, we analyze the situation in which the retailer provides the eBook lending option, the situation that condition in the previous Proposition is satisfied.

After some algebra simplifications, we find that the difference of price for print books under the no eBook lending case and the eBook lending case is greater than zero:

$$\Delta p_r^l = \frac{(\beta^2 - (c + 2s_e - 2s_r) - 2s_e(s_r - s_e))s_r}{\beta^2 - 4(s_e - \beta)(s_r - s_e)} - \frac{s_r + c}{2} > 0$$

Thus, the price of print books is higher in the eBook lending case.

Similarly, after some algebra simplifications, we find that the difference of price for eBooks under the no eBook lending case and the eBook lending case is:

$$\Delta p_e^l = \frac{\beta(c(s_e - 2s_r) - s_e(s_r - s_e)) + \beta^2 s_r - 2s_e(s_r - s_e)(s_e - c)}{\beta^2 - 4(s_e - \beta)(s_r - s_e)} - \frac{s_e}{2} > 0$$

Thus, the price of eBooks is higher in the eBook lending case.

As for the demand of print books, we compute the difference between the indifference point θ_1^l and θ_1 using the value at the equilibrium:

$$\theta_1^l - \theta_1 = \frac{2s_e(s_e + c - s_r) + \beta(2s_r - 3s_e - c) + \beta^2}{\beta^2 - 4(s_e - \beta)(s_r - s_e)} - \frac{(s_r - s_e - c)}{2(s_r - s_e)}$$

Based on the two inequalities: $\beta < s_r - s_e$, and $\beta > 2c$, we find that (1) $(s_r - s_e - c)(s_e(s_r - s_e) - \beta^2) > 0$, (2) $(s_r - s_e)(3s_e(s_r - s_e - c) - 2\beta(2s_r - 3s_e - c)) > 0$, and (3) $2(s_r - s_e)(2(s_e - \beta)(s_r - s_e - c) - \beta^2) > 0$. Based these inequalities, we are able to show that $\theta_1^l - \theta_1 > 0$ after some algebra simplification, which suggests that the indifference level for print books θ_1 in the no eBook lending case is smaller than that in the eBook lending case θ_1^l , implying that the demand of print books is lower in the eBook lending case. Therefore, the "cannibalization effect" does exist in the eBook lending case.