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Product Choice in Two-Sided Media Markets

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by

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Contents

1 Introduction

1.1 Background of Research

When we refer to the media, many examples come to mind: TV-stations, radio channels, the Internet, newspapers, magazines, etc. As noticed by everybody, the media play a very important role and have influence in our daily lives in almost every way: we can listen to radio when driving, will read a newspaper or magazine while lying on the beach, and may surf the Internet with iPad on the subway. We actually spend a remarkable portion of our leisure time in consuming media products. In the U.S., the average adult spends around four and a half hours a day watching television, one and a half hours listening to the radio and half an hour reading newspapers and magazines (offline reading only).[1] Through the media, we get to know the current affairs, learn popular culture, and even entertain ourselves. As pointed out by Anderson and Gabszewicz (2005), therefore, the media affect the quality of life for many people.

The media industry also plays an important role in the economy. Like the finance industry, which provides capital for the economy, the media industry provides information regarding political reforms and policies aimed at economic progress. In this sense, the media affect individuals' informed participation in the economy and civic society. In addition to the indirect impact mentioned

[1] See http://www.emarketer.com/Article/Digital-Set-Surpass-TV-Time-Spent-with-US-Media/1010096.

above, the media also contribute directly to the economic growth. For example, in 2008, the whole media industry contributed 2.74% to GDP growth in the U.K., 2.66% in the U.S., 2.20% in Japan and 0.75% in China.[2]

What makes the media so attractive and important to our daily and economic lives is the information they provide. In order to make media products better meet our needs, the questions of what media firms provide and further what affects their product provision arouse our great interest. Some early literature has done a normative study to answer these questions. Steiner (1952) examines content provision in the radio broadcasting industry and shows that due to the search for advertising revenues, competition could lead to the duplication of popular content types. This occurs because popular content can attract larger audience and thus more advertisers. As for the conclusion obtained by Steiner (1952) that a media monopoly will provide a more diverse product than will competition, Beebe (1977) investigates its validity by relaxing of some assumptions and shows that the conclusions are true only for special cases. Spence and Owen (1977) examine content selection for both pay TV and advertiser-supported television under monopoly and monopolistic competition and show that minority-taste or costly contents tend not to be provided. Doyle (1998) develops further the enquiry on product provision. He shows that under advertiser-supported regime, the products offered in the media market can be any combination of popular and minority-taste contents. Here, the case that all media firms provide minority-taste contents can occur

[2] Please see Albarran (2010) for details.

when advertising is highly valuable when shown to the minority. In additon, media platforms only choose differentiated contents under pure pay TV, which is because same contents will result in Bertrand competion. Similar to the case under the advertiser-supported regime, all combinations of content types can be offered when media firms finance themselves by advertising and subscription revenues.

The above papers provide appealing analyses for helping us understanding product choice in the media market, but they include questionable assumptions when dealing with advertising revenues. They assume that the number of advertisements carried on each program is exogenously fixed and that advertisers have the same willingness to pay for communicating with consumers. These assumptions neglect the impact of consumers on advertisers' choice of placing ads in a specific media platform and also advertisers' influence on consumers if the latter care about the former. The treatment of advertising is unsatisfactory. The reality should be the following. On one side, consumers can be influenced by advertising. If consumers dislike advertising, they will suffer from ad interruption; if consumers obtain a positive net benefit from advertisements, they prefer to get more ad exposure. On the other side, advertisers care about the number of consumers in the media where they place ads: if the media have a large number of consumers, the advertisers prefer to buy more advertising slots and pay high prices to reach them.

The above observation suggests that media firms actually operate simultaneously in both consumer and advertising markets and particularly that these two markets interact with each other. To study such interactions, the media should be regarded as an intermediary that connects consumers and advertisers. This aspect of the media can be explained by the theory of two-sided markets, which becomes popular in recent years. Broadly speaking, in a two-sided market, a platform, or platforms, has two distinct user groups and the participants in each group care directly about the number of participants on the other, typically through externalities. In the case of the media industry, platforms are the media firms while the two user groups are consumers and advertisers. From the point of view of two-sided markets, if advertisers benefit from consumers, platforms can not only charge higher advertising fee but also expand market share of advertisers by increasing their share of consumers. The change of ads, in turn, positively or negatively affects consumer side according to whether they like or hate ads. This is, the correlation between consumers and advertisers affects platforms' revenue from advertiser side and also consumer side if this side is charged. However, these revenues in traditional analysis are distorted due to the restriction of the exogenous fixed advertising levels and ad prices. As can be seen, media's revenue, particularly its composition, can make media platforms behave different from the traditional analysis. Compared to the case in two-sided markets, the advertising revenues in the traditional analysis are lessened from the increase of consumers, which, therefore, lowers incentives to provide products which can attract more consumers. Furthermore, if consumers are charged, the treatment of exogenously fixed number of advertisements neglects how a change in the advertising level will affect the subscription fee and the revenue from consumers. As a result, the constant revenues from consumers have no effect on product provision; however, platforms could provide products to cater for consumers' needs if weak advertising demand is included in the analysis. Note that due to the feedback loop caused by the externalities, the decision process for product positioning can be more complex. Based on the above consideration, therefore, we need to employ a two-sided market framework to examine product choice by media platforms.

Two phenomena have aroused our interest when examining product choice in the media market.

The evidence of the existence of collusive behavior in the media market can be found in some countries. The Italian newspapers have been colluding on the subscription prices even after the regulatory regime switched to a more liberalized system. Several newspapers in the United States in the 1890s colluded to raise either advertising rates or subscription fees. In addition, two stations in Honolulu simulcast their daily morning and evening news broadcasts. All of the above practices suggest that media platforms prefer to cooperate on product choice and/or pricing to maximize their joint profits. From above, we have known that two-sidedness nature can affect the incentives to provide products by media platforms. Then given the collusive behavior in the media market, what products the media will provide, whether similar or different to those in the traditional markets, becomes a real concern.

Due to the moves towards liberalization and technological progress which is lowering the entry cost in the media market, nowadays operation by media platforms in multiple markets has become a common phenomenon. For instance, CNN and NBC provide news not only in the U.S. but also in other countries. Despite serving multiple markets, media platforms are usually observed to display the same content, particularly the same political message, to each individual market. This occurs because of many reasons including the additional cost caused by producing new products. Therefore, in a context where products cannot be tailored to different markets, how to position their products becomes an important bussiness strategy for media platforms.

Motivated by the above facts, we in this dissertation would like to incorporate media collusion and media competition in multiple markets into analyzing the product choice by media platforms by explicitly employing a two-sided market framework.

1.2 Structure of the Dissertation

This dissertation contains the following chapters for the study of product choice by the media firms with a two-sided market framework.

In Chapter 2, we first give an introduction to the two-sided market theory and then we focus on the existing literature on the media market by using the two-sided market theory. In the latter part, we review the branches of literature dealing with "content choice and advertising", "media concentration and collusion behavior", "the desirability of public media firms and media regulation", and "media entry". We also discuss the relationship between these works and each of our chapters.

Chapter 3 investigates the incentives to differentiate products horizontally in a collusive media market. Our findings show that a higher externality between advertisers and consumers participating in the media makes price collusion harder to sustain. This is because the consumer share in the price deviation is larger than the share of 1/2 in punishment and collusion and because externalities enhance the deviation profit more than punishment and collusion profits. We also show that externalities affect the optimal product choice. With closer substitutable products, media platforms tend to deviate in pricing due to the higher price elasticity, which induces platforms to lower the collusive price to sustain collusion. Because the magnitude of the price reduction for large externalities is higher than that of small ones, platforms differentiate their products to a greater degree for larger externalities to save the deviation cost caused by closer substitutes.

Chapter 4 examines the product choice by media platforms when they compete with the same content in several markets. For example, news media provide contents in several countries. Our model builds upon the paper by Peitz and Valletti (2008), which shows that media platforms always maximally differentiate their products with pay-TV but may partially differentiate with ad-supported media. This is an important starting point for our paper where we extend their one-market model to multiple markets. We show that media platforms may provide less differentiated content if they do not charge subscription fee in some markets. The reason is simple: in the markets with free content, advertising is the sole revenue source. Thus, if these markets contribute a large proportion of revenues, media platforms prefer to choose content which can make them obtain large advertising revenues.

Chapter 5 provides the conclusion for the dissertation. We summarize the main results obtained from each chapter. We also discuss the important issues in the media market which should be dealt with in the future research.

2 Literature Review

2.1 Literature on Two-Sided Markets

2.1.1 Economic Background on Two-Sided Markets

We can find two-sided markets in many diverse industries. Dating clubs, for example, need to get both men and women on board their platforms to have a service to offer either one; each group values the clubs only to the extent that the other side joins. Operating systems, such as Microsoft Windows, depend for their success on obtaining application users and developers. Payment systems which link consumers and merchants are similar. Consumers are more willing to carry cards that are accepted by more merchants and merchants are more willing to accept cards that are more widely held by consumers.

In the above examples, there are three principal groups of agents in the market: two distinct agent groups and platforms. Members of one group benefit in some way from contacting with members of the other group. And platforms enable or facilitate interaction between these sides by providing a common place. These features are different from those in traditional one-sided market. Consider a model which includes sellers, buyers and intermediaries, as shown in Figure 2.1.[3] In one-sided markets, the intermediary acquires goods from sellers and resells them directly to buyers. Since this intermediary does not provide a common place to communicate, sellers and buyers cannot contact with each

[3] This figure is based on Hagiu (2007).

other directly. This situation is totally different from two-sided markets.

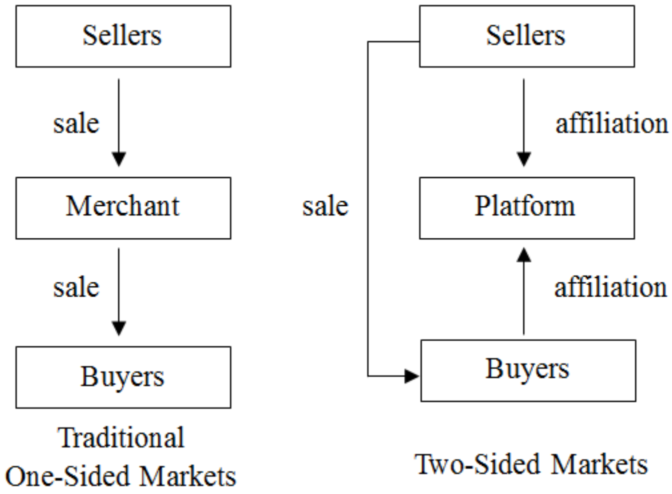

Figure 2.1: Comparison between "One- and Two-Sided Markets"

The above features offer us some criteria to identify two-sided markets. It is intuitive, but not restrictive enough. To this end, on the question of what is a two-sided market, Rochet and Tirole (2006) first propose a formal definition: "a market is two-sided if the platform can affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount; in other words, the price structure matters, and platforms must design it so as to bring both sides on board." As a simple example, consider a situation where a supermarket charge customers \$1 and reduces the fee to retailers by the same amount. If retailers suffer more from being in contact with a smaller number of customers than the decrease of cost, then we can expect that there will be less customers and reltailers in this supermarket.

To satisfy the above definition, the correlation between members of one user group and the other must be needed. In two-sided markets, this relationship can be represented by the existence of “cross-group externalities”. They refer to the case that in a two-sided market a change in usage by one side affects the utility and participation of the other side, and vice versa. In two-sided markets, the size of cross-group externalities affects pricing structure and not only the overall level of fees charged by platforms: the higher the externalities generated to the other side, the lower the price on this side and the higher on the other side. For example, a nightclub always charges men more than women, because the former benefit more from interacting with the latter than vice versa.

Now that we have discussed cross-group externalities, we have to mention two other kinds of externalities in the traditional one-sided market, i.e., direct and indirect network externalities.

A product is said to exhibit direct network externalities if each user’s utility has a positive relationship with the number of other users of that product. Obvious examples are telephone systems, fax machines, and social networks. Consider the first example: as more consumers use telephone, there are more people to communicate with. This makes the telephone become more valuable to its users. By contrast, if the benefit of consuming a product is related with the number of products compatible or complementary with it, the externalities existing in this case are said to be indirect. These externalities arise with complementary goods. Examples include DVD players (with DVDs) and operating systems (with software). If there is a rise in the number of DVDs proposed for a certain DVD format, consumers' benefit will increase when using this particular format DVD player, namely, that an increase in the number of users is mediated by the availability of DVDs.

From above, we can see that the definition for the cross-group externalities is similar to that of indirect network externalities. Indeed, in a technical sense, the cross-group externalities are indirect externalities. The different name in a two-sided market is just to emphasize the externalities that cross distinct markets. Therefore, in a two-sided market, say a shopping mall, direct network externalities correspond to the case that stores benefit from participation of other stores in the mall if commodity variety attracts customers. By contrast, both indirect and cross-group externalities describe the situation where stores and customers benefit from each other's participation in the shopping mall.

Platforms can charge for their service in various ways. Here, we only mention two basic pricing instruments: lump-sum fees or per-transaction charges. For the former case, an agent's payment does not explicitly depend on how well the platform performs on the other side. By contrast, in the latter case, the payment is an explicit function of the number of agents on the other side. Platforms can also combine the use of lump-sum and per-transaction fees; the formulation is termed "two-part tariffs". In practice, the use of these pricing instruments differs significantly across markets. Payment card systems usually charge merchants a usage fee and cardholders an access fee. Dating clubs charge both men and women an access fee for joining the clubs and a usage for using the services, namely, that they use a two-part tariff. For these pricing instruments, which one the platforms use, is dependent on many factors including the difficulty of monitoring usage and the nature of the externalities between the two sides of platforms. However, in general, platforms can obtain a higher profit with per-transaction charges than with lump-sum charges when there are positive externalities on both sides. Since the agents charged on a per-transaction basis need to pay an extra payment for interacting with an extra agent on the other side, they respond less for the increase of market share on the other side. This sugguest that the dergee of competition to acctract agents by lowering prices is lower with per-transaction charging than with lump-sum charging. As a result, less competition leads to higher platform profit when per-transaction fee is used.

When many platforms exist, an agent needs to decide whether to use another while using one platform. If an agent chooses to use only one platform, she is said to "single-home" or otherwise "multi-home". This choice is usually dependent on the trade-off between the network benefits of being in contact with the widest population of the other side and the costs of dealing with more than one platform. Generally speaking, there are three configurations for whether groups single-home or multi-home: (i) both groups single-home, (ii) one group single-homes while the other multi-homes (The configuration is termed "competitive bottlenecks"), and (iii) both groups multi-home. As we observe in the actual market, most two-sided markets appear to have at least one side multi-homes; configuration (i) is scant. Take shopping malls as an example: a consumer may visit several shopping malls while a retailer can have stores in more than one mall.

The decision on whether to multi-home leads to a significant difference to pricing outcomes. The price on the single-homing side tends to be lower with the other side multi-homing. The reason is simple: as multi-homing becomes more prevalent on one side, the agents on the other side are more easily to switch to other platforms to contact a specific agent on the opposite side. In this respect, the platforms are more substitutable. Thus, platforms have to lower their prices to compete for the single-homing side. If one side becomes more multi-homing, the other side is better off.

There are diverse examples for two-sided markets. In order to have a better understanding about these examples and address precisely what our dissertation focuses on, it is helpful to review four different types of two-sided markets based on Evans et al. (2005).

The first type consists of intermediation markets. Platforms in these markets aid members of one or both sides in their quest for a match on the other side. Examples include dating services, real-estate brokers, B2B and B2C websites.

The second type is audience-making markets, where platforms bring advertisers and audiences together, matching buyers and sellers. The platforms use contents, which are either created by themselves or bought from other content providers, to attract consumers. The consumers are then used to attract advertisers. The most prominent markets that fit in this category are yellow page directories, television, newspapers, magazines, the Internet, and the like.

Transaction-based markets are the third type. In these markets, platforms can meter transactions between their affiliated sides. Credit cards are such an example for this type. They provide payment service for the transactions for goods and services between merchants and cardholders. In this case, platforms need to encourage their two sides to interact a lot, i.e. generate as many transactions as possible.

The fourth type, shared-input markets, include hardware and software platforms where participants on at least one side need to access the platform to provide value to participants on at least one other side. In these markets, platforms are important inputs for both sides: users can use the products offered by application developers only if they have the same platform as that relied on by the developers; developers can sell their products only to users that have the same platform they are technologically dependent on.

Up to now there is abundant literature exploring two-sided markets and thereby we can find out many industry-specific papers focusing on the examples in each of the above categories. Caillaud and Jullien (2003) investigate imperfect price competition between matchmakers, studying the chicken and egg problem. Anderson and Coate (2005) analyze the conditions under which there exists market failure on provision of advertising in the TV broadcasting industry. Gabszewicz et al. (2001, 2002, 2004) investigate the program choice in the newspaper market. Rysman (2004) estimates the importance of network effects in the market for Yellow Pages. The card payment systems have attracted the attention of Rochet and Tirole (2002), Wright (2003), Guthrie and Wright(2007). Papers such as Economides and Katsamakas(2006), Viecens (2007), Tag (2009) take a deep look at platforms in the fourth type: Economides and Katsamakas (2006) include proprietary platforms (such as Windows) and open source platforms (such as Linux) in their analysis; Viecens (2007) provides an explanation for some features of the operating system market and for its differences with the video consoles market; Tag (2009) discusses technology platforms' decision between being open or closed to third party application development.

In my dissertation I focus on the media market, which is classified into the second type. In section 2.2, we will review the existing literature in detail. Despite the abundant literature on the media market, there are still considerable issues unexplored. The motivations for my main theses will be introduced in section 2.3.

2.1.2 Canonical Model

The study of two-sided markets have taken off recently. Rochet & Tirole (2003), Caillaud & Jullien (2003) and Armstrong (2006) are pioneer work in this field and most of the subsequent papers are based on the work from these authors. Here, we do not provide a comprehensive analysis of the theory on two-sided market,[4] but for the purpose of this dissertation we only introduce Armstrong's (2006) duopoly model, focusing particularly on the model of two-sided single-homing.

Suppose there are two platforms, A and B, in a two-sided market, which both serve two groups of agents, 1 and 2, to interact. A participant of one group is concerned with the number of participants in the other group. Denote the expected benefit a group-1 (group-2) agent enjoys from interacting with each group-2 (group-1) agent by α_1 (α_2). Each participant single-homes. If platform i charges lump-sum prices p_1^i and p_2^i and then attracts n_1^i and n_2^i participants of the two groups, the gross utilities of a group-1 agent and a group-2 agent are respectively given by

$$u_1^i = \alpha_1 n_2^i - p_1^i;\ u_2^i = \alpha_2 n_1^i - p_2^i. \tag{2 .1}$$

Assume a differentiated market where each group' agents are uniformly distributed on a line of unit length with the two platforms fixed at the two endpoints. From the Hotelling specification with linear transportation cost, the market shares on each side are

$$n_1^i = \frac{1}{2} + \frac{u_1^i - u_1^j}{2t_1};\ n_2^i = \frac{1}{2} + \frac{u_2^i - u_2^j}{2t_2}, \tag{2 .2}$$

where t_1 and t_2 are the transportation cost parameters for group 1 and 2, respectively.

[4]For surveys on two-sided markets, see Armstrong (2006), Rochet and Tirole (2003, 2006) and Evans and Schmalensee (2007).

By plugging (2.1) into (2.2) and using $n_1^j = 1 - n_1^i$, we have

$$n_1^i = \frac{1}{2} + \frac{\alpha_1(2n_2^i - 1) - (p_1^i - p_1^j)}{2t_1};\ n_2^i = \frac{1}{2} + \frac{\alpha_2(2n_1^i - 1) - (p_2^i - p_2^j)}{2t_2}. \quad (2.3)$$

From the last expression in (2.3), we can see that by keeping group-2's prices fixed, platform i can attract a further α_2/t_2 group-2 agents if an extra group-1 agent is on that platform. The interrelation of market shares is caused by externalities in two-sided markets.

By solving the simultaneous equations (2.3), we have the following market shares

$$n_1^i = \frac{1}{2} + \frac{1}{2}\frac{\alpha_1(p_2^j - p_2^i) + t_2(p_1^j - p_1^i)}{t_1t_2 - \alpha_1\alpha_2};\ n_2^i = \frac{1}{2} + \frac{1}{2}\frac{\alpha_2(p_1^j - p_1^i) + t_1(p_2^j - p_2^i)}{t_1t_2 - \alpha_1\alpha_2}. \quad (2.4)$$

As shown above, given other prices fixed, the change of p_1^i will affect both n_1^i and n_2^i, namely, that the platforms can alter market share on both sides by changing price on one side. We can use (2.4) to show the definition proposed by Rochet and Tirole (2006). Suppose platform i lowers p_1^i by one unit and meanwhile increases p_2^i by the same amount, then, after change in pricing, market shares for group 1 and 2 on this platform change by $(t_2 - \alpha_1) / [2(t_1t_2 - \alpha_1\alpha_2)]$ and $(\alpha_2 - t_1) / [2(t_1t_2 - \alpha_1\alpha_2)]$, respectively. Price structure really matters in two-sided markets.

Suppose each platform incurs a per-agent cost f_1 for serving group 1 and f_2 for serving group 2. Then platform i's profit is

$$\pi^i = (p_1^i - f_1)n_1^i + (p_2^i - f_2)n_2^i.$$

By maximization of the above profit with respect to prices, p_1^i and p_2^i, we have the following price reaction functions

$$p_1 = f_1 + t_1 - \frac{\alpha_2}{t_2}(\alpha_1 + p_2 - f_2);\ p_2 = f_2 + t_2 - \frac{\alpha_1}{t_1}(\alpha_2 + p_1 - f_1). \qquad (2.5)$$

Consider the first expression in (2.5). In a Hotelling model without externalities, the equilibrium price for group 1 is $f_1 + t_1$. However, in this two-sided setting, the price is adjusted downward by the factor $(\alpha_2/t_2)(\alpha_1 + p_2 - f_2)$, which measures the external benefit to the platform from attracting an extra group-1 agent. The term $(\alpha_1 + p_2 - f_2)$ represents the external benefit from an extra group-2 agent, where α_1 and $p_2 - f_2$ are the respective extra revenue extracted from group 1 and 2 with an extra group-2 agent. The term α_2/t_2 denotes the additional group-2 agents attracted by an extra group-1 agent.

Solving the simultaneous equations in (2.5), we have equilibrium prices

$$p_1 = f_1 + t_1 - \alpha_2;\ \ p_2 = f_2 + t_2 - \alpha_1.$$

From the above price expressions, we can see that group 1 will be targeted aggressively if it yields a smaller benefits to the other group (α_2 is small) and that it is on the less competitive side of the market (t_1 is large). We can make a similar argument for group 2. Note that the price charged to one group can be negative if this group generates a sufficiently large externality to the other group.

This dissertation extends the above model by endogenizing the product choice by platforms. Chapter 3 employs the two-sided single-homing model to examine how collusion affects product provision. Chapter 4 analyzes how platforms position their products when they compete across different markets with the same product. In this chapter, in addition to the endogenous product choice, we also modify the above model to "competitive bottlenecks" by assuming that group 1 single-homes while group 2 multi-homes. The findings from Armstrong's model also provide useful insights to study the issues raised in our chapters. The finding that a price change on one side can affect market shares on both sides is shown to affect platfoms' profits and incentives to deviate in Chapter 3. In Chapter 4, we have that all the per consumer advertising revenues are passed onto consumers by a form of lower price. This corresponds to the findings obtained from Armstrong's model that the price charged to one side will be lowered, or even to be a negative level, when this side exerts large externalities to the other side. Furthermore, the possiblity of negative prices for consumers allow we impose a non-negativity constraint on prices and thereby derive results different from the case without any constraint.

2.2 Literature on Media Markets

2.2.1 Features of Media Markets

The media industry, which is fully or partially financed by advertising receipts, is a two-sided market. Media platforms in this market facilitate communication between advertisers and consumers by providing contents bundled with ads to consumers. In the following, we will give a detailed description about these.

Advertisers care about the number of consumers in the media platform which they place ads on. They derive a higher surplus from more media users. As a result, advertisers often multi-home to access the widest population of consumers; however, they might single-home if there is limited budget or exclusive dealing.

Media users benefit from consuming media products. For example, consumers can get fun from watching a comedy shown on the TV or relax themselves from listening to a graceful song broadcasted by a radio station. As for the ads bundled in the media products, consumer attitudes towards them are different across the format of media. The advertisements in TV and radio break into the content and supplant it, so consumers dislike advertising; they derive a lower disutility from more advertising. With newspapers and magazines, since consumers can easily bypass the ads, then the nuisance cost caused by them can be negligible.

More precisely, the media platforms are broadcasters for television and radio, publishers for newspapers and magazines, web portals for the Internet, and the like. Platforms often provide contents bundled with ads to media users, and meanwhile sell ad space and consumers' attention to advertisers. Here, the contents can be produced by media platforms or purchased from content providers. Usually, the media platforms obtain revenues through three ways: (i) to derive solely from advertising, (ii) to drive exclusively from subscription fees levied on media users, and (iii) to derive from both advertising and subscription charges. For either side, the fee charged by platforms can be based either on access or on usage. For the purpose of this dissertation, we do not consider the one-sided case, i.e., case (ii).

Figure 2.2 illustrates the typical structure for the media market.[5] As we can see, the media industry is a two-sided market, although it has some specific features.

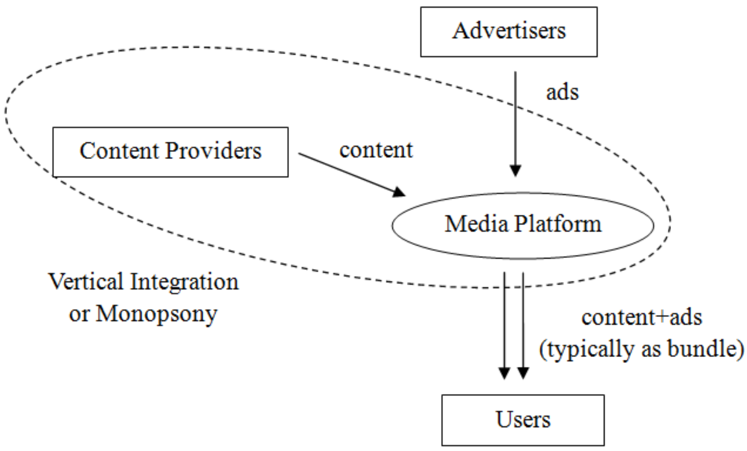

Figure 2.2: Typical Structure for the Media Market

2.2.2 Literature on Media Markets from a Two-Sided Market Framework

There is abundant research on media markets, but in this dissertation I only provide the literature employing a two-sided market framework. Thus far the papers focus on the following aspects.

(1) Content Choice and Advertising

[5] The figure is based on Peitz (2008).

The study of content choice and advertising in the media market originates a long time ago. Most of the early work suggests that popular content will be excessively duplicated and minority-taste content will tend not to be provided (see e.g. Steiner, 1952; Spence and Owen, 1977). While these conclusions are intuitively appealing, the literature does not provide a satisfactory formalization for the advertising market.

Due to the recent development of two-sided market theory, some papers re-examine the content provision and advertising in the media market. By assuming that consumers are indifferent to advertising, Gabszewicz et al. (2001, 2002) show that if the media platforms finance themselves mainly from advertising receipts, they have incentives to duplicate content in order for selling a larger audience to the advertisers. This result stems from the fact that advertising does not entail any cost to consumers. If consumers dislike advertising, Gabszewicz et al. (2004) show that maximal differentiation of content may arise under ad-supported media. Content duplication is also shown by Gal-Or and Dukes (2003), whose results rely on the role of advertising as information about products and as a nuisance to consumers. Different from the above literature, Anderson and Coate (2005) regard the media products as public goods, and examine market failure when they are provided by commercial media. They show that equilibrium advertising levels may be below or above the socially optimal one, depending on the nuisance associated with advertising, the substitutability of contents, and the expected benefits to advertisers from contacting consumers. The equilibrium amount of content may also be suboptimal. Peitz and Valletti (2008) consider the content choice and advertising provision under pay-TV and ad-supported media, respectively. They show that pay-TV always maximally differentiates content whereas ad-sponsored media may provide less differentiated contents. They also show that the advertising level is higher under ad-sponsored media if consumers strongly dislike advertising.

(2) Media Concentration and Collusion Behavior

After the deregulation of ownership in media industries, horizontal mergers and consolidation have become a common practice. These phenomena stimulate lots of economists to consider why there is such a high concentration in the industry. Moreover, how does the concentration affect the strategic incentives of media platforms with respect to their choice of product and advertisement?

On the former question, Gal-Or and Dukes (2006) find out market conditions to make media merger profitable. In a model with differentiated media and products, they show that higher levels of competition for audiences can result in profitable mergers in media markets. If consumers dislike ads, merging media platforms prefer to place fewer ads to attract consumers for higher degree of competition. This yields less information to consumers and thereby alleviates product competition. Since producers' ability to pay for advertising slots increases, media platforms can bargain a lot from them.

There is considerable empirical literature studying the latter question. Thus far the studies do not get a clear-cut result. Some papers find that concentration can increase product variety (see e.g., Jeziorski, 2010) while others show the reverse findings (see e.g. Sweeting , 2010). For ad prices, Brown and Alexander (2005) find that concentration can increase ad prices; by contrast, papers such as Chandra and Collard-Wexler (2009) and Tyler Mooney (2011) find that this is not always the case. There are also theoretical papers focusing on explaining the impact of concentration. Cunningham and Alexander's (2004) analysis focuses on the behavioral response of consumers to the change in advertising intensity. Bush and Zimmerman (2010) emphasize the influence of within-group consumer preference externalities over media content. By allowing for crowding in consumer attention spans for ads or the presence of multi-homing consumers, Anderson et al. (2012) show that mergers can reduce media variety, lower ad levels and increase ad prices.

Some theoretical papers also pay their attention to collusion behavior in the media market. Dewenter et al. (2011) show that compared to competition in both markets, there is less advertising and lower subscription fee for semi-collusion over advertising. For full collusion in both the advertising and the reader market, the results are ambiguous. In addition, in contrast to the one-sided market, semi-collusion and full collusion can improve welfare under certain circumstances. Ruhmer (2011) uses Armstrong's (2006) single-homing model as a stage game to investigate the impact of externalities on the sustainability of collusion. The results show that collusion is harder to sustain as the magnitude of externalities increase. Moreover, for externalities, the high levels of asymmetry between the two sides also make collusion more difficult to sustain. For the empirical study, Argentesi and Filistrucchi (2007) assess collusive behavior in the Italian newspaper industry.

(3) Desirability of Public Media Firms and Media Regulation

The rationale for public intervention in media markets has always been in debate. Thus far, a large body of academic work tries to assess the social desirability of public media platforms and the effect of direct control on media's behavior, focusing particularly on advertising levels, product variety and product quality.

In a representative consumer model, Kind et al. (2007) show that for sufficiently differentiated media platforms, public media firms can mitigate overprovision of advertising by selling less advertising space than the private media. They also find that public media platforms may carry advertising even advertising is wasteful per se. In consideration of the external benefits for society generated by consumers' private information consumption, Rothbauer and Sieg (2011) examine the issue of information program provision for public media platforms without advertising in an ad-supported broadcasting system. They show that output of information can be larger in the presence of public media platforms, but for welfare, the results are ambiguous. Stühmeier and Wenzel (2012) investigate the effects of symmetric and asymmetric advertising regulation on competition for consumers and advertisers in a mixed duopoly framework. They show that both platforms can benefit from the same advertising caps. If public media platforms are more strictly regulated, the commercial media may increase or decrease its advertising level; whether they benefit depends on the trade-off between a positive pecuniary effect from advertising and a negative market share effect of consumers.

Greiner and Sahm (2011) and González-Maestre and Martínez-Sánchez (2013, 2014) include the effect of content quality in consideration of market influence of public media platforms. In a model where content quality is a feature of vertical differentiation on the consumer market and a feature of horizontal differentiation on the advertiser market, Greiner and Sahm (2011) find that an advertising ban in the high quality media reduces not only the total adverting levels in the market but also, surprisingly, consumer demand for the high quality media. González-Maestre and Martínez-Sánchez (2014) show that the interplay between the social cost of advertising and the quality differential between platforms determines whether the individual and total advertising levels in the mixed duopoly are greater than they are in the private duopoly and whether public media platforms are socially desirable. By endogenizing quality choice, their 2013 paper shows that the comparison for the equilibrium levels of quality, advertising and welfare under private and mixed duopolies depends on the interplay between the social cost of advertising and the degree of substitutability between platforms. In addition, the desirability to ban ads on public media platforms is different with exogenous and endogenous qualities.

(4) Media Entry

The innovation and the technological advance have greatly lowered entry barriers to the media market. In order to understand the consequences of this change, some papers investigate the market performance in terms of the extent of entry and advertising in this market.

Choi (2006) develops a model of broadcast competition in the presence of free entry. He considers two alternative business models–the pay media regime and ad-supported regime–and shows that the nature of market failure crucially depends on the way broadcast stations are financed. More precisely, similar to the standard results of the Salop model, under the pay media regime advertising is under-provided and the extent of entry is excessive compared to the social optimum; however, under the ad-supported regime there are no clear-cut results. Crampes et al. (2009) study how different advertising technology affects entry and advertising decisions by platforms in a pay media regime. They show that there are an excessive level of entry and an insufficient level of advertising under constant or increasing returns to scale in the audience size. From the perspective of advertising technology, we can see that Crampes et al. (2009) generalize the model of Choi (2006) which only considers the case of constant returns to scale in the audience size. Stühmeier and Wenzel (2011) focus on the impact of ad-avoidance behavior in media markets. They show that a higher consumer responsiveness to advertising decreases revenues and the degree of entry in the ad-supported regime but leaves revenues and the number of media platforms unaffected for a fixed total viewership in the pay media regime. This is because increased ad-avoidance reduces advertisers' value of placing ads and because lower income from advertisements is compensated by higher subscription income if consumers are charged.

2.3 Relation between the Existing Literature and the Dissertation

From the above description of the research on two-sided markets and on media industries, we can obtain a clear theoretical background about our dissertation and find out the relationship between these works and each of our chapter.

As stated above, media industries are closely related to our daily and economic lives. Thereby, the questions of what media platforms provide and further how their content provision is affected can always arouse our interest. Empirical and anecdotal evidence show the existence of collusive behavior in media industries. As a consequence, the collusive practices naturally stimulate us to consider how content is influenced by collusion. As noticed from the above review of the literature, there are considerable papers studying how market concentration affects content provision. Although collusion and concentration could produce the same market outcome to some extent by reducing competition, the effects of collusion has not attracted the same attention. In particular, the issue of how collusion affects product provision by media platforms has been referred to in none of the existing work by Argentesi and Filistrucchi (2007), Dewenter et al. (2011) and Ruhmer (2011). To fill the gap, our third chapter discusses product choice by collusive media platforms. Because of the two-sided nature, we focus particularly on the impact of externalities between advertisers and consumers participating in the media.

Operation in multiple markets has been commonly observed in media industries. Against this background, how to position their products therefore becomes an important business strategy for media platforms. From the above literature, we know that all the works focus on the product choice in only one market. In the situation where media platforms make decisions independently in each individual market, the existing literature indeed offers a good explanation about product provision. However, for some cases, it is impossible for media platforms to tailor their contents to each individual market. For example, if we interpret the content as the political message the media prefer to display, it is believed that media platforms are unable to fully customize their content to different markets. Based on the above consideration, Chapter 4 investigates how media platforms choose product when all of them compete with the same content across markets.

From the description of the literature on media markets, we also find out some new directions for further research, for which we will leave in our last chapter.

3 Product Differentiation and Collusion in a Two-Sided Media Market

3.1 Introduction

Empirical and anecdotal evidence show collusive behavior by media firms. In the Italian newspaper market, subscription prices are collusive even after the regulatory regime switched to a more liberalized system.[6] In the United States in the 1890s, the Republic and the Globe-Democrat fixed advertising rates with the Post Dispatch in St. Louis. Additionally, the Chronicle and the Post Dispatch aligned to raise the subscription rate for country delivery. Also in the United States, San Diego's Sun and Tribune formed an agreement to raise subscription rates in the city.[7] Collusion in the media market can also involve newsgathering or coverage agreements. For example, in Honolulu, Hawaii, two stations simulcast their daily morning and evening news broadcasts. Additionally, NBC and FOX affiliates set up a local news service to create cooperative, general video news coverage.[8]

Given the media's important role in providing information, its collusive practices stimulate us to consider how media product is affected by collusion. This paper studies product choices made by collusive media platforms. Although the literature has investigated the effect of collusion on product dif-

[6] See Argentesi and Filistrucchi (2007) for details.

[7] See Adams (1996, 2002) for details.

[8] For further examples of collusion in the media, see Dewenter et al. (2011) and Ruhmer (2011).

ferentiation, it has not incorporated the important two-sided nature of media markets. On one side, the advertisers are interested in the number of consumers; hence consumers exert positive externalities on advertisement. On the other side, depending on the media format,[9] advertisers can exert different externalities on consumers. The interdependence between the consumer and the advertising market makes media platforms behave differently from those in traditional one-sided markets. This is particularly noticeable when platforms change prices on one side and market share changes on both sides due to externalities. This feedback effect, which does not arise in one-sided markets, affects platform profits and the incentives to deviate. We explicitly account for media's two-sidedness to investigate the incentives for collusive media platforms to differentiate products horizontally, focusing particularly on the impact of externalities.[10]

To analyze the above question, we use the Hotelling framework with two media platforms and two groups of agents–advertisers and consumers–uniformly distributed along the unit line. For two-sidedness, we restrict our attention to the case that externalities between advertisers and consumers exist only in one

[9]Due to the strong intrusiveness on program content, commercials on television and radio are usually nuisances for consumers. In this case, advertising exerts negative externalities on consumers. For some other media formats, such as newspapers and magazines, ads do not interrupt consumers in the same way, so in some cases, disutility of ads can be ignored. In addition, consumers may prefer ads that provide information they are looking for. For instance, consumers prefer to read more fashion ads in Elle. In these cases, advertising exerts zero or positive externalities on consumers.

[10]Note that the analysis here can also apply to some other two-sided markets that share the same structure with the media.

direction, namely, that advertisers prefer to place ads on a platform with more consumers than less but that consumers are indifferent to the level of advertising. Both consumers and advertisers single-home.[11] At the initial stage, media platforms decide on their product choice, which, once chosen, remains the same for the remainder of the game; after choosing the products, platforms charge prices repeatedly. To see the incentives behind product choice as simply as possible, we only consider a discrete case for product choice. We use the grim trigger strategy to investigate the optimal product choice under collusion.

Our paper contributes to the analysis of collusion in two-sided markets. In this paper we report on the following findings: given the product choice of platforms, price collusion is harder to sustain for a higher externality. This is because the consumer share in the price deviation is larger than the share of 1/2 in punishment and collusion and because externalities enhance the deviation profit more than punishment and collusion profits. Furthermore, externalities affect product choice. If platforms choose products that are closer substitutes, the incentives to deviate in pricing grow due to the higher price elasticity, which induces platforms to lower the collusive price to sustain collusion. Because the magnitude of the price reduction for large externalities is higher than that of small ones, platforms differentiate more for larger externalities to save the deviation cost caused by closer substitutes.

There are several theoretical papers studying collusion in markets with

[11] Our model is an extension of Armstrong's (2006) two-sided single-homing model. He fixes the location at the endpoints of the Hotelling line, however, while we endogenize it.

product differentiation, but most focus on traditional one-sided markets.[12] Within the literature on two-sided markets,[13] the model closest to ours is that of Ruhmer (2011), who uses Armstrong's (2006) single-homing model as a stage game to investigate the impact of externalities on the sustainability of collusion. The results show that for externalities, the high levels of asymmetry between the two sides make collusion more difficult to sustain. Unlike in Ruhmer's (2011) paper with exogenous product choice, our paper endogenizes the incentives to differentiate products for collusive platforms and shows that larger externalities can cause more differentiation.

The remainder of this chapter is organized as follows. The model is presented in section 3.2. Section 3.3 discusses platforms' pricing strategies and analyzes the incentives to follow the agreed product choice. Section 3.4 examines conditions to sustain unconstrained collusive prices. Section 3.5 is devoted to the analysis of the endogenous product choice for collusive platforms. Section 3.6 presents our conclusions.

[12] Some papers analyze the relationship between the degree of product differentiation and the ability of firms to collude. Chang (1991) and Häckner (1995) employ the Hotelling model with quadratic transportation costs, similar to our model setting, to analyze the above issue. Under the assumption of fixed and symmetric product choice, Chang (1991) shows that collusion is more difficult to sustain the smaller the degree of product differentiation. Häckner (1995) instead endogenizes the incentives to differentiate products and shows that firms will choose an intermediate degree of differentiation (i.e., the firms locate at 1/4 and 3/4, respectively) with a sufficiently high discount factor, and that the lower the discount factor, the more firms are forced to increase differentiation. Other papers using a representative consumer model to study these issues include Deneckere (1983), Majerus (1988), Wernerfelt (1989) and Ross (1992).

[13] Using a representative consumer model, Dewenter et al. (2011) study the welfare consequences of collusion within a two-sided market framework. In contrast to the findings in one-sided market, they show that collusion may improve welfare.

3.2 Model

Consider a Hotelling model with two platforms ($i, j = 1, 2, i \neq j$), each serving two distinct groups of agents k (where $k = a, v$ represents advertisers and consumers, respectively). Media platforms have fixed costs in serving the two groups, and they incur the marginal cost of producing the media product and inserting ads. We consider that the platforms have a symmetric cost structure and normalize the fixed and marginal costs to zero. With each group's agents located uniformly on $[0, 1]$, let $\theta_k \in [0, 1]$ denote the location of an agent in group k. Consumers and advertisers single-home.[14] Assume that advertisers are concerned with the number of consumers in the specific platform but that consumers are indifferent to the number of advertisers.[15] Let α measure the expected benefit an advertiser enjoys from each consumer. Platform i charges participation fees p_i and s_i for advertisers and consumers, respectively. If platform i attracts n_i consumers and m_i advertisements, each agent that homes at platform i receives the following utility:

$$u_{i\theta_v} = V - s_i - x_{i\theta_v}^2; \; u_{i\theta_a} = V + \alpha n_i - p_i - x_{i\theta_a}^2, \tag{3 .1}$$

[14]The framework captures a common phenomenon in media markets. Consumers always choose one media platform at any given point in time. In addition, for some media, such as newspapers and magazines, consumers make choices that are persistent over time. Due to contractual restrictions or limited budget, advertisers may select one media firm to host ads. The paper by Kaiser and Wright (2006) provides evidence that the model of two-sided single-homing fits German magazines best.

[15]In our model, it is implicitly assumed that all media consumers watch the ads and purchase one unit of the corresponding product. Thus, each advertiser wants to reach each consumer exactly once, meaning that they only select the platform on which to advertise, not how many ads to place. Here, the number of advertisers is equivalent to the intensity of advertising.

where $x_{i\theta_k}$ denotes the distance between platform i and agent θ_k. Let d_1 and $1-d_2$ (where $d_1 \leq 1-d_2$) represent the respective product choices for platforms 1 and 2, then $x_{1\theta_k} = |\theta_k - d_1|$ and $x_{2\theta_k} = |1 - d_2 - \theta_k|$. In the following, we only consider the case $d_1, d_2 \in \{0, 1/4\}$ to focus on the incentives to differentiate from the fully collusive choice of products.[16] We can extend our analysis to a continuous product choice in greater detail with considerable elaboration. Both advertisers and consumers obtain intrinsic value from joining a media platform,[17] which is sufficiently large enough to fully cover both market sides. For analytical simplicity, we assume a symmetric intrinsic value V for both sides. From the Hotelling specification, the number of each group that joins platform i is given by:

$$n_i = \frac{d_i - d_j + 1}{2} - \frac{s_i - s_j}{2(1 - d_i - d_j)}; \; m_i = \frac{d_i - d_j + 1}{2} - \frac{p_i - p_j + \alpha(n_j - n_i)}{2(1 - d_i - d_j)}. \tag{3.2}$$

The game is played as follows. Media platforms simultaneously decide on product choice d_i at the beginning of time, after which the product choice is fixed forever. In each of the following periods, the platforms will choose prices simultaneously.[18] Each agent then decides the platform in which to participate.

[16] Product choice $d_1 = d_2 = 1/4$ jointly minimizes the total transportation cost.

[17] On the consumer side, the intrinsic value is the benefit consumers obtain from consuming media, such as reading a newspaper or magazine. On the advertiser side, the intrinsic value can be stated as the indirect benefit of advertising, while the term αn_i constitutes the direct benefit of advertising. Here, even if no purchase occurs, i.e., $\alpha n_i = 0$, firms are still willing to advertise to promote their corporate philosophy and foster a positive company image.

[18] Product choice is substantively inflexible compared to price policy. In practice, platforms must decide on their products in advance. Additionally, relocation requires factoring in sunk costs, reputation costs and/or transaction costs; for instance, platforms require massive investments in design and marketing campaigns for their

This is a game of perfect monitoring: all the stage-game actions are revealed before the beginning of the next stage.

3.3 Preliminary Analysis on Pricing Strategies and Product Choice Behavior

We consider a symmetric subgame perfect equilibrium in which (1) platforms' joint equilibrium profits are highest, (2) platforms use grim trigger strategies to support collusion in pricing, and (3) platforms use the stage-Nash equilibrium prices off the equilibrium path. Because the game is symmetrical, we focus on the symmetric equilibrium (i.e., $d_1 = d_2 = d \in \{0, 1/4\}$ and symmetric prices).

In our model platforms have two deviation possibilities: (1) to select a product that is different from the one that was agreed upon or (2) to deviate from the collusive prices but honor the agreed product choice. In the following discussion, we use the below notations to denote the associated profits generated in each case: $\pi_i^N(d_i, d_j)$ is the stage-game Nash equilibrium profit of platform i, for the product choice (d_i, d_j) by platform i and j, respectively. Similarly, given the product choice, $\pi_i^C(d_i, d_j)$ represents the profit of platform i when both platforms adopt collusive price, and $\pi_i^D(d_i, d_j)$ is the profit of platform i when platform i deviates from collusive price. In the above notations, $d_i = d_j = d$ except in the case where deviation on product choice occurs.

Once deviation on product choice occurs, platforms will use the stage-Nash

products. These costs can be prohibitively high, rendering relocation unprofitable.

equilibrium prices in the following periods. In our model product choice is not decided repeatedly, so we use the following condition to sustain the agreed product choice: the average collusive payoff must exceed the average payoff in the subgame after any deviation at the initial stage. Thus, the condition to deter such deviation by platform i reduces to that

$$\pi_i^C(d,d) \geq \pi_i^N\left(d_i^D, d\right),$$

where $d_i^D \neq d$.

Given a symmetric product choice we use grim trigger strategies to sustain price collusion. The incentive condition for the sustainability of collusion in pricing can be formalized as follows:

$$\pi_i^D(d,d) - \pi_i^C(d,d) \leq \frac{\delta}{1-\delta}\left[\pi_i^C(d,d) - \pi_i^N(d,d)\right] \qquad (3.3a)$$

$$\Leftrightarrow \delta \geq \frac{\pi_i^D(d,d) - \pi_i^C(d,d)}{\pi_i^D(d,d) - \pi_i^N(d,d)}. \qquad (3.3b)$$

In the following, we will analyze platforms' pricing strategies and the incentives to follow the agreed product choice.

3.3.1 Off-Path Behavior

Whether product choice deviation or price deviation occurs, platforms will play the one-shot Nash equilibrium. We use superscript N to represent the one-shot Nash equilibrium variables. Because two revenue sources exist, the one-shot Nash profit for platform i is:

$$\pi_i^N = m_i^N p_i^N + n_i^N s_i^N.$$

Solving the equilibrium prices from the first-order conditions for best response and plugging them, we have the following profit for platform i:[19]

$$\pi_i^N(d_i, d_j) = K\left\{\frac{(d_i - d_j)\left[2(d_i - d_j + 6)K^2 - 3\alpha^2 + \alpha(d_i - d_j)K\right]}{2(9K^2 - 2\alpha^2)} + 1\right\} - \frac{\alpha}{2}, \tag{3 ·4}$$

where $K = 1 - d_i - d_j$.

(1) Behavior and Profits following Price Deviation

Given a symmetric product choice, the punishment prices and profits following price deviation are as follows:

$$p_i^N = p_j^N = 1 - 2d;\ s_i^N = s_j^N = 1 - 2d - \alpha;$$
$$\pi_i^N(d, d) = \pi_j^N(d, d) = 1 - 2d - \frac{\alpha}{2}.$$

The externality parameter α has a negative effect on the consumer price and the punishment profit. When advertisers value consumers more highly, (i.e., higher α), platforms can obtain greater revenues from advertisers by increasing the number of consumers. Thus, consumer prices are lowered, but competition does not increase equilibrium consumer shares and causes lower profits. In addition, punishment prices and profits are higher when $d = 0$ than when $d = 1/4$. Due to symmetric product choice and price competition, when platforms move from $d = 0$ to $d = 1/4$, the equilibrium share is still $1/2$ on each side, whereas prices fall significantly in the face of intense price competition caused by closer substitutes.

[19]The second-order condition is satisfied by $2(1 - d_i - d_j) > \alpha$ (the detailed derivation is available upon request to the author), and thus a sufficient condition for S.O.C for any combination of product choice is $0 \leq \alpha < 1$.

(2) Behavior and Profits following Product Choice Deviation

When platform i deviates on product choice, we can use equation (3.4) to express the profit generated in each stage game, denoted by $\pi_i^N\left(d_i^D, d\right)$, by substituting deviation location d_i^D and collusive location d for d_i and d_j, respectively.[20]

3.3.2 Incentives to Follow the Agreed Product Choice

Suppose that platform 1 deviates to $d_1^D = 1/4$ from $(d_1, d_2) = (0, 0)$. To show that the per-period deviation profit, $\pi_1^N(1/4, 0)$, is smaller than the per-period collusive profit, $\pi_1^C(0, 0)$, we first note that $\pi_1^C(0, 0)$ is larger than $\pi_1^N(0, 0)$, i.e., the collusive profit must be larger than the non-collusive, stage-Nash profits. Therefore, it suffices to show that $\pi_1^N(1/4, 0) < \pi_1^N(0, 0)$ for this deviation to be unprofitable. By calculation, we have

$$\pi_1^N\left(\frac{1}{4}, 0\right) - \pi_1^N(0, 0) = \frac{18\alpha + 224\alpha^2 - 621}{64\left(81 - 32\alpha^2\right)} < 0.$$

Since the parameter of externality, α, must satisfy $0 \leq \alpha < 1$ for the second-order condition $(2(1 - d_i - d_j) > \alpha)$ to hold with each profile of product choice, the sign of the above expression is negative.

To grasp the intuition behind the calculation, we check the changes in profit caused by product choice deviation by platform 1, which is roughly approxi-

[20] The profit generated in this case can be obtained only when the second-order condition (i.e., $2(1 - d_i - d_j) > \alpha$) holds. If externality is too large compared to the degree of differentiation between platforms, no interior solution exists. There could be equilibria where the deviating platform attracts all agents from at least one side. In this case, the deviation profit is not as high, but the main argument, discussed below, would still apply qualitatively.

mated by[21]

$$\frac{\triangle \pi_1^N}{\triangle d_1} \approx \left(\underbrace{\frac{\triangle n_1}{\triangle d_1}}_{(a)} + \underbrace{\frac{\triangle n_1}{\triangle s_2}\frac{\triangle s_2}{\triangle d_1}}_{(b)} \right) s_1(d,d)$$
$$+ \left(\underbrace{\frac{\triangle m_1}{\triangle d_1}}_{(a)} + \underbrace{\frac{\triangle m_1}{\triangle p_2}\frac{\triangle p_2}{\triangle d_1}}_{(b)} + \underbrace{\frac{\triangle m_1}{\triangle n_1}\frac{\triangle n_1}{\triangle s_2}\frac{\triangle s_2}{\triangle d_1}}_{(c)} \right) p_1(d,d) .$$

Note that this is the analogue of the envelope theorem; each fractional term in the right-hand side corresponds to the associated partial derivative. For instance, term $\triangle n_1/\triangle d_1$ denotes how n_1 changes as d_1 changes when other variables are held constant. Similarly, we can interpret other terms on the right-hand side.

When there are no externalities ($\alpha = 0$), the external effect of the number of consumers on the benefit of advertisers, labelled by (c), vanishes. The terms labeled by (a) represent the so-called demand effect, which captures the direct effect of product choice change on customer base, whereas the terms labeled by (b) represent the so-called competition effect, which captures the effect through the price competition following the product choice change. In the case of no externalities, consumer and advertiser side can be treated as two independent markets, and therefore we can apply the analysis of location choice in the standard Hotelling model with quadratic transportation costs (see D'Aspremont

[21] This formula is the envelope condition in the case of continuous product choice, and the precision of approximation increases as the change in $\triangle d_1$ gets smaller. Since $\triangle d_1$ is 1/4 due to our restriction on product choice, the following intuition is only suggestive. Nonetheless, this formula captures the main factors of changes, and helps us understand the impacts of them.

et al., 1979); by moving forward to platform 2, platform 1 expands its market share (i.e., demand effect) but endures low price (i.e., competition effect) on each side. It is well-known that the competition effect dominates in such a model, and therefore it's unprofitable to deviate toward the competitor.[22] With the presence of externalities, term (c) is in effect, implying that the change in the consumer side affects the advertiser side. In this case, advertiser's utility is increasing with the number of consumer, so platform 1 has incentives to expand its size by moving forward to platform 2. However, this effect is limited, and indeed does not overturn the effects that are present without externalities; in order for the second-order condition to hold, we need the constraint that externality is small compared to the degree of differentiation between platforms, i.e., $2(1-d_i-d_j) > \alpha$.

Suppose that platform 1 deviates to $d_1^D = 0$ from $(d_1, d_2) = (1/4, 1/4)$. In this case, collusive profit for $(d_1, d_2) = (1/4, 1/4)$ also outweighs the Nash-equilibrium profit for $(d_1, d_2) = (0, 0)$, and therefore it suffices to show that $\pi_1^N(0, 1/4) < \pi_1^N(0, 0)$ for the deviation being unprofitable, which is quite straightforward as follows: note that the two products characterized by $(d_1, d_2) = (0, 1/4)$ are closer substitutes than those characterized by $(0, 0)$. Hence price competition for $(0, 1/4)$ is harsher than for $(0, 0)$. Additionally, platform 1 has a location disadvantage for $(d_1, d_2) = (0, 1/4)$ compared to the case of $(0, 0)$, so

[22] In the standard Holtelling model without externalities, two counteracting effects, i.e., competition effect and demand effect, affect the location decision of each firm. With quadratic transportation costs, the former effect dominates, thus yielding a principle of maximum differentiation (see D'Aspremont et al., 1979).

the equilibrium share of consumer and advertiser generated for $(0, 1/4)$ for platform 1 is smaller than that for $(0, 0)$. Thus, platform 1's Nash-equilibrium profit for $(d_1, d_2) = (0, 1/4)$ is lower than that for $(0, 0)$. Therefore, there is no incentive in the initial stage to deviate when platforms locate at $(d_1, d_2) = (1/4, 1/4)$.

Therefore, from the above discussion we can conclude that deviation on product choice never occurs.

3.3.3 Collusive Price

Given product choice, platforms collude on prices subject to the incentive constraint to follow collusive pricing. Depending on whether the constraint is binding, collusive prices are called unconstrained collusive prices or constrained collusive prices. In this section, we analyze only the former case and use superscript C to denote the relevant variables.

Because of the discrete choice of location, the agents in the center of the Hotelling line (i.e., $\theta_k = 1/2$) pay the highest transportation costs despite of the collusive location. From the indifference conditions of the most remote agents, we can find the unconstrained collusive prices on both sides:

$$p_i^C = p_j^C = V + \frac{\alpha}{2} - \left(\frac{1}{2} - d\right)^2; \; s_i^C = s_j^C = V - \left(\frac{1}{2} - d\right)^2. \qquad (3\ .5)$$

Due to the symmetric product choice, i.e., $d_i = d_j = d$ and equal prices, each platform will split both market sides equally and obtain unconstrained collusive profit, which is given as follows:

$$\pi_i^C(d, d) = \pi_j^C(d, d) = V - \frac{1}{4}(1 - 2d)^2 + \frac{\alpha}{4}. \qquad (3\ .6)$$

Collusion internalizes the externalities, inducing no competition for consumers and advertisers. Therefore, platforms have the market power to charge advertisers higher prices for larger α. With equal market share on both sides, the collusive advertising prices and the collusive profits have an increasing relationship with α. In addition, prices and profits achieve their maximum at $d = 1/4$, which minimizes transportation costs on each side.

3.3.4 Price Deviation

We consider the case in which platform i deviates on collusive prices. Let superscript D denote the relevant variables in price deviation. Depending on the size of α, the agreed product choice and the collusive prices, it is optimal for the deviating platform to steal either a fraction of the market or the entire market from the competitor. In the price reaction functions below, the first equations in (3.7) and (3.8) correspond to the cases in which platform i has a partial share on that side, while the second equations are the reaction functions of the full share cases. Similar to the work of Armstrong (2006) and Ruhmer (2011), the price charged to one side in expressions (3.7) and (3.8) can be expressed as the sum of the standard Hotelling price without externalities (i.e., term(A)) and the adjustment factors (i.e., terms (B) and (C)), which measure the external benefit or loss to the platform. Consider the first equation in (3.7): term (B) represents consumers' impact on advertising fee. As shown in equation (3.2), a unit of price advantage on the consumer side increases the number of consumers in the deviating platform by $1/\left[2\left(1-2d\right)\right]$. Thus, if the amount of undercut is $\left(s_j^C - s_i^D\right)$, consumer demand increases by $\left(s_j^C - s_i^D\right) / \left[2\left(1-2d\right)\right]$, which, in turn, raises advertisers' utility by $\alpha\left(s_j^C - s_i^D\right) / \left[2\left(1-2d\right)\right]$. Hence, the deviating platform i can charge a higher advertising fee if it has the advantage on the consumer side. In the first equation of (3.8), term (C) measures the external loss to platform i stemming from attracting an extra consumer, where $\alpha/\left[2\left(1-2d\right)\right]$ is the extra advertisers platform i attracts when it has an extra consumer and p_i^D is the profit earned from an extra advertiser. In our model, we allow advertisers to care about consumers but consumers to be indifferent to advertisers, so term (B) only appears in (3.7), while term (C) only appears in (3.8).

$$p_i^D = \begin{cases} \underbrace{\frac{(1-2d)+p_j^C}{2}}_{(A)} + \underbrace{\frac{\alpha\left(s_j^C - s_i^D\right)}{2\left(1-2d\right)}}_{(B)} & \text{if } p_j^C < 3\left(1-2d\right) - \frac{\alpha\left(2\alpha+s_j^C\right)}{2(1-2d)} + \frac{\alpha}{2} \\ \underbrace{p_j^C - (1-2d)}_{(A)} + \underbrace{\frac{\alpha\left(s_j^C - s_i^D\right)}{(1-2d)}}_{(B)} & \text{if } p_j^C \geq 3\left(1-2d\right) - \frac{\alpha\left(2\alpha+s_j^C\right)}{2(1-2d)} + \frac{\alpha}{2} \end{cases} \tag{3.7}$$

$$s_i^D = \begin{cases} \underbrace{\frac{(1-2d)+s_j^C}{2}}_{(A)} - \underbrace{\frac{\alpha p_i^D}{2\left(1-2d\right)}}_{(C)} & \text{if } s_j^C < 3\left(1-2d\right) - \frac{\alpha\left(\alpha+p_j^C\right)}{2(1-2d)} - \frac{\alpha}{2} \\ \underbrace{s_j^C - (1-2d)}_{(A)} \quad \text{if } s_j^C \geq 3\left(1-2d\right) - \frac{\alpha\left(\alpha+p_j^C\right)}{2(1-2d)} - \frac{\alpha}{2} \end{cases} \tag{3.8}$$

We have three share regimes in price deviation for platform i: (i) to have a partial share on each side, i.e., $m_i^D, n_i^D < 1$; (ii) to have a partial share on one side but a full share on the other side, i.e., $m_i^D < 1, n_i^D = 1$ and $m_i^D = 1, n_i^D <$

1;[23] and (iii) to have a full share on both sides, i.e., $m_i^D = n_i^D = 1$.

From above, the optimal deviation prices are given as follows:

$$p_i^D = \begin{cases} (1-2d)\frac{\left[2p_j^C-\alpha+2(1-2d)\right](1-2d)+\alpha s_j^C}{4(1-2d)^2-\alpha^2} & \text{if } m_i^D, n_i^D < 1 \\ \frac{1}{2}\left[p_j^C+\alpha+(1-2d)\right] & \text{if } m_i^D < 1, n_i^D = 1 \\ p_j^C+\alpha-(1-2d) & \text{if } m_i^D = n_i^D = 1 \end{cases} \quad (3.9)$$

$$s_i^D = \begin{cases} \frac{(1-2d)\left\{\left[2s_j^C-\alpha+2(1-2d)\right](1-2d)-p_j^C\alpha\right\}-\alpha^2 s_j^C}{4(1-2d)^2-\alpha^2} & \text{if } m_i^D, n_i^D < 1 \\ s_j^C-(1-2d) & \text{if } m_i^D < 1, n_i^D = 1 \\ s_j^C-(1-2d) & \text{if } m_i^D = n_i^D = 1 \end{cases} \quad (3.10)$$

The market share can be derived from the above prices, and the corresponding deviation profits are given by:

$$\pi_i^D(d,d) = \begin{cases} \frac{2R^3+\left(s_j^C-p_j^C-R\right)R\alpha-\alpha s_j^C\left(\alpha-p_j^C\right)+2R^2\left(p_j^C+s_j^C\right)+R\left[\left(s_j^C\right)^2+\left(p_j^C\right)^2\right]}{2(4R^2-\alpha^2)} & \text{if } m_i^D < 1, n_i^D < 1 \\ \frac{1}{4}p_j^C+s_j^C+\frac{\left(\alpha+p_j^C\right)^2}{8R}+\frac{\alpha}{4}-\frac{7}{8}R & \text{if } m_i^D < 1, n_i^D = 1 \\ p_j^C+s_j^C+\alpha-2R & \text{if } m_i^D = 1, n_i^D = 1 \end{cases}, \quad (3.11)$$

where $R = 1-2d$.

Substituting the collusive prices in (3.5) into the above collusive profits, we have

$$\pi_i^D(d,d) = \begin{cases} \frac{32V^2R+8V\alpha(2V-\alpha)+R^2(4-R)\left(16V+8R-R\alpha-2R^2\right)+2R\alpha(4V-\alpha)(2-R)}{32(4R^2-\alpha^2)} & \text{if } m_i^D, n_i^D < 1 \\ \frac{8V(20-R)R+16V(3\alpha+V)+\left(R^2-40R-112\right)R^2+36\alpha^2+12\alpha(4-R)R}{128R} & \text{if } m_i^D < 1, n_i^D = 1 \\ 2V+\frac{3\alpha}{2}-\frac{1}{2}R(4+R) & \text{if } m_i^D = n_i^D = 1 \end{cases}, \quad (3.12)$$

[23] Due to the setting of our model, the deviating platform has a higher incentive to obtain more consumers to increase revenues. Therefore, we only have $m_i^D < 1, n_i^D = 1$ for regime (ii).

where $R = 1 - 2d$.

It is easy to show that profits for price deviation are increasing with the externality parameter α. Suppose that platform i charges the same deviating price for consumers as before, regardless of the change in externalities, which makes consumer size unaffected.[24] Although the above situation is not optimal, platform i still can obtain a higher profit for larger α. This is because advertisers gain a higher utility from the increase of α, which allows platform i not only to charge higher advertising fees but also to expand its market share of advertisers.[25] Because it is always able to mimic the pricing strategy for consumers based on the previous case without any change in externalities, platform i can obtain much higher profits under optimal conditions. Therefore, price deviation is more profitable when α increases. We also find that deviation profits are higher when the products are closer substitutes (i.e., larger d). This is because platforms can further expand their demand with a slight reduction in prices.

3.4 Discount Factor Restriction to Sustain Unconstrained Collusive Prices

In this section, we will examine conditions under which unconstrained collusive pricing is sustainable.

Under a specific share regime, by plugging the relevant profit functions, we

[24] From the expressions in (3.2), we have $n_i^D = 1/2 - \left(s_i^D - s_j^C\right)/\left[2\left(1-2d\right)\right]$. Because α has no effect on s_j^C, the number of consumers does not change if s_i^D is changed, which is similarly irrelevant to the change of externalities.

[25] Note that the number of advertisers does not change when reaching to 1.

can derive the minimum discount factor required to sustain the unconstrained collusive prices, i.e., $\widehat{\delta} = \left[\pi_i^D(d,d) - \pi_i^C(d,d)\right] / \left[\pi_i^D(d,d) - \pi_i^N(d,d)\right]$. If the shares upon deviation for each product choice are within the same regime, by doing the comparative statics for $\widehat{\delta}$ with respect to the externality parameter α and the product choice d, we have the following lemmas.

Lemma 3.1 *Given the product choices of platforms, it is more difficult to sustain the unconstrained collusive prices as the externality parameter increases.*

Lemma 3.2 *Given the intensity of externalities, it is more difficult to sustain the unconstrained collusive prices as products become closer substitutes.*

We consider the impact of the externality parameter α. We know that regardless of an increase in consumers, even for the same share, platforms can enjoy greater revenues by extracting more from advertisers due to their higher degree of reaction to the increase of α. Here, by lowering consumer prices, the deviating platform can enjoy more consumers, larger than the equilibrium share of $1/2$ in the punishment and collusive phases. This implies that α has a greater effect on $\pi_i^D(d,d)$ than $\pi_i^N(d,d)$ and $\pi_i^C(d,d)$. Therefore, platforms have high incentives to deviate for large α. The intuition for Lemma 2 is the following. By using the same price differential for consumers, the deviating platform can obtain a larger consumer share at $d = 1/4$ than that at $d = 0$ due to the higher price elasticity for closer substitutes. Additionally, the fact that collusive prices at $d = 1/4$ are higher than those at $d = 0$ gives the deviating platform a greater advantage in attracting more consumers. Because the consumer size in deviation is much higher than that in competition or collusion, advertisers enjoy more and thus the deviating platform enjoys higher revenues from closer substitutes. Therefore, unconstrained collusive prices are harder to sustain as products become closer substitutes. Based on the regime of $m_i^D = n_i^D = 1$, we draw Figure 3.1 to illustrate the results from Lemmas 3.1 and 3.2. Suppose that there are two values for externality parameter: α_1 and α_2 with $\alpha_1 > \alpha_2$. On the δ-axis, the first two points denote $\widehat{\delta}\,|_{d=1/4}$ for α_1 and α_2, respectively; the last two points denote $\widehat{\delta}\,|_{d=0}$ for α_1 and α_2, respectively. As it can be seen for $d \in \{0, 1/4\}$, $\widehat{\delta}$ required for α_1 is higher than that for α_2. In addition, for α_i $(i = 1, 2)$, $\widehat{\delta}$ required for $d = 1/4$ is higher than that for $d = 0$.

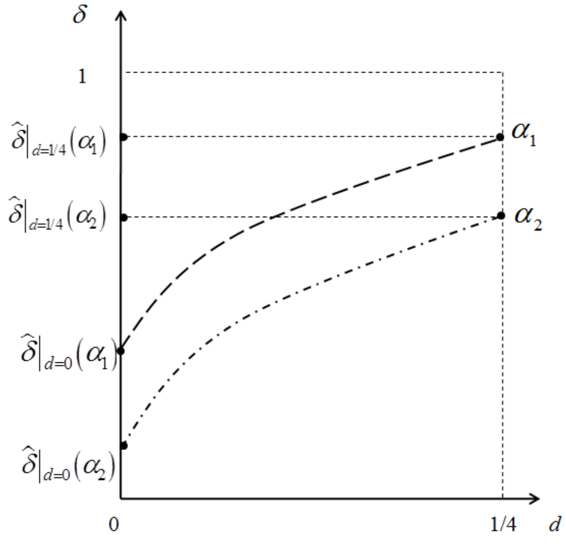

Figure 3.1: The Relationship Among d, α and δ

3.5 Product Differentiation for Collusive Platforms

In this section, we will consider the optimal product choice for collusive platforms when collusion is sustainable. Here, to find out the maximum collusive profit for a given product choice, we will consider the following maximization problem for platform i:

$$\begin{aligned} \max_{s,p} \ \overline{\pi}_i^C(d,d) &= \frac{s+p}{2} \\ s.t.\ \delta &\geq \frac{\overline{\pi}_i^D(d,d) - \overline{\pi}_i^C(d,d)}{\overline{\pi}_i^D(d,d) - \overline{\pi}_i^N(d,d)}. \end{aligned}$$

If the value of the discount factor is not lower than $\widehat{\delta}$ in the previous section, unconstrained collusive prices are sustainable. If not, other prices are required to make collusion successful. Because the cases in which incentive constraints are nonbinding are similar to those in section 3.3.3, here we only analyze the case in which the constraint is binding. Thus, let p and s denote the constrained collusive prices for advertisers and consumers, respectively.[26] The one-shot profit from punishment is independent of the collusive prices so that $\overline{\pi}_i^N(d,d) = \pi_i^N(d,d) = 1 - 2d - \alpha/2$ as before. The profits for price deviation are similar to those in (3.11), which only requires replacing s_j^C and p_j^C by s and p, respectively. After performing the calculation, we have[27]

$$\overline{\pi}_i^C(d,d) = \frac{s+p}{2} = \begin{cases} [2(1-2d)-\alpha]\frac{3\delta+1}{2(1-\delta)} & \text{if } \delta < 1/3 \\ [2(1-2d)-\alpha]\frac{2-3\delta}{2(1-2\delta)} & \text{if } 1/3 \leq \delta < 1/2 \end{cases}. \quad (3.13)$$

In the above expressions, the first line corresponds to the constrained profit obtained when the deviation to have a partial share on each side is deterred.

[26] Here, the top bar denotes the binding constraint cases for profits.
[27] The derivations are given in the appendices.

By contrast, the second line refers to the profit obtained when the deviation to capture the whole share on each side is deterred. We only have constrained profit for $\delta < 1/2$. This is because for large δ, the incentive constraint is nonbinding and thus the unconstrained collusive profit are obtained.

To find out the optimal product choice, we need to compare collusive profit in different product choice and then choose the one which offers the larger profit. In particular, we discuss how the optimal product choice depends on the level of discount factor, or the level of externality. By the formulas of the associated profits in (3.6) and (3.13), we can find the region of the parameter for which either close substitute ($d = 1/4$) or remote substitute ($d = 0$) is optimal. However, this argument involves tedious cases due to full/partial share consideration in deviation (by (3.13)). To simplify the argument without sacrificing the essence, we let $V \geq 13/4$,[28] so that the deviating platform's shares satisfy $m_i^D = n_i^D = 1$ in the unconstrained collusion regardless of product choice. With this restriction, the threshold of δ between constrained and unconstrained collusion is indeed between 1/3 and 1/2, and therefore the collusive profits are derived as the following manner; the constrained collusion with $m_i^D, n_i^D < 1$, for $\delta < 1/3$, the constrained collusion with $m_i^D = n_i^D = 1$, for $1/3 \leq \delta < \widehat{\delta} \leq 1/2$, and the unconstrained collusion for $\delta > \widehat{\delta}$. If V is smaller, the form of collusive profits need modification, which implies that the threshold

[28] With the price expressions in (3.5) and the second conditional expressions in (3.7) and (3.8), we can get $V \geq \left(\alpha - 8\alpha^2 + 26\right) / \left[4\left(\alpha + 2\right)\right] = g$. This condition guarantees that regime of $m_i^D = n_i^D = 1$ occurs for both product choices for unconstrained collusion. Because $0 \leq \alpha < 1$ and $g'_\alpha = -2\left(\alpha + 3\right)\left(\alpha + 1\right) / \left(\alpha + 2\right)^2 < 0$, we can get that $V \geq g\left|_{\alpha=0}\right. = 13/4$.

value of δ for the following result must differ, but the argument is essentially the same.

Let $d^*(\delta, \alpha)$ denote the optimal product choice for the collusive platforms as a function of the discount factor δ and externality parameter α.

The following proposition summarizes the results for given externality parameter α.

Proposition 3.1 *Suppose $V \geq 13/4$. Then platforms will choose $d^*(\delta, \alpha)$ using the following method:*

$$d^*(\delta, \alpha) = \begin{cases} 1/4 & \text{if } \delta \geq \widetilde{\delta} \\ 0 & \text{if } \delta < \widetilde{\delta} \end{cases}, \text{ where } \widetilde{\delta} = (4V - 5 + 5\alpha) / [8(V + \alpha - 1)].$$

Note that $\widetilde{\delta}$ is the threshold discount factor at which the colluding platforms are indifferent to locating between at $d = 1/4$ and $d = 0$.

The intuition of Proposition 3.1 is the following. When δ is high, platforms are not constrained by the incentive constraint at both product choices, so they maximize collusive profits with respect to both product choice and prices. Because $d = 1/4$ minimizes transportation costs, platforms choose $d^*(\delta, \alpha) = 1/4$ and charge unconstrained collusive prices. When δ becomes sufficiently low, the constraint is binding for $d = 1/4$ but not for $d = 0$. In this case, platforms compare the constrained collusive profit for $d = 1/4$ with the unconstrained collusive profit for $d = 0$ to select products. At $d = 0$, platforms charge prices which are independent of δ, whereas at $d = 1/4$, they must reduce the constrained prices to sustain collusion as δ decreases. Because by our definition

$\widetilde{\delta}$ is the discount factor that makes the highest possible collusive profit equal at both $d = 1/4$ and $d = 0$, as long as the discount factor is larger than $\widetilde{\delta}$, constrained profit at $d = 1/4$ is still higher than the unconstrained collusive profit at $d = 0$. In contrast, when $\delta < \widetilde{\delta}$, the opposite case occurs. Finally, for very low discount factors, both constraints at $d = 1/4$ and $d = 0$ are binding, and thus constrained prices are charged. At $d = 1/4$, however, platforms cannot sustain the same maximum collusive prices as those at $d = 0$. This occurs because platforms have a higher incentive to deviate at $d = 1/4$. The reason is straightforward: by lowering consumer prices, platforms can obtain a larger consumer share in price deviation than in competition. Moreover, with the same reduction in prices, the consumer share in deviation at $d = 1/4$ increases much more than that at $d = 0$ due to the higher price elasticity for closer substitutes. This allows advertisers to obtain greater utility and platforms to enjoy higher revenues from price deviation at $d = 1/4$. Thus, due to the higher incentives to deviate, platforms must decrease collusive prices at $d = 1/4$ more than those at $d = 0$ to make collusion sustainable. Therefore, platforms increase differentiation to obtain higher collusive profits for a low enough δ (i.e., $d^* (\delta, \alpha) = 0$).

Figure 3.2 illustrates the optimal product choice in the α-δ plane. The solid curves, from top to bottom, represent $\widehat{\delta}\,|_{d=1/4}$, $\widetilde{\delta}$ and $\widehat{\delta}\,|_{d=0}$ as functions of α, respectively. From Proposition 3.1 we have $d^* = 1/4$ for $\delta \geq \widetilde{\delta}\,(\overline{\alpha})$ for a fixed $\overline{\alpha}$. As it can be seen from Figure 3.2, the colluding platforms choose

$d^*(\delta, \alpha) = 1/4$ in the dark area; by contrast, they choose $d^*(\delta, \alpha) = 0$ in the other area.

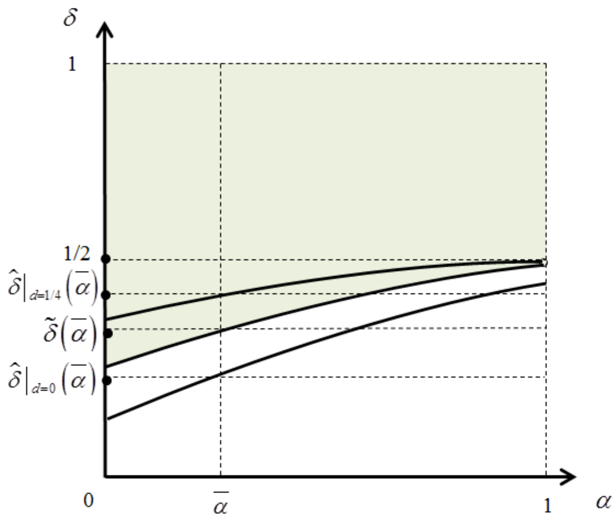

Figure 3.2: Optimal Product Choice for Given α or δ

In Figure 3.2, by fixing δ at some level, we can also show how change in the externality parameter affects the optimal product choice. The findings are summarized in the following proposition.

Proposition 3.2 *Suppose* $V \geq 13/4$. *Then platforms will choose* $d^*(\delta, \alpha)$ *using the following method:*

Define $\widetilde{\alpha} = [4V(1 - 2\delta) + 8\delta - 5] / (8\delta - 5)$.

(1) For $\widetilde{\alpha} \geq 1$, *platforms choose* $d^*(\delta, \alpha) = 1/4$ *regardless of the size of the externality parameter* α*;*

(2) For $0 < \widetilde{\alpha} < 1$, *platforms choose* $d^*(\delta, \alpha) = 1/4$ *if* $\alpha < \widetilde{\alpha}$. *Otherwise,* $d^*(\delta, \alpha) = 0$*;*

(3) For $\widetilde{\alpha} \leq 0$, *platforms choose* $d^*(\delta, \alpha) = 0$ *regardless of the size of the externality parameter* α.

Note that $\widetilde{\alpha}$ is the threshold externality parameter at which the colluding platforms are indifferent to locating between at $d = 1/4$ and at $d = 0$.

The intuition is as follows. As α increases, for each product choice, the deviation incentive gets larger and thus unconstrained collusion gets harder to sustain. To see the intuition, let us consider a particular δ between $\widehat{\delta}\,|_{d=1/4}$ for $\alpha = 0$ and $1/2$. If α is small, the deviation incentive is so low that unconstrained collusive prices can be sustainable at both choices. In this case, platforms choose $d^*(\delta, \alpha) = 1/4$. For medium α, since the deviation incentive caused by the increase of α affects first for $d = 1/4$ (by Lemmas 3.1 and 3.2), the constraint is binding only for $d = 1/4$ but not for $d = 0$. In this case, platforms compare the constrained collusive profit for $d = 1/4$ with the unconstrained collusive profit for $d = 0$: they choose $d^*(\delta, \alpha) = 1/4$ for $\alpha < \widetilde{\alpha}$ but otherwise $d^*(\delta, \alpha) = 0$ for $\alpha \geq \widetilde{\alpha}$. When deviation incentive is high enough to make unconstrained collusive prices unstainable at $d = 1/4$, colluding platforms must lower prices. For α such that $\alpha < \widetilde{\alpha}$, the deviation incentive is not large. This implies that the price reduction is small, so that the constrained profit at $d = 1/4$ is larger than the unconstrained profit at $d = 0$. In contrast, for a large externality parameter such that $\alpha \geq \widetilde{\alpha}$, colluding platforms must lower prices significantly at $d = 1/4$ to the level for which they receive a smaller collusive profit than the unconstrained collusive profit at $d = 0$. Therefore, platforms choose $d^*(\delta, \alpha) = 1/4$ if $\alpha < \widetilde{\alpha}$ but $d^*(\delta, \alpha) = 0$ if $\alpha \geq \widetilde{\alpha}$. Finally, for large α, the deviation incentive is so large that the constraints can be binding at both product choices. In this case, constrained collusive prices are charged. By using the logic analogous to that of Proposition 3.1, we have $d^* (\delta, \alpha) = 0$.

3.6 Conclusions

This paper investigates the impacts of externalities on collusive behavior in the media market. We use the single-homing model of two-sided markets with once and for all product choice and a pricing game that is repeated infinitely. Additionally, we assume grim trigger strategies to support collusion in pricing. Our findings show that externalities affect platforms' incentives to deviate and thus the optimal product choice: the larger the externalities, the higher the degree of product differentiation for the collusive platforms.

We now conclude by discussing the robustness of our findings in a more general setting. In the analysis, we consider the case in which externalities exist in only one direction, namely, that advertisers care about consumers but that the latter are indifferent about the former. This does not seem to be a very restrictive assumption. Ads in some media formats such as newspapers and magazines are not especially intrusive so that the disutility from ads is likely to be less pronounced and, in some cases, even neglected. If consumers and advertisers are concerned about each other, the analysis will be similar to the scenario in which the value of externalities is fixed on one side but changes on the other. If consumers, for instance, dislike ads, the profits in punishment, collusion and deviation need to be altered accordingly. Compared to the case in which there are no externalities on the consumer side, the feedback loop changes: the increased number of advertisers, caused by more consumers by undercutting the competitor's price, will reduce the number of consumers. Although the incentives to collude are altered, relaxing the assumption by allowing externalities in the consumer side only changes the results quantitatively. In the paper, we also assume that the intrinsic values are identical and the transportation cost parameters are equal to 1 on both sides. The modification that consumers and advertisers have different intrinsic values directly affects only unconstrained collusive profit and the incentive to sustain unconstrained collusion. Transportation cost parameters can be interpreted as a kind of market power for platforms to charge prices such that different transportation cost parameters would not alter the findings qualitatively but only quantitatively.

In our research, we use the grim trigger strategy to analyze collusive behavior. Future research can investigate how our findings change when other punishment mechanisms, such as the stick and carrot strategy, are used to support collusion. Another area of research is studying the use of other pricing strategies (e.g., discriminatory pricing or no pricing for a group of agents) and investigating their impact on collusive product choice. For future research, we hope this paper has shed some light on the understanding of the fundamental interactions underlying collusion in two-sided markets.

Appendix 3A

This appendix shows the maximization problem with incentive constraints.

For a given product choice, platform i will choose its collusive prices based on the following maximization problem:

$$\max_{s,p} \ \pi_i^C(d,d) = \frac{s+p}{2} \ s.t. \ \delta \geq \frac{\overline{\pi}_i^D(d,d) - \overline{\pi}_i^C(d,d)}{\overline{\pi}_i^D(d,d) - \overline{\pi}_i^N(d,d)}.$$

Here, $\overline{\pi}_i^N(d,d) = \pi_i^N(d,d) = 1-2d-\alpha/2$. Note that in the following argument, when we use expressions from (3.7) to (3.11), s_j^C and p_j^C should be replaced by s and p, respectively.

(1) If platform i finds it optimal to have a partial share on each side with price deviation, the deviation profit can be obtained from the first expression in (3.11). After performing the calculation, we have

$$s = \frac{(3\delta+1)(1-2d) - \alpha(\delta+1)}{1-\delta}; \ p = \frac{(3\delta+1)(1-2d) - 2\alpha\delta}{1-\delta};$$
$$\pi_i^C = [2(1-2d) - \alpha]\frac{3\delta+1}{2(1-\delta)}.$$

By substituting the above expressions for s and p into the first conditional expressions in (3.7) and (3.8), we get $\delta < 1/3$.

(2) If platform i finds it optimal to have a partial share on the advertiser side but a full share on the consumer side, we can use the second expression in (3.11) as the deviation profit. After performing the calculation, we have

$$s = \frac{1-2d-\alpha(1-\delta)}{1-2\delta}; \ p = 3(1-2d) - \alpha;$$
$$\pi_i^C = [2(1-2d) - \alpha]\frac{2-3\delta}{2(1-2\delta)}.$$

Plugging s and p into the second expressions in (3.9) and (3.10), we can get the optimal deviation prices. With these prices, we can find that market share on each side is equal to 1, which is in contradiction to our assumption. Thus, we do not have this regime.

(3) If platform i finds it optimal to have a full share on each side with price deviation, the deviation profit is $\overline{\pi}_i^D(d,d) = p + s + \alpha - 2(1-2d)$, which is obtained from the last expression in (3.11). By plugging the relevant profits into the incentive constraint, we have

$$\underbrace{(2\delta - 1)(p+s)}_{(1)} + \underbrace{(2-3\delta)[2(1-2d)-\alpha]}_{(2)} \geq 0$$

Note that $2(1-2d) - \alpha > 0$ due to the second-order condition, thus whether the above constraint is binding depends on the relationship between δ and $1/2$ as well as between δ and $2/3$. If $\delta < 1/2$, term (1) is negative and term (2) is positive. Thus, we can increase $p+s$ until the constraint becomes binding. If $\delta \geq 1/2$ there is no solution to this problem, which means that the incentive constraint never binds and the unconstrained collusive prices are attainable. In a word, the constraint is binding only if $\delta < 1/2$. In this case, we can obtain the following collusive profit

$$\overline{\pi}_i^C = [2(1-2d) - \alpha] \frac{2-3\delta}{2(1-2\delta)}.$$

This arises when δ is below some level at which the unconstrained profit equals this constrained profit, and also this level is above $1/3$.

Therefore, from the above argument we have the expressions in (3.13).

Appendix 3B

This appendix shows proofs of Propositions 3.1 and 3.2

(1) Proof of Proposition 3.1

There are two types of collusive profits, namely, the ones with and without binding constraints; for the constrained case, we also have two forms in (3.13). Thus, before deciding the optimal product choice, we need to find out which kind of collusive profit platform can obtain for a given product choice. To do this, we need to find out the relationship between $\widehat{\delta}$ and $1/3$ as well as between $\widehat{\delta}$ and $1/2$ for each product choice, which are to be shown in the following argument.

In the share regime we consider, we have

$$\widehat{\delta} = \frac{4V + 20d + 5\alpha - 4d^2 - 9}{8V + 32d + 8\alpha - 8d^2 - 14}.$$

By comparison, we have

$$\widehat{\delta}\,|_{d=0} - 1/3 = (4V + 7\alpha - 13) \,/\, [6\,(4V + 4\alpha - 7)] > 0;$$

$$\widehat{\delta}\,\big|_{d=1/4} - 1/2 = 2\,(\alpha - 1) \,/\, (16V + 16\alpha - 13) < 0.$$

The above relationships are based on the following inequalities from $V \geq 13/4$:

$$4V + 7\alpha - 13 \geq 7\alpha \geq 0;$$

$$4V + 4\alpha - 7 \geq 6 + 4\alpha > 0;$$

$$16V + 16\alpha - 13 \geq 39 + 16\alpha > 0.$$

Due to the monotonic relationship between $\widehat{\delta}$ and d, therefore, we have $\widehat{\delta}\left|_{d=1/4}\right. >$ $1/3$ and $\widehat{\delta}\left|_{d=0}\right. < 1/2$.

Based on our lemmas and the above results, we can make the following argument.

1) For $\delta \geq \widehat{\delta}\left|_{d=1/4}\right.$, neither constraint is binding at $d = 0$ and $d = 1/4$, so the unconstrained collusive prices can be sustained. In this case, $d^* (\delta, \alpha) = 1/4$.

2) For $\widehat{\delta}\left|_{d=0}\right. \leq \delta < \widehat{\delta}\left|_{d=1/4}\right.$, the constraint is binding at $d = 1/4$ but not at $d = 0$. Here, we compare $\pi_i^C (d, d)\left|_{d=0}\right.$ with $\overline{\pi}_i^C (d, d)\left|_{d=1/4}\right.$ on the second line of (3.13). Let

$$x = \overline{\pi}_i^C (d, d)\left|_{d=1/4}\right. - \pi_i^C (d, d)\left|_{d=0}\right. = \frac{-4V - 5\alpha + 5 + 8\delta (V + \alpha - 1)}{4 (1 - 2\delta)}.$$

If $x = 0$, we have $\widetilde{\delta} = (4V - 5 + 5\alpha) / [8 (V + \alpha - 1)]$. For $\delta > \widetilde{\delta}$, we have $x > 0$ due to $x'_\delta = (1 - \alpha) / \left[2 (2\delta - 1)^2\right] > 0$. In this case, $d^* (\delta, \alpha) = 1/4$. Similarly, $x < 0$ and thus $d^* (\delta, \alpha) = 0$ for $\delta < \widetilde{\delta}$.

3) For $\delta < \widehat{\delta}\left|_{d=0}\right.$, both constraints are binding at $d = 0$ and $d = 1/4$. Since $\widehat{\delta}\left|_{d=0}\right. > 1/3$, we need consider the following cases.

- For $1/3 \leq \delta < \widehat{\delta}\left|_{d=0}\right.$, by comparing $\overline{\pi}_i^C\left|_{d=1/4}\right.$ and $\overline{\pi}_i^C\left|_{d=0}\right.$ on the second line of (3.13), we can get $d^* (\delta, \alpha) = 0$. This is because $\overline{\pi}_i^C\left|_{d=0}\right. - \overline{\pi}_i^C\left|_{d=1/4}\right. =$ $(3\delta - 2) / [2 (2\delta - 1)] > 0$.

- For $\delta < 1/3$, by comparing $\overline{\pi}_i^C\left|_{d=0}\right.$ and $\overline{\pi}_i^C\left|_{d=1/4}\right.$ on the first line of (3.13), we have $d^* (\delta, \alpha) = 0$. This is because $\overline{\pi}_i^C\left|_{d=0}\right. - \overline{\pi}_i^C\left|_{d=1/4}\right. = (3\delta + 1) / [2 (1 - \delta)] >$ 0.

In sum, $d^* (\delta, \alpha) = 0$ for $\delta < \widehat{\delta}\left|_{d=0}\right.$.

(2) Proof of Proposition 3.2

Here, we only discuss the comparison between the constrained collusive profit for $d = 1/4$ and the unconstrained collusive profit for $d = 0$. Since the rest of the proof is analogous to that of Proposition 3.1, we omit them.

From the expression of x defined in the above argument, we have $x = 0$ for $\widetilde{\alpha} = \left[4V\left(1-2\delta\right)+8\delta-5\right]/\left(8\delta-5\right)$. Since $x'_{\alpha} = \left(8\delta-5\right)/\left[4\left(1-2\delta\right)\right] < 0$, we have $x > 0$ for $\alpha < \widetilde{\alpha}$, which implies that $d^{*}\left(\delta,\alpha\right) = 1/4$. Similarly, $x < 0$ and thus $d^{*}\left(\delta,\alpha\right) = 0$ for $\alpha > \widetilde{\alpha}$.

4 Product Differentiation and Advertising in Multiple Markets

4.1 Introduction

Nowadays many media platforms operate business simultaneously in several different markets to maximize benefits or to gain competitive advantage. Taking CNN and NBC as examples, they compete not only in the US but also in other countries. Also, CNBC and Bloomberg TV provide finance programs to many different markets. Each market is heterogeneous with respect to consumer preferences, market size and competitive structure, but it is not always possible for media platforms to tailor their contents to each individual market. In this chapter, we investigate how media platforms behave in product positioning when all of them compete with the same content across markets.

Product provision by firms which serve multiple markets has been studied by Loertscher and Muehlheusser (2008). They consider the case in which the firm serving multiple markets competes with local firms in each single market; however, all of our firms compete across markets. Moreover, we include the effect of consumer prices and advertisements. In contrast, they abstract price competition and only consider product choice. There are other papers investigating endogenous content provision within the Hotelling framework, but most focus on the choice in a single market. Gabszewicz et al. (2001, 2002) assume that consumers are indifferent about the level of advertising, and show that the degree of differentiation depends on unit receipt from advertising. When consumers dislike advertising, Gabszewicz et al. (2004) conclude that maximal differentiation arises under ad-supported media (when the disutility from advertising is linear in the advertising level). The paper by Gal-Or and Dukes (2003) offers an explanation for minimum differentiation, which relies on the role of advertising as information about products and as a nuisance to consumers. Peitz and Valletti (2008) consider the content choice and advertising provision under pay-TV and ad-supported media, respectively. Their model shares several properties with ours. In particular, the configuration is competitive bottlenecks and consumers dislike ads. They show that pay-TV always maximally differentiates content whereas ad-supported media may provide less differentiated contents.

We analyze a Hotelling location game where two media platforms compete with the same content in two separate markets. The platforms choose the intensity of advertising and subscription fee.[29] Our conclusions show how product positioning is affected by market size, competition intensity, and the non-negativity constraint on prices. When there is no restriction with respect to price, media platforms maximally differentiate contents. In each market of our model competition effect dominates demand effect, so even if they compete in different markets, platforms maximize content differentiation. However, if we restrict price to be non-negative, the outcome changes: partial differentia-

[29] When the non-negativity constraint on prices is binding, (i.e., the media becomes ad-supported), platforms only determine the advertising space.

tion may arise if the non-negativity constraint is binding. Since advertising is the only revenue source for the market where the constraint is binding, media platforms, if competing only in this market, will choose location that offers maximum advertising revenue, but not necessarily the endpoints. In contrast, competition effect still dominates in the market where the constraint is non-binding. Therefore, when the former market is sufficiently important in revenue composition, the media platforms competing in multiple markets will choose their contents closer to the location which generates maximum advertising revenues, which may lead to partial differentiation.

The remainder of this chapter is organized as follows: section 4.2 establishes the model, the equilibrium is analyzed in section 4.3, and section 4.4 provides the conclusion.

4.2 Model

There are two separated media markets, $k = 1, 2$. These markets differ in size and it is assumed that the size of market 2 is N times larger than market 1. Consider two media platforms, $i = A, B$, each of which serves two distinct groups of agents: consumers who like to consume media content, and advertisers who want to inform consumers about their products via the media. Each group consists of a unit mass of agents. Platforms have fixed cost and marginal cost in serving consumers and advertisers which we normalize to zero. Each platform chooses its own content location from the unit interval $[0, 1]$.

Parameter d_A denotes the distance between the endpoint 0 and the location of platform A, while parameter d_B is the distance between the endpoint 1 and the location of platform B. Points d_A and $1 - d_B$ accordingly represent the respective content choice for platforms A and B. Without loss of generality, we assume that $d_A \leq 1 - d_B$. In our model, platforms cannot tailor their products to each individual market where they operate. For example, CNN provides some contents which are made in US to the world.

Consumers in market k are distributed uniformly on the $[0, 1]$-interval with $\beta_k \in [0, 1]$ representing their preferences. When consuming content that does not satisfy his/her taste, a consumer incurs a disutility that is related to the square of the distance of his/her choice from his/her ideal point on the line, namely $\tau_k (\beta_k - d_A)^2$ or $\tau_k (1 - d_B - \beta_k)^2$ with $\tau_k > 0$ designating the transportation cost parameter.[30] Assume that the transportation cost parameter in market 1 is higher than that in market 2, i.e., $\tau_1 > \tau_2$, which implies that consumers consider content more substitutable in market 2 than those in market 1. For example, U.S. consumers have strong persistence of political news compared to some other countries. Consumers are assumed to dislike advertising. We use δ to denote the disutility parameter for ads and its domain is $0 < \delta < 1$.[31] If content contains a_{ki} amount of advertising, the utility of type-β_k

[30] When platforms endogenously select their locations in the Hotelling model, the specification of quadratic transportation costs can guarantee the existence of an equilibrium, which may not exist with linear transportation costs. We use the specification of quadratic transportation costs to simplify the analysis. Yet, this does not seem to be a very restrictive assumption.

[31] The reason for choosing this domain is to guarantee the existence (i.e., there are solutions for (4.5)) and positive value of advertising.

consumer who chooses platform A in market k is given by

$$U_{kA} = v_k - \delta a_{kA} - \tau_k \left(\beta_k - d_A\right)^2 - p_{kA},$$

where v_k is the intrinsic utility in market k, which is assumed to be large enough to ensure full market coverage.[32] Parameter p_{kA} is the subscription fee charged by platform A in market k.

Advertisers are characterized by parameter θ, which is uniformly distributed on the interval $[0,1]$. A type-θ advertiser can obtain profit θ from each consumer who sees the ads. Thus, advertisers will place ads on a platform with acceptable consumer size x_{ki} and advertising price r_{ki} if $\theta x_{ki} \geq r_{ki}$. This implies that advertising quantity in this platform is $a_{ki} = 1 - r_{ki}/x_{ki}$.

Media platforms have two sources of revenue: consumers and advertisers. Therefore, platform i's profit generated in market 1 and 2 is given by

$$\begin{aligned} \pi_i &= \pi_{1i} + \pi_{2i} = x_{1i} p_{1_i} + a_{1i} r_{1i} + N x_{2i} p_{2_i} + a_{2i} r_{2i} \\ &= x_{1i} \left[p_{1_i} + a_{1i} \left(1 - a_{1i}\right)\right] + N x_{2i} \left[p_{2_i} + a_{2i} \left(1 - a_{2i}\right)\right]. \end{aligned}$$

We consider a three-stage game. At the initial stage, the platforms determine their content locations to maximize the gross profits in these two markets. At the second stage, they choose subscription fees and advertising intensities in market 1. Finally, they make their decisions in market 2.[33]

[32] Without loss of generality, in the following we assume that v_k is same in both markets, i.e., $v_1 = v_2 = v$.

[33] The results will not change if media platforms make their decisions in market 1 and 2 simultaneously.

4.3 Equilibrium

4.3.1 Without a Non-negativity Constraint on Prices

We first analyze platform competition in market 2. From the Hotelling specification, the consumer number of platform i in market 2 is given as follows:

$$x_{2i} = \frac{1 + d_i - d_j}{2} - \frac{\delta\left(a_{2i} - a_{2j}\right) + \left(p_{2i} - p_{2j}\right)}{2\tau_2\left(1 - d_i - d_j\right)}. \quad (4.1)$$

At the third stage, platform i chooses the strategic variables a_{2i} and p_{2i} to maximize π_i. The equilibrium is characterized by the following first-order conditions:

$$\frac{\partial \pi_i}{\partial p_{2i}} = N\left[x_{2i} + \frac{\partial x_{2i}}{\partial p_{2i}} p_{2i} + a_{2i}\left(1 - a_{2i}\right)\frac{\partial x_{2i}}{\partial p_{2i}}\right] = 0, \quad (4.2)$$

$$\frac{\partial \pi_i}{\partial a_{2i}} = N\left[\frac{\partial x_{2i}}{\partial a_{2i}} p_{2i} + a_{2i}\left(1 - a_{2i}\right)\frac{\partial x_{2i}}{\partial a_{2i}} + \left(1 - 2a_{2i}\right)x_{2i}\right] = 0. \quad (4.3)$$

Analogous analysis can be applied to market 1. By calculation, the advertising level and subscription fee for each platform in different markets can be expressed as follows:

$$a_{ki} = \frac{1-\delta}{2};\ p_{ki} = \frac{\left(1 - d_i - d_j\right)\left(3 + d_i - d_j\right)\tau_k}{3} - \frac{1-\delta^2}{4}. \quad (4.4)$$

By summing up the profits generated in markets 1 and 2, we have the following equilibrium profit:

$$\pi_i = \frac{1}{18}\left(\tau_1 + N\tau_2\right)\left(d_i - d_j + 3\right)^2\left(1 - d_i - d_j\right).$$

By differentiating the above profit function, we can show that media platforms locate at the endpoints, i.e., $d_A = d_B = 0$.[34]

[34]In our model, the analysis at the first stage is similar to that in the standard Hotelling model with quadratic transportation costs (D'Aspremont et al., 1979).

Without loss of generality, we focus on market k to interpret the equilibrium price and location. The term $(1-\delta^2)/4$ in the subscription fee p_{ki} in (4.4) denotes the advertising revenue per consumer. The expression for p_{ki} implies that all the per consumer advertising revenues are passed onto consumers by a form of lower price, namely, that advertising revenues do not affect the profits of platforms.[35] In our model, there is no competition for consumers and advertisers across these two markets, therefore, together with the result of "profit neutrality", we can regard each market as the standard Hotelling model. Two counteracting forces affect the location in each market: the increase of captive consumers (i.e., the demand effect) and the intense price competition (i.e., the competition effect) when platforms move closer to each other. With quadratic transportation costs the latter effect always dominates, thus maximum differentiation arises in our model.

4.3.2 With a Non-negativity Constraint on Prices

The above analysis allows for negative prices, but it is not always possible for platforms to subsidize consumers, due to adverse selection or opportunistic behaviors.[36] Thus from now on we consider the case in which platforms are constrained to set non-negative prices. The case in which the non-negativity constraint is nonbinding is similar to those in section 4.3.1, and it occurs when

[35] According to Peitz and Valletti (2008), this phenomenon is called "profit neutrality". It is surely an artifact of the model setup that media platforms choose the intensity of advertising, but this setting simplifies the analysis without loss of generality.

[36] If consumers are paid to get the media products, platforms will attract some non-targeted consumers that have no value to advertisers.

content preferences are large compared to the nuisance cost caused by advertising, i.e., $3\left(1-\delta^2\right) < 4\left(1-d_i-d_j\right)\left(3+d_i-d_j\right)\tau_k$. This is because platforms can obtain some degree of market power over consumers to charge non-negative prices by offering differentiated media products. For the case in which the constraint is binding, we have two cases due to $\tau_1 > \tau_2$: one that only the constraint in market 2 is binding and the other where the constraint is binding in both markets. In this paper, we mainly consider the first case.[37] When the above condition is violated, the subscription fee in market 2 becomes negative and thus zero equilibrium price is charged. In this case, the first-order condition to determine the advertising intensity for platform i in market 2 changes as follows:

$$\frac{\partial \pi_i}{\partial a_{2i}} = N\left[a_{2i}\left(1-a_{2i}\right)\frac{\partial x_{2i}}{\partial a_{2i}} + \left(1-2a_{2i}\right)x_{2i}\right] = 0.$$

For symmetric locations, the equilibrium advertising level in market 2 is given by

$$a_2 = a_{2i} = \frac{1}{2} + \frac{\tau_2(1-2d)}{\delta} - \sqrt{(1-2d)^2\frac{\tau_2^2}{\delta^2} + \frac{1}{4}}. \qquad (4.5)$$

This symmetric equilibrium advertising level corresponds to the uniform distribution case of Peitz and Valletti (2008). It can be shown that when consumers do not mind much being exposed to advertising, the advertising level a_2 is decreasing with the nuisance parameter δ. For the first market, the first-order conditions are still analogous to expressions in (4.2) and (4.3), so in market 1

[37] We can derive the similar result when the non-negativity constraint is binding in both markets.

we can obtain the same results as those in section 4.3.1 for given locations of platforms.

We now consider the stage where platforms choose the contents. If the first-order condition at stage 1 holds, we have the following equation:

$$\frac{\partial \pi_i}{\partial d_i} = [p_{1i} + a_{1i}(1-a_{1i})]\left(\frac{\partial x_{1i}}{\partial d_i} + \frac{\partial x_{1i}}{\partial a_{1j}}\frac{\partial a_{1j}}{\partial d_i} + \frac{\partial x_{1i}}{\partial p_{1j}}\frac{\partial p_{1j}}{\partial d_i}\right)$$
$$+ N a_{2i}(1-a_{2i})\left(\frac{\partial x_{2i}}{\partial d_i} + \frac{\partial x_{2i}}{\partial a_{2j}}\frac{\partial a_{2j}}{\partial d_i}\right) = 0.$$

For symmetric equilibrium, the above equation can be expressed as

$$-\frac{(1+4d)\,\tau_1}{6} + N a_2(1-a_2)\left[\frac{1}{2} + \frac{\delta}{2(1-2d)\,\tau_2}\frac{\partial a_{2j}}{\partial d_i}\Big|_{d_i=d_j=d}\right] = 0, \qquad (4.6)$$

where

$$\frac{\partial a_{2j}}{\partial d_i}\Big|_{d_i=d_j=d} = -\frac{2a_2(1-a_2)\,\delta\left[\frac{\delta^2}{\tau_2^2}(2-d)\,a_2(1-a_2) + 2(1-d)(1-2d)^2\right]}{\tau_2\left[-\frac{\delta^4}{\tau_2^4}a_2^2(1-a_2)^2 + \left(2\frac{\delta^2}{\tau_2^2}a_2(1-a_2) + 2(1-2d)^2\right)^2\right]} < 0.$$

The first term of expression (4.6) is negative, while the second term, which is similar to expression (12) in Peitz and Valletti (2008), is ambiguous. By analyzing the relationship between market size N and the content differentiation, we have the following proposition.

Proposition 4.1 *In the subgame perfect equilibrium, platforms which serve multiple markets will choose contents using the following method when the non-negativity constraint on prices is binding in market 2:*

If $\delta/\tau_2 < \sqrt{2\left(1+\sqrt{2}\right)/a_2(1-a_2)}$, *content differentiation is decreasing in* N, *and reaches maximum for* N *sufficiently small. Otherwise, maximal differentiation arises regardless of the size of* N.

To understand content choice clearly when media platforms compete in multiple markets with the same products, we first consider the case in which platforms only compete in a single market, respectively, and then operate in both markets 1 and 2.

Consider that platforms compete only in market 1. When the non-negativity constraint is nonbinding, as mentioned above, there is a full pass-through of advertising revenues into lower subscription fee, implying commercials do not affect equilibrium profits. In this case, the analysis at the stage of content choice reduces to the standard Hotelling model with quadratic transportation costs, so maximum differentiation arises. If platforms compete only in market 2, advertising becomes the only revenue source when the non-negativity constraint on prices is binding. Therefore, platforms will choose the content which offers the highest advertising revenue. In market 2, there are two effects for location decision: the demand effect and the competition effect of advertising, whose relative magnitude is ambiguous. When advertising is not so much of a nuisance (i.e., δ is small) or contents are hardly substitutable (i.e., τ_2 is large), the competition effect is small and thus platforms do not need to differentiate their contents maximally. However, maximal differentiation arises for δ sufficiently large or τ_2 sufficiently small. This occurs because by differentiating contents the media can obtain some degree of market power over their consumers to place ads.

When platforms compete in both markets 1 and 2 with the same content, they trade-off revenues generated from these two markets: the effects in market 1 make maximum differentiation desirable while the advertising revenues in market 2 may induce platforms increase content duplication. For δ sufficiently large or τ_2 sufficiently small, the above analysis implies that platforms which operate in multiple markets will choose the endpoints of the line. For small δ or large τ_2, we have the following intuition. When market 2's size N is relatively large, advertising revenue becomes more important. Thus media platforms choose content which is much similar to the case in which they operate only in market 2. In contrast, when market 2's size is not so large, the revenues from market 1 are relatively important, namely, that platforms maximally differentiate the content for N sufficiently small.[38]

Figure 4.1 displays the relationships between the program content d and market 2's size N for $\tau_1 = 1$, $\delta = 0.2$ and $\tau_2 = 0.8, 0.2, 0.1, 0.05$, respectively. The horizontal dashed lines correspond to the case where ad-supported media competes only in market 2, while the solid curves represent the case in which platforms operate in two markets. Figure 4.1 shows that d is increasing in N

[38]Our results also apply to the case of $\delta = 0$, although there are no solutions for advertising in (4.5). By the same logic mentioned above, if consumers do not mind advertising, platforms would compete for consumers so that content duplication occurs for sufficiently large N. This extends the result of content duplication for sufficiently important advertising provided by Gabszewicz et al. (2001, 2002) in a single market to many markets. Different from ours, Loertscher and Muehlheusser (2011) show that the content provision is not affected by the large enough advertisements in a sequential location game. Here, note that content duplication does not occur for $\delta > 0$. If platforms duplicate content, in market 2 a platform can get all consumers from its competitor by reducing the advertising level. The above situation induces zero revenues. Furthermore, price competition effect always dominates demand effect in market 1. Therefore, platforms have a tendency to differentiate the content to make positive revenues. Mathematically, the L.H.S. of expression (4.6) reduces to $-(1+4d)\tau_1/6 - Na_2(1-a_2)d/(1-2d)$, which is negative as $d \to 1/2$.

and $d = 0$ for N sufficiently small.

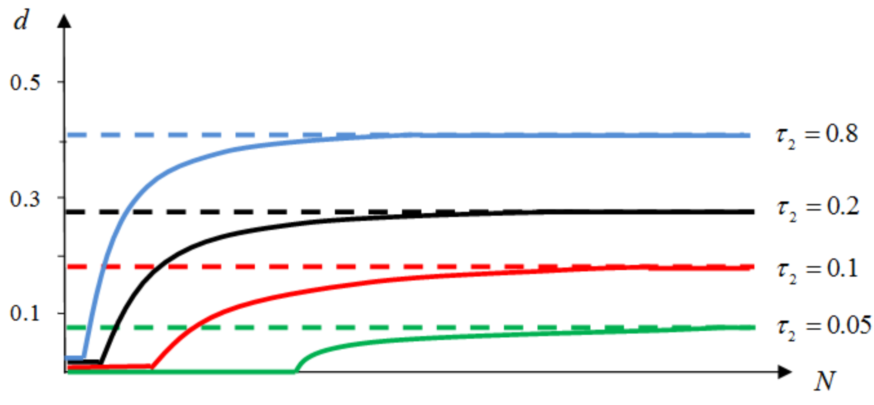

Figure 4.1: The Relationship Between d and N

Differentiating d with respect to δ, τ_1 and τ_2 yields the following comparative-static results on the equilibrium content.

Corollary 4.1 *If partial differentiation arises when platforms compete in multiple markets, the equilibrium content d is increasing with τ_2 but decreasing with δ and τ_1.*

As δ increases, consumers become more sensitive to advertising. However, by differentiating content, platforms obtain some degree of market power over consumers, which allows platforms to place ads without losing their consumers. Therefore, given the relative size of these two markets, platforms differentiate their contents more to obtain their advertising revenues from market 2 if δ becomes large. We can make a similar analysis for τ_2. But platforms' incentive to differentiate content is decreasing as τ_2 increases. This is because platforms' market power over consumers increases as consumers regard contents as hardly substitutable (i.e., large τ_2). In addition, equilibrium content d and τ_1 have a negative relationship: as τ_1 gets smaller, the competition in market 1 becomes more intense, which makes the profit generated from this market shrink relative to that from market 2. Thus platforms have incentives to move away from the endpoints where the platforms locate when they compete only in market 1.

4.4 Conclusion

In this chapter we investigate a Hotelling model where media platforms compete with the same content in two heterogeneous markets. Our findings are closely related to the non-negativity constraint imposed on the per-consumer price: it shows that if there is no restriction on price, media platforms maximally differentiate their contents; by contrast, less differentiated content may be provided if non-negativity constraint is binding.

We have specified a relatively simple model where there is no competition for consumers and advertisers across markets. Our model can fit some phenomena. However, in some cases there still exists competition for consumers, advertisers, or both. Thus, relaxing this assumption might yield interesting insights, which should be undertaken in future research.

5 Discussions and Conclusions

Given the media's important role in providing information, this dissertation examines product choice by media platforms in the contexts of media collusion and of media competition in multiple markets by employing a two-sided market framework.

Chapter 3 investigates the incentives for collusive media platforms to differentiate products horizontally, focusing particularly on the impact of externalities. The findings show that the increase of externalities between advertisers and consumers participating in the media can expand price deviation incentives, rendering collusion hard to sustain. Therefore, platforms differentiate their products to a greater degree for large externalities to prevent collusion from breaking down.

Due to deregulation and technological advancement, nowadays many media platforms compete simultaneously in several different markets. Motivated by this trend, Chapter 4 investigates the problem of product positioning by media platforms when they compete across markets. Here, we impose the restriction that the same content will be provided in different markets. By generalizing Peitz and Valletti's (2008) model to multiple markets, we show that less differentiated content may be provided if there is no fee for consumers to access to the media in some markets.

The dissertation tackles only a small subset of economics issues raised by media industries; there are still a lot of things that need to be tackled with from an academic perspective. Here, we provide some directions for the future research before closing.

The first is to reconsider the rationale for public invention in the Internet and digital media. The role of public media firms and media regulation is to increase content variety and reduce the nuisance cost from advertising. In practice, however, this rationale is facing the challenge from the Internet and digital media. Due to technological advance which is lowering both the costs of transmission and program production, the Internet and digital media provide a huge amount of content. In addition, consumers can easily skip the advertising placed in the Internet and digital media, although these media obtain most of their revenue from advertising. That is, the media market conditions have drastically changed. From the review of the existing literature, we can see that all the papers pay their attention to the traditional media such as TV broadcasting. The research on the role of public intervention in the Internet and digital media is scant. Therefore, reexamination of the rationale for public media firms and regulation in these "new media" becomes a real concern.

The second direction is to examine how discriminatory pricing affects product variety in the media market with a free entry model. Up to now, the literature studying the extent of entry in the media market assumes that media platforms charge uniform prices to advertisers and consumers. Although the analysis of uniform pricing provides useful insights about the extent of entry in the media market, it is hard to think of many actual markets where firms only use this specific pricing mode. In reality, media platforms can set different prices to different agents. For example, newspapers can charge new subscribers a low introductory fee or charge advertisers different rates to place ads. In addition, as shown in our dissertation, the nature of two-sidedness of the media affects platforms' profit in a way different from that in traditional market. Therefore, it is natural to include discriminatory pricing to analyze how the profit of firms and the degree of entry in the media market are affected.

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