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NETWORK EXTERNALITY**

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Discussion Paper No. 05-09

May 2005

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PROFIT MAXIMIZATION AND SOCIAL OPTIMUM WITH NETWORK EXTERNALITY

by

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June 2004

Revisal January 2005

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Abstract

The paper analyzes the options open to monopoly firms that sell software or internet service. We consider two groups of customers which are different in their reservation prices. The monopoly in general use price discrimination between customers by producing two versions of the product at different prices where the existing low price must be zero for the lower quality product (i.e., free version). The monopoly can sell advertising space to increase its revenue but risk losing customers that are annoyed by advertising. We show that the monopoly has an incentive to increase its output due to the network externality. We also find cases where the maximum profit is consistent with maximum social welfare. This means that no government regulation is needed. The model is consistent with the empirical marketing software product and internet service in the real-world (e.g., Adobe Acrobat).

Keywords: Network Externality, Net Advertising, Social Optimum

Introduction

The software industry has been characterized in a market where two different products or services are sold at different prices. Some firms offer a simple version for free, while more advanced programs which require backup services are sold to customers who pay a monthly service subscription fee. Some examples can be given below:

(1) Email service (e.g., Hotmail and Yahoo) offer free email services with limited storage ability (2 or 4 mega bites) or limited size of attachment. While these services are offered for free, subscribing and paying a membership fee allows customers more advance email system, etc.

(2) Adobe Acrobat Reader is a simple program that reads a PDF (Portable Document Format) document. Usually any computer user can access the lower quality service for free (for example reader 6). However, improved programs, such as Reader 7, 8 and 9 require a monthly payment. An advanced guidebook with instructions is supplied to holders of licensed-paid programs. In recent versions of this program, documents can be edited, converted to different formats and are electronically transferable - enabling easy and convenient on-line viewing and printing. A variety of services and prices is required because customers are non-homogeneous in their tastes, needs and characteristics.

(3) Another example is the very popular “Dating” and “Blind Dates” sites that offer different services to customers. Usually, the site offers on-line registration on the internet for free, and in turn the agency obtains information like personal names of customers, their age, profession, hobbies etc., and their various contact details. In addition, each member is usually required to fill in a questionnaire about the characteristic details of the person they would like to meet. A non-member cannot

connect and communicate with anyone. He can leave a message to be called by a specific member, but he cannot initiate a direct communication to the member. The member who pays a monthly fee has, in addition to the regular service, the ability to send a message to the site and can receive any information either from non-members or subscribed members. Non-members can receive messages from subscribed members only, but not from other non-members. This matter was recently discussed by Bernard and Bruno (2003) who assessed internet sites which offer membership with advanced services and discuss the question of whether this initiates a more effective externality effect. They mention for example the “Dating Site” and ask what should the owner of this site do? Should the owner offer advanced services with more qualification and various types of membership in order to promote customers entry into the site?

In addition to these standard sources of revenue, the monopoly receives more revenue from companies who add links to computer business home pages where information is advertised and distributed. Adding standard information services via the internet, combined with commercials that feature information and exposing (willing and/or unwilling) customers to these commercials may increase revenue.

The information delivery monopoly may consider different kinds of policies to achieve its goal of profit maximization and we focus on what are the social welfare implications of various possible policies that could be practiced by the monopoly. As we know from earlier literature the positive network externalities is internalized/ considered by profit maximizing monopoly that is encouraged to expand production level. This well known phenomena discussed already by Rohlfs (1974). The results of our paper are that under specific circumstances the monopoly is able to attain the first

best solution i.e., the social welfare optimum is identical to the profit maximizing monopoly solution.

We examine below different policies used by the monopoly.

The first possible policy is to allow any customer to have access to and use of information for free, by removing all protective devices both from simple and basic services as well as from the more sophisticated and qualified services. The source of income comes only from advertisement. This policy leads to a large number of customers using the site's information. These customers are then exposed either willingly or unwillingly to advertisements sold by the site owner to companies charging them payments that are proportional to the number of customers who enter the site and are exposed to the commercial.

The second policy is to differentiate (or even discriminate) between some customers who receive free basic information and service, and other customers who pay a monthly fee for advanced and high-quality information and service. However, under this policy, despite discriminating/differentiating prices of services, all customers who use the site in either level of service are exposed to advertising that indirectly generates revenue to the site's owner.

The third policy is to differentiate between free of fee for basic service and membership fee for advanced service, giving only the members the option to avoid undesirable advertisements.

The fourth policy consists of full-protection of all basic or high-quality services where the site owner charges all customers for any information or service used by them, and yet all customers are exposed to the full array of advertising.

The fifth possible policy of the monopolist is to charge for all services used by all customers and to add an additional periodic charge for the convenience of not being exposed to advertising while using the services provided by the web site.

Path breaking of Conner and Rumelt (1991) address the question as to whether a software publisher should pursue a strategy of software protection or allow some pirating by customers (i.e., free use of software products). The main benefit of allowing free use by customers is the advantage of increasing returns to scale. By having more users (even free users) the benefit of legitimacy of who pays for the service or product increases (with positive network externalities in the use of the software).¹ The tradeoff between revenue losses by removing protection devices, thus allowing a free-for-all policy and the revenue and benefit gain as a result of network externalities is examined.

Shy and Thisse (1999) extend the analysis to a duopoly situation deriving the conditions under which the free entry and use of software positively affects both the producer revenues as well as the social welfare. They conclude similarly to Conner and Rumelt (1991) that returns to scale in the network industry “support” free use of software. Our main contribution lies in the combining of price differentiation for varying service levels with the option of generating revenues from different sources of advertising and showing how these combinations affect social welfare.

Several articles analyzed the influences of free downloadable products from the internet on the demand for software staff. The breakthrough paper by Conner and Rumelt (1991) discusses that free downloads have two contradictory effects on the revenues and profit of software suppliers. On the one hand it leads to a direct

¹ The concept of network externalities also discussed in the eighties papers by Katz and Shapiro (1985, 1986), Farrel and Saloner (1985, 1986).

reduction in sales to potential customers, while on the other hand it leads to an indirect increase in sales. This may occur when more users of the programs increase the benefit of other customers. Increasing returns to a scale of this kind may encourage software suppliers to allow free entry and use of their services. This issue also discussed recently by Gayer and Shy (2003, 2004) who examine music piracy. They show that if network externalities exist it is worthwhile to allow free recording. The losses due to free use can be compensated for by taxing hardware and transferring it to the software industry, as well as payment accrued from record companies and the musicians. Their conclusion regarding avoiding membership fee is similar to ours, however, the whole issue of revenue from advertising which can compensate for the loss induced by free use is not discussed by them.

Another aspect is the question of software protection and the efficient ways to avoid illegal use or installation of software. Recently Chen and Pug (1999), Banerjee (2003) and Poddar (2003) discussed this issue, stating the case where by some cost the illegal download phenomena should be stopped. They develop a model where installation of devices from illegal use reduces the number of users thus the social welfare. Alternatively, the producer may consider an appropriate price that increases the number of legal users resulting higher social welfare. In contrary to their conclusion, Banerjee (2003) shows that free use without enforcement of government to protect downloading of any kind is even better from the society's welfare point of view.

A different perspective on illegal downloading activity is developed by Poddar (2003). By increasing direct and indirect costs of illegal users, illegal activity can be avoided or at least significantly reduced. Even if the direct cost of illegal use is low,

the indirect cost can be that illegal customers get low quality software and take a risk in causing possible damage to their computer operating system.

The above papers follow much of the literature regarding illegal copying of intellectual property, such as documents, articles and papers from original books and journals, (see Bensen and Kirby (1989), Leibowitz (1985), Johnson (1985), Johnson (1985) and Novos and Waldman (1984)).

The main claim derived from these works is that publishers can gain higher profit by copyright elimination. By allowing free copying from the original publisher, more profit can be gained. For example, when price discrimination and libraries or public institution are charged much higher prices for books and journals compared to private individuals it might be beneficial for the publishers to charge even higher price from the library in exchange for eliminating the copy right laws associated with copying material. Accordingly, the library can charge an entry fee to many more consumers who benefit from free copying to a greater extent. The additional revenue from price discrimination between public and private consumers may be larger than the losses acquired from either avoiding the copying charge or the sale decrease in the private sector. This kind of price discrimination between different kinds of customer groups and different levels of quality demanded as well as different levels of compulsory advertisement is discussed in our paper.

The structure of the paper is as follows:

The main part of the paper (the model) considers some alternative policies of a monopoly which includes prices for subscribers and non subscribers as well as exposure to advertisements, and compares the optimal solution of profit maximization, with the social welfare solution. We show several scenarios where the

solution of the monopoly and the social optimum are similar. The welfare comparison and the policy implication are derived in the concluding section.

The Model

The assumptions of the model are as follows:

1. We consider a market with 2η consumers who are interested in receiving some degree of software services supplied by a monopoly. The monopoly supplies two different kinds of services: (i) a basic program with low level and low quality of service and (ii) a more advanced program with high-quality service including many characteristics that are absent in the basic service. An example can be taken from Acrobat Reader (a basic program) vs. Acrobat Reader and Writer (a more advanced software).
2. The revenue of the monopoly is either from selling services of two different values or by selling advertisements to firms who are interested in this kind of advertisement that are imposed on the 2η consumers who have access to the site and service supplied by the monopoly, and may be exposed willingly or unwillingly to the commercials.
3. The monopoly may consider five different policies and opt for only one policy that maximizes profit.
 - a. To supply and allow free full access to the site and to all services to the 2η customers, while selling the advertising possibilities to outside firms and forcing all 2η customers to the view commercials.
 - b. To allow only basic service for free to some customers advertised by the firms, while are charged a monthly fee for the high-quality services provided to them. The advertising is forced on all customers.

- c. To allow basic service for free to customers who in effect pay the price by being forced to view commercials, while high-quality service customers can avoid being subjected to commercial viewing, but **voluntarily** have the option to click on the commercial page, if they so wish.
 - d. To supply only advanced and high-quality service for those who pay a periodic fee, but all users are subjected to advertising.
 - e. To supply only high-quality service to members who **pay the fee and still they** have the choice of paying an additional monthly fee to avoid the advertising.
- 4. The heterogeneity of customers can result from differences of socio economic background such as:
 - a. Different wage rates affecting the demand for different qualities of services. For example, high wage earners desire high-quality service and may desire to avoid advertising because of their time value, which would not be the case with low-wage earners.
 - b. More qualified and talented customers can save money by buying low service levels from the company.
 - c. Customers with free time may enjoy advertising.
- 5. The monopoly offers high-quality service only to customers who pay a periodical fee, delivering only the monopoly supply two quality levels of service.
- 6. The monopolies can attain a high profit level by combining different pricing policies for different qualities of services **and by charging for commercial**

posted by companies according to the members and the structure of site's users.

7. We will now discuss the five different policies mentioned above in assumption 3.

In the model below we discuss the price strategy in the software industry when a monopoly choose either to supply the software program for free or to charge each customer membership fee.

The monopoly supplies a program by a site on the internet. There are heterogeneous customers where type O customers are support-oriented consumers benefit a more advanced program, readily willing to pay a membership fee for the services, while type I customers are support independent consumers, who have no benefit from advanced services, but only a regular service that they receive for free.

Thus, each consumer in the society faces three possibilities and has to choose one out of the following three alternatives:

1. To sign and pay a membership fee for the service
2. To receive the same service for free
3. Not to use the service at all

q customers from the population use (either for free or by paying a fee) the services. The utility of each individual is increased when more customers use the service.

This phenomenon of increasing returns to scale in the network industry is very common, e.g., exchanging information or files from a software is more beneficial as more customers are involved in the market. This approach follows Cabral, Salant and Woroch (1999) who discuss the issue of a monopoly that initiates new technology or promotes an entry of a durable good that may generate network externalities. The question then is what should be the price policy of such a monopoly. The monopoly

can sell a small quantity at a high price which declines **along** time or alternatively sell more units to more customers by charging lower prices which increase along time. Their model concludes that the optimal policy is to initially start price with low prices and by that to generate high benefit for the externalities and its positing effect on the utility of customers and their own demand. Below we depict conditions where the other alternative of initial high price is more profitable. These positive externalities emerge as a result of interaction between customers. **On one hand the customers who benefits advanced service has the following utility:**

$$(1) \quad U_o \stackrel{def}{=} \begin{cases} (1 + \alpha + \beta)f(q) - p & \text{Membership customers and possibility of avoiding advertisements} \\ (1 + \alpha + \beta)f(q) - p - \psi & \text{Membership customers and pay } \psi \text{ for possibility of avoiding advertisements} \\ (1 + \alpha)f(q) - p & \text{Membership customers} \\ f(q) & \text{Free use customers} \\ 0 & \text{No use customers} \end{cases}$$

where p is the membership fee determined by the monopoly that is **charged from each customers who is interested in advanced** service. α is the value of the advanced program service and support of the service measured and evaluated by customer O.

β measures the additional utility from commercial avoidance, and ψ **is an additional payment that is charged from a customer who wants to avoid compulsory advertisement.**

$f(q)$ represents the positive externalities on the utility of an individual customer who benefits from the use of other customers, where $f' > 0$ and $f'' < 0$.

The monopoly considers two possibilities:

1. To charge a high-fee membership for type O customers.
2. To charge a low-fee membership for all customers.

On the other hand, a customer who does not **get a benefit from using** the advances service and **still does or** does not pay a fee towards the service has the following utility:

$$(2) \quad U_I \stackrel{def}{=} \begin{cases} (1+\beta)f(q) - p & \text{Membership customers and possibility of avoiding advertisements} \\ (1+\beta)f(q) - p - \psi & \text{Membership customers and pay } \psi \text{ for possibility of avoiding advertisements} \\ f(q) - p & \text{Membership customers} \\ f(q) & \text{Free use customers} \\ 0 & \text{No use customers} \end{cases}$$

Using equations (1) and (2) we can distinguish between customers of type O and type I as we define below:

Customers of type O prefer signing up for a membership fee instead of free use if:

$$(1+\alpha)f(q) - p \geq f(q) \Rightarrow p \leq \alpha f(q) ;$$

Customers of type I prefer free use for basic service, if:

$$f(q) - p < f(q) ,$$

The monopoly gains **either** directly from membership fees and/or indirectly from free users and from selling advertisements shown on the screen upon entering the site. The revenue gained by the monopoly from advertising firms, depends on all site users both those who pay for the site's service and those who receive it for free. The more customers exposed to commercials, the more the advertising firms pay money to the monopoly.

We can define the monopoly profit is:

$$(3) \quad \pi = (p - c - \mu)q_m - \phi + \rho_m \tau_m q_m + \rho_{nm} \tau_{nm} (q - q_m)$$

The monopoly profit depends on members who pay the fee, q_m , as well as all q customers where $q \geq q_m$.

ϕ is the cost of opening and activating the site, developing the program and other site costs (total fixed costs that are not affected by the number of users or entries into the site).

c is the constant marginal cost of supplying the service for each member who pays the fee, p , and μ is the protection cost per customer to avoid a use without a payment.

The last four terms are ρ_m , ρ_{nm} , τ_m and τ_{nm} , where ρ_m and ρ_{nm} are the payments charged by the owner of the site (the monopoly) from advertising companies resulting from members' viewing of commercials and non-members respectively.

τ_m is the actual frequency voluntary viewing of advertisement by members, and τ_{nm} is the actual frequency compulsory viewing of non-members or members.

The monopoly may generate two types of discrimination as follows:

A. Discrimination between quality of service between members who pay a fee and non-members who do not pay a fee.

B. Discrimination between customers with respect to advertisement exposure: Members can avoid exposure to advertisements either by mandatory fee or by receiving this privilege for free. However, non-members are subject to “compulsory exposure”. Members can voluntarily activate advertisements by opening the appropriate link and initiating the actual viewing on the computer screen at τ_m frequency. Non-members or members who are required to pay but do not wish to do so, are exposed to commercial viewing at τ_{nm} frequency. The latter frequency of commercial exposure is larger than the former, i.e., $\tau_{nm} > \tau_m$. We also define ρ_m and ρ_{nm} as payments charged by the owner of the site (the monopoly) from

advertising companies resulting from members' viewing of commercials and non-members respectively.

The expected relationship between the two payments is $\rho_{nm} > \rho_m$. Accordingly, the advertising company is prepared to pay the fee per customer viewing, while the monopoly has the discretion to charge an even higher fee for commercials viewed by non-members.

Two reasons for the above expected relationship relates to the response of the site owner and subscribed members are explained as follows:

- (1) The cost of watching commercials by a member who pays a fee and whose time value is higher; therefore he will try to avoid commercial viewings and influences. This means that the efficiency of commercials issued by the advertising companies on the brainwash of the member is lower and so they are prepared to pay for broad casting them less.
- (2) The site owner can optionally prevent members from commercial viewing, while exposing non-members to more advertising and to become more influenced by commercial viewings. The efficiency of commercials from viewers who spend enough time searching specific products displayed in advertisements leads to the advantage of the companies who benefit from the advertisements and are therefore prepared to pay more to "brain-wash" non-members. Thus, we can conclude it is more likely that $\rho_m < \rho_{nm}$

From the monopoly's general profit function, we can derive several pricing strategies. The optimal solution from the profit point of view is compared to the optimal solution from a social welfare perspective.

As mentioned in the introduction of the paper the monopoly may consider five possibilities:

- (a) Non-protection policy for all users, where a basic service is supplied for free.
- (b) Non-protection policy combined with possible membership fee, where a basic service is supplied for free, and advanced service is supplied for membership fee.
- (c) No-protection policy combined with membership and no advertising option for a member avoiding advertisements. The monopoly may consider two values of membership fee high and low and chooses the high fee²
- (d) Protection policy with the possibility of avoiding exposure to advertising. In this case no service is distributed for free.
- (e) Protection policy with the possibility of avoiding advertisements. In this case no service is distributed for free, but the monopoly supplied for extra charge a compulsory advertisement³.

We discuss in this paper only three cases, (b), (c) and (e), where the profit maximizing monopoly generates the same solution which is identical to the social optimum solution.

We investigate the reasons and under what conditions the monopoly solution is indeed identical to the social optimum.

(b) Non-protection policy combined with possible membership fee.

In this case, the advanced service and high quality information is protected, and is thus reserved for members who pay an entrance fee. However, other customers can access the basic service for free. All types of customers are exposed to advertisements. Type O customers pay a fee and type I avoid payment.

In unpublished paper the authors prove that the high fee is more profitable. The proof can be sent upon request.²

³ In unpublished paper the authors prove that the low fee is more profitable. The proof can be sent upon request

Therefore, the monopoly can charge a high entry fee, p , for advanced services derived from the following:

$$(4) \quad (1 + \alpha)f(2\eta) - p \geq f(2\eta)$$

Thus, the optimal fee, p , is: $p^b = \alpha f(2\eta)$

The price at equation (4) is the equilibrium price of monopoly. At this price customers of type O are indifferent to paying for advanced service or receiving free use of basic service. An infinite price increase causes type O customers to avoid paying the fee while customers of type I will tend to choose free basic service so the monopoly also avoids price reduction too. **Because no entry of customers of type I occurs while price reduce leads to profit losses from type O customers** the monopoly has no incentive to change the price in any direction, i.e., the price is at equilibrium. **(see also figure 1-2).**

The monopoly's profit is:

$$(5) \quad \pi^b = [\alpha f(2\eta) - c]\eta + \rho_{nm}\tau_{nm}2\eta - \phi$$

The type O customer gains the utility $U_0 = (1 + \alpha)f(2\eta) - \rho = f(2\eta)$, while the utility of type I customer is $U_I = f(2\eta)$, due to the fact that a type I customer does not benefit from returns to scale α , but only from the use of all customers.

The consumers' surplus is:

$$(6) \quad CS^b = 2\eta f(2\eta)$$

and social welfare, W^b , in this case will be a simple summation of all consumers surplus and producer profits. Thus:

$$(7) \quad W^b = [\alpha f(2\eta) - c]\eta + [\rho_{nm}\tau_{nm} + f(2\eta)]2\eta - \phi$$

Figure 1 and 2 represent the demand for advanced service by all customers and the profit derived as a function of those who are full service members.

Figure 1

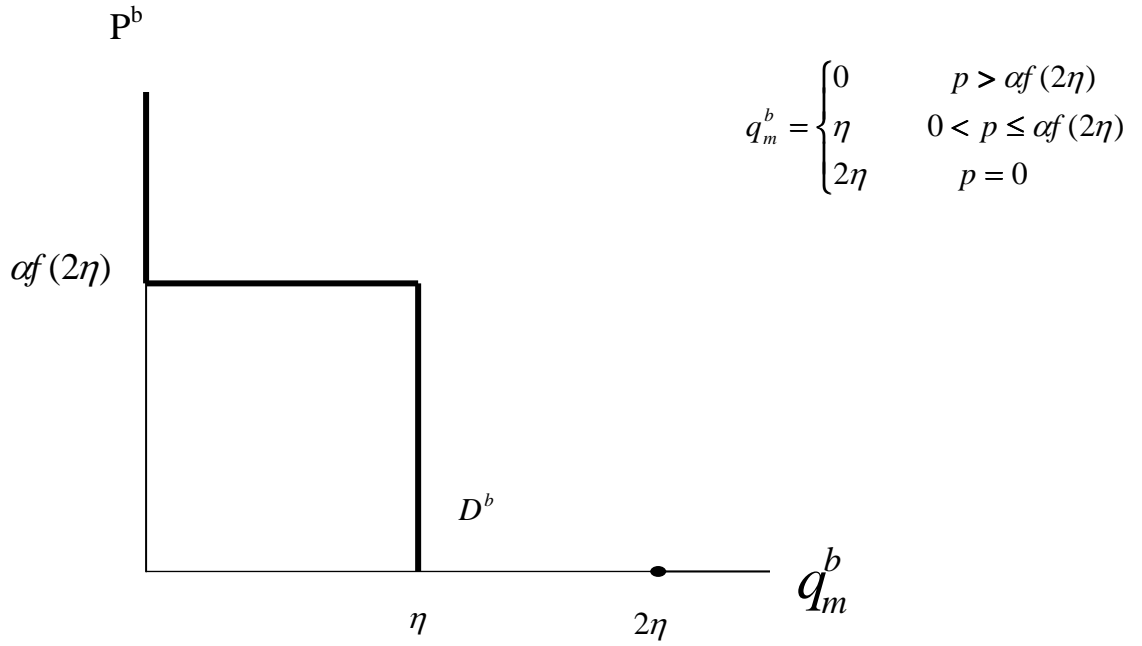


Figure 1: The demand for advanced service

Figure 2

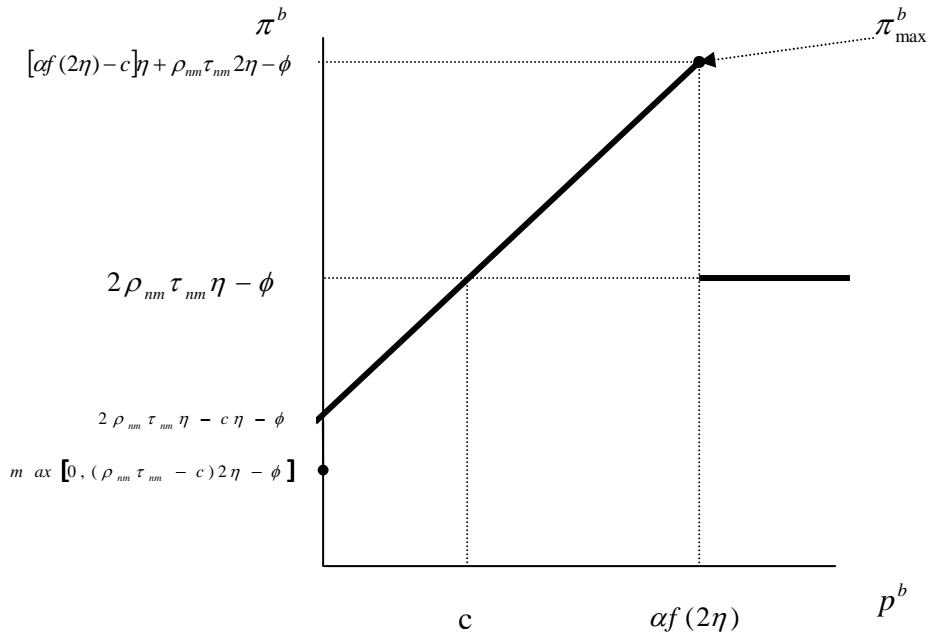


Figure 2: Monopoly profit as a function of membership fee.

$$\pi^b = \begin{cases} 2 \rho_{nm} \tau_{nm} \eta - \phi & p > \alpha f(2\eta) \\ p \eta + \rho_{nm} \tau_{nm} 2\eta - c \eta - \phi & 0 < p \leq \alpha f(2\eta) \\ m \max [0, (\rho_{nm} \tau_{nm} - c) 2\eta - \phi] & p = 0 \end{cases}$$

Figure 2 describes the relationship between monopoly profit and the “entrance fee”. At zero fee advanced service leads to profit generated from advertisement only, but as price is positive and $\alpha f(2\eta)$ increases, profit is boosted to maximum. Above this price, the profit is again derived only from advertising.

The reason why p^b is derived by the monopoly in the above case maximizes the social optimum is because of the specific distribution of two types of customers. At $p^b = \alpha f(2\eta)$ all customers’ surplus from network externalities are squeezed from the consumers of type O by the monopoly. Furthermore, there is discontinuity in price distribution, such that an infinite decrease in price doesn’t encourage additional customer of type I to join to the advanced service supplied and just reduces the profit by exactly marginal profit that is equal to the marginal benefit /surplus of customers of type O. This means that there is no Deadweight Losses as a result of price reduction.

On the other hand, any infinite increase in price above optimal p^b brings all customers of type O to use only free basic service and minimizes monopoly profit significantly by having profit just from advertisement fees. This is a stable and an efficient solution.

(c) No-protection policy combined with membership fee that covers advanced service and compulsory advertisement

Free entry for basic services are offered, and for a membership fee both advanced services and the privilege of avoiding advertisements are incurred. In this case, a type I customer can receive basic service, but cannot avoid viewing of advertisements, while a type O customer who pays for advanced services is able to avoid advertising without paying an additional fee. The latter can view commercials by choice, i.e., by clicking on the link for entry to the advertising site, otherwise he is able to avoid it.

By charging fee only η consumers of type O pay a membership fee, thus the highest price they are willing to pay is:

$$(8) \quad (1 + \alpha + \beta)f(2\eta) - p \geq f(2\eta) \Rightarrow p^c = (\alpha + \beta)f(2\eta)$$

The monopoly profit is:

$$(9) \quad \pi^c = [(\alpha + \beta)f(2\eta) + \rho_m \tau_m + \rho_{nm} \tau_{nm} - c]\eta - \phi$$

The net utility of type O customers is:

$$U_o = (1 + \alpha + \beta)f(2\eta) - p = f(2\eta),$$

while customers of type I get a basic service for free, their utility is U_I where:

$$U_I = f(2\eta).$$

This indicates some utility for every type of customers, and also that the utility of type O customer is induced from the service use of other customers.

$$(10) \quad CS^c = 2\eta f(2\eta)$$

while the social welfare is:

$$(11) \quad W^c = [(\alpha + \beta)f(2\eta) + \rho_m \tau_m + \rho_{nm} \tau_{nm} - c]\eta + f(2\eta)2\eta - \phi$$

Figure 3

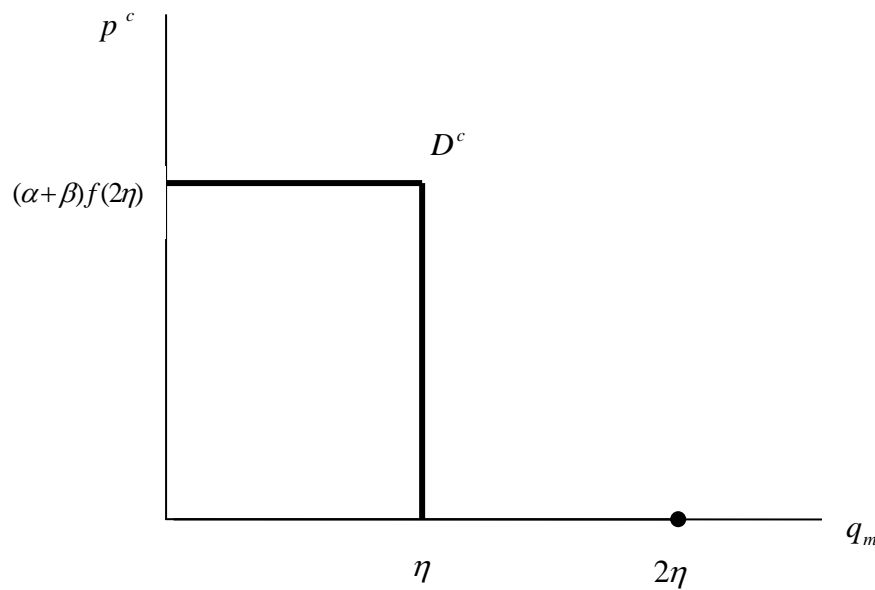


Figure 3: The demand for advanced service with no advertisement option.

Figure 4

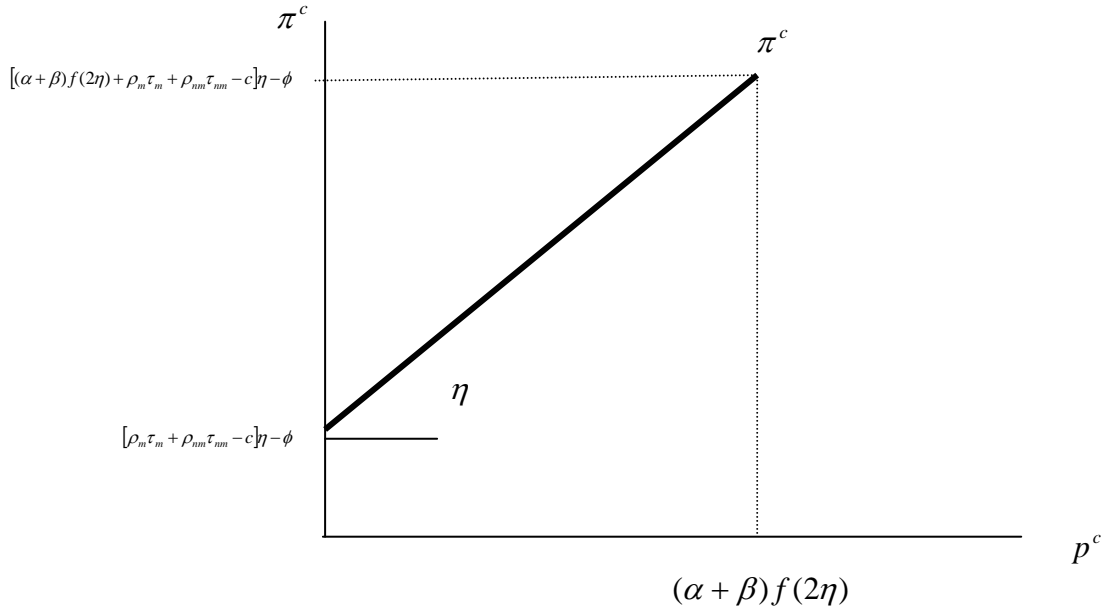


Figure 4: Profit as a function of membership fee with no advertising option.

Figure 3 illustrates the demand for service while the monopoly determines the free basic service forcing customers to view commercials, but members who pay a fee can avoid the commercial with no extra charge.

Figure 4 illustrates the trajectory of profit change as a function of the fee level. Here only type O customers buy the service while customers of type I use only the basic service for free.

In this case the monopoly charges a high price, p^c , from members eliminating the use of advanced services from customers of type I, however, allowing them to get a basic service for free. By that the monopoly allows customers of type O to gain maximum benefit from the network externalities such that the monopoly maximizes its own profit on one hand, while allowing to extract maximum consumers' surplus for those O customers who benefit from the use of any service by all 2η customers. Any increase in the price by the monopoly causes the customers of type O to prefer utility of type I customers, thus, a lot of the social welfare loss is generated. However,

a decrease in the price by infinite small value doesn't change the total number of I or O customers. There is no switching process from being customer I into O. Thus, the price reduction doesn't change the total social welfare, but just leads to reallocation between less monopoly profit and more consumers' surplus which canceled out each other. Case c is very similar in the basic policy of the monopoly at case b, with one exception which is the differences in the value of β , i.e., the disutility from the compulsory exposition to advertisement by all 2η customers.

Therefore the monopoly can charge a higher fee p^c than p^b , based on the information of the high level of β . This information can be revealed by a research on consumers preferences and behavior towards advertisement. Still the monopoly determines such a high price that distinguish two type of customers: members who pay and benefit from the network externalities (α) as well as the benefit from avoiding compulsory advertisement (β).

(e) Protection policy with the possibility of avoiding advertisements

The monopoly can avoid entrance from free use of any kind with the protection cost per member μ . In addition to membership fee, the customer can eliminate advertisements by paying ψ .

In this case all customers (of type O and I) pay a membership fee. All 2η customers pay a fee in addition to ψ . Therefore the monopoly can charge the maximum price derived from equations (12) and (13):

$$(12) \quad (1 + \beta)f(2\eta) - p - \psi \geq 0$$

Thus,

$$(13) \quad p^e = (1 + \beta)f(2\eta) - \psi$$

The profit of the monopoly is now:

$$(14) \pi^e = [(1 + \beta)f(2\eta) + \rho_m \tau_m - \mu - c]2\eta - \phi$$

The consumers' surplus is derived from type O customer as follows:

$$(15) CS^e = \alpha f(2\eta)\eta$$

in turn, the social welfare in this case is:

$$(16) W^e = \alpha f(2\eta)\eta + [(1 + \beta)f(2\eta) + \rho_m \tau_m - \mu - c]2\eta - \phi$$

In this case too, all 2η customers (of type O and I) pay the relative low membership fee and also pay a fee ψ as additional costs of avoiding compulsory advertisement. The monopoly finds that by exposing all customers to advanced service on one hand, while just earning from all customers who are willing to be exposed voluntarily to advertisement, all kinds of distortion from compulsory behavior are eliminated, while the benefit to the monopoly like to the society as a whole from the network externalities is reached.

In contrary to the case where the monopoly forces all 2η members to be exposed to a compulsory advertising and reduces the social welfare of society in order to increase its own profit. In such a case the monopoly leaves to the economic agents more degrees of freedom by allowing some customers who dislike significantly from advertisement (high value of β), to pay for and to benefit from eliminating this kinds of compulsory advertising which leads to optimal social welfare solution that is determined by the monopoly.

The results of the three cases can be summarized in the Table below:

Table 1:

cases	No. Of Customers	Consumers' Surplus	Monopoly Profit	Social Welfare
b. Fee for advanced service, no advertising protection.	η	$2\eta f(2\eta)$	$[\alpha f(2\eta) - c]\eta + \rho_{nm}\tau_{nm}2\eta - \phi$	$[\alpha f(2\eta) - c]\eta + [\rho_{nm}\tau_{nm} + f(2\eta)]2\eta - \phi$
c. Fee for the right of both advanced service and advertising elimination, no fee for basic service.	η	$2\eta f(2\eta)$	$[(\alpha + \beta)f(2\eta) + \rho_m\tau_m + \rho_{nm}\tau_{nm} - c]\eta - \phi$	$[(\alpha + \beta)f(2\eta) + \rho_m\tau_m + \rho_{nm}\tau_{nm} - c]\eta + f(2\eta)2\eta - \phi$
e. No basic service, extra fee for advertising elimination.	2η	$\eta\alpha f(2\eta)$	$[(1 + \beta)f(2\eta) + \rho_m\tau_m - \mu - c]2\eta - \phi$	$\alpha f(2\eta)\eta + [(1 + \beta)f(2\eta) + \rho_m\tau_m - \mu - c]2\eta - \phi$

The conditions are:

If $\alpha_1 > \frac{2f(2\eta) - 2\mu - c}{f(2\eta)}$ (α is high) and $\beta f(2\eta) + \rho_m\tau_m < \rho_{nm}\tau_{nm}$ (β is low) then

the social planner and the monopoly chose case b.

If $\alpha_2 > \frac{\rho_m\tau_m - \rho_{nm}\tau_{nm} - 2\mu - c}{f(2\eta)} + \beta + 2$ (α is high) and $\rho_{nm}\tau_{nm} < \beta f(2\eta) + \rho_m\tau_m < \rho_{nm}\tau_{nm} + c$

(β has an intermediate/ a median value) then the social planner and the monopoly chose case c.

If $\alpha_2 < \frac{\rho_m\tau_m - \rho_{nm}\tau_{nm} - 2\mu - c}{f(2\eta)} + \beta + 2$ (α is low) and $\rho_{nm}\tau_{nm} < \beta f(2\eta) + \rho_m\tau_m < \rho_{nm}\tau_{nm} + c$

(β has an intermediate/ a median value) then the social planner and the monopoly chose case e.

Conclusions

In this paper we address the case of a monopoly in the software market which offers two levels of software services to distinct customer groups. The revenue of the monopoly is derived both from selling the product to the customers as well as from paid advertisement. The market is also characterized by network externalities in which customers utility (and price she is willing to pay) increases with the number of users (including free users).

The monopoly faces several policy and pricing options which involve the combination of price discrimination as well as involuntary exposure to advertisement.

For each of these options we calculate the level of private profit and social welfare.

We found that the monopoly profit depends on three factors:

- (a) The degree of network externalities. A higher degree is incentive for the monopoly to attract more users by offering free use.
- (b) The degree of disutility attributed to compulsory advertisement exposure. A high disutility level may lead the monopoly to eliminate a compulsory advertisement from members (either for free or for fee) and expose more non-members to compulsory advertisement.
- (c) The price paid by marketers for advertisement installed in the site will affect both the prices charged by the monopoly as well as the availability of the non advertisement option offered to subscribed members.

Three scenarios are discussed in which the social optimum solutions are identical to the monopoly optimal strategy. This occurs as a result of the monopoly that internalizes the externalities in its own decision towards more production which cancel out the common attitude of the monopoly towards under-production. This

happens when increase in the number of customers due to network externality is compensated by the monopoly tendency to charge higher prices and reduce customers.

In those cases no government intervention is required, as the monopoly strategy is identical to the social welfare optimum.

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