

Optimal Online Interactive Service Policy and Pricing Decision with Negative Network Externality

David C. Teng David M. Chiang
Graduate Institute of Business Administration
National Taiwan University
chingit@ms22.hinet.net cmh@ccms.ntu.edu.tw

Abstract

In online interactive service industries, customers' utility is mainly from the service received but it is also affected by other customers' annoying behavior. Annoying behavior is configured to increase the utility of externality-loving customers who do it but on the contrary reduce the utility of externality-hating customers.

This paper proposes the optimal online interactive service policy and pricing decision in three sections. First, "forbiddance" policy is the norm. Second, "allowance" policy is the norm. Third, "forbiddance" policy is partially expected.

The results contradict to some intuitions. First, intuition may tell us that negative externality is harmful to customers' utility and service provider's revenues. Thus, it is favorable to eliminate the externality. In this paper, "forbiddance" policy that eliminates the annoying behavior is not always optimal. When the externality-loving segment is large enough, it's optimal to adopt "allowance" policy to delight this segment.

Second, intuition may tell us meeting the preference of the majority of customers brings the most revenues. In this paper, the intuition may guide to the wrong way especially when "forbiddance" policy is the norm. Besides, we propose three simple decision support figures for service providers.

(Keywords : Internet Marketing; Electronic Commerce Management; Service Operations on the Web; Network Externality)

1. Introduction

1.1 Externalities in Online Interactive Service Industries

Online interactive services include at least online games, online auctions, and online chat rooms. In these industries, the customers' utility is mainly from the online interactive service received but the presence or behavior of other customers in the same system will affect it [8] [12]. In online games, chatting answers of quests may reduce other players' fun in quest solving. In online auctions, exaggerate overpricing may waste potential buyers' time. In online chat rooms, commercially personal selling may waste users' time if they are not interested. The utility change due to other customers' presence or behavior is called "externality" other customers bring.

Customers may bring positive [9] [12] or negative [8] [12] [14] [16] externalities into the system through various ways. For example, signals of quality, utility of communication [9], congestion [16], competition for resources [14], presence of different social classes [8], or intergroup utility piracy [4]. All means above could alter customers' utility and decision by presence of another individual or another group of customers.

1.2 Literature Review

The term "network externality" is generally recognized after the works of [4] and [9]. Network externality in nature is the externality result from equivalent adoption decisions by other customers [4] [9].

The literature of network externality could be categorized into three parts. Economists firstly focus on the positive and direct network externality. Second, the positive and indirect network externality also attracts some attention [1] [2]. Third, the literature [8] that discussed about negative network externality is rather little. In sum, the literature in Economics largely focused on social welfare and less emphasizes the managerial implications than the literature in Management Sciences.

Literature in Management Sciences focuses on negative network externalities. If the service provider ignores the congestion externality, the problem of unexpected congestion may emerge. The utilization rate may deviate from optimality [16].

Besides, Metcalfe's Law should be modified, because the utility of each link between customers may not always be symmetric, positive, and even existing. One trial shows that the monopolistic system owner may overprice, overestimate revenues, and wrongly focuses on too more customers with negative network externality ignored [4]. Generally speaking, network externalities are far less studied in Management Sciences.

1.3 The Purpose of This Paper

This paper aims to find the optimal online interactive service policy (to forbid or to allow) and pricing decision with the existence of forbiddable annoying behavior in three sections (Section 3, 4, and 5). First, "forbiddance" policy is the norm. Second, "allowance" policy is the norm. Third, "forbiddance" policy is partially expected.

This paper also examines two intuitions. First, intuition may tell us that negative externality is harmful to customers' utility and service provider's revenues. Thus, it is favorable to eliminate the externality. Second, intuition may tell us meeting the preference of the majority of customers brings the most revenues.

The first intuition obviously undervalues the externality-loving customers. When externality-loving customers are willing to pay a higher price, it's possibly more favorable to accommodate externality-loving customers only.

The second intuition neglects the alternative only serving a smaller group of customers. The alternative may generate more revenues when the group alone can fill the capacity completely and pay a higher price for preferred policy (forbiddance to externality-hating customers and allowance to externality-loving customers).

1.4 The Importance of The Topic

The topic is rather important in industries such as online games, online auctions, and online chat rooms, because various behaviors may create externality in customers' interactions. For example, exaggerate overpricing in online auctions may waste potential buyers' time and greatly reduce their utility and then affect their choices among similar service providers. Furthermore, should the online interactive service provider allow the occurrence of annoying behavior or forbid that? It's an interesting problem not solved yet but contributes a lot to practitioners' decision making.

1.5 Comparison with Past Literature

Compared with past literature, the paper configures that there are two groups of customers having different quality recognition and that is different from only one group of customers having same quality recognition [10]. Models including different tastes may describe the reality more precisely.

The externality-loving customers may cause no externality (to externality-hating customers) if they are forbidden to do the annoying behavior. That is different from externality due to other customers' presence [14] [16]. The configuration in this paper is proper to describe marketing situations.

The externality-loving customers were once treated as "pests" and they generate rather few revenues to service provider [4]. In this paper, the externality-loving customers were treated as normal customers generating the same revenues as externality-hating customers if no annoying behavior real takes place.

The paper points out a new source of negative externality among customers: annoying behavior. That is, the externality is accompanied with the annoying behavior of the externality-loving customers. In online games, the answer-chatting customers may reduce other quest-solving customers' fun. The externality does not come from the presence of the answer-chatting customers, but from the annoying behavior "chatting the answer" they do.

The issue of optimal policy and pricing decision is rarely addressed in the past literature.

1.6 The Organization of the Paper

The remainder of the article is organized in five sections. Section 2 describes the model. Section 3 analyzes the optimal policy and pricing decision when

forbiddance is the norm. Section 4 analyzes the optimal policy and pricing decision when allowance is the norm. Section 5 is the generalization of Section 3 and 4. Then conclusion and future research opportunities are drawn.

2. Model

2.1 Online interactive service System and Customer Segmentations

The online interactive service provider is configured as a monopolist. This paper segments the customers into two groups. One group is composed of externality-hating customers who are represented as A-group customers and the other group is composed of externality-loving customers who are represented as B-group customers.

2.2 Price and Utility

The online interactive service provider only can set a single price toward two groups of customers and simultaneously set the policy (to forbid or to allow). Every customer's utility is zero if he (she) chooses not to join in the online interactive service system. Implying that every customer would join in the system if and only if his (her) utility could be nonnegative in the online interactive service system. Every customer joining in the system obtains utility (represented by S in the model) and pays the price (represented by P in the model).

Many factors may be considered and expected by customers [11] but the paper addresses utility change due to forbiddance or allowance of annoying behavior. "Desired" and "adequate" are two service levels [17]. The former is the satisfactory level and the latter is not-dissatisfactory level. Based on the two concepts, three sections and corresponding configurations are described:

In Section 3, "forbiddance" is the norm. B-group customers treat "forbiddance" as adequate and treat "allowance" as desired. Therefore, B-group customers obtain additional utility (denoted by E) doing annoying behavior under the "allowance" policy. Analysis is done in Section 3.

In Section 4, "allowance" is the norm. B-group customers take "allowance" as adequate. Therefore, no additional utility would be received since annoying behavior is not a privilege but taken for granted. On the contrary, B-group customers would lose some utility (denoted by E) if the annoying behavior were forbidden. Analysis is done in Section 4.

In Section 5, "forbiddance" policy is adopted by only a part of the industry and the remaining part set "allowance" policy. B-group customers may set a reference point between "forbiddance" and "allowance" policies. To be more specific, B-group customers obtain additional utility (denoted by e_1) facing "allowance" policy and lose utility (denoted by e_2) facing "forbiddance" policy. Analysis is done in Section 5.

Here, $(e_1 + e_2)$ is assumed to be equal to E because the same behavior offers the same utility (denoted by E) to B-group customers regardless of the norms of the industries. The configurations of three sections are showed in Table 1.

Table 1 : Configuration of three sections

Utility Policy Section	B-group customers' utility		A-group customers' utility	
	Forbiddance	Allowance	Annoying behavior takes place	Otherwise
Section 3	S	S + E	$S - N * N_n$	S
Section 4	$S - E$	S	$S - N * N_n$	S
Section 5	$S - e_2$	$S + e_1$	$S - N * N_n$	S

For example, there are 3 B-group customers doing annoying behavior in the system and every A-group customer's utility is $S - P - 3N_n$ and every B-group customer's utility is $S - P + E$ (under the setting of Section 3). The utilities from different sources are additive and that is common in model configurations [7] [13].

2.3 Notations and Variables

Notations used in the model are as follows:

S: every customer's utility from the online interactive service system

E: the utility difference between to do and not to do annoying behavior for any B-group customer

N_n : the utility reduction for any A-group customer facing per B-group customer doing annoying behavior

M: the number of A-group customers

N: the number of B-group customers

P: the single price charged to every customer

C: the capacity of the online interactive service provider

FO: the policy "forbiddance"

AL: the policy "allowance"

Section 3, 4, 5 manipulate the utility addition and subtraction those due to forbiddance or allowance of can/cannot doing annoying behavior for B-group customers. The policy and price set by the online interactive service provider are decision variables and the "join-or-not" decisions made by customers are endogenous variables. The revenue received by the online interactive service provider is the main dependent variable.

S, E, N_n are given positive numbers and M, N, C are given positive integers. Furthermore, P is restricted to be positive.

If the customers choose in sequence, then A_i is denoted to the i^{th} customer choosing in A-group customers and B_j is denoted to the j^{th} customer choosing in B-group customers.

2.4 Procedure of the Events

The scenarios to be discussed all follow the same procedure of the events:

First, the online interactive service provider sets the behavior policy as "forbiddance" or "allowance" and meanwhile sets a single price to every customer.

Second, all B-group customers as a whole choose whether to join the service system or not. (This could be relaxed at 2.5)

Third, all A-group customers as a whole choose whether to join the service system or not. (This could be relaxed at 2.5)

Fourth, all customers obtain the utility they perfectly expect and the service provider collects the revenues.

2.5 The Irrelevance of Choice Sequence among Customers

In 2.4, B-group customers are assumed to choose simultaneously and make the same decision. After B-group customers' choices, A-group customers are assumed to choose simultaneously and make the same decision.

In 2.5, we prove that same-group customers all make the same decision (to join or not) under any choice sequence in Appendix.

2.6 Intuition to be Examined

In intuitions, the online interactive service provider should meet the preference of the majority. When each segment alone can fill the capacity completely, meeting preference of either one segment is equally optimal. Figure 1 illustrates the thinking.

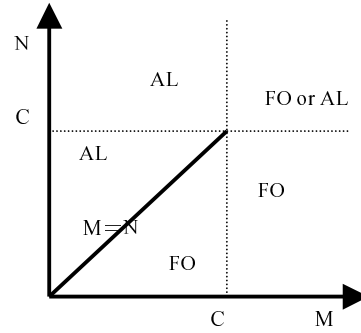


Figure 1 : The optimal policy in intuition

In Figure 1, 2, 3, and 4, "AL" is assigned when the optimal policy is "allowance" and "FO" is assigned when the optimal policy is "forbiddance". "FO or AL" is assigned when both policies are equally optimal.

3. "Forbiddance" Policy is the Norm

In online games, online auctions, and online chat rooms, most service providers forbid cheating and threatening. Every customer knows the norm and takes "forbiddance" policy as granted.

B-group customers thus obtain "normal" utility (denoted by S) without doing the behavior they love, but B-group customers' utility may increase (denoted by E) if they are permitted to do the behavior.

In this setting, every B-group customer's utility is always no less than every A-group customer's utility. This is tabularized in Table 2.

Table 2 : The utility settings in Section 3

Utility Policy Group	Forbiddance	Allowance	
		With B-group	Without B-group
A	S	$S - N * N_n$	S
B	S	S + E	

Since every B-group customer's utility is always no less than every A-group customer's utility, it's impossible

only to attract A-group customers through behavior policy and pricing decision. This is proved in Lemma 3.

Lemma 3 :

When “forbiddance” is the norm, the online interactive service provider cannot only attract A-group customers only through behavior policy and pricing decision.

Proof:

According to Table 2, it's obvious that under any policy the reservation price of B-group customers is always no smaller than the reservation price of A-group customers. Thus, no price exceeds the reservation price of B-group customers but at the same time not exceeds the reservation price of A-group customers. Lemma 3 is proved.

With Lemma 3 proved, the online interactive service provider should treat B-group customers as the main segment and try to serve them in the first priority.

Because the sizes (denoted by M , N) of two groups of customers and the capacity (denoted by C) of the online interactive service provider are relevant factors in decision-making, three scenarios incorporating the factors are presented in Table 3 and guide the following analysis.

Table 3 : The parameter settings in Section 3

Scenario 1	$N \geq C$ and $M + N \geq C$
Scenario 2	$N < C$ and $M + N \geq C$
Scenario 3	$N < C$ and $M + N < C$

3.1 Scenario 1 : $N \geq C$, $M + N \geq C$

In scenario 1, the capacity could be filled completely only by B-group customers. Thus, the online interactive service provider should adopt “allowance” policy to meet B-group customers’ preference and charge them a higher price.

Theorem 1 :

When “forbiddance” is the norm and $N \geq C$, the optimal policy is “allowance” and the optimal price is $P = S + E$.

Proof:

When “allowance” policy is adopted, the price can be set at $P = S + E$, which is the reservation price of B-group customers. The system could only attract B-group customers to completely fill the capacity. Thus, the revenues would be $C^*(S + E)$.

When “forbiddance” policy is adopted, the price can be set at $P = S$, which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to completely fill the capacity. Thus, the revenues would be C^*S .

For $C^*(S + E) > C^*S$, the optimal policy is “allowance” and the optimal price is $P = S + E$. Theorem 1 is proved.

The managerial implication of Theorem 1 is further discussed. When B-group customers alone can

completely fill the capacity, the online interactive service provider should only meet B-group customers’ preference and charges them a higher price for the policy they prefer.

3.2 Scenario 2 : $N < C$, $M + N \geq C$

In scenario 2, the capacity could *not* be filled completely by only B-group customers, but could be filled completely by two groups of customers. Thus, the online interactive service provider should set the price to balance the additional revenues from attracting A-group customers and the additional loss from lowering price to attract A-group customers.

Theorem 2.1

Under the setting “forbiddance” is the norm and $N < C$ and $M + N \geq C$. When $N > \frac{CS}{S + E}$, the optimal policy is “allowance” and the optimal price is $P = S + E$.

Theorem 2.2

Under the setting “forbiddance” is the norm and $N < C$ and $M + N \geq C$. When $N < \frac{CS}{S + E}$, the optimal policy is “forbiddance” and the optimal price is S .

Proof:

When “allowance” policy is adopted, the price can be set at $P = S + E$, which is the reservation price of B-group customers. The system could only attract B-group customers to fill part of the capacity. Thus, the revenues would be $N^*(S + E)$.

When “allowance” policy is adopted, the price can be set at $P = S - N^*N_n$, which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to completely fill the capacity. Thus, the revenues would be $C^*(S - N^*N_n)$.

When “forbiddance” policy is adopted, the price can be set at $P = S$, which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to completely fill the capacity. Thus, the revenues would be C^*S .

For $C^*S > C^*(S - N^*N_n)$, the optimal policy and pricing decision only depends on whether C^*S is larger than $N^*(S + E)$.

If $N > \frac{CS}{S + E}$, the optimal policy is “allowance” and the optimal price is $P = S + E$. Theorem 2.1 is proved.

If $N < \frac{CS}{S + E}$, the optimal policy is “forbiddance” and the optimal price is $P = S$. Theorem 2.2 is proved.

When the size (denoted by N) of B-group customers is smaller than the capacity (denoted by C), Theorem 2 may apply. The optimal policy and pricing decision could be judged by comparing the gain from attracting more customers (M of A-group customers) and the loss from

lowering price to attract the additional customers. When the gain is larger than the loss, it's optimal to set policy as “forbiddance” and set the price $P = S$ to attract both groups of customers. Otherwise, it's optimal to set policy as “allowance” and set the price $P = S + E$ only to attract B-group customers even the capacity is only partially filled.

3.3 Scenario 3 : $M < C, N < C, M + N < C$

In scenario 3, the size of the whole market is below the capacity. As a result, each group of customers cannot completely fill the capacity.

Theorem 3.1

Under the setting “forbiddance” is the norm and $M + N < C$. When $M*S < N*E$, the optimal policy is “allowance” and the optimal price is $P = S + E$.

Theorem 3.2

Under the setting “forbiddance” is the norm and $M + N < C$. When $M*S > N*E$, the optimal policy is “forbiddance” and the optimal price is $P = S$.

Proof:

When “allowance” policy is adopted, the price can be set at $P = S + E$, which is the reservation price of B-group customers. The system could only attract B-group customers to fill part of the capacity. Thus, the revenues would be $N*(S + E)$.

When “allowance” policy is adopted, the price can be set at $P = S - N*N_n$, which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to fill still only part of the capacity. Thus, the revenues would be $(M + N)*(S - N*N_n)$.

When “forbiddance” policy is adopted, the price can be set at $P = S$, which is the minimum of the reservation prices of both groups of customers, to attract both groups of customers to fill still only part of the capacity. Thus, the revenues would be $(M + N)*S$.

For $(M + N)*S > (M + N)*(S - N*N_n)$, the optimal policy and pricing decision only depends on whether $(M + N)*S$ is larger than $N*(S + E)$.

When $M*S < N*E$, the optimal policy is “allowance” and the optimal price is $P = S + E$. Theorem 3.1 is proved.

When $M*S > N*E$, the optimal policy is “forbiddance” and the optimal price is $P = S$. Theorem 3.2 is proved.

Theorems 3.1 and 3.2 have their managerial meaning. If the gain were larger than the loss, “allowance” policy would be optimal. Otherwise, “forbiddance” policy would be optimal.

The analytical result of Theorem 1~3.2 are combined to form Figure 2.

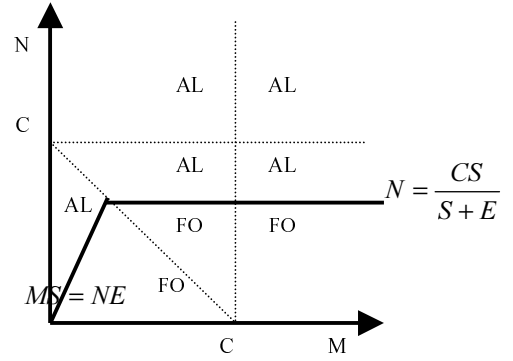


Figure 2 : The optimal policy when “forbiddance” policy is the norm

Comparing Figure 2 with Figure 1, it's surprising that the policy and pricing decision made by intuition could deviate from optimality when $M > C$ or $N < C$.

4. “Allowance” Policy is the Norm

In online games, online auctions, and online chat rooms, most service provider allow customers idle and not respond to others' inquiry. Every customer knows the norm and takes “allowance” policy as granted.

Now B-group customers treat “allowance” policy as the baseline and the right they own. Therefore, B-group customers' utility drops to $S - E$ facing “forbiddance” policy. Thus, B-group customers' utility is no less than A-group customers' utility facing “allowance” policy, but B-group customers' utility is less than A-group customers' utility facing “forbiddance” policy. The utility setting is tabularized as Table 4.

Table 4 : The utility settings in Section 4

Utility Policy Group	“Forbiddance” policy	“Allowance” policy	
		With B-group customers	Without B-group customers
A	S	$S - N*N_n$	S
B	$S - E$	S	

Five scenarios, which regard the relative sizes of M and N and C , are analyzed to find the optimal policy and pricing decision. Table 5 could illustrate the settings of five scenarios.

Table 5 : The parameter settings in Section 4

Scenario 1	$M \geq C, N \geq C, \text{ and } M + N \geq C$
Scenario 2	$M \geq C, N < C, \text{ and } M + N \geq C$
Scenario 3	$M < C, N \geq C, \text{ and } M + N \geq C$
Scenario 4	$M < C, N < C, \text{ and } M + N \geq C$
Scenario 5	$M < C, N < C, \text{ and } M + N < C$

4.1 Scenario 1 : $M \geq C, N \geq C, M + N \geq C$

In scenario 1, each group of customers alone can fill the capacity completely. Both “forbiddance” and “allowance” policy are optimal.

Theorem 4

When “allowance” policy is the norm and $M \geq C$ and $N \geq C$, both “allowance” and “forbiddance” policies are optimal and the optimal price is $P = S$.

Proof:

The proof of Theorem 4 is similar to the proofs in Section 3.

According to Theorem 4, targeting on each group of customers could reach the optimality when each group alone can completely fill the capacity.

4.2 Scenario 2 : $M \geq C, N < C, M + N \geq C$

In scenario 2, A-group customers alone can completely fill the capacity. The optimal policy is “forbiddance” and the optimal price is $P = S$.

Theorem 5

When “allowance” policy is the norm and $M \geq C$ and $N < C$, the optimal policy is “forbiddance” and the optimal price is $P = S$.

The proof of Theorem 5 is similar to the proofs in Section 3.

Further, the implication of Theorem 5 is discussed. When A-group customers alone can completely fill the capacity, it’s optimal to adopt “forbiddance” policy and set the price $P = S$. That is, focusing on A-group customers could generate the maximal revenues.

4.3 Scenario 3 : $M < C, N \geq C, M + N \geq C$

In scenario 3, B-group customers alone can completely fill the capacity. The optimal policy is “allowance” and the optimal price is $P = S$. The argument is proved in Theorem 6.

Theorem 6

When “allowance” policy is the norm and $M < C$ and $N \geq C$, the optimal policy is “allowance” and the optimal price is $P = S$.

The proof of Theorem 6 is similar to the proofs in Section 3.

According to Theorem 6, it’s optimal to set policy as “allowance” and set price as $P = S$ to focus on B-group customers when only B-group customers can completely fill the capacity.

4.4 Scenario 4 : $M < C, N < C, M + N \geq C$

In scenario 4, each group of customers can only fill part of the capacity. Both groups of customer can completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 6.

Table 6 : The policy and pricing decisions and their corresponding revenues in scenario 4 in Section 4

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S$	$N * S$
2	Allowance	$P = S - N * N_n$	$C * (S - N * N_n)$

3	Forbiddance	$P = S$	$M * S$
4	Forbiddance	$P = (S - E)$	$C * (S - E)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

4.5 Scenario 5 : $M < C, N < C, M + N < C$

In scenario 5, each group of customers can only fill part of the capacity. Even both groups of customers cannot completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 7.

Table 7 : The policy and pricing decisions and their corresponding revenues in scenario 5 in Section 4

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S$	$N * S$
2	Allowance	$P = S - N * N_n$	$(M + N) * (S - N * N_n)$
3	Forbiddance	$P = S$	$M * S$
4	Forbiddance	$P = (S - E)$	$(M + N) * (S - E)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

Theorem 7.1

Under the setting allowance is the norm and $M < C$ and $N < C$. When $N > M$ and $N < \frac{E}{N_n}$, the optimal policy is “allowance”.

Theorem 7.2

Under the setting allowance is the norm and $M < C$ and $N < C$. When $N < M$ and $N > \frac{E}{N_n}$, the optimal policy is “forbiddance”.

The proofs of Theorems 7.1 and 7.2 are similar to the proofs in Section 3.

The analytical result of Theorem 4~7.2 are combined to form Figure 3.

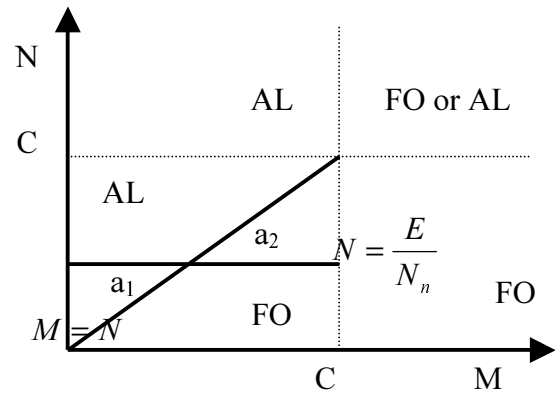


Figure 3 : The optimal policy when “allowance” policy is the norm

It's interesting that intuition applies well in most cases except the two areas: a_1 and a_2 in Figure 3; e.g. in area a_1 , "forbiddance" policy is optimal when $(M+N)*(S-E) > N*S$. The case is contradictory to intuition.

When "allowance" policy is the norm, the intuition (see Figure 1) applies well in most cases. However, the possibility of misjudgment of policy and pricing decision still exists when $M < C$ and $N < C$.

5. "Forbiddance" Policy is Partially Expected (Generalization of 3. and 4.)

Some customers may seek others' personal data in their interest. In online games, online auctions, and online chat rooms, some service providers forbid the behavior and others allow that. Thus, customers take neither "forbiddance" nor "allowance" policy as granted. This reality in practice is called "partially expected" in this paper.

B-group customers facing "allowance" policy would feel better to be allowed to do the behavior they love. In the model, B-group customers' utility would raise (denoted by e_1) when B-group customers face "allowance" policy.

On the other hand, B-group customers facing "forbiddance" policy would feel somehow disappointed to be forbidden to do the behavior they love. In the model, B-group customers' utility would drop (denoted by e_2) when B-group customers face "forbiddance" policy.

The value of e_1+e_2 is assumed to be equal to E for the same utility due to the same behavior.

Section 3 is a special case of Section 5 by setting $e_1 = E$ and $e_2 = 0$. Also, the Section 4 is another special case of Section 5 by setting $e_1 = 0$ and $e_2 = E$. Thus, Section 5 is the generalization of Section 3 and 4. Those are shown in Table 8.

Table 8 : The utility settings in Section 5.

Utility Group	Policy	"Forbiddance" policy	"Allowance" policy	
			With B-group customers	Without B-group customers
A		S	$S - N*N_n$	S
B		$S - e_2$	$S + e_1$	

Five scenarios, which regard the relative sizes of M and N and C , are analyzed to find the optimal policy and pricing decision. Table 9 could illustrate the settings of five scenarios.

Table 9 : The parameter settings in Section 5

Scenario 1	$M \geq C, N \geq C, \text{ and } M + N \geq C$
Scenario 2	$M \geq C, N < C, \text{ and } M + N \geq C$
Scenario 3	$M < C, N \geq C, \text{ and } M + N \geq C$
Scenario 4	$M < C, N < C, \text{ and } M + N \geq C$
Scenario 5	$M < C, N < C, \text{ and } M + N < C$

5.1 Scenario 1 : $M \geq C, N \geq C, M + N \geq C$

In scenario 1, each group of customers alone can completely fill the capacity. It's optimal to adopt "allowance" policy to attract B-group customers and set price at $P = S + e_1$.

Theorem 8

When "forbiddance" is partially expected and $M \geq C$ and $N \geq C$, the optimal policy is "allowance" and the optimal price is $P = S + e_1$.

The proof of Theorem 8 is similar to the proofs in Section 3.

Further, the implication of Theorem 8 is discussed. Although meeting preference of either group of customers could completely fill the capacity, it's optimal to meet B-group customers' preference for their high utility perceived ($S + e_1 > S$).

5.2 Scenario 2 : $M \geq C, N < C, M + N \geq C$

In scenario 2, A-group customers alone can completely fill the capacity.

Theorem 9.1

Under the setting "forbiddance" is partially expected and $M \geq C$ and $N < C$. When $N > \frac{CS}{S + e_1}$, the optimal policy is "allowance" and the optimal price is $P = S + e_1$.

Theorem 9.2

Under the setting "forbiddance" is partially expected and $M \geq C$ and $N < C$. When $N < \frac{CS}{S + e_1}$, the optimal policy is "forbiddance" and the optimal price is $P = S$.

The proofs of Theorems 9.1 and 9.2 are similar to the proofs in Section 3.

Theorems 9.1 and 9.2 could be applied in situations that market is divided into a high-end segment with fewer customers and a low-end segment with more customers. In such situations, only attracting one group of the two groups of customers is optimal by serving the high-end segment and charging them a higher price or serving the low-end segment and charging them a lower price. It's worthy to pay attention that the model applies most when the high-end customers would do some annoying behavior to reduce low-end customers' utility.

5.3 Scenario 3 : $M < C, N \geq C, M + N \geq C$

In scenario 3, B-group customers alone can completely fill the capacity.

Theorem 10

When "forbiddance" is partially expected and $M < C$ and $N \geq C$, the optimal policy is "allowance" and the optimal price is $P = S + e_1$.

The proof of Theorem 10 is similar to the proofs in Section 3.

5.4 Scenario 4 : $M < C, N < C, M + N \geq C$

In scenario 4, each group of customers alone can only fill part of the capacity. Both groups of customers can completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 10.

Table 10 : The policy and pricing decisions and their corresponding revenues in scenario 4 in Section 5

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S + e_1$	$N^*(S + e_1)$
2	Allowance	$P = S - N^*N_n$	$C^*(S - N^*N_n)$
3	Forbiddance	$P = S$	M^*S
4	Forbiddance	$P = S - e_2$	$C^*(S - e_2)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

5.5 Scenario 5 : $M < C, N < C, M + N < C$

In scenario 5, each group of customers alone can only fill part of the capacity. Even both groups of customers cannot completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 11.

Table 11 : The policy and pricing decisions and their corresponding revenues in scenario 5 in Section 5

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S + e_1$	$N^*(S + e_1)$
2	Allowance	$P = S - N^*N_n$	$(M + N)^*(S - N^*N_n)$
3	Forbiddance	$P = S$	M^*S
4	Forbiddance	$P = S - e_2$	$(M + N)^*(S - e_2)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

Theorem 11.1

Under the setting forbiddance is partially expected and $M < C$ and $N < C$. When $N > \frac{MS}{S + e_1}$ and

$N < \frac{e_2}{N_n}$, the optimal policy is “allowance”.

Theorem 11.2

Under the setting forbiddance is partially expected and $M < C$ and $N < C$. When $N < \frac{MS}{S + e_1}$ and

$N > \frac{e_2}{N_n}$, the optimal policy is “forbiddance”.

The proofs of Theorems 11.1 and 11.2 are similar to the proofs in Section 3.

The analytical result of Theorem 8~11.2 are combined to form Figure 4.

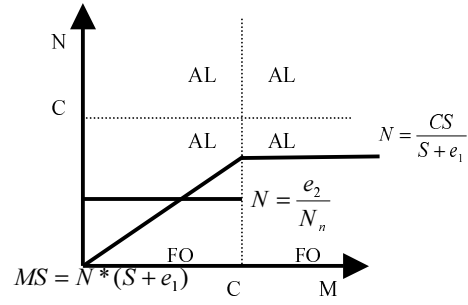


Figure 4 : The optimal policy when forbiddance policy is partially expected

It's surprising that the policy and pricing decision made by intuition (Figure 1) could deviate from optimality when $M > C$ and $N < C$. Besides, “allowance” policy could be optimal even when the externality-hating segment (denoted by M) is larger than the externality-loving segment (denoted by N) and the capacity (denoted by C).

6. Conclusion

When customers in reality are of two distinct groups with opposite preferences, following the intuition (Figure 1) to accommodate the majority may not guide the decision toward optimality. By comparing Figure 1 with Figure 2, 3,4 we know that intuition applies well only in limited situations.

This paper improves policy and pricing decisions and presents three decision support figures (Figure 2, 3, 4). It's convenient to judge the optimal policy (to allow or to forbid) and corresponding optimal price with the three figures when parameters' values are known.

The results contradict to some intuitions. First, intuition may tell us that negative externality is harmful to customers' utility and service provider's revenues. Thus, it is favorable to eliminate the externality. In this paper, “forbiddance” policy that eliminates the annoying behavior is not always optimal. When the externality-loving segment is large enough, it's optimal to adopt “allowance” policy to delight this segment.

Second, intuition may tell us meeting the preference of the majority of customers brings the most revenues. In this paper, the intuition may guide to the wrong way especially when “forbiddance” policy is the norm.

This paper conforms to recent empirical researches and also manifests its uniqueness. [12] pointed out that externality caused by customers' behavior is related with situation context (“allowance” policy or “forbiddance” policy). The paper is a trial to incorporate Martin's opinion into model analysis. This paper bases on “customer-centric” concept [15] to analyze the influence of service policy on customers' utility. The presented model includes conflicting attributes (opposite preferences) as [3] and addresses the importance to understand customers' characteristics and needs as [6].

There are some future research possibilities. First, the model can be extended to the two online interactive service providers' case and the game theory would apply to offer more insights of the issue in competitions.

Second, the assumption that A-group customers all know the choice behavior of B-group customers can be relaxed to see the effects of imperfect information.

Appendix

Appendix is available from the authors if readers are interested.

Reference

- [1] Bensaid, B. & Lesne, J.-P. "Dynamic monopoly pricing with network externalities," *Intern. J. of Ind. Organ.*, 1996,14(6),837-855.
- [2] Cabral, L.M.B. & Salant, D.J. & Woroch, G.A. "Monopoly pricing with network externalities," *Intern. J. of Ind. Organ.*, 1999,17(2),199-214.
- [3] Chen, C. "Designing for the environment: A quality-based model for green product development," *Management Sci.*, 2001,47(2),250-263.
- [4] Chiang, D.M. & Teng, D.C. "Network externalities between two groups of customers," *NTU Management Rev.*, 2001,12(1),1-36.
- [5] Farrell, J. & Saloner, G. "Standardization, compatibility, and innovation," *Rand J. of Econ.*, 1985,16(1),70-83.
- [6] Freytag, P.V. & Clarke, A.H. "Business to business market segmentation," *Ind. Marketing Management*, 2001,30(6), 473-486.
- [7] Johnson, M.D. "Modeling choice strategies for noncomparable alternatives," *Marketing Sci.*, 1986,5(1), 37-54.
- [8] Katz, E. & Spiegel, U. "Negative intergroup externalities and market demand," *Economica*, 1996,63(251),513-520.
- [9] Katz, M.L. & Shapiro, C. "Network externalities, competition, and compatibility," *Am. Econ. Rev.*, 1985,75,424-440.
- [10] Kotler P. & Leong, S.M. & Ang, S.H. & Tan, C.T. *Marketing management: An asian perspective*. Prentice Hall. 1996.
- [11] Kurtz, D.L. & Clow, KE. *Service marketing*. John Wiley & Sons. 1998.
- [12] Martin, C.L. "Consumer-to-consumer relationships: Satisfaction with other consumers' public behavior," *J. of Consumer Affairs*, 1996,30(1),146-169.
- [13] McFadden, D. "Choice theory approach to market research," *Marketing Sci.*, 1986,5(4),275-297.
- [14] Riggins, F.J. & Kriebel, C.H. & Mukhopadhyay, T. "The growth of interorganizational systems in the presence of network externalities," *Management Sci.*, 1994,40(8),984-998.
- [15] Sheth, J.N. & Sidodia, R.S. & Sharma, A. "The antecedents and consequences of customer-centric marketing," *J. of the Academy of Marketing Sci.*, 2000,28(1),55-66.
- [16] Westland, J.C. "Congestion and network externalities in the short run pricing of information system online interactive services," *Management Sci.*, 1992,38(7),992-1009.
- [17] Zeithaml, V.A. & Berry, L.L. & Parasuraman, A. "The nature and determinants of customer expectations of online interactive services," *J. of the Academy of Marketing Sci.*, 1993,21,1-12.