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Demand and Supply Model in the Network Market: Two-Sided Markets the Case of the Cellular Industry

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Abstract: In this paper we reconsidered several pricing policies in the network industry and compared the advantages of some (five) policies on other policies from point of views of the monopoly who considers profit maximization The uniqueness of the network industry is that the demands for services include at least two parties, the sender of a message and the receiver of the message. These demands that are not necessarily symmetric can be estimated very accurately using nowadays technologies like RFID etc. by seller of the network services. Knowing the accurate demands the optimal pricing can be determined.

Keywords: Network Industry, Sender, Receiver, Monopoly, Social Optimum.

JEL: E6, L1, L63, L13, L4, L5.

1. INTRODUCTION

The network industry market has characteristics that differ from those of the more traditional markets for goods and services. In most cases the demand for a specific item is derived from the benefit that the buyer obtains and the optimal solution can be determined either from the perspective of a profit maximizer (the monopoly case) or from that of a social planner. In the case of network items such as telephone services, communication via the internet, email messages, fax services, or regular letters, etc; the demand for these services is determined bilaterally by both the sender and the receiver of the service. Moreover, the demand to receive a message (such as a phone call) and the demand to send the same message are most likely independent and asymmetric. By asymmetry we imply that there are different reservation prices and different price elasticities for sent messages versus received messages. We adopt an everyday example to illustrate this point. Assume a family with three generations of grandparents, parents and children who are also grandchildren of the grandparents. There is significant asymmetry between the desire of the grandparents to receive a phone call from their children and perhaps even more so to receive a call from their grandchildren. Our approach differs from the approach of Jeon, Laffont and Tirole [1] who impose a restriction of identical senders and identical receivers under the heading that "it take two to tango", and their “tango” can only take place in symmetric steps.

Our approach adopts an asymmetric environment. The asymmetry exists due to different desires of individuals to send and to receive messages at any given time. The most usual practice of the network industry is to charge the sender a service fee for each use since the sender initiates the message. For example, when a person sends a local regular letter he/she is required to put a 44 cents stamp on the envelope (in the US) or pays a certain amount for initiating a phone call, while the receiver remains passive and benefits by receiving a "free of charge" service. This pricing system does not reflect the real full effects of utility and costs of the market (See Hermalin and Katz [2] and Laffont, Rey and Tirole [3]). By charging only the sender for both benefits (that might sometimes be negative) of the sender and the receiver, we fail to internalize the utility and/or disutility of the receiver and therefore cannot necessarily guarantee either maximizing monopoly profits or achieving maximum social welfare.

Mobile telephone markets are now served by a small number of competing networks. The focus of research has shifted recently to oligopolistic markets characterized by a two-way interconnection. When communication is established this potentially provides benefit to the whole society in macro terms as well as to the private economic agent (sender or receiver). On the one hand, telecommunications investment has contributed to the economic activity and economic growth (e.g., Lee, Levendis and Gutierrez [4] and Wolde-Rufael [5]) and on communication users on the other hand.

When communication is established this potentially provides utility for the initiator (sender) and for the receiver, thus both should be charged for the communication.

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However, a substantial body of research deals with the system where only the Calling Party Pays (CPP), i.e., only the initiating sender is charged. The receiver's positive utility (if indeed it is positive) has been widely neglected in the literature with some exceptions. (Important papers are of Hermalin and Katz [2], Jeon, Laffont and Tirole [1] and Kim and Lim [6]. Moreover, as mentioned by Berger [7], many recent papers published in the second half of the 1990s on the issues of communication markets (See also Gans and King [8]; Dessein [9]; Schiff [10], Cambini and Valletti [11]), follow leading papers of Armstrong [12] and Laffont, Rey and Tirole [3, 13] where they share the basic assumption that only the caller (sender) benefits from a call, but not the receiver. However, Berger [7], as well as Hahn [14], DeGraba [15], Hermalin and Katz [16, 17], Jeon, Laffont and Tirole [1] deal with positive externalities. However, the possibility of also charging the receiving party has been totally ignored by the above literature. We show that pricing can be either positive or negative from the point of view of a monopoly profit-maximizing supplier of communication services or from the point of view of a social planner whose objective is welfare maximization. This has not been discussed in the above references.

Very recently Hermalin and Katz [17] again raised the pricing issue for senders and receivers who derive benefits from telecommunication messages and generate external effects on each other. The authors say very precisely that "Until very recently almost all theoretical works on interconnection pricing ignored the benefits enjoyed by the receiving party." They were convinced that this assumption of no receiver benefit is not acceptable and that we should therefore avoid using it. The fact that there are mutual benefits to both parties may create important implications for efficient pricing for both senders and receivers.

Another recent paper of Spiegel, Tavor and Templeman [18] also discusses the telecommunication issue of pricing in the case of asymmetry between utilities towards sending and receiving calls. They compared pricing policies under simple and discriminating profit maximizing monopolies vs. the optimal policy of the social planner.

In this paper we reconsider the pricing policy of this kind of network industry, using a very simple and special case of linear demands. We show the Pareto improvement of a pricing policy implemented both on senders and receivers. Similarly, we show the potential profits that can be generated by a monopoly that practices "bilateral" pricing on both senders and receivers.

We show different pricing policies applied by both suppliers (monopoly or social planner) and compare the several solutions between senders and receivers as well as those between monopoly and social optimum pricing in symmetric and asymmetric environments.

The one concern that may be raised is whether this kind of "revolutionary" pricing can be implemented in a network externalities environment. To determine the sender's demand is more likely to be achievable. However, determining the demand of the receiver seems to be a more difficult task. We believe that since the recent RFID (Radio Frequency Identification) devices are so "cheap and tangible", we can use this technology to investigate and derive the demands of both senders and receivers, which can prove useful when applied to the network industry.

It should be emphasized that we are excluding the possibility of interdependency between received calls and initiated calls. However, in reality this kind of interdependency exists since often a phone call from individual *i* to *j* may generate a further initiated recall from the former passive receiver, thus generating a case of demand interdependency. In our model we assume homogeneous pairs of customers who contact each other in a world of perfect information. We compare the pricing policy that is applied in most network industries where in a two-sided market only the party initiating the connection pays for the service. We claim that a more profitable and effective policy for both the firm and for society at large would be that of adopting a pricing policy of a two-sided market where both the party initiating the call and the party receiving the call are charged.

The structure of the paper is as follows: In section 2 we develop the model of cellular pricing considering five different cases of monopoly pricing. In the third section the social welfare solutions are discussed followed by an implication section, and a concluding section.

2. MODEL OF CELLULAR PRICING

Assume a market of two related customers A and B. One is a sender of a message, S, and the other is a receiver of the message, R, and vice versa, i.e. Each of the two customers have their own demand curves to send and to receive calls from each other as follows:

$p_{AS} = AS - q_{AS}$ for sending calls by customer A

$p_{AR} = AR - q_{AR}$ for receiving calls by customer A

$p_{BS} = BS - q_{BS}$ for sending calls by customer B

$p_{BR} = BR - q_{BR}$ for receiving calls by customer B

Where D_A and D_B represent the demand curves of customer A and customer B respectively.

AS, *AR*, *BS* and *BR* are the reservation prices of sending (*S*) receiving (*R*) cellular calls by the customer A and customer B.

q_{AS} is the quantity demanded of sending cellular phone calls by customer A

q_{AR} is the quantity demanded of receiving cellular phone calls by customer A

q_{BS} is the quantity demanded of sending cellular phone calls by customer B

q_{BR} is the quantity demanded of receiving cellular phone calls customer B

p_{AS} is the price customer A is willing to pay for sending cellular phone calls

p_{AR} is the price customer A is willing to pay for receiving cellular phone calls

p_{BS} is the price customer B is willing to pay for sending cellular phone calls

p_{BR} is the price customer B is willing to pay for receiving cellular phone calls

The marginal cost to supply any kind of a call is constant regardless who initiates the call, either customer A or customer B.

Another simplified assumption is that $q_{AS} = q_{BR}$ since only the actual phone connection indeed costs the supplier of the service. In case the phone call is unaccomplished there is no revenue on the one hand, but at the same time we assume no costs occur.

We first begin discussing optimal pricing in the case where the company in the communication market is a monopoly who seeks profit maximization. The social welfare objective function will be discussed later.

The last assumptions relate to the importance of activating the calls. First we assume the importance of initiating, i.e., sending a call is usually larger than the importance of receiving[1] (where the customer is passive in the call activity). Thus, we assume that formally *AS*>*AR* and *BS*>*BR*. In addition we assume also asymmetry towards cellular calls by the two individuals. For example, in our case we can assume that the desire of a parent to be in touch with his/her child is more significant than the desire of the child to be in touch with his/her parent(s). This is because we know the nature of parents' concern to their child more than the concern of child toward the parent.[2] This is defined formally by denoting:

AS>BS and AR>BR

In this sense we differ significantly from several important works, e.g. Jeon, Laffont and Tirole [1] who assume that the surpluses of senders and receivers are identical and proportional.

Moreover it is possible that some of the four reservation prices can be positive as well as negative in scenarios where at least some of the receivers have disutility from specific call receiving. As a result we can conclude further that in cases where we allow price differences on the one hand, and price charges for either sending or receiving calls where in some cases negative price(s) (at least for receiving calls) are the optimal decision. Not all prices can be negative to profit maximizing monopoly, but in some cases the monopoly may subsidize a call receiving in order to allow higher revenues from the call sender.

Based on the assumptions, we will discuss below five different pricing cases the monopoly may consider:

1. Charging only the sender for each sent call. This kind of policy is conducted in most of the European countries.
2. Charging both the sender and receiver for the same call. This system is popular in cellular companies for international cellular calls.
3. Charging only the receiver for call receiving. In some state of America, or in collect call to cellular phone.
4. Charging the sender for sent call while subsidizing the receiver for the same received call. This kind of policy is poplar in T.V. programming like American Idol where audience votes by calling cellular phone and charged per call, and the cellular companies transfer a specific percent from the total charging to the programming producer.
5. Charging both senders (i.e., customer A or customer B) on phone calls while charging a positive price from customer A for call receiving and subsidizing customer B for a call receiving.[3] This is variation of cases 2 and 4 above.

We define below the objective of profit maximization functions of a monopoly and determining the F.O.C. and the S.O.C. in the five cases:

2.1. Case 1

1. Price for connection between a sender and receiver is charged only on the sender. This system is most popular in the communication market nowadays where the passive receiver only pays the burden of getting a message (like phone call) spending time and sometimes other aggravation, but is not charged otherwise financially.

In this case the objective function of the monopoly is to maximize the profit as follows:

(1.1) $$\pi = p_{AS}q_{AS} + p_{BS}q_{BS} - c(q_{AS} + q_{BS})$$

where the decision variables are q_{AS} and q_{BS} are defined above:

The F.O.C. are:

(1.2) $$\frac{\partial \pi}{\partial q_{AS}} = AS - 2q_{AS} - c = 0$$

(1.3) $$\frac{\partial \pi}{\partial q_{BS}} = BS - 2q_{BS} - c = 0$$

From (1.2) and (1.3) we get the optimal communication times of each sender (customer A or customer B) as follows:

(1.4) $$q_{AS} = \frac{AS - c}{2}$$

(1.5) $$q_{BS} = \frac{BS - c}{2}$$

While prices which the monopoly charges are:

- [1] Although in case a of receiving a medical test result from call of the doctor to his/her patients the opposite holds.
- [2] The same a-symmetry can exist in case of message of a commercial advertiser who send a message to a potential customer who receives a message by phone call or the internet.
- [3] It is a private case of case 2 where we allow "charging" the receiver a negative price.

(1.6) $p_{AS} = \dfrac{AS + c}{2}$ and $p_{BS} = \dfrac{BS + c}{2}$

Profits the monopoly gains are:

(1.7) $\pi_1 = \dfrac{(AS - c)^2}{4} + \dfrac{(BS - c)^2}{4}$

as $q_{AS} = q_{BR}$ and $q_{AR} = q_{BS}$

The consumer surplus of the customer A and (CS_A) the customer B (CS_B) in the monopoly equilibrium are

(1.8) $$CS_A = \frac{(AS - p_{AS})q_{AS}}{2} + \frac{\left[AR + \left(AR - q_{AR}\right)\right]q_{AR}}{2} = \frac{(AS - c)^2}{8} + \frac{\left(4AR - BS + c\right)\left(BS - c\right)}{8}$$

(1.9) $$CS_B = \frac{(BS - p_{BS})q_{BS}}{2} + \frac{\left[BR + \left(BR - q_{BR}\right)\right]q_{BR}}{2} = \frac{(BS - c)^2}{8} + \frac{\left(4BR - AS + c\right)\left(AS - c\right)}{8}$$

The total welfare of the monopoly solution that we measure by the simple summation of all consumers surplus and the monopoly profits are:

(1.10)
$$W_1 = \frac{\left(2AR + BS - c\right)\left(BS - c\right)}{4} + \frac{\left(2BR + AS - c\right)\left(AS - c\right)}{4}$$

2.2. Case 2

The monopoly charges fees from sender as well as receiver simultaneously. In this case the profit function is defined as follows:

(2.1) $\pi = p_{AS}q_{AS} + p_{AR}q_{AR} + p_{BS}q_{BS} + p_{BR}q_{BR} - c(q_{AS} + q_{BS})$

Since $q_{AS} = q_{BR}$ and $q_{AR} = q_{BS}$, the F.O.C. for maximization are:

(2.2) $\dfrac{\partial \pi}{\partial q_{AS}} = AS - 2q_{AS} + BR - 2q_{AS} - c = 0$

(2.3) $\dfrac{\partial \pi}{\partial q_{BS}} = BS - 2q_{BS} + AR - 2q_{BS} - c = 0$

Since the connection times between sender and receiver by definition are equal we get the quantities of equilibrium as follows:

(2.4) $q_{AS} = q_{BR} = \dfrac{AS + BR - c}{4}$

(2.5) $q_{BS} = q_{AR} = \dfrac{BS + AR - c}{4}$

while equilibrium prices are

(2.6) $p_{AS} = \dfrac{3AS - BR + c}{4}$, $p_{AR} = \dfrac{3AR - BS + c}{4}$, $p_{BS} = \dfrac{3BS - AR + c}{4}$, $p_{BR} = \dfrac{3BR - AS + c}{4}$

While AS>BS and AR>BR we find that $p_{AS} > p_{BS} > 0$ if 3BS>AR-c. However optimal prices for receivers p_{AR} and p_{BR} are both positive if

(2.7) 3AR>BS-c and

(2.8) 3BR>AS-c.

In this case the total price charged by the producer from the sender and the receiver is equal to:

(2.8') $p_A = p_{AS} + p_{BR} = \dfrac{AS + BR + c}{2}$ and

(2.8") $p_B = p_{BS} + p_{AR} = \dfrac{BS + AR + c}{2}$

The profit of the monopoly is:

(2.9) $\pi_2 = \dfrac{\left(AS + BR - c\right)^2}{8} + \dfrac{\left(BS + AR - c\right)^2}{8}$

From (2.7), (2.8) and (2.9) we find that:

(2.10) $\pi_2 > \dfrac{2}{9}\left[\left(AS - c\right)^2 + \left(BS - c\right)^2\right]$

The immediate comparison between (1.7) and (2.10) dose not reveal in which of the cases profit is higher. A discussion below verifies this issue.

$CS_A = CS_{AS} + CS_{AR} = \dfrac{\left(AS + BR - c\right)^2}{32} + \dfrac{\left(BS + AR - c\right)^2}{32}$ (2.11)

(2.12) $CS_B = CS_{BS} + CS_{BR} = \dfrac{\left(AS + BR - c\right)^2}{32} + \dfrac{\left(BS + AR - c\right)^2}{32}$

(2.13) $W_2 = \dfrac{1.5\left(AS + BR - c\right)^2}{8} + \dfrac{1.5\left(BS + AR - c\right)^2}{8} = 1.5\pi_2$

The comparisons between this case and case 1 above lead to several conclusions discussed below:

Case 2 that we suggest in our paper has not practiced yet in the network business although we believe it should be considered by theorist as well as businessmen. Mutual charging, both participants, senders as well as receivers, on messages open new avenues for profits and welfare gains, by allowing more degree of freedom for the decision makers to achieve their objections.

In this sense case 1 or case 3 are private case of case 2 where only one party is imposed the payment burden.

Case 1 or case 3 can be the optimal solution in case 2 if by the optimization process is the optimal solution leading to zero price burden on one party, while all burden is imposed either only on the sender, or only on the receiver. In such a case the profit in case 2 approaches the profit of the other two cases. However, based on our basic assumption since AS>AR, BS>BR, and AS>BS, we can conclude only that in extreme case the optimal solution in case 2 is $p_{AR} = p_{BR} = 0$, thus, the monopoly in case 2 adopts the optimal solution of maximum profit that is achieved upon case 1. In this case the conclusion is that $\pi_1 = \pi_2$. However, this solution is achieved ex-ante and not because of restriction under which only sender should pay for message and not the receiver as we get in the regular case 1 discussed above.

In any other case the constrained case 1 where only sender is charged, the profit should be smaller than the profit of case 2where the solution that is achieved with positive prices on both senders (A and B) and simultaneously a positive price on either one or both receiver(s). Thus, $\pi_2 > \pi_1$.

Concluding that $\pi_1 > \pi_2$ is unfeasible, since the monopoly can always conduct a price policy where only senders are charged and even then $\pi_1 = \pi_2$.

Based on that conclusion it is worthwhile to discuss several immediate implications on the two cases (1 and 2).

a) Assuming positive price on both senders and receivers in case 2 we can find from (1.6) (2.8') and (2.8") that the total price the monopoly receive in case 2 is larger than the price the senders are charge in case 1. However, the price that each sender is charged in case 2 is not necessarily higher than in case 1. since AS > BS and AS>AR>BR we can say that it is more likely that sender A in case 2 pays more than sender A in case 1, still the price differences between senders A or B in both cases are ambiguous.

b) The immediate conclusion derived from the above is that the quantities sold to each sender, as well as the total quantities sold, in case 2 can be either smaller or larger.

c) In any case the profit in case 2 is either larger or equal to the profit in case 1 as we have explained above.

d) d. Since $\pi_2 \geq \pi_1$ and prices and quantities comparisons are ambiguous the relationship between consumers surplus values in both cases is ambiguous as well. Only in case where prices charge in case 2 lead to larger quantities supplied to A and/or B, we can definitely determine that case 2 is socially preferable. Otherwise, the comparisons are again ambiguous.

2.3. Case 3

The monopoly charges only the receiver. This case was applied centuries ago when the mailing system is imitated. In current years the sender has to put appropriate stamps value to receive the service for sending a letter of a package by mail, the former system was applied historically differently: The receiver paid for the mail service upon receiving the message and approval of this acceptance of the letter or the package. In this case the profit of the monopoly is:

(3.1) $$\pi = p_{AR}q_{AR} + p_{BR}q_{BR} - c(q_{AR} + q_{BR})$$

The F.O.C. for profit maximization are:

(3.2) $$\frac{\partial \pi}{\partial q_{AR}} = AR - 2q_{AR} - c = 0$$

and

(3.3) $$\frac{\partial \pi}{\partial q_{BR}} = BR - 2q_{BR} - c = 0$$

The quantities and process of equilibrium are:

(3.4) $$q_{AR} = \frac{AR - c}{2}\ ,\ q_{BR} = \frac{BR - c}{2}$$

and

(3.5) $$p_{AR} = \frac{AR + c}{2}\ ,\ p_{BR} = \frac{BR + c}{2}$$

The profit of the monopoly from the consumers surplus and the social welfare at equilibrium are:

(3.6) $$\pi_3 = \frac{(AR-c)^2}{4} + \frac{(BR-c)^2}{4} < \pi_1$$

(3.7) $$\begin{aligned} CS_A &= \frac{(AR - p_{AR})q_{AR}}{2} + \frac{\left[AS + \left(AS - q_{AS}\right)\right]q_{AS}}{2} = \\ &= \frac{(AR-c)^2}{8} + \frac{\left(4AS - BR + c\right)\left(BR - c\right)}{8} \end{aligned}$$

(3.8) $$\begin{aligned} CS_B &= \frac{(BR - p_{BR})q_{BR}}{2} + \frac{\left[BS + \left(BS - q_{BS}\right)\right]q_{BS}}{2} = \\ &= \frac{(BR-c)^2}{8} + \frac{\left(4BS - AR + c\right)\left(AR - c\right)}{8} \end{aligned}$$

and

(3.9)
$$W_3 = \frac{\left(2AS + BR - c\right)\left(BR - c\right)}{4} + \frac{\left(2BS + AR - c\right)\left(AR - c\right)}{4}$$

2.4. Case 4

The monopoly charges customer A the sender and pays customer B as the call receiver from the sender, i.e., customer A.

In this case the call receiver who may have disutility from receiving a message from customer A, the sender, to encourage customer B to receive the message and gain the revenues from the payment of the sender. In this case the demand of customer B, D_B, is as follows:

(4.1)
$$D: \begin{cases} p_{BS} = BS - q_{BS} & \text{for sending calls by the customer B} \\ p_{BR} = BR + q_{BR} & \text{for receiving calls by the customer B} \end{cases}$$

Thus, the profit function of the monopoly is:

(4.2) $$\pi = p_{AS}q_{AS} + p_{BS}q_{BS} - p_{BR}q_{BR} - c(q_{AS} + q_{BS})$$

The F.O.C. for maximization are:

(4.3) $$\frac{\partial \pi}{\partial q_{AS}} = AS - 2q_{AS} - BR - 2q_{AS} - c = 0$$

and

(4.4) $$\frac{\partial \pi}{\partial q_{BS}} = BS - 2q_{BS} - c = 0$$

From F.O.C. we get the quantities and prices of equilibrium charged by the monopoly as follows:

(4.5) $q_{AS} = q_{BR} = \dfrac{AS - BR - c}{4}$, $q_{BS} = q_{AR} = \dfrac{BS - c}{2}$

and

(4.6) $p_{BS} = \dfrac{BS + c}{2}$, $p_{BR} = \dfrac{3BR + AS - c}{4}$, $p_{AS} = \dfrac{3AS + BR + c}{4}$

The net price received by the monopoly for each message from customer A to customer B is:

(4.7) $p_A = p_{AS} - p_{BR} = \dfrac{AS - BR + c}{2}$

Therefore, the monopoly profit the consumers surplus and the social welfare are:

(4.8) $\pi_4 = \dfrac{(AS - BR - c)^2}{8} + \dfrac{(BS - c)^2}{4}$

(4.9)

$$CS_A = CS_{AS} + CS_{AR} = \frac{(AS - p_{AS})q_{AS}}{2} + \frac{\left[AR + (AR - q_{AR})\right]q_{AR}}{2} = \\ = \frac{(AS - BR - c)^2}{32} + \frac{(4AR - BS + c)(BS - c)}{8}$$

(4.10)
$$CS_B = CS_{BS} + CS_{BR} = \frac{(BS - p_{BS})q_{BS}}{2} + \frac{(p_{BR} - BR)q_{BR}}{2} = \\ = \frac{(AS - BR - c)^2}{32} + \frac{(BS - c)^2}{8}$$

and

(4.11) $W_4 = \dfrac{1.5(AS - BR - c)^2}{8} + \dfrac{(2AR + BS - c)(BS - c)}{4}$

2.5. Case 5

The monopoly charges customer A as a sender to customer B and as a receiver from his customer B. Customer B is charged for sending the message to the customer A, but is paid for message received from customer A. In this case the demand of customer A stays as before, but the demand of customer B as a send and as a receiver is as follows:

(5.1)
$$D:\begin{cases} p_{BS} = BS - q_{BS} & \text{for sending calls by the customer B} \\ p_{BR} = BR + q_{BR} & \text{for receiving calls by the customer B} \end{cases}$$

The monopoly profit function is as follows:

(5.2) $\pi = p_{AS}q_{AS} + p_{AR}q_{AR} + p_{BS}q_{BS} - p_{BR}q_{BR} - c(q_{AS} + q_{BS})$

The F.O.C. for profit maximization is:

(5.3) $\dfrac{\partial \pi}{\partial q_{AS}} = AS - 2q_{AS} - BR - 2q_{AS} - c = 0$

(5.4) $\dfrac{\partial \pi}{\partial q_{BS}} = BS - 2q_{BS} + AR - 2q_{BS} - c = 0$

From the F.O.C. we find the quantities and prices of equilibrium:

(5.5) $q_{AS} = q_{BR} = \dfrac{AS - BR - c}{4}$

(5.6) $q_{BS} = q_{AR} = \dfrac{BS + AR - c}{4}$

The net price the monopoly receives for messages initiated by customer A is:

(5.7) $p_{AR} = \dfrac{3AR - BS + c}{4}$, $p_{BS} = \dfrac{3BS - AR + c}{4}$, $p_{BR} = \dfrac{3BR + AS - c}{4}$, $p_{AS} = \dfrac{3AS + BR + c}{4}$

we find that at equilibrium the net prices are equal to:

(5.8) $p_A = p_{AS} - p_{BR} = \dfrac{AS - BR + c}{2}$, $p_B = p_{BS} + p_{AR} = \dfrac{BS + AR + c}{2}$

and the profit at equilibrium is:

(5.9) $\pi_5 = \dfrac{(AS - BR - c)^2}{8} + \dfrac{(BS + AR - c)^2}{8}$

The consumers surplus and welfare function are:

(5.10)
$$CS_A = CS_{AS} + CS_{AR} = \frac{(AS - p_{AS})q_{AS}}{2} + \frac{(AR - p_{AR})q_{AR}}{2} = \\ = \frac{(AS - BR - c)^2}{32} + \frac{(BS + AR - c)^2}{32}$$

(5.11)
$$CS_B = CS_{BS} + CS_{BR} = \frac{(BS - p_{BS})q_{BS}}{2} + \frac{(p_{BR} - BR)q_{BR}}{2} = \\ = \frac{(BS + AR - c)^2}{32} + \frac{(AS - BR - c)^2}{32}$$

(5.12) $W_5 = \dfrac{1.5(AS - BR - c)^2}{8} + \dfrac{1.5(BS + AR - c)^2}{8} = 1.5\pi$

3. SOCIAL WELFARE SOLUTION

The social optimal solutions of the five previous scenarios will be discussed in the sections below. In this first section we calculate the optimal solutions of the social planner who desires the maximization of simple summation of consumers (customer A and customer B) and the producer surplus. We then try to compare the 5 solutions to each other, as well as to the monopoly solutions above where the objective functions are to maximize seller's profits.

3.1. Case 1

In this case a price is charged only to the sender, who initiates the message, while the receiver is free of charge upon receiving the message.

Social welfare function is defined as follows:

(6.1) $$W = p_{AS}q_{AS} + p_{BS}q_{BS} - c(q_{AS} + q_{BS}) + \frac{(AS - p_{AS})q_{AS}}{2} +$$

$$+ \frac{\left[AR + \left(AR - q_{AR}\right)\right]q_{AR}}{2} + \frac{(BS - p_{BS})q_{BS}}{2} + \frac{\left[BR + \left(BR - q_{BR}\right)\right]q_{BR}}{2}$$

Since $p_{AS} = \left(AS - q_{AS}\right)$ and $p_{BS} = \left(BS - q_{BS}\right)$, and since $q_{AS} = q_{BR}$ while $q_{AR} = q_{BS}$, (6.1) can be rewrite as:

(6.1') $$W = \left(AS - q_{AS}\right)q_{AS} + \left(BS - q_{BS}\right)q_{BS} - c(q_{AS} + q_{BS}) + \frac{q_{AS}^{\ 2}}{2} + \frac{q_{BS}^{\ 2}}{2} +$$

$$+ \frac{\left(2AR - q_{BS}\right)q_{BS}}{2} + \frac{\left(2BR - q_{AS}\right)q_{AS}}{2}$$

Where the last two terms measures the surpluses of <u>both</u> passive receivers that are measured by the areas below there demand curves.

The two decision variables of the social planners are q_{AS} and q_{BS}.

The F.O.C. for maximization is:

(6.2) $$\frac{\partial W}{\partial q_{AS}} = AS - 2q_{AS} - c + q_{AS} + BR - q_{AS} = 0$$

and

(6.3) $$\frac{\partial W}{\partial q_{BS}} = BS - 2q_{BS} - c + q_{BS} + AR - q_{BS} = 0$$

From (6.2) and (6.3) we get optimal values of q_{AS}, q_{BS}, p_{AS} and p_{BS} as:

(6.4) $$q_{AS} = q_{BR} = \frac{AS + BR - c}{2}$$

(6.5) $$q_{BS} = q_{AR} = \frac{BS + AR - c}{2}$$

(6.6) $$p_{AS} = \frac{AS - BR + c}{2} \text{ and } p_{BS} = \frac{BS - AR + c}{2}$$

(6.7) $$\pi_1 = \frac{\left(AS - BR - c\right)\left(AS + BR - c\right)}{4} + \frac{\left(BS - AR - c\right)\left(BS + AR - c\right)}{4} =$$
$$= \frac{\left(AS - c\right)^2 - BR^2}{4} + \frac{\left(BS - c\right)^2 - AR^2}{4}$$

The consumer surplus of customer A, CS_A, and customer B, CS_B, are respectively:

(6.8) $$CS_A = \frac{(AS + BR - c)^2}{8} + \frac{\left(3AR - BS + c\right)\left(BS + AR - c\right)}{8}$$

where the first term references the surplus of customer A as a sender and the second term the surplus of customer A as a receiver.

(6.9) $$CS_B = \frac{(BS + AR - c)^2}{8} + \frac{\left(3BR - AS + c\right)\left(AS + BR - c\right)}{8}$$

where the first term references the surplus of customer B as a sender and the second term the surplus of customer B as a receiver.

The summation of (6.7), (6.8) and (6.9) representing the social welfare in case 1 is:

(6.10) $$W_1 = \frac{(AS + BR - c)^2}{4} + \frac{(BS + AR - c)^2}{4}$$

3.2. Case 2

A price is charged from both the call sender as well as the receiver. In this case the objective function is:

(7.1)
$$W = p_{AS}q_{AS} + p_{AR}q_{AR} + p_{BS}q_{BS} + p_{BR}q_{BR} - c(q_{AS} + q_{BS}) + \frac{(AS - p_{AS})q_{AS}}{2}$$
$$+ \frac{(AR - p_{AR})q_{AR}}{2} + \frac{(BS - p_{BS})q_{BS}}{2} + \frac{(BR - p_{BR})q_{BR}}{2}$$

where the first five terms represent the seller surplus, and the next last four terms represent the consumer surpluses as sender as well as receiver.

Since $p_{AS} = \left(AS - q_{AS}\right)$, $p_{BS} = \left(BS - q_{BS}\right)$, $p_{AR} = \left(AR - q_{AR}\right)$ and $p_{BR} = \left(BR - q_{BR}\right)$ and since $q_{AS} = q_{BR}$ and $q_{AR} = q_{BS}$, (7.1) can be rewrite as:

(7.1')
$$W = \left(AS - q_{AS}\right)q_{AS} + \left(AR - q_{BS}\right)q_{BS} + \left(BS - q_{BS}\right)q_{BS} + \left(BR - q_{AS}\right)q_{AS} - c(q_{AS} + q_{BS}) +$$
$$+ \frac{q_{AS}^{\ 2}}{2} + \frac{q_{BS}^{\ 2}}{2} + \frac{q_{BS}^{\ 2}}{2} + \frac{q_{AS}^{\ 2}}{2}$$

where again q_{AS} and q_{BS} are decision variables. Therefore the F.O.C. of profit maximization is:

(7.2) $$\frac{\partial W}{\partial q_{AS}} = AS - 2q_{AS} + BR - 2q_{AS} - c + q_{AS} + q_{AS} = 0$$

(7.3) $$\frac{\partial W}{\partial q_{BS}} = BS - 2q_{BS} + AR - 2q_{BS} - c + q_{BS} + q_{BS} = 0$$

and the optimal quantities for customer A and customer B are:

(7.4) $$q_{AS} = q_{BR} = \frac{AS + BR - c}{2}, \quad q_{BS} = q_{AR} = \frac{BS + AR - c}{2}$$

The optimal prices for customer A and customer B are:

(7.5) $$p_{AS} = \frac{AS - BR + c}{2}, \quad p_{AR} = \frac{AR - BS + c}{2},$$
$$p_{BS} = \frac{BS - AR + c}{2} \text{ and } p_{BR} = \frac{BR - AS + c}{2}$$

In this case we see that the total price should be socially charged by the producer from the sender and the receiver for each message is equal, as expected, to the marginal cost, c. Thus,

$$p_A = p_{AS} + p_{BR} = c, \quad p_B = p_{BS} + p_{AR} = c$$

In the social optimum solution the producer's pure economic profit is zero as defined by (7.6)

(7.6) $$\pi_2 = p_{AS}q_{AS} + p_{AR}q_{AR} + p_{BS}q_{BS} + p_{BR}q_{BR} - c(q_{AS} + q_{AR}) = 0$$

since prices are equal to the marginal cost, c, we face no producer surplus and customer A and customer B consumers surpluses are respectively defined by (7.7) and (7.8) below as follows:

$$(7.7)\ CS_A = CS_{AS} + CS_{AR} = \frac{\left(AS+BR-c\right)^2}{8} + \frac{\left(BS+AR-c\right)^2}{8}$$

$$(7.8)\ CS_B = CS_{BS} + CS_{BR} = \frac{\left(AS+BR-c\right)^2}{8} + \frac{\left(BS+AR-c\right)^2}{8}$$

Therefore, the social welfare value of Case 2 can be summarized by the summation of (7.6), (7.7) and (7.8) as:

$$(7.9)\ W_2 = \frac{\left(AS+BR-c\right)^2}{4} + \frac{\left(BS+AR-c\right)^2}{4}$$

The comparison between case 1 and case 2 reveals an equal quantities supplied by the producer, therefore, the total welfare in those cases are also the same.

However, in terms of re-distribution of the "pie" there are differences. In case 2 all surpluses are distributed only to the consumers A and B while in case 1 producer surplus is also positive.

3.3. Case 3

In this case any cost of a message should be covered, but only by the charging the receiver and not the sender of the message.

The social welfare function, *W*, is defined as follows:

(8.1)

$$W = p_{AR}q_{AR} + p_{BR}q_{BR} - c(q_{AR}+q_{BR}) + \frac{(AR-p_{AR})q_{AR}}{2} + \frac{\left[AS+\left(AS-q_{AS}\right)\right]q_{AS}}{2} + \frac{(BR-p_{BR})q_{BR}}{2} + \frac{\left[BS+\left(BS-q_{BS}\right)\right]q_{BS}}{2}$$

Since $p_{AR} = \left(AR - q_{AR}\right)$ and $p_{BR} = \left(BR - q_{BR}\right)$ and since $q_{AS} = q_{BR}$ and $q_{AR} = q_{BS}$, (8.1) can be rewrite as:

(8.1')

$$W = \left(AR-q_{AR}\right)q_{AR} + \left(BR-q_{BR}\right)q_{BR} - c(q_{AR}+q_{BR}) + \frac{{q_{AR}}^2}{2} + \frac{{q_{BR}}^2}{2} + \frac{\left(2BS-q_{AR}\right)q_{AR}}{2} + \frac{\left(2AS-q_{BR}\right)q_{BR}}{2}$$

Where the last two terms measures the surpluses of <u>both</u> passive receiver that are measured by the areas below their demand curves.

The two decision variables of the social planners are q_{AR} and q_{BR}.

Thus, the F.O.C. for welfare maximization is:

$$(8.2)\ \frac{\partial W}{\partial q_{AR}} = AR - 2q_{AR} - c + q_{AR} + BS - q_{AR} = 0$$

$$(8.3)\ \frac{\partial W}{\partial q_{BR}} = BR - 2q_{BR} - c + q_{BR} + AS - q_{BR} = 0$$

Quantities and prices at social welfare optimization are:

$$(8.4)\ q_{AR} = q_{BS} = \frac{BS+AR-c}{2} \text{ and } q_{BR} = q_{AS} = \frac{AS+BR-c}{2},$$

$$(8.5)\ p_{AR} = \frac{AR-BS+c}{2} \text{ and } p_{BR} = \frac{BR-AS+c}{2}.$$

The producer's surplus (profit) is:

$$(8.6)\ \pi_3 = \frac{\left(AR-BS-c\right)\left(AR+BS-c\right)}{4} + \frac{\left(BR-AS-c\right)\left(BR+AS-c\right)}{4} = \frac{\left(AR-c\right)^2 - BS^2}{4} + \frac{\left(BR-c\right)^2 - AS^2}{4} < 0$$

Since AS>BR and BS>AR while AS>BS and AR>BR regardless the relationship between AR and BS we conclude that $\pi_3 < 0$.

The right term of (8.4) is negative and in absolute level is larger than the left term in that equation. Thus either the left term is positive or for sure if this term is also negative the summation of the two terms is negative.

The consumer surplus of customer A, CS_A and customer B, CS_B, are respectively:

$$(8.7)\ CS_A = \frac{(AR+BS-c)^2}{8} + \frac{\left(3AS-BR+c\right)\left(BR+AS-c\right)}{8}$$

$$(8.8)\ CS_B = \frac{(BR+AS-c)^2}{8} + \frac{\left(3BS-AR+c\right)\left(AR+BS-c\right)}{8}$$

The social welfare can be summarized as:

$$(8.9)\ W_3 = \frac{(AR+BS-c)^2}{4} + \frac{(BR+AS-c)^2}{4}$$

Again in this solution the total pie representing the social optimum is the same as in previous cases, but the distribution of the total welfare are different in each case.

3.4. Case 4

In this case both senders either customer A or customer B, pays for sending messages, while only customer B is paid for messages received.

Customer A demand function for sending message is:

$$D_A : \left\{ p_{AS} = AS - q_{AS} \quad \text{for sending calls by customer A} \right.$$

Customer B demand functions for sending or receiving messages are:

$$D_B : \begin{cases} p_{BS} = BS - q_{BS} & \text{for sending calls by the customer B} \\ p_{BR} = BR + q_{BR} & \text{for receiving calls by the customer B} \end{cases}$$

and the total social welfare of the economy is defined as *W*:

$$(9.1)\ W = p_{AS}q_{AS} + p_{BS}q_{BS} - p_{BR}q_{BR} - c(q_{AS}+q_{BS}) + \frac{(AS-p_{AS})q_{AS}}{2} + \frac{\left[AR+\left(AR-q_{AR}\right)\right]q_{AR}}{2} + \frac{(BS-p_{BS})q_{BS}}{2} + \frac{(p_{BR}-BR)q_{BR}}{2}$$

Since $p_{AS} = \left(AS - q_{AS}\right)$, $p_{BS} = \left(BS - q_{BS}\right)$ and $p_{BR} = \left(BR + q_{BR}\right)$ and since $q_{AS} = q_{BR}$ and $q_{AR} = q_{BS}$, (9.1) can be written as:

(9.1') $W = (AS - q_{AS})q_{AS} + (BS - q_{BS})q_{BS} - (BR + q_{AS})q_{AS} - c(q_{AS} + q_{BS}) +$

$$+\frac{q_{AS}^2}{2} + \frac{(2AR - q_{BS})q_{BS}}{2} + \frac{q_{BS}^2}{2} + \frac{q_{AS}^2}{2}$$

The two decision variables of the social planners are q_{AS} and q_{BS}. Thus, the F.O.C. for welfare maximization is:

(9.2) $\frac{\partial W}{\partial q_{AS}} = AS - 2q_{AS} - BR - 2q_{AS} - c + q_{AS} + q_{AS} = 0$

(9.3) $\frac{\partial W}{\partial q_{BS}} = BS - 2q_{BS} - c + AR - q_{BS} + q_{BS} = 0$

The quantity of messages at equilibrium sent by customer A and by customer B, and received by customer B and A respectively is:

(9.4) $q_{AS} = q_{BR} = \frac{AS - BR - c}{2}$, $q_{BS} = q_{AR} = \frac{BS + AR - c}{2}$

While the prices at equilibrium are:

(9.5) $p_{AS} = \frac{AS + BR + c}{2}$, $p_{BR} = \frac{BR + AS - c}{2}$ and $p_{BS} = \frac{BS - AR + c}{2}$.

The net price that the service supplier receives from a message that is indicated by customer A, P_A, is as follows: $p_A = p_{AS} - p_{BR} = c$

The profit in case 4, π_4, is given below:

(9.6) $\pi_4 = \frac{(BS - AR - c)(BS + AR - c)}{4} = \frac{(BS - c)^2 - AR^2}{4}$

π_4 can be positive only if $BS > AR + c$ otherwise it is negative.

The consumers' surplus and the total social welfare can be summarized as

(9.7) $CS_A = CS_{AS} + CS_{AR} = \frac{(AS - BR - c)^2}{8} + \frac{(3AR - BS + c)(BS + AR - c)}{8}$

(9.8) $CS_B = CS_{BS} + CS_{BR} = \frac{(BS + AR - c)^2}{8} + \frac{(AS - BR - c)^2}{8}$

(9.9) $W_4 = \frac{(AS - BR - c)^2}{4} + \frac{(BS + AR - c)^2}{4}$

3.5. Case 5

In this case the social optimum is investigated where customer A who is the sender as well as the receiver is charged for the service. However, customer B is charged only for sending, but is paid by the service supplier for actually receiving messages.

Customer A demand function for sending message is:

$$D_A : \begin{cases} p_{AS} = AS - q_{AS} & \text{for sending calls by customer A} \\ p_{AR} = AR - q_{AR} & \text{for receiving calls by customer A} \end{cases}$$

The demand functions of customer B, D_B, are similar to case 4 above, i.e.,

$$D_B : \begin{cases} p_{BS} = BS - q_{BS} & \text{for sending calls by the customer B} \\ p_{BR} = BR + q_{BR} & \text{for receiving calls by the customer B} \end{cases}$$

The social welfare function, W, in this case is:

(10.1) $W = p_{AS}q_{AS} + p_{AR}q_{AR} + p_{BS}q_{BS} - p_{BR}q_{BR} - c(q_{AS} + q_{BS}) + \frac{(AS - p_{AS})q_{AS}}{2} +$

$$+\frac{(AR - p_{AR})q_{AR}}{2} + \frac{(BS - p_{BS})q_{BS}}{2} + \frac{(p_{BR} - BR)q_{BR}}{2}$$

Since $p_{AS} = (AS - q_{AS})$, $p_{BS} = (BS - q_{BS})$, $p_{AR} = (AR - q_{AR})$ and $p_{BR} = (BR + q_{BR})$ and since $q_{AS} = q_{BR}$ and $q_{AR} = q_{BS}$, (10.1) can be rewrite as:

(10.1') $W = (AS - q_{AS})q_{AS} + (AR - q_{BS})q_{BS} + (BS - q_{BS})q_{BS} - (BR + q_{AS})q_{AS} - c(q_{AS} + q_{BS}) +$

$$+\frac{q_{AS}^2}{2} + \frac{q_{BS}^2}{2} + \frac{q_{BS}^2}{2} + \frac{q_{AS}^2}{2}$$

The two decision variables of the social planners are q_{AS} and q_{BS}.

The F.O.C. for welfare maximization is:

(10.2) $\frac{\partial W}{\partial q_{AS}} = AS - 2q_{AS} - BR - 2q_{AS} - c + q_{AS} + q_{AS} = 0$

(10.3) $\frac{\partial W}{\partial q_{BS}} = BS - 2q_{BS} + AR - 2q_{AR} - c + q_{BS} + q_{BS} = 0$

and quantities and prices of equilibrium are:

(10.4) $q_{AS} = q_{BR} = \frac{AS - BR - c}{2}$, $q_{BS} = q_{AR} = \frac{BS + AR - c}{2}$

(10.5) $p_{AS} = \frac{AS + BR + c}{2}$, $p_{AR} = \frac{AR - BS + c}{2}$, $p_{BS} = \frac{BS - AR + c}{2}$, $p_{BR} = \frac{BR + AS - c}{2}$

respectively.

Again we find that at equilibrium the net prices are equal to the message's marginal cost, c, i.e.,

$p_{AS} - p_{BR} = c$, $p_{AR} + p_{BS} = c$

Therefore the profit function is zero

(10.6) $\pi_5 = p_{AS}q_{AS} + p_{AR}q_{AR} + p_{BS}q_{BS} - p_{BR}q_{BR} - c(q_{AS} + q_{BS}) = 0$

The consumers' surplus and the total social welfare are:

(10.7) $CS_A = CS_{AS} + CS_{AR} = \frac{(AS - BR - c)^2}{8} + \frac{(BS + AR - c)^2}{8}$

(10.8) $CS_B = CS_{BS} + CS_{BR} = \frac{(BS + AR - c)^2}{8} + \frac{(AS - BR - c)^2}{8}$

(10.9) $W_5 = \frac{(AS - BR - c)^2}{4} + \frac{(BS + AR - c)^2}{4}$

3.6. Numerical Illustration

In order to demonstrate the role of the firm in the optimal pricing policy and the profits and welfare comparisons for our five cases we use a simple numerical example.

We assume two consumers A and B where the Reservation Price of consumer A is larger than that of consumer B (as a sender as well as a receiver) where sending a message is more important than receiving it.

Thus:

RP_{AS} = 100 is the reservation price of sender A

RP_{AR} = 50 is the reservation price of receiver A

RP_{BS} = 45 is the reservation price of sender B

RP_{BR} = 35 is the reservation price of receiver B

The marginal cost of each message, *C*, is 5.

Table 1 shows the optimal prices, quantity, profits, consumer surplus of consumer and consumer B and the social welfare for the five cases.

In table 2 we use the same parameter values where RP_{BS} increase to 80 (instead of 45 as previously).

Based on the tables we show that indeed the profit in case 2 where both sender and receiver pay is significantly higher than in cases 1 and 3 where only one of the parties pays.

The same is true when comparing cases 4 and 5 where the latter yields a higher profit by allowing more degrees of freedom, that of charging both the sender as well as the receiver.

4. IMPLICATIONS

In this section we use the results derived above for further considerations:

Taking the appropriate values of producer surplus, consumer surplus and social welfare in the five cases above and comparing them lead to the following conclusions:

a) The social welfare values are at maximum and are equal in the first three cases. However, the distributions of the total welfare are different. In the first case the producer profit is positive, thus the consumer surplus is lowest. In the second case there are no profits thus the total welfare is distributed to the consumers, and in the third case where the producer faces losses the consumers' pie is the largest.

b) In cases four and five the total social welfare values are equal to each other and are smaller than in the other three cases. While the profit of the producer in case five is zero the small pie is distributed only to the consumers, while in case four the profit value of the producer is ambiguous, thus, the consumer surplus can be either smaller or larger than in case five.

In the discussion below we summarize the main conclusions from the results of the profit maximization monopoly cases and the social planner cases:

For this purpose we use the following notations:

Define q_i^M or $\sum q_i^M$ the quantity of monopoly solution, M, in case, i, (i=1,…,5).

Define q_i^S or $\sum q_i^S$ the social optimum quantity, S, in case, i, (i=1,…,5).

The same with W_i^M , W_i^S , π_i^M and π_i^S , representing the welfare and the profit values of the monopoly, M, and the social planner, S, in all five cases.

2. The comparison of monopoly quantities, $\sum q_1^M$ and $\sum q_2^M$, derived from (1.4), (1.5), (2.4) and (2.5) and the social optimum quantity $\sum q_1^S$ that is derived from the summation of (6.4) and (6.5), (that is the same as at $\sum q_2^S$ (see at (7.4)), reveals the following:

3. The relation between quantity supplied by the monopoly in cases 1 and 2 are ambiguous as mentioned above. However, both of these quantities are smaller than the parallel quantities in the social optimum cases.

4. As a result we can derive some welfare implications.

5. Since the monopoly can charge in case 2 both sender and receiver, he exploits his power to maintain more profit than in case 1 or case 3 and accordingly charges higher prices. Still the comparison between the welfare values of W_2^M and W_1^M is ambiguous.

Table 1. Comparison Between Five Cases Solutions with a Low Reservation Price.

	P_{AS}	q_{AS}	P_{AR}	q_{AR}	P_{BS}	q_{BS}	P_{BR}	q_{BR}	Profit	Consumer Surplus A	Consumer Surplus B	Social Welfare
Case 1	52.5	47.5	0	20	25	20	0	47.5	2656.25	1928.13	734.375	5318.75
Case 2	67.5	32.5	27.5	22.5	22.5	22.5	2.5	32.5	3125.00	781.25	781.25	4687.50
Case 3	0	15	27.5	22.5	0	22.5	20	15	731.25	1640.63	871.88	3243.75
Case 4	85	15	0	20	25	20	50	15	850.00	912.50	312.50	2075.00
Case 5	85	15	27.5	22.5	22.5	22.5	52.5	15	1425.00	365.63	384.38	2175.00

Table 2. Comparison Between Five Cases Solutions with a High Reservation Price

	P_{AS}	q_{AS}	P_{AR}	q_{AR}	P_{BS}	q_{BS}	P_{BR}	q_{BR}	Profit	Consumer Surplus A	Consumer Surplus B	Social Welfare
Case 1	52.5	47.5	0	37.5	42.5	37.5	0	47.5	3662.5	2300	1237.5	7200
Case 2	67.5	32.5	18.75	31.25	48.75	31.25	2.5	32.5	4065.63	1016.41	1016.41	6098.44
Case 3	0	15	27.5	22.5	0	22.5	20	15	731.25	1640.63	1659.38	4031.25
Case 4	85	15	0	37.5	42.5	37.5	50	15	1856.25	1284.38	815.63	3956.25
Case 5	85	15	18.75	31.25	48.75	31.25	52.5	15	2365.63	600.78	619.53	3585.94

6. In any case the welfare that we get in a monopoly environment is smaller than in social optimum. $W_1^M < W_1^S = W_2^S = W_3^S$.
7. In cases 4 and 5 the welfare values generated either by the monopoly or the social optimum planner are smaller than in the other three cases. Since the policies that are used are not efficient, neither the monopoly nor the social optimum can achieve maximization. Only in cases where the relationships between AS, AR, BS and BR are different from what we have assumed can the results can be different, and in some cases the pricing policy of cases 4 or 5 can be optimal from the point of view of the profit maximizing monopoly or the social optimum planner. This we plan to investigate in future research.

CONCLUSIONS

In this paper we reconsidered several pricing policies in the network industry and compared the advantages of some (five) policies on other policies from the perspective of a profit maximizing monopoly and a social planner who desires social welfare maximization.

The uniqueness of the network industry is that the demand for services include at least two parties: the sender of a message (i.e. phone or cellular calls, regular letters or express mail, email message etc.) and the receiver of the message. These demands are not necessarily symmetric and do not necessarily reflect a positive benefit from sending or receiving messages. Today these values can be estimated very accurately using technologies like RFID etc. by the seller of the network services. We show that under some conditions the traditional pricing policy of charging either only the sender or only the receiver is inferior to a solution of a combined pricing of both parties simultaneously. These conclusions can be applied either by the monopoly or by the social planner, and may open new avenues of pricing policy in the network markets.

Since the theoretical model was simplified and limited to the case of asymmetric attitudes of senders and receivers, this already opens several directions for future research. One area that requires research is the case where connections are not completed. Another possibility is the development of a more dynamic model when a first generation sender may leave messages on an answering machine which may lead to further messages when the original receiver becomes a sender and vice versa. Then the optimal pricing becomes even more complicated since negative pricing can be useful for sending messages via the answering machine which may then generate a further message by the original receiver.

Another possibility of future extensions is that of adding a third party who is involved in the network market.

Today senders and receivers of emails or other internet services do not pay for those services and the optimal pricing consists of a third party such as advertisers who are charged for the benefit that they may gain.

Another possibility is to deal with the case where communication customers are faced with a duopoly environment (namely landline and cellular companies). In that case pricing policy turns into a price war between the two companies and may be compared to our current results. This we leave for future research.

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