

# *An Analysis of Competition Strategies of Note-taking App Market based on Hotelling Model Theory*

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**Abstract:** Responses to COVID-19 have speeded the adoption of digital technologies by several years, resulting in flourishing Note-taking software markets. This paper studies the competition between the two most popular note-taking apps with horizontal differentiations for tablet users: Notability and GoodNotes 5. A modified Hotelling model is used where firms' persuasive advertisements will affect consumers' preferences, hence implicitly changing their location and their overall travel costs. A two-stage process is considered during firm competition when building up models. In the first stage, firms decide on the levels of advertisement of their products in the first stage, then set different prices to maximize profits. By solving this modified model and analyzing the equilibrium profits, the result shows that advertising leads to the same price tactics for the two firms. However, due to the existence of advertising strategies, firms have to bear the cost of this extra advertising competition. Therefore, both firms in the end will receive lower levels of profits compared to the standard model. Indicating that persuasive advertisement has caused Pareto inefficiency, leading to deadweight loss and reduced profit gains for the two firms.

**Keywords:** Terms-Note-taking apps market, oligopolistic competition, Hotelling model, game theory

## 1. Introduction

The COVID-19 pandemic triggered a massive and abrupt digital transformation in society. The pandemic compelled us to make a remarkable digital leap in school education. This necessitated significant changes not only come from the teachers and students, but also from their families, school administration, and society as a whole. Riding on the booming online learning demand amid COVID-19, more people started to use iPad with note-taking apps to support their continuation of learning during the pandemic.

Notability and GoodNotes5 are two of the most popular note-taking apps that available to iPad users. Users may use the software to take handwritten notes on an iPad, ideally using an Apple Pencil. Each app has its own set of advantages and disadvantages, making the decision to utilize one more of a personal preference than a scientific one. The product of the two firms are similar with some key differences, therefore, most consumers would only purchase one of the products based on their needs. Both Notability and GoodNotes5 accepts a variety of brush types and paper formats. However, Notability provides an audio recording feature - the audio and written notes are synced, so users may touch on what they typed and hear the audio at that same instant. While at the same

time, the design of GoodNotes5 is reminiscent of a binder and notepad management system. Folders can contain notebooks, making this app's organization a breeze. The notebooks are customizable and provide the feel of a real notebook. As a result, consumers who want to study utilizing the recording feature will choose Notability whilst others choose GoodNotes5 if they want attractive notes or to make diaries and schedules with multiple templates.

Since both applications offer similar features and share a similar target audience, they have been in direct competition to each other. Both applications had identical one-time purchase prices, with Notability costing \$10 and GoodNotes5 costing \$7. Notability has announced that it would switch to a subscription-based model since November 1st, 2021. Note that after one year, essential functionality included in original app purchases would stop working if users do not subscribe. As a result, to get "the full Notability experience" offered by the new version of the app now requires an annual per year subscription. Notability and its parent business, Ginger Labs, got a lot of coverage over the following several days as well as unfavorable social media comments on social platforms like Twitter, Instagram, and Reddit. Users generally expressed dissatisfaction with a corporation that was preparing to revoke access to something they believed they only had to pay for once. Whilst at the same time, the direct competitor of Notability - GoodNotes remains unchanged strategy with its original one-off purchased model. This led to a flood of favorable news of GoodNotes as a result of the negative coverage of its competitor. The Notability users then have been left frustrated. People who criticized Notability for its abrupt shift in pricing approach frequently praised GoodNotes for retaining its one-time purchase price of \$7. Goodnote's low one-time fee and positive media reputation have made it more competitive in note-taking app market. Recognizing this, GoodNotes even held a business strategy of rare 50 percent promotion on the current edition of their program: GoodNotes5.

Seeing this situation of the duopoly, advertising might boost consumer concentration around one of the items, hence increasing market price competition. The distinctions in products of Notability and GoodNotes cannot be easily evaluated in terms of quality. Consumers couldn't agree on which app is better since the main function is similar and their special features are targeting slightly different types of users for the two applications. Instead, consumers with different preferences would purchase simply based on the special needs for certain functions and characteristics. As introduced earlier, Notability is the better option for someone who only wants to take notes and get things done - especially on a "as needed" basis. Meanwhile, GoodNotes5 provides greater benefits when users want to viewing PDFs and marking material. For Notability and GoodNotes5, each of them has a positive market share with similar price. The firms can influence the distribution of customer tastes in favor of one of its goods by using different advertising strategies. It is noticeable that consumers of these two firms have already known the existence of the products. Therefore, by using persuasive advertising strategies, firms can make consumers to believe that their product is more suitable for them. We here use a game theoretical approach to analyze the competitive relationship between Notability and GoodNotes5. Due to reasons above, it is reasonable to use a Hotelling duopoly model with horizontal differentiation to study the competition between Notability and GoodNotes5.

## 2. Literature Review

Because of the Covid-19 pandemic, people have begun to work remotely and more tablets are being utilized consequently. As a result, there is a growing demand for note-taking software and hence encouraged more scholars to study on those note-taking apps. EM Stacy et al. have studied that it is necessary to research on learning outcomes with today's digital note-taking tools, especially as the possibility of a physio-cognitive link between writing and learning is considered [1]. Their research helped students and instructors make evidence-based decisions about which formats and techniques work best for learning. Hsu YH. and Chen CH. looked at the interface usability of regularly used functionality in existing note-taking applications (Apps) and provided some design ideas in their

studies [2]. EAM Reguera and M Lopez evaluate the influence of implementing a digital white-board in student involvement after the COVID-19 epidemic impacted educational practices [3]. This paper contributes to the studies on note-taking apps from the economic point of view using game-theoretical approaches.

Harold Hotelling developed Hotelling's linear city model in his article. He established the concepts of locational equilibrium in a duopoly, in which two companies must pick a location while taking into account the distribution and transportation costs of their customers. According to his theory, the features on which there is no widespread agreement are variations of products, modeled as horizontal differentiation [4]. So far, we haven't come across any relevant study on the market of note-taking apps, but there have been several practical implementations of Hotelling models in the past. For example, Wei Zhang and Shuaian Wang investigated the product difference of traditional parking lots versus sharedparking lots using the Hotelling model [5]. They developed several equilibrium studies, taking into account market competition, to calculate the equilibrium parking pricing of both parking lots. PS Calem and JA Rizzo created a variation of the Hotelling location model in which businesses compete on specialized mix and service quality, and used it to explore service mix differences in hospital marketplaces, focusing on the impact of key crucial features on specialization patterns [6]. Our contribution from this paper is to apply the Hotelling model to the market of remote note-taking apps. We chose two representative duopoly firms, Notability and GoodNotes, then investigated and modeled their market rivalry using Hotelling models.

The rest of this paper consists of the following parts. Section 2 formally introduces the model. Section 3 solves the Nash equilibrium strategies and outcomes for both firms. Section 4 analyses the equilibrium profits and compared it to the standard Hotelling model. Section 5 concludes the results and makes comments on possible future improvements of the model.

### 3. Model

Consider there are two note-taking apps in the market: Notability, denoted by firm  $i$ , and GoodNotes, denoted by firm  $j$ . Each firm offering their products to consumers who require to take notes on their device. Consumers with slightly different needs are uniformly located at  $x \in [0,1]$ , where 0 refers to that consumers rely more on recording and 1 refers to that consumers requires better organised folders. Thus the two firms locates at each end of the interval. Firm  $i$  locates at  $l_i = 0$ , and firm  $j$  locates at  $l_j = 1$ .

Because two firms offer very similar products, they compete each other by posting persuasive advertisements. Here we consider a two-stage process during firms competition. In the first stage, firms decide on the levels of advertisement of their products. We denote the effect of the advertisement as  $A_k$ , where  $k = i, j$ . The cost of posting advertisement is

$$C(A_k) = \frac{\lambda}{2} A_k^2$$

Those advertisements can make consumers feel that they are more close to their products (i.e. shifts their location). For a consumer who locates at  $x$  and receiving both advertisements, he shifts his location by the relative levels of the advertiments that both firms posts (i.e. his location now is  $-(A_i - A_j)$ ). For example, if  $A_i > A_j$ , this consumer's new location will be closer to 0, which means that the travel cost is cheaper if they buys from Notability.

Then, in the second stage, given those levels, firms set the prices  $p_i$  and  $p_j$  for their products to maximize their profits.

Suppose consumer has all received both advertisements. Then consumer's utility if he buys from firm  $i$  is given by the following expression. We define  $\Delta A \equiv A_i - A_j$

$$u_i = \begin{cases} v - p_i - t(x - \Delta A) & \text{if } 0 \leq x - \Delta A \leq 1 \\ v - p_i & \text{if } x - \Delta A < 0 \\ v - p_i - t & \text{if } x - \Delta A > 1 \end{cases}$$

If the consumer buys from firm  $j$ , the utility is

$$u_j = \begin{cases} v - p_j - t(1 - x + \Delta A) & \text{if } 0 \leq x - \Delta A \leq 1 \\ v - p_j - t & \text{if } x - \Delta A < 0 \\ v - p_j & \text{if } x - \Delta A > 1 \end{cases}$$

We denote the indifferent consumer's location  $x^m \in [0,1]$  such that at  $x^m, u_i = u_j$ . We obtain the expression of  $x^m$  as follows:

$$x^m = \frac{1}{2} - \frac{p_i - p_j}{2t} + \Delta A$$

Then all consumers with  $x \leq x^m$  will purchase from firm  $i$ , whereas all consumers with  $x > x^m$  buys from firm  $j$ . To simplify the model, we so far assumes full market coverage.

#### 4. Equilibrium

We solve this two-stage problem using backward induction. First we assume that  $A_i$  and  $A_j$  are already decided. We can express firms' profit functions. The profit function for firm  $i$  is

$$\pi_i = (p_i - c)x^m - \frac{\lambda}{2}A_i^2$$

Substitute  $x^m$ , firm  $i$ 's problem then becomes

$$\max_{p_i} \pi_i = (p_i - c) \left( \frac{1}{2} - \frac{p_i - p_j}{2t} + \Delta A \right) - \frac{\lambda}{2}A_i^2$$

In order to find the price that maximises firm's profit, we take first order condition  $\frac{\partial \pi_i}{\partial p_i} = 0$ , which induces the best response function for firm  $i$  given by

$$B_i(p_j) = \frac{p_j + c + t(1 + 2\Delta A)}{2}$$

Similarly, we construct the profit function for firm  $j$  as

$$\pi_j = (p_j - c)(1 - x^m) - \frac{\lambda}{2}A_j^2$$

Substitute  $x^m$ , firm  $j$ 's problem then becomes

$$\max_{p_j} \pi_j = (p_j - c) \left( \frac{1}{2} + \frac{p_i - p_j}{2t} + \Delta A \right) - \frac{\lambda}{2}A_j^2$$

By taking first order condition  $\frac{\partial \pi_j}{\partial p_j} = 0$ , I obtain the best response function for firm  $j$  given by

$$B_j(p_i) = \frac{p_i + c + t(1 - 2\Delta A)}{2}$$

By solving (7) and (10) together, I obtain the Nash equilibrium price for firm  $j$  given by

$$p_j^* = t + c - \frac{2}{3}t\Delta A$$

This solves the Nash equilibrium price for firm  $i$

$$p_i^* = t + c + \frac{2}{3}t\Delta A$$

By comparing their Nash equilibrium prices, we can observe intuitively that the two firms' Nash equilibrium prices are symmetric. This is a reasonable result since  $\Delta A \equiv A_i - A_j$ . In the case where firm  $i$  has spent more on advertisement than firm  $j$ , resulting  $\Delta A > 0$ . Then it is reasonable for firm  $i$  to set higher prices as their product is more attractive to consumers and vice versa.

By substituting  $p_i^*$  and  $p_j^*$  into  $x^m$  and obtain

$$x^m = \frac{1}{2} + \frac{1}{3}\Delta A$$

Substitute  $x^m$  and  $p_i^*$  into the profit functions, we can obtain the equilibrium profits for firms as functions of the levels of advertisements:

$$\begin{aligned}\pi_i^*(A_i, A_j) &= \left(t + \frac{2}{3}t\Delta A\right) \left(\frac{1}{2} + \frac{1}{3}\Delta A\right) - \frac{\lambda}{2}A_i^2 \\ \pi_j^*(A_i, A_j) &= \left(t - \frac{2}{3}t\Delta A\right) \left(\frac{1}{2} - \frac{1}{3}\Delta A\right) - \frac{\lambda}{2}A_j^2\end{aligned}$$

Then we solve the profit maximising advertisement levels firms chooses in the first stage. Firm  $i$ 's problem then becomes

$$\max_{A_i} \pi_i = t \left(1 + \frac{2}{3}A_i - \frac{2}{3}A_j\right) \left(\frac{1}{2} + \frac{1}{3}A_i - \frac{1}{3}A_j\right) - \frac{\lambda}{2}A_i^2$$

Take first order condition  $\frac{\partial \pi_i}{\partial A_i} = 0$ , this induces the best response function for firm  $i$ 's advertising  $A_i$  is given by

$$B_i(A_j) = \frac{4tA_j - 6t}{4t - 9\lambda}$$

Firm  $j$ 's problem then becomes

$$\max_{A_j} \pi_j = t \left(1 - \frac{2}{3}A_i + \frac{2}{3}A_j\right) \left(\frac{1}{2} - \frac{1}{3}A_i + \frac{1}{3}A_j\right) - \frac{\lambda}{2}A_j^2$$

(7) Take first order condition  $\frac{\partial \pi_j}{\partial A_j} = 0$ , this induces the best response function for firm  $j$ 's advertising  $A_j$  is given by

$$B_j(A_i) = \frac{4tA_i - 6t}{4t - 9\lambda}$$

Solving the best response function together we obtain the Nash equilibrium advertisement for firm  $i$  and  $j$  are

$$A_i^* = A_j^* = \frac{16t^2 - 18t}{24\lambda t - 27\lambda^2}$$

The result suggests that in equilibrium firms choose the same level of advertisements. In other words, in equilibrium, there is  $\Delta A^* = 0$ . By substituting the equilibrium levels of advertisement, the resulting equilibrium prices will also be the same.

$$p_i^* = p_j^* = t + c$$

This is the same result as in the standard model of Hotelling model with horizontal differentiation without advertisement.

To understand this result, consider the assumption that firms are symmetric in terms of how their advertisement affects consumers' location and hence their utility of purchasing products. Thus, it is reasonable to expect that the effects of two firms' advertisements will offset each other in the end due to competition.

## 5. Welfare Analysis

Since we obtained the Nash equilibrium advertisement for firm  $i$  and  $j$  are

$$A_i^* = A_j^* = \frac{16t^2 - 18t}{24\lambda t - 27\lambda^2}$$

When  $\lambda = 1$

$$A_i^* = A_j^* = \frac{2t}{3}$$

We substitute  $A_i^*$  and  $A_j^*$  into the equilibrium profits functions for the two firms, given that in equilibrium  $\Delta A^* = 0$ , the resulting equilibrium profits are the same provided when  $\lambda = 1$ . We can obtain that the equilibrium profits for the two firms

$$\pi_i^* = \pi_j^* = \frac{1}{2}t - \frac{2}{9}t^2$$

Without advertisement, the standard model gives the profit functions for the two firms are

$$\pi_i^* = \pi_j^* = \frac{1}{2}t$$

The differences between profits with and without advertisements are (25) – (24) which is  $\frac{2}{9}t^2$  for both firms. this indicates that without advertisements, each firm will earn a greater profits of  $\frac{2}{9}t^2$ . By comparing the profit functions with and without advertisements, we notice that the existence of advertisements will only increase the extra cost but nothing else for the firms. In the situation where both two firms imposing advertisements, the producer surplus will decrease due to higher extra cost of advertising. At the same time, consumer surplus will not change since the willingness to pay minus the price does not change. Therefore, the social surplus (social welfare) will decrease by the amount of lost producer surplus after posting advertisement. That lost in consumer surplus also lead to dead weight lost.

As a result, the existence of advertisements generates no profit but more costs, leading to a Pareto inefficient outcome. It seems that firms can be better off not posting any advertisement at all. However, the existence of advertisements is still reasonable as there's always competition between Notability and GoodNotes 5. With the ability of posting advertisement, do not set advertise is not the best response. As long as one of the two firms between Notability and GoodNotes 5 impose per-

suasive advertisements whilst the other one does not, the firm with advertisements will attract a lot more consumers than the other one, obtaining a much greater profits.

This is also what has happened to those two firms in reality in the Chinese market. At the very first stage, when the note-taking app market hasn't become mature, Notability has imposed more advertisements on the Chinese market, both informative and persuasive advertisements. It has therefore owns a greater amount of users in China, indicating that the location of the indifferent consumer  $x^m$  locate closer to 0 - where Notability locates. Therefore, as soon as the GoodNotes 5 enter the market and wants to compete against Notability, in order to attract consumers to consume and make profits, it has to impose the same amount of advertisements as Notability does to gain a positive market share. This is the same as the model suggests. Otherwise, all of the consumers will still purchase the product produced by Notability due to information failure, or simply because they do not know the suitable feature they needed from GoodNotes 5.

## 6. Conclusion

This paper analyzes the competition in a Hotelling model of a note-taking-app duopoly market, where Notability and GoodNotes5 choose different strategy in order to maximize their own profit. In this model, consumers differ in their tastes for two competing products according to different persuasive advertisements. Advertising is viewed as a means for companies to change the distribution of consumer tastes toward one of the products. Our model assumes that advertisement will not directly affect the consumer's utility; instead, it will implicitly shift consumers location to affect their travel cost. By raising one of the two firms' advertising, consumers' travel costs for purchasing goods from that specific company will diminish, thus enhancing their utility. Our results suggests that in equilibrium firms will eventually choose the same level of advertisement. The resulting equilibrium prices of both firms are the the same as in the standard Hotelling model with horizontal differentiation without advertisement. Thus it suggests that firms obtains Pareto inefficient outcomes in the presence of advertisements.

Additionally, for firms with similar product like Notability and GoodNotes5, advertising may intensify competition and induce a decrease in the profit of the advertised product, whilst the final location of consumer's preference will not change. This result shows that the two firms does not necessarily have an incentive to engage in advertising. However, none of the companies will stop imposing advertisements if they have the ability to do so. According to the profit-maximizing strategy, once one of the firms begins imposing the advertisement, the other firm will impose the same amount.

In reality, it is inevitable to have some problems while practicing the model. It is difficult to quantify the number of advertisements for both organizations because they must impose the advertisements on many platforms in variety of ways. This is due to Notability and GoodNotes5 distinguishing their products in terms of functionalities and target audience. As a result, they will attempt to maximize the impact of their persuasive campaign by imposing it on a market with a greater potential purchasing power group, thus attracting more consumers.

However, there are still many aspects that the model has not captured compared to the real world situation. The model has worked out the case when two firms act simultaneously, whereas in the reality, Notability enters the market earlier than Goodnotes, it has therefore acquired lager market share in the first place. Hence, Goodnotes needs to spend more efforts in order to persuade consumer to switch to their product. Thus, the effect of their advertisement on consumers are different. With higher market share, it is easier for Notability to spread their reputation. The real world situation is more dynamic than the model. Later researches can study the model with two firms acting sequentially to see if Notability has gained more market share with first-mover advantage.

On the other hand, this model does not capture the situation for changing pricing strategy. For example, when Notability suddenly announced to switch to paid subscription since November 1st 2021, it also has larger effect in reducing the potential users. By responding to this strategy, the Goodnotes can be better off and gain more potential consumers. Thus, further modification of the model is needed in order to capture those features.

## References

- [1] Stacy, Elizabeth Moore, and Jeff Cain. "Note-taking and handouts in the digital age." *American journal of pharmaceutical education* (2015).
- [2] Hsu, Yi-Hung, and Chien-Hsiung Chen. "Usability Study on the User Interface Design of Tablet Note-Taking Applications." *International Conference on Human-Computer Interaction*. Springer, Cham, 2021.
- [3] Reguera, Elsa Aniel Mendez, and Mildred Lopez. "Using a digital whiteboard for student engagement in distance education." *Computers & Electrical Engineering* 93 (2021): 107268.
- [4] Hotelling, Harold. "Stability in competition." *The collected economics articles of Harold Hotelling*. Springer, New York, NY, 1990. 50-63.
- [5] Zhang, Wei, and Shuaian Wang. "Pricing of Shared-Parking Lot: An Application of Hotelling Model." *International Conference on Intelligent Interactive Multimedia Systems and Services*. Springer, Cham, 2018.
- [6] Calem, Paul S., and John A. Rizzo. "Competition and specialization in the hospital industry: an application of Hotelling's location model." *Southern Economic Journal* (1995): 1182-1198.