An Economic Theory of Customer Complaint Management[1]

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Abstract

We develop a multiple-sender-receiver model with voluntary participation decision to address the salient features of customer complaint management in practice, i.e., low complaint/dissatisfaction ratio, little correlation between complaint and objective failure, and a variety of responsive mechanism. The privately informed customers choose among costly complain, keep quiet, and exit, and the revenue-maximization firm chooses whether to undertake corrective action as response to the action profile of consumers. We study the Bayesian-Nash equilibrium of this game, and compare two specific mechanisms: active and passive responsive mechanisms. It's shown that the fully-revealing equilibrium occurs only when the complaining barrier is moderate. Because the optimal mechanism is not robust, and suboptimal robust mechanism is featured by less informative partial revealing equilibrium, the observed low complaint/dissatisfaction ratio arises as one equilibrium outcome. We identify firm's reputation, the variant of quality, and competitive environment as the determinants of firm's preferred mechanism. It's found out that firm, in particular low reputation firm, would set socially excessive complaining barrier, hence the legal intervene on complaint handling procedure to some extent is justified. Moreover, we assess the dual role of competition pressure on complaint management, and using evolutionary game theory to evaluate current popular business strategy.

Key Words: Strategic information transmission, Customer Complaint, Defensive Marketing Strategy, Consumer's expectation

1 Introduction

Complaining from dissatisfied consumers is considered as an indispensable tool to learn the Voice of the Customer and becomes increasingly important in many business contexts (Crask et al, 1995). Indeed, most services firms including airlines, wireless phone, medical services and financial services set various formal procedures to handle the users complaints. Therefore, marketing researchers refer to consumer complaint management as an important part of defensive marketing strategy (Fornell and Wernerfelt, 1987, 1988) which aims at customer retention by pleasing them[1], in contrast with the offensive marketing strategy that focus on generating new customers.

Despite its practical importance and some interesting features, the economic theory of complaint management is quite incomplete. Marketing researchers connect complaining behavior with consumer expectation and product's realized quality, and suggest that the complaints provide firms with valuable way to learn the true quality of products and services, as well as customers dissatisfaction[2], thus may serve as "early warning signal" (Fornell, 2007). However, this information view of customer complaints suffers from two problem. On the one hand, due to the subjective nature of consumers satisfaction, theory predicts that misrepresentation problem, in particular, exaggerations, would prevail and affect information extraction. This is confirmed by many empirical evidences that there are small correlations between customer dissatisfaction or product/service failure and complaints (Bearden and Teel, 1983, Halstead et al, 1996). On the other hand, some damages occurring may hardly be the fault of firm, such as the inevitable random errors in production line, exogenous factors like climate or traffic jam, or just heterogeneous perception of customer, the firm needs "sufficient" communication to justify the costly corrective action. Nevertheless, although almost every firm claims to facilitate voicing of complaints, various barriers to complaining exist across industries[3], substantive cost to make formal complaints

[1] It's well-recognized among marketing researchers that keeping a current customer is much cheaper, thus much more profitable, than obtain a new customer. According to a official report issued by U. S. government, the profit ratio on average is as large as 5 to 1 (TARP, 1979)

[2] For example, Crask et al (1995) summarize that the substantial variability and non-durability of service quality make the feedback from customers almost the only criterion to assess service quality. And the classical marketing textbook (Kotler et al, 1999) cite many examples that complaint stirs innovation. Fornell (2007) addresses the role of complaint in customer-company relationship.

[3] According to ACSI (American Customer Satisfaction Index) data, hospitals, life insurance, and airlines are on the worst extreme of treating complaints, while supermarket does good job.

and provide stringent burden of proofs incurs on clients. Moreover, many corrective actions, like system update, reliability improvement, reducing waiting time, and better service attitude, to a large extent is public good (Fornell and Wernerfelt, 1988)[4]. Hence it's not surprising that in real world the majority of dissatisfied customers don't complain to the business at all[5]. Furthermore, in most contexts the dissatisfied clients have outside option, thus why don't those dissatisfied customer *vote with their feet* directly, rather than voluntarily informing the management about their feelings[6]? Therefore increasing investigation makes clear that there are huge inconsistencies between maximizing customers dissatisfaction as firms claim, and the real practice to handle customer complaints[7].

In this paper we address these salient features in a signaling game model in which the firm is restricted to treat all customers equally, i. e., neither discrimination nor private reward toward complainer is allowed, and the customer could decide whether to shift brand after receiving private signal, and highlight the design of optimal responsive mechanism with respect to the clients' actions. Our work is built on the basis of the paradigm of Exit-Voice by Albert Hirschman (1970)[8], and it relates to an important aspect in economy: how to use voice and exit to influence the organizations? We show that our model, though highly simplified, could generate many results consistent with stylized facts about customer complaint management, and provide new insights regarding the efficiency of the current practice.

We consider the game between two customers and a firm. The profit-

[4]According to the monthly report from U.S. Department of Transportation, the most common complaint problems are flight problem, boarding, customer services. The most common complaints to Dell call centers are long waiting time (Fornell, 2007). Obviously, the corrective action on this regard would benefit every customer, regardless whether he has complained

[5]Kotler et al (1999) claim that only about 5% dissatisfied customers tell the company their problem.

[6]Analogue to the insight from Palfrey and Rosenthal (1984), we must confront not only strategic revelation, but also strategic behavior with regard to participatio

[7]In a recent vivid account "The Case for Turning Customer Delight into Disgust", *Financial Times*, Aug 24, 2008, the columnist Lucy Kellaway summarizes the relationship between company and a single customer in one sentence " The company (easyjet) has destroyed my goodwill, but my goodwill doesn't matter". It's found that ACSI scores, the indicator of customer satisfacation, has little relationship with stock market performance of that firm.

[8]This paradigm has already generated numerous applications on marketing, political science, sociology, public administration, and industrial relations. However, to the best of our knowledge, our work is the first theoretical attempt to understand the dissatisfied customers incentive and strategy, and characterize the optimal organizational strategy as response to clients' action.

maximization product/service producer doesn't know the satisfaction of consumers, which is a noisy signal about the realized quality of service. At the outset of the game she moves first by announcing the responsive mechanism (which prescribes under what contexts corrective action would be undertaken, and the barrier to complain). Taking the responsive mechanism as given, the privately informed customers simultaneously choose among exit, complain, and silence. The symmetric Bayesian-Nash equilibrium of the game between customers under particular mechanism is highlighted. Rather than applying revelation principle directly, compare two specific mechanisms, which generalize the system in practice, as functions with respect to the actions of clients. The first one is active responsive mechanism, which is characterized by that even single complaint suffices to convince firm to undertake corrective action, thus the firm could retain customers on the expense of possible high adjustment expenditure. The other one is passive responsive mechanism, which prescribes that improvement is implemented only when both customers complain. Therefore the cost of corrective action is reduced, but the dissatisfied users may reluctant to complain and the risk to lose customer increases. The trade-off between the risk to lose customers (information extraction) and the expenditure on frequent corrective action (information aggregation) underlies the choice of decision rule.

Our interests concentrate on the optimal responsive mechanism, and focus on the relationships between the efficiency and the revenue maximization. We found that the likelihood to have complain monotonically increases with respect to complain barrier. Thus modest complaint barrier is necessary for the firm to learn the truth. Since the firm doesn't want to undertake costly corrective action too frequently, the optimal decision rule prescribes corrective action only when two complaints are heard, thus she prefers passive responsive mechanism. However, the game-form of this mechanism is a coordination game, thus multiple equilibrium arises, and since *ex ante* participation constraint differs from interim participation constraint, this mechanism is sensitive to market competition. Therefore the first-best mechanism is not robust, and the firm may turn to suboptimal active responsive mechanism. Under this mechanism the optimal complaint barrier is higher than the efficient level, and separating equilibrium is not in the interest of firm, thus the observed tendency that most dissatisfied consumers never complain may be one equilibrium outcome of the discretion of the firm. Moreover, the optimal mechanism varies according to firm-specific characteristics (firm reputation), industrial characteristics (variants of quality) and competitive environment. Therefore, our results also shed light on a variety of complaint responsive mechanism in practices. We further explore the welfare implication of those mechanism, demonstrate that firm is likely to set exces-

sive complaining barrier, thus provide justification for the public intervene in complaint handling procedure. Then we address the dual role of competition in complaint management. Hirschman (1970) suggests the possible negative role of competition in inducing performance improvement, and we show that competition pressure matters via two ways: on one hand increasing competition pressure affects decision rule selection by forcing the firm to select inefficient robust complaint management system, on the other hand it limits complain barrier under suboptimal mechanism. It's ambiguous to assert which effect dominates. Hirschman's view could be partly justified since under optimal mechanism interim participation constraint differs from ex ante participation constraint, dissatisfied customers could find out close substitute easily in the presence of severe competition, consequently they lack the motivation to make costly complaint.

This research also nest two main views about complaint management strategies in marketing practice. Many organizations aims at minimize complaints (TARP, 1986), while Fornell (2007) strongly suggests that firm should encourage dissatisfied customer to complain to extract more information from customers. In our framework these two strategies correspond two possible mechanism choices in equilibrium, and Fornell's advice indeed implies the switch from mixed-strategy equilibrium under active responsive mechanism to fully-revealing equilibrium under passive responsive mechanism, which is also Pareto-dominance equilibrium. However, we demonstrate that this shift needs the mutual cooperation between customers and firm.

Broadly, our model also reminds the decision maker to be cautious toward statistical results from any sample consisted of self-selected senders. Particularly, we cannot interpret no news as good news or bad news, without knowledge about the fine details which determine the incentive to report. Hence very few voices may represent much and is worthy of the attentions of the administrator to re-evaluate the true state. On the other hand, if complaint is quite cheap, like the internet poll, or the feedback for the service of online seller, then the information content of these feedback diminishes, since only the readers who dislike it most may have the strongest incentives or feeling to express the views[9]. Since methodologically our model could be seen as providing a micro-foundation for Exit-Voice Theory, it could be extended to many non-business fields, like the handling of the voice of minority, the information extraction from dissents, and so on.

[9] As indirect empirical evidence, Klein et al (2006) address the strategic motivation to leave feedback on eBay.

1.1 Some features of complaint management

As Fornell and Wernerfelt (1988) suggest, complaint management is much more general than warranties and guarantees. In their summary, complaint management typically applies to all customers, rather than a subset of clients; and it's closely related to the efforts on quality improvement. Moreover, "effort to facilitate voicing of complaints" is a crucial part of complaint management. It's also widely recognized that customer complaint mainly is driven by failing expectation, thus both expectations and quality realization are essences. These features motivate the basic ingredients of our model, such as the corrective action as public good, and the key role of complaining barrier set-up as policy choice.

The following stylized facts about complaint behavior are concerns of our work.

First, it's well-established that only minority of dissatisfied customers complain directly to the service provider, though the percentage varies by industry and type of problem(TARP, 1996). And a famous marketing textbook even asserts that as much as 95% of dissatisfied customers never tell the company their problem (Kotler et al 1999). Hence, it suggests that not complaining is more likely a part of equilibrium behavior, rather than abnormal action.

Second, since most customer complaints are unsolicited (Richins and Verhage, 1985), economic theory may suggest because of the possible misreport problem, complaint is not a perfect indicator of service quality. This is confirmed by various researches. For instance, Snellman and Vihtkari (2003) illustrate that the most frequent complainers are those who actually consider themselves guilty for the outcome. Doerpinghaus (1991) suggests that disappointed expectations, rather than poor service quality, may result in complaints. And it's recognized that complaint frequency is not significantly related to the dissatisfaction (Andreasen, 1977; Bearden and Teel, 1983). Even worse, Halstead et al (1996) found that poor performance in one service area may predispose the complainers to negatively evaluate and complain other service areas or attributes. Hence consistent with the finding by TARP (1979), customer satisfaction may not reflect the service quality or customer satisfaction.

Finally, despite the claims made by many firm that complaining is encouraged, substantive barriers exist. TARP (1979) identifies time and effort involved, ignorance about how to complain, and uncertainty about redress after complaints as the primary sources of cost. Moreover, complaining barrier, consequently complain behavior, varies considerably across countries, industries, even firms. Many surveys since Richins and Verhage (1985) have

established that dissatisfied customers from some specific countries are significantly less likely to complain, thus culture background may matter. TARP (1986) demonstrates that complaint/dissatisfaction ratio varies significantly across industries, in which tourist and luxury products have higher ratio, and consumer products has the lowest one. Fornell (2007) identifies hospitals, life insurance, airlines and health insurance as the worst ones in complaints handling, while supermarkets and automobile work well. Even the firms in the same industry have quite different complaint handling practices. For example, Ryanair, the leading low-cost airline in Europe, is (in)famous for its bad attitude toward complaints and obstruct procedure to complain[10]. On the other hand, Southwest Airlines, the low-cost airline in U.S., maintain the lowest complaint rate and very high customers' satisfaction[11].

1.2 Related Literature

In most mechanism design and implementing literature the individual rationality problem is solved by assigning allocation to each customer. This modeling strategy could not be applied in mechanism design with respect to complaints straightforwardly, because in many cases the divisible private good which can be freely redistributed doesn't exist, or it's too expensive to be provided. In other words, our environment is not "economic" in terms of Moore and Repullo (1988). The absence of monetary transfer differentiates our work from the study on the private provision of public good initiated from Palfrey and Rosenthal (1984).

Fornell and Wernerfelt (1987, 1988) provide a theory about customer complaint behavior, on the basis of Exit-Voice paradigm. However, their works assume that a fixed ratio of consumer will complain, thus in effect ignore the incentives of individual consumer. To reconcile the inconsistency between the efficiency of handling customer complaint and the practice of prevalent inappropriately dealing, Homburg and Furst (2007) resort to psychological and organizational theory. To the best of our knowledge, Prendergast (2002) is the only game-theoretic work on customer complaints. His paper considers complaints as a way to solve agency problem, since the clients could figure out the mistakes in agent's decision to the firm. Hence customer serves as a monitor, and his focus is on the possible collusion between customer and

[10]The customers could not find out any email address or telephone number to consult service. Any complaints have to be faxed to the headquarter of airlines in Ireland in order to be considered.

[11]According to the monthly Air Travel Consumer Report issued by U.S. Department of Transportation, Southwest ranks consistently best on Complaints per 100,000 enplanements.

agent. Alternatively, we take this divergence in interests as given and analyze the design of optimal responsive mechanism, without any involvement of agency problem, and our interest concentrates on the trade-off between efficiency and revenue maximization.

This work is linked to the emerging works on costly voting, where the number of votes is not fixed since citizens could voluntarily choose whether to participate voting (Myerson, 2000, Piketty, 2000, Borgers, 2004, Krishna and Morgan, 2008). Our work contributes to these literatures by explicit formulating "voting with feet", an alternative to influence the policy maker which could be traced to Charles Tiebout (1956).

Our paper connects to the huge literatures on strategic information transmission (Crawford and Sobel, 1982, Persico, 2004, Battaglini, 2004). In particular, two recent papers exemplify the exaggerations incentive in the contexts of multiple senders. Morgan and Stoken (2008) study the information value of poll, where only binary message is available. They show that the fully-revealing equilibrium is impossible to be achieved as the number of agents becomes large, since the individual incentive to exaggerate increases. In a variation of Crawford and Sobel's cheap talk model where the decision maker maximizes aggregate welfare, Kawamura (2008) address public good provision. He also shows the impossibility of fully-revealing equilibrium because of exaggeration problem and gives credit to the binary message as robust communication mode. But customer complaint differs from these communication problem in that the payoff of firm depends directly on the action of customers, i.e., whether those customers choose to continue buying, even in the limit case of cheap talk, due to the fact that voluntary participation is crucial. Besides, we also take participation problem into account, which distinguishes our work from all previous works. Moreover, since in model and reality the firm has some control on the complaining barrier, communication cost is also a strategic choice, in contrast with the uniformly absence of communication cost in cheap talk literature.

Klemperer (1995) and Farrell and Klemperer (2007) demonstrate the importance of the formation of consumers expectation in the context characterized by switching costs and network effects, which is shared here. But their focus are mainly on price setting and the choice of switching cost, while our work could be considered as a complementary in the sense that we address quality choice and responsive mechanism design in the presence of expiring outside option. Actually, though researchers in industrial organization have studied extensively on offensive marketing strategy such as promotion, pricing, and advertisement, very little attention is paid to those defensive strategies without monetary transfer. We hope our work could be seen as a first step to understanding this important marketing strategy in terms of

economic reasoning.

1.3 Structure of this work

Section 2 lays out our model, explores the benchmark case that the responsive mechanism is in the absence, and describes some restrictions on parameters. Section 3 investigates the equilibrium properties under active and passive responsive policies. In Section 4 we compare the efficiency and profit under these two responsive mechanisms, highlights some comparative statics and the role of competition in mechanism choice, and discuss some relaxation of our assumptions. Section 5 concludes and suggests research agenda.

2 Preliminary

2.1 The environment

There are one firm, two *ex ante* identical customer in our model. There are two periods $t = 1, 2$, the state space in each period is $\theta_t \in \{B, G\}$, where G stands for good state and B denotes bad state. In the first period, each customer draws a private informative signal or *information type* $s_i \in \{B, G\}$ $(i = 1; 2)$ regarding the initial state of world. $s_i = B$ is unfavorable signal, while $s_i = G$ represents favorable signal, which could be interpreted as dissatisfied and satisfied customer, respectively. Therefore, the signal space includes four possible events $\{BB, BG, GB, GG\}$.

Upon learning their signals, the customers choose among $E(xit), C(omplaint)$, and $K(eep\ silence)$. Complaining incurs communication cost D, which is set by the firm. There is a decreasing outside option for exit, which generates payoff $\omega \in (0, 1)$ if exit in the first period, and shrinks to ξ (a small positive number) in the second period[12]. In the second period all non-exit customers (*attached* customers) observe the true state θ_2 perfectly, Thus if $\theta_2 = G$, attached customers stay, realize payoff θ_2, and become *lock-in*. Otherwise they exit and get ϵ.

The firm could incur F to undertake corrective action to ensure that the true state is good i.e., $\theta_2 = G$. If no corrective action is undertaken, the status quo remains, so $\theta_2 = \theta_1$. To concentrate on the issue of interest, it's assumed that the revenue of firm is defined exclusively on the value of every lock-in customer, V, thus maintaining *customer base* is key to the success

[12] Alternatively, this decreasing outside option could be interpreted as switching cost.

of firm. Therefore, the first period could be thought as introductory phase, which generates negligible revenue compare with consumers' future purchase behavior.

The timing of this game is the following. At time 0 nature chooses θ_1 and the firm announces the responsive policy g that associates an outcome with every action profile of customers, and a communication cost D imposed on every complaint. In period 1 each customer observes the signal s_i, chooses from $A_i = \{E, C, K\}$ independently. The firm observes the action of customer, and decides whether to undertake corrective action in accordance with the committed policy g. At period 2 the true state is learnt by everyone, and customer chooses to be lock-in or exit.

2.2 Information structure

Both firm and customer have the common prior about the initial state of the world $\Pr(\theta_1 = G) = p$, which has the natural interpretion as customer expectation or firm's reputation. The signal is informative in the sense that

$$\Pr(s_i = k \,|\theta_i = k) = q > \tfrac{1}{2}, \text{ for all k=G, B}$$

As we demonstrate above, customers act when they draw the private signal, thus we are concerned the interim stage. From now on we will use the following notations to simplify our analysis.

For dissatisfied customer, he will speculate the event and adjust the belief, thus he prescribes $\underline{u} = \Pr(\theta_1 = G \,|s_1 = s_2 = B)$ if event BB occurs, and $u = \Pr(\theta_1 = G \,|s_1 \neq s_2)$ if event GB happens. The satisfied customer expects $\overline{u} = \Pr(\theta_1 = G \,|s_1 = s_2 = G)$ in event GG, and u in event BG.

However, no customer knows the other's signal when taking action, hence he has only probability estimate on which event occurs. He has to infer both the likelihood of true state and the signal of the other side exclusively based on his own signal. We denote $\gamma_{s_{-i},s_i} = \Pr(s_{-i} \,|s_i)$ as customer i's perceived probability that the opponent receives s_{-i}, conditional on his own signal. We lay out those conditional probabilities as following:

$$\begin{aligned}
\gamma_{BB} &= \tfrac{(1-p)(1-q)^2+pq^2}{(1-p)(1-q)+pq} \\
\gamma_{GB} &= \tfrac{q(1-q)}{(1-p)(1-q)+pq} \\
\gamma_{BG} &= \tfrac{q(1-q)}{(1-p)q+p(1-q)} \\
\gamma_{GG} &= \tfrac{(1-p)q^2+p(1-q)^2}{(1-p)q+p(1-q)}
\end{aligned}$$

The belief system thus is the following:

s	B	G
B	$\underline{u},\underline{u}$	u,u
G	u,u	$\overline{u},\overline{u}$

Figure 1a

	B	G
B	γ_{BB}	γ_{GB}
G	γ_{BG}	γ_{GG}

Figure 1b

	B	G
B	γ_{BB}	γ_{BG}
B	γ_{GB}	γ_{GG}

Figure 1c

Figure 1a shows the perception about θ_1. The belief system with four events, BB, GB, BG, GG, with each player's belief *in* each event, is depicted in Figure 1b and 1c. For instance, though the row player could not tell BB from GB, he assigns probability γ_{BB} and γ_{GB}, respectively, which corresponds to expected payoff $\underline{u}$ and u. The column player is similar.

2.3 Policy and equilibrium

For the firm, she doesn't want to undertake costly corrective action too frequently. Thus she has to make inference about signal event based on consumers' actions. On the other hand, her responsive policy affects the incentives of customers. To avoid credibility problem of commitment, first we impose the following condition about corrective cost to make sure that the firm has some incentives to fulfill her promise, and no ex ante incentive to change.

Condition 1 $2pV < F < 2\left(1-\underline{u}\right)V$

The first inequality guarantees the informational value of complaints. Otherwise, the firm would undertake corrective action at time 0 and ensure $2V - F$, which exceeds *ex ante* expected profit $2\left(1-p\right)V$. The second inequality emphasizes that firm should undertake corrective action in some events. Otherwise, even if the firm could directly observe the customers' signals and the worst event BB happens, she won't act since the expected profit $2\underline{u}V$ still exceeds that under corrective action. An further implication of these conditions is that the firm's optimal outcome function is to undertake corrective action only in event BB, thus the ideal of firm is implicitly defined.

The information available to the firm are two numbers, the number of complaint received, and the number of exits. We restrict attention to monotonic outcome correspondence g in the sense that if the firm undertakes corrective action whenever the tuple observed exceeds a threshold level. In literal words, if a single voice convinces the firm to change, so do two voices or one voice plus one exit.

This policy implies anonymity, thus the firm could not discriminate customers. The optimal responsive policy which maximizes profit of firm should

guarantee that no customer is willing to leave, hence only actions C and K are used under this policy. The profit under policy g could be expressed as

$$\pi_g = (1 - \Pr(\theta_2 = 0))\, 2V - \Pr(\text{corrective action})\, F$$

The firm wants to maximize the profit function, subject to relevant incentive compatibility constraint and participation constraint of customers.

To concentrate on the customers' behavior that is of interest, we impose the following assumptions on the value of outside option.

Condition 2 *The value of outside option ω satisfies the following assumption:*

1. $\omega \geq \underline{u}$
2. $\omega < u$
3. $\omega < 1 - D$

Assumption 2.1 says that if the firm never responds and the customer could observe all signal directly, he would quit if in the worst signal event. Assumption 2.2 is ex-ante participation constraint, which also implies that if the prior remains, staying in the firm is preferred to exit. Assumption 2.3 means that if the customer expect that his complaint may result into corrective action, then complaint is preferred to exit[13].

Once the policy is announced and signals are received, the game between those two customers starts. The customers are allowed to use mixed strategies. A strategy used by information type s thus is $\sigma : S \to \Delta(A)$, which is a function mapping private signal into the set of probability distribution over action set A. And the equilibrium is formally defined as:

Definition 3 *Given the announced responsive policy g, the Bayesian-Nash Equilibrium is σ^* such that for each player i and every possible signal s_i, the behavioral strategy $\sigma(s_i)$ maximizes player i's expected payoff, that is, $Eu_i\left(\sigma_i^*, \sigma_{-i}^* | s_i\right) \geq Eu_i\left(\sigma_i, \sigma_{-i}^* | s_i\right), \forall i \in \{1, 2\}, \forall \sigma_i$.*

[13]This is quite analogous with the insights on network competition with quality difference. The key point there and here is the similar: the formation of consumers' expectation about the true state. "(T)his logic making expectations stubbornly unresponsive to price or performance) would focus expectations on a firm that plainly could dramatically improve its product if necessary- even if it never actually does so" (Farrell and Klemperer, 2007, P.2042)

The action of customer only depends on his own private signal, so all the customers with the same type choose the same strategy. Thus we confine attention to characterize symmetric Bayesian-Nash equilibrium. We say that every type adopts separating strategy if each takes a distinct action. The equilibrium is *fully-revealing* if σ is one-to-one mapping from information type to action. The customers adopts a *pooling strategy* if each type takes the same action. An equilibrium is called *partially revealing* if in equilibrium at least one type's strategy is mixed strategy.

Here we briefly outline the methodology. We first propose the alternatives of responsive policy, then examine the equilibrium strategies of customers under these policies, respectively, and calculate the profit of firm under each mechanism. Finally, we compare these mechanisms, and select the optimal one

2.4 Benchmark case: No response

In this subsection we analyze the benchmark case where the firm doesn't make any response to the action of the customers. This highlights the classic case discussed in market competition: vote with feet. If the status quo will always maintain, the responsive policy could be characterized as $(\alpha^*, \beta^*) = (\infty, \infty)$.

The game form of this mechanism in the interim stage is shown in Figure 2. Type B doesn't know his opponent's type, so he could not identify the events BB and GB. The corresponding interim games are presented in Figure 2a, which is decomposed as Γ_{BB} and Γ_{GB}. Γ_{BB} represent the game whenever both customers are of low type, which is assigned probability γ_{BB} by the row player, conditional on his bad signal. Γ_{GB} stands for the game where one low type and one high type present, on which the type B row player ascribes probability γ_{GB}.

Γ_{BB}

	E	K	C
E	ω, ω	$\omega, \underline{u}$	$\omega, \underline{u} - D$
K	$\underline{u}, \omega$	$\underline{u}, \underline{u}$	$\underline{u}, \underline{u} - D$
C	$\underline{u} - D, \omega$	$\underline{u} - D, \underline{u}$	$\underline{u} - D, \underline{u} - D$

Γ_{GB}

E	K	C
ω, ω	ω, u	$\omega, u - D$
u, ω	u, u	$u, u - D$
$u - D, \omega$	$u - D, u$	$u - D, u - D$

Figure 2a Interim Game faced by type B

On the other hand, when the row player's type is G, he attaches probability γ_{BG} to this event in which he plays the strategic form game Γ_{BG} in Figure 2b. Besides, he puts probability γ_{GG} to the event where the right-hand game Γ_{GG} in Figure 2b is played.

	Γ_{BB}			Γ_{GG}		
	E	K	C	E	K	C
E	ω, ω	ω, u	$\omega, u-D$	ω, ω	ω,$\overline{u}$	ω,$\overline{u}-D$
K	u, ω	u, u	$u, u-D$	$\overline{u}, \omega$	$\overline{u}$,$\overline{u}$	$\overline{u}$,$\overline{u}-D$
C	$u-D, \omega$	$u-D, u$	$u-D, u-D$	$\overline{u}-D, \omega$	$\overline{u}-D, u$	$\overline{u}-D$,$\overline{u}-D$

Figure 2b Interim Game faced by type 1

Conditional on his own type, the customer chooses the strategy profile to maximize his expected payoff i.e., the weighted sum of his payoff in those two normal-form games. It's clear that for any positive communication cost D, complain is strictly dominated by silence, regardless of type. Therefore in equilibrium no complaint would be ever heard.

With Assumption 2, straightforwardly we have $\sigma^*(G) = K$, the satisfied customer stays and keeps quiet. Then we turn to type B, though he doesn't know the real event, he is sure that his opponent would do nothing if being of type G. If he chooses to quit, his payoff is certainly ω. If he decides to keep silence, then in the event BB he expects to get $\underline{u}$, and his payoff is u if event 10 occurs. Hence if he chooses K, his expected payoff is

$$\gamma_{BB}\underline{u} + \gamma_{GB}u = \frac{(1-p)(1-q)}{(1-p)(1-q)+pq}$$

His best response with respect to his own signal thus relies on the attractiveness of outside option.

$$\sigma^*(B) = \begin{cases} K, \text{ if } \omega \leq \frac{(1-p)(1-q)}{(1-p)(1-q)+pq} \\ E, \text{ if } \omega > \frac{(1-p)(1-q)}{(1-p)(1-q)+pq} \end{cases}$$

The resulting threshold equilibrium could be summarized in the following proposition:

Proposition 4 *If the firm never responds to the action of customers, then C is unused in any equilibrium, and the outcome depends on the relative attractiveness of outside option.*

1. *If $\omega \leq \frac{1}{1-\frac{p}{1-p}\frac{q}{1-q}}$, then the pooling equilibrium emerges, every customer keeps silence in the first period, and the expected profit is:*
   $\pi^{Pooling} = 2(1-p)V \quad (1)$

2. *If $\omega > \frac{1}{1-\frac{p}{1-p}\frac{q}{1-q}}$, then in equilibrium both types take separating strategy, the satisfied customer keeps quiet and dissatisfied one exits, the expected profit is:*
   $\pi^{Fully-revealing} = \left[p(1-q)^2 + (1-p)q^2\right] 2\overline{u}V + 2q(1-q)(1-p)V = 2(1-p)qV \quad (2)$

Since the The firm won't listen to the voice of customer, the dissatisfied customer would vote with his feet. The profit of firm thus only depends on the likelihood that the true state if good. The first term in (2) represents the expected revenue in event GG, which occurs with probability $p(1-q)^2 + (1-p)q^2$; the second term is the expected revenue in event GB or BG, where one customer leaves.

Under pooling equilibrium both customers select to be attached in the first period. The posterior belief concerning true state thus remains the same as the prior $1-p$, in which case both customers choose to be lock-in if observing good true state, and exit otherwise.

The result thus is consistent with that from classic literature on market competition: the more severe the competition, the lower the profit. Particularly, it says that if someone don't want to listen to the action of others, she would not hear that. In this case, no voice says nothing about the feeling of customers.

3 Equilibrium Analysis for One Firm

In this section we investigate Nash equilibrium under two specific responsive mechanisms. Active responsive mechanism (A) prescribes that the firm undertakes corrective action even only one complaint is heard, and passive responsive mechanism (P) needs two complaints or one exit to convince the firm to act. By assumption 1, we know that the firm want to implement the choice rule that undertaking corrective action only when two bad signals occur. Combine with the proper incentive compatibility constraint, we show that only passive responsive mechanism could implement this rule. However, by analyzing the game-form of this mechanism we show that this mechanism could not fully implement this desirable rule, and many undesirable equilibrium outcome may arise, due to the multiplicity of equilibrium in coordination game. Then we move to investigate active responsive mechanism and show that even though it could not implement the best choice rule, it always has unique equilibrium, which precludes any undesirable equilibrium outcome.

3.1 Passive responsive mechanism: coordination game

We first investigate the passive responsive policy which implies the firm responds to either two voices or one exit or both. Under this policy complaints are complementary. In the interim stage since one complaint doesn't suffice to affect the firm, thus coordination action is key to corrective action.

However, because of the nature of incomplete information, if the dissatisfied customer is pessimistic about the coordination of his opponent, he may choose exit, rather than complain.

In the interim stage the games faced by the customers could be described as the follows:

Γ_{BB}

	E	K	C
E	ω	ω	ω
K	1	$\underline{u}$	$\underline{u}$
C	$1-D$	$\underline{u}-D$	$1-D$

Γ_{GB}

	E	K	C
E	ω	ω	ω
K	1	u	u
C	$1-D$	$u-D$	$1-D$

Γ_{BG}

	E	K	C
E	ω	ω	ω
K	1	u	u
C	$1-D$	$u-D$	$1-D$

Γ_{GG}

	E	K	C
E	ω	ω	ω
K	1	$\overline{u}$	$\overline{u}$
C	$1-D$	$\overline{u}-D$	$1-D$

Figure 3 The game form of mechanism P

The belief system remains what is presented in Figure 2b-d.

Here only one action doesn't suffice to affect the firm, thus coordination action is key to corrective action. However, since they act exclusively on the basis of their own signals, their strategy depends on their beliefs about the opponent. So if the dissatisfied customer is pessimistic about the coordination of his opponent, he may choose exit, rather than complain.

The most desirable social choice rule to the firm (second-best), as we have shown before, is undertaking corrective action when BB occurs. By revelation principle, the *informative separating equilibrium* CK, which prescribes C upon bad signal and K conditional on good signal is preferred. Under this equilibrium no customer exits or lies, and the firm will undertake corrective action only when two bad signal occur. For this to be equilibria, it has to

be mutual best response. Hence we need $\gamma_{BG}u + \gamma_{GG}\overline{u} \geq \gamma_{BG} + \gamma_{GG}\overline{u} - D$ and $\gamma_{BB}\underline{u} + \gamma_{GB}u < \gamma_{BB} + \gamma_{GB}u - D$ as incentive compatibility constraints of satisfied customer and dissatisfied one, respectively. Namely we have

$$\frac{pq(1-q)}{(1-p)q+p(1-q)} < D < \frac{pq^2}{(1-p)(1-q)+pq} \quad (3)$$

Moreover, we also need interim stage participation constraint. By Assumption 2.1, $\omega < u$, thus $\sigma^*(G) \neq E$ holds. Thus exit is strictly dominated

strategy for the high type. For type-B, which requires $\gamma_{BB} + \gamma_{GB}u - D > \omega$. The expected profit hence is:

$$\pi_P^* = \pi_P^{FR} = 2V\left[1 - p\left(1 - q^2\right)\right] - \left[\left(1 - p\right)\left(1 - q\right)^2 + pq^2\right]F \quad (4)$$

Thus by selecting passive responsive mechanism and setting communication cost to moderate level, the firm could implement her preferred outcome function as equilibrium outcome.

However, multiplicity of equilibria arises here due to the fact that the game form is coordination games. Since the fully-revealing equilibrium fails to be unique, undesirable equilibrium outcome may present, which worth our check. The payoff to strategy K is at worst the posterior of bad state $\Pr\left(\theta = B \,|s_i = B\right) = \gamma_{BB}\underline{u} + \gamma_{GB}u = \frac{(1-p)(1-q)}{(1-p)(1-q)+pq}$, which consists the benchmark for comparing. Depending on the attractiveness of outside option, i.e., whether interim participation constraint holds, we could divide it into two cases.

Case I. $\frac{(1-p)(1-q)}{(1-p)(1-q)+pq} > \omega$

This case arises whenever the dissatisfied customer still maintains sufficient confidence about other's type, or the outside option is not too attractive, then E is strictly dominated by K and would not be a part of rationalizable strategy.

There are two subcases. If communication cost D is so high that the payoff to keeping quiet exceeds complain, regardless of his opponent's type and action, then K is the only Nash equilibrium surviving iterated deletion of strictly dominated strategy. Straightforward calculation show that this condition is satisfied if $\gamma_{BB}\underline{u} + \gamma_{GB}u > \gamma_{BB} + \gamma_{GB}u - D$. Thus if $D > \frac{pq^2}{(1-p)(1-q)+pq}$, then the pooling equilibrium KK prevails and the customers always keep quiet, and the expected profit is the same as that given in (1).

If communication cost is not too high, We have two pure-strategy Nash equilibrium, in additional to the fully-revealing equilibrium CK.

KK, is always an equilibrium since if the opponent adopts this strategy, the player has no incentive to deviate. The profit to firm is (1)

CC, which implies that everyone always complains, is also an equilibrium profile whenever $\gamma_{BG}u + \gamma_{GG}\overline{u} < 1 - D$, namely $D < \frac{p(1-q)}{(1-p)q+p(1-q)}$.Now complaint is entirely uninformative, so the *babbling equilibrium* emerges, which generates profit $\pi_P^b = 2V - F$

We could not find out any interval such that a unique pure-strategy equilibrium exists. Besides, there is a mixed-strategy equilibrium which prescribes $\sigma(G) = K, \sigma_C(B) = \frac{(1-p)(1-q)+pq}{pq^2}D$.

Scholars may suggest to use sophisticate equilibrium selection mechanism to choose plausible equilibrium. In this case it may work, since when exit becomes the dominated strategy, the game form becomes 2×2 coordination game, where we may use risk-dominance criterion (Harsanyi and Selten, 1987) to define the cost interval which favors informative separating equilibrium CK. However, when exit becomes possible, any equilibrium selection criterion in coordination game doesn't hold.

Case II. $\frac{(1-p)(1-q)}{(1-p)(1-q)+pq} < \omega$

Note that by Assumption 2.2 and 2.3, $\omega < \min\{u, 1-D\}$, so here $D < \frac{1}{1+\frac{1-p}{p}\frac{1-q}{q}}$ should always hold.

Here the point is though participation constraint holds ex ante, it may fails in interim stage. When customer learns his own signal, he would review the outside opportunity again, which may consist the threat to the firm.

First, we note that CC is always one Nash Equilibrium as long as $D < \frac{p(1-q)}{(1-p)q+p(1-q)}$.

Second, If $D \geq \frac{p(1-q)}{(1-p)q+p(1-q)}$, then K is dominant strategy for type-G customer. Thus we could turn attention to dissatisfied customer. Intuitively, if the communication cost is high, or the posterior is pessimistic, then the unsatisfied customer may bypass voice. The mixed-strategy equilibrium which randomizes between leaving and silence becomes the unique equilibrium. This situation happens if C becomes the strictly dominated strategy:

$$\gamma_{BB}\underline{u} + \gamma_{GB}u > \gamma_{BB} + \gamma_{GB}u - D$$

so $D \geq \frac{pq^2}{(1-p)(1-q)+pq}$ suffice to make C an unattractive choice, then we could eliminate this dominated action. In mixed-strategy equilibrium the probability to keep silence satisfies the following equation:

$$(1-\sigma_E)\gamma_{BB}\underline{u} + \sigma_E\gamma_{BB} + \gamma_{GB}u = \omega$$

Thus $\sigma = (\sigma_K, 0, \sigma_E)$, where $\sigma_E = \frac{\omega[(1-p)(1-q)+pq]-(1-p)(1-q)}{pq^2}$

On the other hand, if $D < \frac{pq^2}{(1-p)(1-q)+pq}$, then the situation becomes more complicate. The separating strategy (CK) is the pure strategy Nash equilibrium if $\gamma_{BB} + \gamma_{GB}u - D > \omega$ also holds, which means:

$$\frac{p(1-q)}{(1-p)q+p(1-q)} < D < \frac{(1-p)(1-q)+pq^2}{(1-p)(1-q)+pq} - \omega$$

However, this pure strategy equilibrium fails to be unique, there exists another mixed-strategy Nash equilibrium. The type-B may adopt completely mixed strategy to randomize among E, K, C if $\frac{p(1-q)}{(1-p)q+p(1-q)} < D < \frac{pq^2}{(1-p)(1-q)+pq}$, since iterated deletion of weakly dominated strategy could not reduce the set of actions in equilibrium. The only mixed strategy conditional on signal $s = B$ thus is $\sigma^*(B) = (\sigma_E, \sigma_K, \sigma_C)$, which could be get from

$$\begin{aligned} &\omega = \sigma_E(\gamma_{BB} + \gamma_{GB}u) + (1-\sigma_E)(\gamma_{BB}\underline{u} + \gamma_{GB}u) \\ &= \sigma_K(\gamma_{BB}\underline{u} + \gamma_{GB}u - D) + (1-\sigma_K)(\gamma_{BB} + \gamma_{GB}u - D) \end{aligned}$$

so $\sigma_E = \frac{\omega-(\gamma_{BB}\underline{u}+\gamma_{GB}u)}{\gamma_{BB}(1-\underline{u})} = \frac{\omega[(1-p)(1-q)+pq]-(1-p)(1-q)}{pq^2}$

and $\sigma_K = \frac{\gamma_{BB}+\gamma_{GB}u-D-\omega}{\gamma_{BB}(1-\underline{u})} = \frac{(1-p)(1-q)+pq^2-(D+\omega)[(1-p)(1-q)+pq]}{pq^2}$

Comparative statics show that as outside option becomes more tempting, dissatisfied customer is more likely to choose exit. However, the probability to keep quiet decreases as communication cost increases. This counterintuitive result demonstrates that here communication cost just affect the relative choice between K and C, but is irrelevant with exit option. As D increases, the customer needs to put more weight on option C to ensure that complaining is still an undominated strategy.

Once we substitute the restriction of ω imposed by Condition 2.2 into the formula here, we have $0 \leq \sigma_E \leq \frac{(1-p)(2q-1)}{q^2}$, which clarifies the bound of exit probability in equilibrium. To understand the size of exit and its consequence, we examine the most competitive environment where $\omega = 1-p$. Then in equilibrium $\sigma_E = \frac{(1-p)(2q-1)}{q^2}$. Straightforwardly, the probability to lose at least one customer is $\left[pq^2 + (1-p)(1-q)^2\right]\left[1-(1-\sigma_E)^2\right] + 2(1-q)q\sigma_E$, where the first term prescribes the likelihood to lose customer in worst case BB, and the second term summarizes the possible loss when one good signal and one bad signal present. Interestingly, when the customer becomes uninformed, the probability to lose converges to 0! The intuition is that the customer learns nothing in period one, thus his prior maintains and interim participation constraint still holds. On the other hand, when the signal becomes precise, the probability of loss converges to $p(1-p^2)$, significantly higher than zero. The underlying reason is by vanishing quality variance the dissatisfied customer immediately learns the true state, and due to the high communication cost he is reluctant to complain, so he doesn't hesitate to leave.

In summary, though passive responsive mechanism with moderate communication cost could implement the best choice rule, it has two drawbacks

which may seriously limit its application in practice. First, due to the nature of coordination game of this game-form, the inevitable multiplicity of equilibria arises, the undesirable equilibrium outcome may emerge. Second and perhaps more important, as we illustrate in Case II, even if we could select unique equilibrium by some plausible equilibrium selection criterion, like risk-dominance criterion (Harsanyi and Selten, 1987), this fails when outside option becomes appealing. In the interim stage when the customers need to make decision, his participation constraint then differs from the ex ante participation constraint, thus retaining customer is more challenging than attracting customer in the first place. In other words, this mechanism is not robust to competition environment.

3.2 Active responsive policy: one complaint suffices

Due to the shortcoming of passive responsive mechanism, we turn to the active responsive mechanism which is characterized by that any single consumer is pivotal and suffices to change the *status quo*. Under this mechanism the firm commits to some *ex post* inefficient action, i.e., undertaking corrective action when only one complaint is heard, even though then her prior remains. However, this mechanism also has two appealing properties which are in the absence under passive responsive mechanism. Since $u(E) = \omega < 1 - D = u(C)$, exit is strictly dominated strategy in the interim stage, so ex ante participation constraint alone suffices to keeping customers. Besides, the game-form of this mechanism ensures unique symmetric Nash equilibrium everywhere, thus this mechanism could fully implement the rule chosen by the firm. Now we examine these in details.

Under this policy the firm would most actively responds to customers, since "one complain changes". The game form is shown in Figure 2[14]:

Γ_{BB}

	E	K	C
E	ω	ω	ω
K	1	$\underline{u}$	1
C	$1-D$	$1-D$	$1-D$

Γ_{GB}

	E	K	C
E	ω	ω	ω
K	1	u	1
C	$1-D$	$1-D$	$1-D$

[14]For simplificity, we just present the payoff to the row player. The payoff to the column player could be get by symmetry condition.

	E	K	C
E	ω	ω	ω
K	1	u	1
C	$1-D$	$1-D$	$1-D$

Γ_{BG}

	E	K	C
E	ω	ω	ω
K	1	$\overline{u}$	1
C	$1-D$	$1-D$	$1-D$

Γ_{GG}

Figure 4 The game-form of active responsive mechanism

The belief system is the same as Figure 1b-d.

Since E is unused in equilibrium, the complete information game Γ_{BB} becomes a Chicken game, where two asymmetric pure-strategy equilibrium (C, K) and (K, C), as well as a mixed-strategy equilibrium, exist. We rule out those asymmetric ones by the concerns about anonymity.

In the first place, we explore the fully-revealing equilibrium. The informative separating strategy CK is an equilibrium strategy profile if the incentive compatibility for the satisfied customer $\gamma_{BG} + \gamma_{GG}\overline{u} > 1 - D$ and that for dissatisfied customer $\gamma_{BB} + \gamma_{GB}u < 1 - D$ both holds, which implies $\frac{p(1-q)^2}{p(1-q)+(1-p)q} < D < \frac{pq(1-q)}{(1-p)(1-q)+pq}$.

Moreover, CK is also the strategy surviving iterated elimination of strictly dominated strategy for dissatisfied customer, we have the following claim.

Claim 5 *The unique equilibrium strategy profile is CK, if and only if* $\frac{p(1-q)^2}{p(1-q)+(1-p)q} < D < \frac{pq(1-q)}{(1-p)(1-q)+pq}$.

It's easy to calculate the expected profit to the firm

$$\pi_A^{FR} = 2V\left[1 - p\left(1-q\right)^2\right] - \left[1 - p\left(1-q\right)^2 - \left(1-p\right)q^2\right]F \quad (5)$$

Under this mechanism, the only possible collapse is the event that the true state is bad but both get favorable signal, thus the likelihood to lose customer base is $p\left(1-q\right)^2$. Since any unfavorable signal leads to voice, consequently corrective action, the probability to undertake action is the same as complaint rate (the probability for the firm to receive complaint), which is capture by the content in the bracket of the second term. So $1 - p\left(1-q\right)^2 - \left(1-p\right)q^2$.

Since in general active responsive mechanism is not efficient for the firm, there is no guarantee that fully-revealing equilibrium achieve maximal profit, given the selected mechanism. Thus we need to examine other equilibrium as alternatives.

When incentive compatibility constraint for dissatisfied customer fails, namely $D \geq \frac{pq(1-q)}{(1-p)(1-q)+pq}$, then though the satisfied customer still keeps silence, the unsatisfied customer will randomize between action K and C. Hence the equilibrium strategy is the mixed strategy that assigns positive probability on action profile KK and CK. The probability to complain whenever having bad signal, $\sigma_C = \frac{(1-D)[(1-p)(1-q)+pq]-(1-p)(1-q)}{pq^2}$. This implies *partially revealing equilibrium*. The satisfied customer always keeps quiet, and the dissatisfied complains with probability σ_C, and keeps silence with the complementary probability. σ_C has a natural interpretation as the complaint/dissatisfaction ratio.

As to the profit to the firm, the signal event GG occurs with probability $(1-p)\,q^2 + p\,(1-q)^2$, where no customer complains. On the other hand, in event BB complaint occurs with probability $1-(1-\sigma_C)^2 = \sigma_C\,(2-\sigma_C)$, and in GB (or BG) it happens with probability σ_C, while no voice is heard when two favorable signals present. The complain rate thus is the probabilistic weighted sum of these events $\left[(1-p)\,(1-q)^2 + pq^2\right]\sigma_C\,(2-\sigma_C) + 2q\,(1-q)\,\sigma_C$.

Since the firm would improve conditional on a single complaint, then the only event that both customers quit happens with probability

$$p\left[(1-q)^2 + q^2\,(1-\sigma_C)^2 + 2q\,(1-q)\,(1-\sigma_C)\right] = p\,(1-q\sigma_C)^2.$$

The expected profit thus is

$$\begin{gathered}\pi_A^{PR} = [1-p\,(1-q\sigma_C)^2]2V - \\ \left\{\left[(1-p)\,(1-q)^2 + pq^2\right]\sigma_C\,(2-\sigma_C) + 2q\,(1-q)\,\sigma_C\right\}F \quad (6)\end{gathered}$$

In another extreme situation, if $\gamma_{BB}\underline{u} + \gamma_{1B}u \geq 1-D$ holds, by symmetry, K will be the dominant strategy. Tedious algebra shows that this implies $D \geq \frac{pq}{(1-p)(1-q)+pq}$, where both customers keep silence and the equilibrium pools low and high signals. Thus we return to benchmark case that in the first period both customers keep quiet, the firm's posterior remains as $\Pr(\theta = G \,|a_1 = a_2 = K) = 1-p$, and no expenditure incurs since no complaint is heard. The expected profit thus is the same as (1)

Moreover, if incentive compatibility condition for satisfied customer fails, namely the communication cost is so small that $D \leq \frac{p(1-q)^2}{p(1-q)+(1-p)q}$, then silence is not dominant strategy even for the satisfied customer. The unique equilibrium is dissatisfied always complains and satisfied customer randomizes between C and K. Hence the unique equilibrium strategy is the combination of CK and CC. Then the firm would be cheated and incur inefficiently

high expenditure on frequent corrective action. The expected profit thus is lower than that under fully-revealing equilibrium.

We characterize the entire equilibrium behavior under mechanism A in the following proposition.

Proposition 6 *Under mechanism A, given condition 2, the equilibrium outcome varies in accordance to the size of communication cost D.*

1. *If* $D \geq \frac{1}{\frac{1-p}{p}\frac{1-q}{q}+1}$, *then* K *is the dominant strategy for all customer, regardless of his signal. The expected profit is equation (1).*

2. *If* $D \in \left(\frac{1-q}{\frac{1-p}{p}\frac{1-q}{q}+1}, \frac{1}{\frac{1-p}{p}\frac{1-q}{q}+1}\right)$, *then in equilibrium satisfied customer keeps silence, while dissatisfied customer complains with probability* $\sigma_C = \frac{(1-D)[(1-p)(1-q)+pq]-(1-p)(1-q)}{pq^2}$. *The expected profit is equation (6).*

3. *If* $D \in (\frac{1-q}{\frac{1-p}{p}\frac{q}{1-q}+1}, \frac{1-q}{\frac{1-p}{p}\frac{1-q}{q}+1}]$, *then the outcome is fully-revealing equilibrium in which the satisfied customer keeps quite, and the dissatisfied one complains. The expected profit equals to (5).*

4. *If* $D \in (0, \frac{1-q}{\frac{1-p}{p}\frac{q}{1-q}+1}]$, *then the dissatisfied customer complains, and satisfied customer randomizes between complain and silence.*

5. *If* $D = 0$, *the babbling equilibrium where everyone complains emerges, and the expected profit is* $\pi_A^b = 2V - F$.

Proof. *Follows from the above discussion.* ■

A surprising result is that given active responsive mechanism, from the perspective of firm, in general there is conflict between information efficiency and revenue maximization. In other words, the profit-maximization firm always has the incentive to induce mixed strategy equilibrium, rather than the fully-revealing equilibrium. This result is stated formally in the following proposition.

Proposition 7 *Given active responsive policy, the revenue-maximization firm will set communication cost at* D^* *to induce the partially revealing equilibrium in which the dissatisfied customer randomizes between complain and silence.*
Proof. *First, we need to show that partially revealing equilibrium could induce highest revenue. Therefore, differentiate (5) with respect to D, we need*

$\frac{\partial \pi_A^{PR}}{\partial D}\Big|_{D=\frac{1-q}{\frac{1-p}{p}\frac{1-q}{q}+1}} > 0$, *which implies that increasing communication cost on the partition point between fully-revealing equilibrium and mixed-strategy equilibrium strictly raises profit. Note that* $\frac{\partial \pi_A^{PR}}{\partial D} = \frac{\partial \pi_A^{PR}}{\partial \sigma_C}\frac{\partial \sigma_C}{\partial D}$,*since* $\frac{\partial \sigma_C}{\partial D} < 0$, $\frac{\partial \pi_A^{PR}}{\partial D} > 0$ *if and only if* $\frac{\partial \pi_A^{PR}}{\partial \sigma_C} < 0$. *Because* $\sigma_C \to 1$ *when* $D \to \frac{1-q}{\frac{1-p}{p}\frac{1-q}{q}+1}$, $\frac{\partial \pi_A^{PR}}{\partial \sigma_C}|_{\sigma_C=1} < 0 \Rightarrow 2pV < F$, *which is exactly the statement in Condition 1.* ■

Then we could derive the optimal level of communication cost D^* which maximize profit. The firm's objective could be described as maximizing (6) with respect to σ_C, subject to the constraint derived from Condition 2 $\sigma_C \geq \frac{\omega[(1-p)(1-q)+pq]-(1-p)(1-q)}{pq^2}$. Then we could get

$$D^* = \min\{1-\omega, \frac{pq}{(1-p)(1-q)+pq}\frac{(1-q)\left[(1-p)(1-q)^2+pq^2-q^2\right]F}{\left[(1-p)(1-q)^2+pq^2\right]F-2pq^2V}\}$$

Consequently, the equilibrium complaint/dissatisfaction ratio is

$$\sigma_C^* = \min\{\frac{\left[(1-p)(1-q)^2+pq^2+q(1-q)\right]F-2pqV}{\left[(1-p)(1-q)^2+pq^2\right]F-2pq^2V}, \frac{\omega[(1-p)(1-q)+pq]-(1-p)(1-q)}{pq^2}\}$$

and the profit is

$$\pi_A^* = [1-p\left(1-q\sigma_C^*\right)^2]2V - \{\left[(1-p)\left(1-q\right)^2+pq^2\right]\sigma_C^*\left(2-\sigma_C^*\right)+2q\left(1-q\right)\sigma_C^*\}F$$

To understand this proposition, we need to recall the assumption regarding corrective cost in Condition 1, which prescribes that undertaking corrective action is optimal choice for the firm only in event BB. Under active responsive mechanism, the firm in effect commits to corrective action contingent upon event BG(GB) and BB. However, under events BG and GB, which occur with probability $2q\left(1-q\right)$, the firm's belief concerning the true state remains the same, thus corrective action is not ex post optimal. Therefore, the firm has to increases complain barrier to reduce complaint/dissatisfaction ratio, consequently the frequency of inefficient corrective action. Though under this mixed-strategy equilibrium the firm may miss the really bad event BB, where corrective action is necessary, the latter loss is relatively small, compared with cost-reduction in events BG and BG.

This simple proposition sheds light on the well-established fact that many dissatisfied clients never complain. Given active responsive policy, the profit-maximization firm prefers to sacrifice information efficiency to reduce the

adjustment expenditure, thus it would like to set excessive complaining barriers to ensure that dissatisfied customer will not always complain. Therefore, the observed low complaint rate among dissatisfied consumers may be the deliberate policy choice of the firm.

Straightforward calculation again confirms that the optimal outcome under passive responsive mechanism is the best to the profit-maximization firm (second best). However, it also suffers from two shortcomings: *multiplicity of equilibria* and *sensitivity to competition*. Hence there is no guarantee that only desirable equilibrium outcome arises. Taking this fact into account, the firm may be more cautious.

In summary, there are two perfect Bayesian equilibrium, one is mixed-strategy equilibrium under active responsive mechanism, and the other is fully-revealing equilibrium under passive responsive mechanism. Though the latter is optimal, the former is robust, thus may arise if the firm has pessimistic perception about the coordination of customers. The firm has to weigh the risk to lose customer against the cost to incur inefficiently frequent corrective action. In practice directly exit is still rare as initial response among dissatisfied customers[15], it seems that suboptimal robust mechanism is more likely to be selected by practitioners, thus active responsive mechanism has some parallels in the real world. We illustrate it in the following numerical example:

Example 8 *Let* $p = 0.5, q = 0.8, V = 1, F = 1.1, \omega \leq 0.5$. *It's easy to check that these parameters satisfy condition 1 and 2. Then under active responsive mechanism, communication cost is set at* $D_A^* = 0.198$, *equilibrium complain/dissatisfaction ratio is* $\sigma_C^* = 0.94$, *and profit is* $\pi_A^* = 1.235$.
The possible situation under passive responsive mechanism is more complicate, and we address only the best and mixed-strategy equilibrium. The best equilibrium is separating equilibrium where dissatisfied customer always complain, which requires $D \in [0.16, 0.64]$ *and generates slightly higher profit* $\pi_P^* = 1.266$. *(2.5% higher)*
In the worst equilibrium the dissatisfied customer randomizes among actions. Under the exactly same communication cost interval, if $\omega < 0.2$, *then no exit occurs, but dissatisfied one complains with* $\sigma_C \in [0.25, 1]$. *If* $\omega \in [0.2, 0.5]$, *then exit is possible, and in equilibrium* $\sigma_C \in [0.25, 1]$, *while* $\sigma_E \in [0, 0.43]$.

Figure 5 demonstrates this example. To simplify illustration, we just present the pure strategy equilibrium under passive responsive mechanism

[15] Voorhees et al (2006) found that among those consumers who did not complain, only 6.12% explicitly mention brand switching as his action as response to dissatisfaction.

with dash line. We could see the pooling equilibrium and babbling equilibrium generates much lower profit, while second best outcome is slightly better than the outcome in suboptimal mechanism. In constrast, active responsive mechanism always has unique equilibrium.

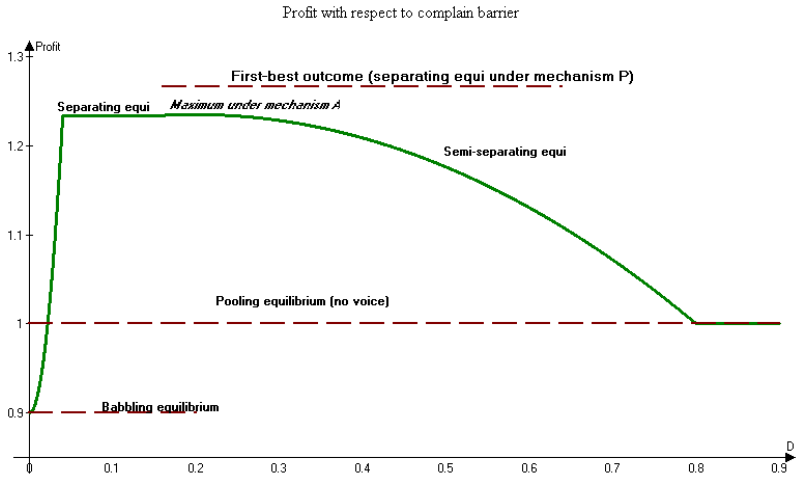

Figure 5 The comparison between two mechanisms

3.3 Complaint Management under Competition

In the precedent section we treat outside option ω as exogenous to measure the degree of competition, thus the firm serves as a monopoly. A natural extension is to consider complaint management strategies by competitive firms, in which classical economic thoughts may suggest that market force suffices to restore firm's performance. In this section we will examine the duopoly case, thus two *ex ante* identical firms compete for customers by setting its own complaint management strategy. Surprisingly, we find that the active responsive mechanism, though worst, is still an equilibrium outcome because it not only retain own customers, but also may attract customers from competitor.

There are two firms denoted by α and β, they are ex ante identical in the sense that their product has the same p and q. Without loss of generality, we abstract from pricing decision[16]. Thus the only decision available to them is to choose complaint management decision rule and complaining barrer D_j,

[16]It's straightforward to show that pricing decision only affects participation constraint, thus by varying price the Individual Rationality constraint may bind in any case. Moreover, since two firms are identical, the price charged should also be the same.

$j = \alpha, \beta$. To compare with the monopoly case analyzed above, we assume that there are four ex ante identical customers who are equally assigned to each firm before the game starts. This assignment could be implemented by equalizing expected payoff from each firm, i.e. ex ante participation constraint binds and customers are indifferent between α and β. Therefore, duopoly case could be considered as replication of monopoly environment, except now the outside option ω_j is endogenous. Hence the decision rule set available is the same as before. As regard to the timing, we require the firms commit to responsive mechanism at first, then customers choose the seller, and the others together with the information structure is the same as before. Therefore outside option incorporates the both the actions of customer and the responsiveness in the competiting firm. Still, communication among customers within and between firms is in absence. We also require the absence of communication between firms, thus they have to make decision simultaneously.

Therefore, when choosing complaint management strategy, the firm has to take into account the strategy of her competitor. Indeed, new game between firms appears before customers make decision. We elaborate it in the following figure.

$mechanism$	A	P
A	π_A, π_A	π'_A, π'_P
P	π'_P, π'_A	π_P, π_P

Figure 6 Mechanism chosen by Firm (α as row player, β as column)

The analysis becomes more complicate, since customers' action interacts with the competitor's strategy, and customers need to form expectation about the quality in the other firm. We still analyze the expected profit in each scenario, where customers' decision is a subgame. And we are still concerned with symmetric equilibrium under each mechanism.

3.3.1 Symmetric Choice I: (A, A) and (P, P)

First we investigate the action choice (A, A), each firm sets identical active responsive mechanism, thus $D_\alpha = D_\beta = D$. Before we have shown that mechanism A guarantees unique equilibrium and is immune to competition in monopoly case. But, the situation changes considerably in duopoly case. Basically, ex ante participation constraint that $1 - D \geq \omega_j$, $j = \alpha, \beta$ never holds for any strictly postive communication cost. Indeed, any symmetric subgame equilibrium under (A, A) is outcome-equivalent to babbling equilibrium in the sense that everyone exits for $D > 0$, and randomizes among

exit, complain and silence when $D = 0$. Thus firm always spend on corrective action.

The pessimistic result also emerges under (P, P). There is no D simultaneously satisfying IC $\frac{pq(1-q)}{(1-p)q+p(1-q)} < D < \frac{pq^2}{(1-p)(1-q)+pq}$, together with IR $D < p\left(1-q^2\right) - \frac{pq(1-q)}{(1-p)1-q+pq}$. Thus fully-revealing equilibrium again becomes impossible. Because of the binding participation constraint, all equilibrium outcome is equivalent to babbling equilibrium.

Even though babbling equilibrium is worse than ex ante expected profit, as Assumption 1 said, the firm would not turn to entirely non-responsive policy as the benchmark case we considered in Section 2. The point here is the participation constraint is demanding and if a firm (say, firm α) never responses, dissatisfied customer immediately leaves. Then the competitor β would gain and the profit to α is even worse than babbling equilibrium. Hence, neither α nor β is incline to nonresponsive strategy.

Here we see that in competitive environment complaint responsiveness indeed rewards customers with an option to correct possible failure. This option value would be taken into account when customers choose seller. Therefore, both firm would provide equal option value under symmetric choice, as response to competition.

3.3.2 Asymmetric Case: (A, P)

Without loss of generality, we consider the case that α chooses active responsive mechanism and β selects the passive responsive mechanism. Again, there are multiple equilibrium under mechanism P. If we consider the second best outcome under P, then the participation constraint for firm α is $1-D_\alpha \geq 1-p\left[1-q^2\right]$, thus α could induce $\sigma_C^\alpha = \frac{\left[(1-p)(1-q)^2+pq^2+q(1-q)\right]F-2pqV}{\left[(1-p)(1-q)^2+pq^2\right]F-2pq^2V}$, and $\pi'_A = [1-p\left(1-q\sigma_C^\alpha\right)^2]2V-\{\left[(1-p)\left(1-q\right)^2+pq^2\right]\sigma_C^\alpha\left(2-\sigma_C^\alpha\right)+2q\left(1-q\right)\sigma_C^\alpha\}F$, the same as (6). On the other hand, the participation constraint for firm β is consistent with the incentive compatibility constraint, hence $D_\beta < p\left(1-q\sigma_C^\alpha\right)^2 - \frac{pq(1-q)}{(1-p)(1-q)+pq}$ and π'_P the same as (5).

However, the shadow of undesirable equilibrium under mechanism P always exists, in which the dissatisfied customer randomizes among exit, complain and silence, in particular, the exit rate could be as high as $\sigma_E^{'} = \frac{q-\left(1-q\sigma_C^\alpha\right)^2[pq+(1-p)(1-q)]}{q^2}$. In contrast with switching customer base under strategy combination (P, P), here firm β lose dissatisfied customer, but doesn't get incoming customer as compensation. Again we see the risk of choosing optimal mechanism when facing the competitor who select suboptimal mechanism. Active responsive mechanism, even though suboptimal in the sense

that inefficient corrective action is undertaken, could not only retain customers, but also generate new customer on the expense of competitor, thus the profit would be much higher.

3.3.3 Selecting customer complaint management strategy

Though (A, A) and (P, P) finally both induce the outcome equivalent to babbling equilibrium, since both firms have the incentive to tempt customers from competitor, only (A, A) will eventually emerges. Hence under our competitive environment the Betrand competitor (they set the same business strategy and equal expected payoff to the customers) would choose active responsive mechanism, even though it's not ex ante optimal and nevertheless social optimal or informational efficient.

But a new problem concerning the commitment power of firm may emerge. The reason is: by symmetry of firms' strategies, in equilibrium even when the undesirable equilibrium occurs, both firms have the same likelihood to lose customer as well as to get incoming customers from the competitor. In other words, firm α and β exchange customer base and maintain the same number of customers ex post. Thus both firms have little motivation to stick to mechanism $g \in \{A, P\}$. Thus competition pressure here may destroy the incentive of firm to take improvement. We will explore it later to discuss the role of competition in complaint management strategy.

Though we preclude commitment problem of firm by making assumptions about parameters in the context of monopoly, in practice it should be important, and as we have seen in competitive market this problem is very likely to happen. Therefore, to undertake welfare analysis and derive lessons for regulation, in following section we will highlight on monopoly case.

3.3.4 Alternative modeling strategy

The pessimistic result above to large extent relies on the assumption that firm commits to complaint management mechanism before customers choose seller. Since responsiveness to complaint serves as competition tool and assign customer an option, ex ante the expected payoff from either firm equals, and the interim participation constraint doesn't hold. Here we take alternative timing line, namely firm announces complaint management mechanism after customers choosing seller. Furthermore, the customers in competitor firm doesn't know this mechanism. Then the ex ante participation constraint simplifies to $p_\alpha = p_\beta = p$, and the interim one becomes $D_i < p, i = \alpha, \beta$. Therefore, the results in single firm case still hold here, the characterization of passive and active responsive mechanism remains the same, as well

as the multiplicity of equilibrium under passive responsive mechanism again plagues in subgame. Hence which equilibrium outcome may emerge under passive responsive mechanism still depends on the beliefs about customers' action.

Under this specification both (A, A) and (P, P) could be Nash equilibrium. If both firm have confidence in the coordination among customers, in other words, they trust the "loyalty" of customers. Then the passive responsive mechanism would be chosen and firm would get maximal profit. Otherwise, if one firm doesn't have sufficient confidence in either the loyalty of her own customers or that of her competitor, she may select active responsive mechanism to capture her own customers, as well as tempt customers from competitor. Therefore eventually both would select suboptimal responsive mechanism.

4 Mechanism Selection

In this section we will address social welfare and study mechanism selection problem from the perspective of regulator, who care the welfare as a whole. Then we move to positive issues to examine the complaint management in practice, and investigate the particular environment that favors one mechanism over another. We further explore two important issues in details: the role of competition and the outcome of altering mechanism. Finally we discuss the plausibility of our assumptions.

4.1 Social welfare

Though we have demonstrated that undertaking corrective action only in signal event BB is optimal for the firm, a social-planner may have different view. The difference comes from two forms: first, customers and firm may have different valuation about corrective action; second, firm imposes communication cost on the customers, thus she fails to take into account the complaining expenditure. Because from the perspective of society fully-revealing equilibrium is more efficient, the maximum social welfare under passive responsive mechanism is:

$$W_P^* = 2\left[1 - p\left(1 - q^2\right)\right] - \left[(1-p)(1-q)^2 + pq^2\right] F - 2\left[q(1-q) + (1-p)(1-q)^2 + pq^2\right] D_P^*$$

where $D_P^* = \frac{q}{\frac{1-p}{p}\frac{q}{1-q}+1}$ is the minimal communication cost to maintain fully-revealing equilibrium.

On the other hand, the maximum welfare under active responsive mechanism is:

$$W_A^* = 2\left[1-p\left(1-q\right)^2\right] - \left[1-p\left(1-q\right)^2-\left(1-p\right)q^2\right]F - 2\left[q\left(1-q\right)+\left(1-p\right)\left(1-q\right)^2+pq^2\right]D_A^*$$

$D_A^* = \frac{1-q}{\frac{1-p}{p}\frac{q}{1-q}+1}$ and has the similar interpretation as D_P^*.

In both W_P^* and W_A^* the first term is the customers' expected payoff, the second term represents the firm's expected expenditure on corrective action, and the third term measures the customers' expected expenditure on complaining. We ignore the profit of the firm since we think about a competitive environment, thus the profit to firm would not disappear, instead, it just transfer to another firm which provides outside option in our model[17].

We compare the welfare under these two mechanisms and find out that the welfare ranking depends on customer expectation p.

Proposition 9 *There exists a threshold value of reputation p^* such that the welfare-maximization regulator should assign active responsive mechanism to the the firm with $p > p^*$, and passive responsive mechanism to the firm with $p \leq p^*$.*

Proof. *The difference in welfare could be written as the following:*

$\triangle W = W_A^* - W_P^* =$

$2q\left(1-q\right)\left(2p-F\right) - 2\left[q\left(1-q\right)+\left(1-p\right)\left(1-q\right)^2+pq^2\right]\left(D_A^*-D_P^*\right) \quad (8)$

Since $q > \frac{1}{2}$, $D_A^* - D_P^* = \frac{p(1-q)(1-2q)}{p(1-q)+(1-p)q} < 0$ always holds, thus the second term of $\triangle W$ is always negative. As $p \to 0$, $\triangle W \to -2q\left(1-q\right)F < 0$, and as $p \to 1$, $\triangle W \to 2q\left(1-q\right)\left(2-F\right) - 2q\left(1-2q\right) > 0$ by deduce Assumption 1 to limit case. Since $\triangle W$ is continuous with respect to p, by Mean Value Theorem there is a p^* such that $\triangle W\left(p^*\right) = 0$. ■

There are two effects in welfare comparison. The first is the *surplus change effect*. Active responsive mechanism commits to corrective action in event BG and GB, which occur with probability $2q\left(1-q\right)$, in contrast with passive responsive mechanism, the first term capture the expected welfare change due to changing mechanism. The second is the *complaining barrier reduction effect* as shown in the second term of (8), which is always non-positive since active responsive mechanism always could give rise to fully-revealing equilibrium with lower communication cost. When the firm's reputation is low (high p), customers have low expectation about the product/service, the first

[17]Taking into account the profit, however, won't alter our basic result on welfare comparison.

effect dominates since then learning the true state and restoring customers' confidence is of priority, even at the expense of overly frequent responses. On the other hand, for the high reputation firm since the customers' expectation is quite high, regulator doesn't need impose too frequent response to restore satisfaction.

This proposition suggests that from the view of social welfare, the regulation on customer complaint management should vary across firms. Particularly, as the Proposition 7 shows that firm won't choose fully-revealing equilibrium given active responsive mechanism, thus if the regulator only monitors the mechanism in use, low reputation firm would set inefficiently high complain barrier. On the other hand, under passive responsive mechanism fully-revealing equilibrium is in the interest of both firm and regulator, though the firm may not set complain barrier to the minimal possible level. Therefore, it provides a rationale for existing regulations which aim at reducing complain barriers. Our analysis also suggests that such regulations are the most important in contexts where customers expectation is low, or firms are of low reputation.

This model also sheds light on the legal intervention in Europe. The legal development on customer complaint in European countries since 1990s focuses mainly on transferring the burden of proof from complaining customers to the firm. The directive on product liability and safety issued around 1990 required the firm to use accepted means of defense to convince the court, otherwise she will be held liable (de Ruyter and Brack, 1993). This effort could be understood as public intervention aiming at reducing complain cost on customers, which in general enhance the welfare, though the extent may vary across industries and firms.

4.2 Predictions about complaint management in practice

Because Our model is highly stylized, it's difficult to use it directly to account

for any variants in complaint management in field. Particularly, since we focus on corrective action as public good and assume unobservable roots of complaint, and we limit model to 2-customer case, our framework could neither capture some other features of complaint management like direct reward or private compensation for loss, nor be interpreted plainly as the responsive policy in practice. However, beyond the normative implications it provides, this model still could make some predictions about complaint management, which more or less are consistent with practices. We summarize the differences of these two mechanisms in Table 1.

Items	A	P
π		High
Optimal communication cost	D^*	$(\frac{pq(1-q)}{(1-p)q+p(1-q)}, \frac{pq^2}{(1-p)(1-q)+pq})$
Collapse likelihood	$p(1-q\sigma_C^*)^2$	$p(1-q^2)$
Complaint Rate	Low	
Complaint/Dissatisfaction rate	$\sigma_C^* < 1$	1
NO. equilibria	1	Many
Exit	No	Yes when $\omega > \Pr(\theta = 1 \mid s = 0)$

Table 1. The relative performance of mechanism A and P

Though comparative statics is risky when there are multiple equilibria, we still could focus on some cases where one mechanism is more likely to be chosen, like the limit case of parameters.

4.2.1 Case I: standardized product industry

q, the informative signal, has a natural interpretation as quality variants, which is higher in service industry, but lower in product industry. Therefore, to account for those standardized products we should let $q \to 1$ and examine this limit case.

On one hand, the communication cost interval to have fully-revealing equilibrium under passive responsive mechanism, is $(0, 1)$. On the other hand, under active responsive mechanism the interval for fully-revealing equilibrium disappears, mixed-strategy equilibrium occurs for any $D \in (0, 1)$. Due to the diminishing noise, customer becomes almost perfect informed about the true state, as well as his opponent's signal. Hence the probability weights attached on either game Γ_{BG} or Γ_{GB} vanish, and Γ_{BB} becomes significant. However, under active responsive mechanism Γ_{BB} is anti-coordination game, whose unique symmetric Nash equilibrium is mixed-strategy equilibrium, while under passive responsive mechanism Γ_{BB} is a coordination game. Because vanishing strategic uncertainty facilitates coordination, as the literature in global games suggests (Carlsson and van Damme, 1993, Morris and Shin, 2003), both complain becomes the unique equilibrium in Γ_{BB}. This equilibrium is the best for both the firm. Therefore, a testable prediction is that among standardized products industries, if the competition is not too severe, then the firm would like to choose passive responsive mechanism, otherwise active responsive mechanism is likely to be selected. Since in this limit case the size of communication cost matters little, the main difference between these two mechanism is complaint/dissatisfaction ratio, In practice

this prediction implies that monopolist firm in standardized product industry has higher complaint/dissatisfaction ratio, while this indicator is low in competitive environment.

This profit difference $\triangle\pi$, however, diminishes as customer becomes perfectly informed and the customer's expectation becomes extremely high. Thus for high reputation firm within standardized product industry ($q \to 1$), the profit loss due to active responsive mechanism is quite small. On the other hand, as we have shown before, active responsive mechanism ensures unique equilibrium and is robust to competition. Hence, our model predicts that active responsive mechanism is more tempt for reputed firm in competitive standardized product industry, in which fully-revealing equilibrium won't emerge. Consequently, high reputation firm in this industry has low complaint/dissatisfaction rate, and vice versa.

4.2.2 Case II: firm's reputation

We have shown that in general multiplicity of equilibria generates the observed variety of customer complaint management. Since our highly stylized model just examine two-customers context, and we still know little about detailed responsive decision rule in real world, we are not able to connect these practices to the mechanisms examined in our framework directly, thus testable predictions on this respect are difficult to be examined. We may turn to other variables that have more natural interpretation, and perhaps are easily to observe, like complaining barrier or firm's reputation (p), to generate testable predictions.

Because D^* may locate into the cost interval to guarantee fully revealing equilibrium under passive responsive mechanism, we could not infer the mechanism choice by the size of complain barrier. However, comparative statics of D with respect to p reveals that under these two mechanisms, these cost intervals move to different directions. Particularly, D^* is reduced as long as firm's reputation decreases, since low reputation firm is more vulnerable to losing customer due to the sharp change in participation constraint, information becomes more valuable. Therefore, the profit-maximization firm facing low customer expectation would like to encourage the complaint from dissatisfied users by reducing the communication cost. However, under passive responsive mechanism, either $\frac{pq(1-q)}{(1-p)q+p(1-q)}$ or $\frac{pq^2}{(1-p)(1-q)+pq}$, the lower and upper bounds in (3) on truthful equilibrium, decreases whenever firm's reputation increases, and coincides when $p \to 0$ (thus fully-revealing equilibrium disappears). Therefore, even though $D^* \in \left(\frac{pq(1-q)}{(1-p)q+p(1-q)}, \frac{pq^2}{(1-p)(1-q)+pq}\right)$ may hold, as reputation changes these values finally diverge. If we consider

firm's reputation as firm-specific characteristic, and variant of quality q as industry-specific characteristic, the prediction by this observation thus is that complain barriers among high reputation firms within the similar industry are cluster on two extremes. Some firms may be trapped into partially revealing equilibrium under active responsive mechanism, which generates the observation of low complaint/dissatisfaction ratio and high complain barrier. Other firms may successfully induce fully-revealing equilibrium with high complaint/dissatisfaction ratio and low complain barrier. Given the outside option, the higher the reputation are those firms, the more divergence presents.

4.3 Policy reform

Marketing research identifies two most common objectives of complaint management: to restore customers' satisfaction, and to provide management with valuable information. Basically two courses of action in complaint management practice are employed to achieve these objectives. On one hand, many firms attempt to minimize the number of complaints (TARP, 1979, Fornell and Westbrook, 1984). On the other hand, Fornell and Wernerfelt (1987, 1988), and particularly Fornell (2007) argues that it's more advantageous to maximize the number of dissatisfied customers who complain. Our framework sheds light on these two views. In terms of our work, the former practice corresponds to active responsive mechanism where semi-separating equilibrium emerges, while the latter proposal indeed could be understood as a shift to a passive responsive mechanism with fully-revealing equilibrium, in which all dissatisfied customers complain. This model provides a rationale for Fornell's suggestion, and in effect nests those two practices on customer complaint management. In our view, the former practice represents the prevalence of suboptimal but robust mechanism, which is characterized by excessive complain barrier and generates low complaint/dissatisfaction ratio. As we have shown, fully-revealing equilibrium will be implemented by the profit-maximization firm only under passive responsive mechanism, which is far from robust though Pareto-dominance.

Fornell's proposal considers this switch of equilibria mechanism choice as entirely upon the decision of firm, however, as we indicated, the beliefs of customers and the market environment also matter for this jump. To understand under which condition this reform works, namely fully-revealing equilibrium emerges when mechanism switchs, evolutionary game theory provides useful tools since it address the stable behavior of rational agent in long-term adjustment process.

Evolutionary game theory suggests that mixed-strategy equilibrium is not

ESS in coordination game in the presence of replicator dynamics (Weibull, 1995) or learning dynamics (Echenique and Edlin, 2004), thus we focus on the pure strategy equilibrium under passive responsive mechanism. The question of interest is starting from the optimal active responsive mechanism (thus mixed-strategy equilibrium occurs), the firm suddenly changes to passive responsive mechanism with the same communication cost, what kind of equilibrium behavior will those consumers converge to? The answer depends on the initial position of equilibrium value σ_C^*. Given D_A^* and switch to new mechanism P, we could obtain mixed-strategy Nash equilibrium value σ_C. If the initial value $\sigma_C^* > \sigma_C$, then the behavior of dissatisfied customer would end up to $\sigma_C = 1$, namely separating equilibrium occurs. Otherwise always silence becomes stable. Because exit is not used under active responsive mechanism, it wouldn't be considered by consumer in adjustment process.

Using Proposition 5 and the fact that in the mixed-strategy equilibrium under passive responsive mechanism $\sigma_C = \frac{(1-p)(1-q)+pq}{pq^2}D$, we could find the condition that desirable equilibrium is the outcome of such adjustment process. By Proposition 5, if $D_A^* = \frac{pq}{(1-p)(1-q)+pq}\frac{(1-q)\left[(1-p)(1-q)^2+pq^2-q^2\right]F}{\left[(1-p)(1-q)^2+pq^2\right]F-2pq^2V}$, namely the competition pressure is not severe, then straightforward calculation shows that truth-telling equilibrium is basin of attraction under policy reform if and only if

$$\left[(1-p)(1-q)^2+pq^2-q^2\right]\frac{1-2q}{q}F < q(F-2pV)$$

Otherwise, when $D_A^* = 1-\omega$, $\sigma_C > \sigma_C^*$ always holds. Therefore, fully revealing equilibrium is the outcome of replicator dynamics under cutthroat competition.

In our example 6, under $D_A^* = 0.198$ new passive responsive mechanism would give complaint/dissatisfaction ratio as $\sigma_C = 0.31$, which is smaller than σ_C^*. Thus fully-revealing equilibrium would eventually emerge in adjustment process, and the policy switch suggested by Fornell would succeed.

4.4 The role of competition

In "*Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States*", particularly chapter 5, Albert Hirschman pays substantive attentions to customer complaint, and conjecture that competition may serve as collusive tool among firms to avoid responding to the voices of customer. On the consumer side, dissatisfied clients may turn to the available outside option quickly, therefore lack the motivation to convey information to the firm. On the firm side, insufficient volume of voice has tiny influences on

"lazy" monopoly, so she may welcome competition to some extent. For example, the availability of telegraph and telephone makes the shortcoming of the mail service more tolerable, thus indeed permits the Post Office to exploit its customers. This view reflects the conflicts between exit and complain, moreover, competition and voice, as the alternatives for recuperation.

In our work competition pressure affects complaint management via two ways. First, it affects the mechanism choice, as we shown in Part 3, due to the divergence between ex ante participation constraint and interim participation constraint, the optimal mechanism becomes particularly non-robust under severe competition (high ω), which means that extremely undesirable outcome may arise in equilibrium. Therefore the cautious firm may turn to suboptimal mechanism. We refer to it as *decision rule selection* effects, the more severe the competition, the less likely the firm selects optimal decision rule, and the more likely excessive complain barrier is implemented. Second, though suboptimal mechanism is immunity to exit, competition pressure works on limiting the choice of complain barrier, because of $1 - D > \omega$ by Condition 2. Thus the firm could not choose D arbitrarily on the basis of quality variation and reputation, instead, $D \in (0, 1 - \omega)$ must be respected. We name this as *limit complain barrier* effect, the larger the outside option ω, the lower the complain barrier D. Therefore, as regard to the argument of Albert Hirschman, we have indicated that in general the firm would select the inefficient suboptimal complaint management mechanism as response to increasing competition pressure, since under optimal mechanism informed dissatisfied customer would easily found out the substitutes, thus he lacks the incentive to transmit information to the firm. However, increasing competition also limits complain barrier, thus the firm even may not be able to implement the profit-maximization communication cost level under suboptimal mechanism. Which effect dominates varies from case to case, and the overall effects of competition on complaint management are still ambiguous[18].

4.5 Discussion

In this subsection we briefly discuss the robustness of the mechanism selection, in other words, we want to see whether the relaxation of some assumption would significantly change our results.

We assume that the outside option shrinks from ω in the first period to zero in the second period, which looks too restrictive. A more realistic

[18] We have some preliminary speculation that the relationship between competition pressure and complaint management may be nonlinear. Increasing competition from low level may deterioriate complaint management by reduce the volume of complaints on monopoly, while severe competition works mainly through limiting complain barrier.

formulation will be setting $\omega' < \omega$ as the available outside option in the period 2. Hence, customer may compare ω' with the expected payoff in Γ_{ij}, for instance, in Γ_{BB} now $u(K,K) = \max\{\omega', \underline{u}\}$. If $\omega' < \underline{u}$, then it doesn't affect the equilibrium behavior, otherwise the payoff to strategy may change accordingly. However, the basic results about the characterization of those two mechanisms won't change much.

It's presumed that the firm could commit to the announced responsive mechanism, which may not be realistic since in practice there is rarely any announced threshold of complaint that trigger the corrective action. Once we give up full commitment the renegotiation problem inevitably arises. In particular, the active responsive mechanism becomes incredible since corrective action is not the optimal response in the presence of one good signal and one bad signal. Thus the mechanism in work could only be the passive responsive mechanism. And as we have shown, this rule, though could implement the optimal outcome, is not robust, so lack of commitment indeed makes the firm worse.

Some readers may consider the robustness of active responsive mechanism is the artifact of two-customer formulation. In real world perhaps no firm would implement the costly corrective action upon a single complaint, thus coordination problem among consumers always emerges. However, the basic trade-off underlying the mechanism choice here and in practice is always the trade-off between information aggregation and information extraction. Optimal outcome may require high cutoff level of complaints, either explicitly or implicitly, in which the single complaint has little impact on the final decision, thus customers lack the incentive to report and exit becomes a temptation. On the other hand, reducing this threshold increases the customers' willingness to communicate, consequently make exit less attractive and undesirable equilibrium outcome less likely, on the expense of too frequent corrective action. In summary, we speculate that the main positive result that optimal mechanism is likely to be non-robust, thus less likely to be selected by the firm, holds even in the case of many customers. Similarly, the fundamental issue that the incentive of customers to convey information depends on the decision making process maintains whenever the firm is also has informed.

We have restricted the attentions in symmetric equilibrium, which gives rise to the unique implementation under active responsive mechanism. Though we think this concentration is reasonable since it's quite plausible that customers act on the basis of their own types, it may lack theoretical justification. Particularly, evolutionary force makes the symmetric mixed-strategy equilibrium unstable in long run. We investigate the outcome if asymmetric equilibrium is allowed in active responsive mechanism. Therefore, in equilibrium one consumer would never complain, while the other always complains

conditional on bad signal, and the firm could not extract any information from one customers. The inefficient corrective action occurs only in either event BG or GB. The profit to the firm thus exceeds that under fully-revealing equilibrium, and whether it achieves π^* depends on the fine details of environment and technology. However, there is no clear ranking between the possible asymmetric equilibrium outcome and symmetric equilibrium outcome, despite that under passive responsive mechanism all outcomes beside the fully-revealing equilibrium are undesirable, thus the desirable properties of active responsive mechanism would remain.

5 Conclusion

In this paper we cast Exit-Voice Theory into mechanism design approach to address the customer complaint management, which is of practical importance. Our parsimonious model demonstrates the basic trade-off between information extraction and profit maximization in the presence of self-selected informed consumers, thus due to the multiplicity of equilibrium, the optimal mechanism is not robust. Furthermore, we show that suboptimal robust mechanism generates the equilibrium outcome consistent with the observation of low complaint/dissatisfaction ratio. We assess the welfare implication of mechanism selection and suggest the large inefficiency when firm has the full power to decide complaint management system, hence there is space for public intervention on reducing complain barrier. Moreover, we provide some testable predictions and explore the role of competition pressure in complaint management.

In practice the voice from customer about his feeling may include the choice from multiple interval, like Very dissatisfied, Dissatisfied, Normal, Satisfied, Very satisfied, despite the assumption of uniformly negative views here. But we suspect the usefulness of allowing finer partition to express the feeling in this model. Neither misrepresentation problem nor free-rider problem would be eliminated by finer partition, the incentive to exaggerate remains, so it's not expected that fully revealing equilibrium emerges, as Kawamura (2008) demonstrated. He also provides the rationales of binary choice ("Yes" and "No") as communication mode between multiple agents and on decision maker. Moreover, it becomes inevitably arbitrary to define complain/dissatisfaction ratio in the presence of multiple choice.

Our work considers the outside option as given, which is a coarse approximate of competition pressure. It will be of great interest to explicitly formulating market competition. Thus more than one firms would compete for large number of customers, and outside option becomes endogenous vari-

able chosen by the competitor. Moreover, complaint management becomes a strategic variable which may be related to pricing decision, volume of advertisement, and other offensive marketing strategies. This may lead to a unified theory about marketing strategy.

In practice complaint coexists with praise, firm frequently receives the praise from customers. Our model could not accommodate praise since it would not lead to corrective action, thus is strictly dominated action. Moreover, any theories based on rational agent and involved private transfer (like prize) to award praise or complaint inevitably lead to frequent complaint or praise, which is far from the observation about real world. We speculate that we may need to resort to some psychological factors to explain this phenomena, for example, many experimental works have accumulated huge evidences that people is willing to take individually costly action to punish the deviator and maintain cooperation in long term. Thus reciprocity concern matters in the motivation to complain and exit. Furthermore, investigating the role of communication in repeated game could improve our understanding about the role of complaint management in long-run firm-customer relationship, where "loyalty" naturally arises as one equilibrium outcome. We leave this issue for future research.

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