Pre- and Post-Purchase Management of Customer Satisfaction

Dmitri Kuksov and Ying Xie
Washington University in St. Louis

October, 2007

Abstract

Recently, and especially in expanding markets, firms put an extraordinary emphasis on customer satisfaction, sometimes treating it as a superior measure of a company performance to current earnings. While customer satisfaction increases future profits through the effect of positive consumer feedback on future demand, customer satisfaction efforts have a short-term cost. Therefore, a question arises as to what level of customer satisfaction is optimal for the firm when the costs of customer satisfaction are accounted for. This paper explores two strategies in customer satisfaction: pre-purchase management of customer satisfaction through providing a higher expected value for money (i.e., lower price) to the potential customers, and the post-purchase management through providing extra services and/or gifts (not promised at the time of the purchase) after the purchase to the existing customers – and shows that if post-purchase management is not feasible a forward-looking firm should decrease its first-period price if and only if the price history is not observed by later consumers. If post-purchase management is feasible, the firm should use it if the market is growing fast enough. Furthermore, if the market is growing slowly, the firm should both reduce the first-period price and provide extra services and/or gifts after the purchase, while if the market is growing fast, the effect on the price may reverse: the firm may find it optimal to charge higher price in the first period, shifting all its customer satisfaction efforts to the post-purchase management. Additionally, the paper shows that the optimal efforts in customer satisfaction should be higher when the idiosyncratic part of the consumer uncertainty is larger.

Keywords: Customer Satisfaction, Pricing, Uncertainty, Game Theory.

1 Introduction

The ever-increasing pace of technological advances and the evolving marketplace result, partly, in the incentive for consumers to increasingly rely on the outside sources of information in evaluating products, rather than to just rely on own experience. Thankfully, the current technologies, especially the internet, provide plenty of opportunity for information sharing among consumers. But at the same time, as consumers post more and more product ratings and reviews, the amount of available information rapidly becomes too difficult to process, and consumers have to resort to more abstract (summary) measures of reviewer opinions. In particular, the use of customer satisfaction ratings, is one of the popular measures consumers use as an input in their purchase decisions. For example, travel web-sites, such as hotels.com or travelocity, prominently display the average rating that customers have given to each hotel; amazon.com, as well as other internet merchants, display product ratings.

The goal of this paper is to investigate how firms should adapt their strategy in view of the consumer uncertainty and the use of customer satisfaction ratings (CSR) of prior consumers. Specifically, we consider some instruments a firm optimizing long-term profits can use to increase customer satisfaction, and whether (under what conditions) a firm would find it optimal to use these instruments. A trade-off a firm must consider is whether it is more profitable to spend on increasing customer satisfaction now, or spend an equivalent amount in a direct promotion to the later consumers (for example, by a lower price or some other promotion). If the firm decides to invest in customer satisfaction of the current customers, it should decide how to allocate this budget across different types of efforts to satisfy customers.

In order to achieve this goal, we must first hypothesize what contributes to customer satisfaction, and how customer satisfaction ratings observed by later consumers are formed. While some consumer reports provide reviews of product quality, many customer satisfaction ratings measure the overall customer satisfaction with the product or the purchase of the product. Even when customers report the product quality, they still often report it in the context of price they paid. For example, a home theater projector (Optoma HD70, about $800 in July 2007) review at Amazon.com states "so it's not the greatest projector ever made... but it is easily the best for the price". The customer then rates it as 5 (out of 5) stars. Note that even if the prospective customer reads all the 30 reviews, she will still not be able to correct for the effect

of price, because the review never states the price paid through the entire several-paragraph text. This is not an uncommon situation with online reviews. In fact, Amazon.com guideline of how to write a review explicitly states that a review should NOT include "availability, price, or alternative ordering/shipping information" (see http://www.amazon.com/gp/customer-reviews/guidelines/review-guidelines.html). It is also a frequent scenario that a high-end product is rated less because it is too expensive. An implication is that while an objective quality rating should not depend on the price, the (overall) customer satisfaction can be affected by the price. Furthermore, since many products have very large number of reviews (for products which have any reviews, several hundred reviews are not uncommon), an aggregate product *rating* rather than individual reviews may be playing an important role as well.

The overall product rating reported is usually the simple average of individual product ratings, which are ratings of satisfaction by each customer on a discrete scale. For example, Amazon.com, hotels.com, Overstock.com, and SmartBargains.com ask for consumer ratings on a scale of one to five, while ebay.com and shopping.yahoo.com has merchant ratings as positive vs. negative, with "x% positive" being the aggregate measure. Overstock.com and SmartBargains.com, in addition to the product rating on a scale of one to five, have a "bottom line" rating of "would you recommend this to a friend," which is a binary rating. We adopt the latter (binary) rating example as a building block of our model mostly due to its analytical tractability.

For the purpose of our model, we therefore assume that a customer is satisfied if he/she does not regret having made the purchase, i.e., to answer the question "Are you satisfied with the product/purchase," the customer responds "yes" if she does not wish she did not make this purchase. Future consumers then have access to the aggregate measure of these binary ratings of satisfaction: the percentage of people who rated their satisfaction as positive. Note that in this binary rating context, this summary measure is the same as the whole distribution of ratings. To consider the short-term vs. long term profit maximization, we develop a two-period model where the second-period consumers observe the above customer satisfaction rating of the first-period consumers. As observability of price history may or may not be easy, we consider both scenarios: when price history is observed, and when it is unobserved by the second-period consumers. For example, when second period demand is coming from mostly the same pool of consumers as the first-period demand, the assumption of price history observability may represent the reality

better. On the other hand, when the set of first-period and second-period consumers are different, it may be more natural to assume that price history is not observed. The latter situation may be more applicable for durable goods or when demand is rapidly growing.

The above structure of customer satisfaction formation leads to the following two possibilities for a firm to affect customer satisfaction ratings: First, the firm may decide to reduce price, so that the current consumers would perceive the product as providing higher overall value (relative to the price paid), and would not regret purchasing even if the products fails to meet expectations. Second, the firm may engage in post-purchase activities as to raise *existing customer* (rather than consumer who is a *potential* customer) satisfaction. One of the major differences in the outcomes of these two strategies is that the pre-purchase activities would draw additional customers, while the unannounced post-purchase activities will not.[1] The question then becomes whether the firm wants to attract the marginal customers, who have a higher chance of turning out to be dissatisfied than an average (non-marginal) customer, or rather first make sure that people who buy value the product a lot, and then give something extra unexpectedly. An example of such post-purchase effort may be a firms' willingness to accept product returns beyond the return policy, since it may serve the function of reducing the number of the dissatisfied customers.[2]

The main results we obtain are the following. First, if the firm can not use post-purchase efforts to increase customer satisfaction or chooses not to use them, then it should set its first-period price below the single-period optimizing price if the price history is unobserved by the later consumers. This lowered first-period price is observationally similar to the penetration pricing strategy. Therefore, the effect of customer satisfaction ratings should be viewed by a firm as a positive in considering market penetration strategy in this case, and may help understand why firms often choose the penetration pricing strategy when introducing products that have high and growing demand.[3] On the other hand, if the price history is observed by the later consumers (and the later consumers are rational enough to see how the price affects customer satisfaction rating), the firm should not want to price any different from the single-period profit maximizing

[1] Even if consumers expect the post-purchase activities, the actual firm's decision on them does not change the demand from initial consumers.

[2] Ross stores (a growing discount apparel chain), for example, had a policy to accept returns well beyond the 30-day money back term printed on the receipt.

[3] If the demand for the product is very low, it may not be sold in enough quantity for product ratings to be easily observable.

price.

Second, the firm can only find it optimal to use post-purchase efforts to increase customer satisfaction if the market is growing. In other words, growing market is a necessary condition for the firm to be interested in post-purchase customer satisfaction activities.[4] If it is optimal for the firm to engage in the post-purchase customer satisfaction efforts, then when the price history is observed, the firm will want to set the first-period price lower than the single-period optimal price (which is different from the result when the firm did not engage in the post-purchase customer satisfaction activities and the price history is observed). Furthermore, the optimal amount of price reduction in this case is even higher than in the case of unobserved price history but when post-purchase efforts were not an option.

Third, when the price history is unobserved and the firm is able to use post-purchase effort, the firm may find it optimal to actually set the first-period price *higher* than the single-period optimal profit maximization would suggest. This happens when the market grows fast enough, and the reason for it is that although the higher price decreases customer satisfaction rating (consistently with the first result), it also decreases demand and therefore, makes it easier to manipulate the average customer satisfaction rating through the post-purchase activities.

In addition, we consider how the amount of idiosyncratic uncertainty (i.e., uncertainty about the part of the value that is independent across consumers) affects the results, and show that a higher uncertainty of this kind results in higher incentives for the firm to engage in customer satisfaction activities (both through price and post-purchase effort). While one may have expected such a result for the amount of uncertainty about the part of the value that is correlated across consumers, one may find it surprising that the firm would have a higher incentive to spend on customer satisfaction when the independent-across-consumers part of the valuation is higher.

The rest of the paper is structured as follows. The following subsection discusses the existing literature related to customer satisfaction and the relation of our paper to that literature. Section 2 formally defines the two-period model we discussed above. Section 3 solves this model and derives the optimal pricing and post-purchase activity level under different information structure

[4]This can be viewed as consistent with observed firm behavior: for example, Home Depot has been a leader in customer satisfaction in the 1980's and early 1990's, when do-it-yourself home improvement was a growing trend. In the new millennium, with slowed market growth within that segment, Home Depot became notorious for shirking on customer service.

scenarios. In particular, it derives the results stated above. Section 4 discusses how our model relates to consumer loyalty. Section 4 further discusses the model implications and interpretation of the results and concludes.

1.1 Relation to Prior Literature

Existing literature on customer satisfaction has either concentrated on considering optimal contracts to align incentives between the channel members given a particular response function of the future demand to current customer satisfaction efforts (e.g., Hauser et al. 1994, Simester et al., 2000, Chu and Desai, 1995), or has studied the determinants of customer satisfaction (see, e.g., Anderson and Sullivan, 1993; Oliver 1980). In particular, Hauser et al. (1994) consider the optimal incentives a firm should provide its employees to exert optimal effort in customer satisfaction, Simester et al. (2000) study the financial impact of customer satisfaction improvement program in the United States and Spain, and Chu and Desai (1995) consider how to coordinate the manufacturer-retailer channel in providing optimal effort to increase future demand. This paper, on the other hand, considers, in a particular setting, how the future demand should depend on the customer satisfaction rating, and which mechanisms should the firm employ to raise the customer satisfaction rating under different market conditions. Chen and Xie (2005) examine how a firm should respond to product reviews, while this paper investigates how firm should adapt its marketing strategy to affect product ratings.

The large literature on the antecedents of customer satisfaction generally finds that customer perceived (experienced) quality and expectation disconfirmation are the two major factors determining customer satisfaction. In that literature, perceived quality is usually defined as the "utility derived from consumption" and is "analogous to Thaler's (1985) notion of acquisition utility" (see Anderson and Sullivan, 1993, p. 128, for both quotes).Furthermore, satisfaction is also affected by the choice alternatives (Inman et al. 1997), i.e., perceived quality is a *relative* value to the other choice options.In our paper, similarly to the previous literature, we formulate customer satisfaction as driven by the experienced (perceived) value of the product relative to price, where the value should be thought of as relative to the value of other choices available to the consumer.

Another stream of literature has investigated the consequences of customer satisfaction. For

example, Danaher and Rust (1996) empirically show that customer satisfaction has a positive impact on the word of mouth, which, in turn, has a positive impact on sales and market share; Hogan et al. (2003) show that word of mouth is more important during the early part of the product life cycle, because the early adopters' word of mouth affects the growth rate of product adoption; and it has been well established (e.g., Zeithaml et al. 1996, Anderson et al. 2004) that customer satisfaction is positively correlated with the firm's financial future. Our theoretical analysis is consistent with the results of the above studies and suggests that a higher expected market growth leads the firm to modify its decisions as to increase efforts in customer satisfaction. Therefore higher customer satisfaction may also be a consequence of the manager's expectation of future category growth, which in turn may be correlated with the firm's future profitability. The existing empirical results are thus also consistent with our theory.

In a broader context, this paper also relates to the literature on the effect of product uncertainty and the firm effort to convey a desirable value perception to the consumer. Some examples in the marketing literature include Kalra et al (1998), considering how a firm may use delay in its response to competitive entry to convey that its product has higher quality, Anderson and Simester (1998), considering the informative role of sale signs about the price and future product availability, and Iyer et al (2005), considering the optimal design of communication through advertising. In contrast to the signalling literature (e.g., Milgrom and Roberts, 1986, Bagwell and Riordan, 1991, Desai and Srinivasan, 1995, Zhao 2000, Balachander 2001, etc.), we consider the optimal investment in customer satisfaction in the absence of signalling motives, by explicitly concentrating on the case when both the firm and the consumers are unsure of the value they will obtain from the product/service. The firm's behavior in our context resembles "signal-jamming" (Fudenberg and Tirole, 1986): to interfere with rational consumer inference from customer satisfaction ratings as to bias it upwards. In the equilibrium, rational consumers adjust for this behavior and are not biased. However, as we will see in Section 3.3, in the equilibrium, rational consumers may be less sure of the true value of the product if the firm uses post-purchase effort to increase the customer satisfaction rating.

2 Model Setup

A firm is selling one product to consumers in two time periods. The total mass of consumers in the first time period is normalized to 1, and in the second time period is M. Each consumer i of either time period t has a single-unit demand and has the utility of

$$U_i = h_i + \eta + \varepsilon_i - p_t,$$

where $h_i + \varepsilon_i$ is the consumer-specific part of product valuation, η is the consumer-independent part of the valuation, which may be interpreted as the correlation of preference shocks across consumers, and p_t is the price of the product at time t. We assume that the distributions of h_i and ε_i are independent of each other and across consumers. Consumers know h_i prior to purchase, but only learn the full utility after the purchase. Thus, the utility of a product has a known (to the individual) component h_i and the uncertain component $\eta + \varepsilon_i$, where the uncertain component is correlated but different across individuals.[5] The consumer utility "error term" $\eta + \varepsilon_i$ can be thought of as one non-separable variable, but it is modelled through the sum of independent and common across consumers components to capture the possibility that consumer experiences, while different between consumers and/or consumption occasions, tend to correlate across consumers.

We will interpret consumer demand in the two periods as coming from disjoint sets of consumers. As a normalization, assume also that η and ε_i are mean-0. Furthermore, to be specific and for analytical tractability, assume h_i is distributed uniformly on $[0, V]$ for some $V > 2 + 2\varepsilon$, ε_i is distributed uniformly on $[-\varepsilon, \varepsilon]$, and (the prior belief on η is that) η is distributed uniformly on $[-1, 1]$.[6]

Consumers maximize their expected utility. For simplicity, we assume that in the first period, neither the firm nor consumers know η, so that a first-period consumer's expectation of η and

[5] While we do not explicitly have the "brand intercept" term standing for the part of the utility that is certain and correlated across consumers, the average of h_i across i is not normalized to zero and therefore makes such a term redundant.

[6] Setting the range of potential common shock value to 2 is without loss of generality as it reflects a multiplicative-scalar normalization of the utility function and the monetary units. Restricting V to be high enough (V higher than the sum of the ranges of η and ε) simplifies calculations as it requires existence of at least one consumer who would be satisfied at any realization of η and ε_i given the equilibrium price, which we will show to be at most $V/2$. We do not assume that $\varepsilon > 0$; in other words, we allow the possibility that there is no individual-specific random error term in the consumer post-purchase satisfaction (i.e., that $\varepsilon = 0$). However, considering $\varepsilon > 0$ will allow us to draw additional comparative statics implications.

ε_i is 0.[7] After the purchase, first period customers may provide satisfaction feedback in which they report whether they are satisfied or not with the purchase. We assume that a first-period customer gives a rating of 1 ("satisfied") if post-purchase, having experienced the true value of the product to him/herself, the consumer does not regret purchasing the product (i.e., does not wish he/she chose the no-purchase option).[8] All or a fraction of first-period consumers post their ratings, so that the second-period consumers know the fraction of the first-period consumers who were satisfied, which we will call "the customer satisfaction rating" or by its acronym CSR.[9] While the first period's consumers have no further information (besides priors), the second period consumers use Bayesian updating to update their expectation of the uncertain value of the product.

Since consumer distribution changes with price, price affects customer satisfaction ratings. Another potential instrument in affecting customer satisfaction rating is to provide an unexpected value to consumers after the purchase.[10] To investigate the relative incentives of using these two instruments that are not cost-driven, we assume that the cost of the value provision is equal to the value created, so that the benefits of equally costly to the firm pre-purchase price reduction and post-purchase effort are equal to the consumer. In other words, providing post-purchase value is equivalent, from the model setup stand-point, to giving money back to consumers. This assumption takes away the incentive to use one vs. the other strategy simply because one of them is less costly to the firm. Note also that the product design would often have already incorporated features that consumers value above the cost. We assume that if the firm provides

[7] It turns out that whether the firm, in the second period, knows the true fit of the product to the market (η) or only this customer rating, is inconsequential, since without possibility of product returns and no future periods only the perceived value matters.

[8] For a more general form of customer satisfaction, and to further capture the effect of expectation disconfirmation, one can introduce a different (higher) weight on expectation disconfirmation ($U - \mathrm{E}U$), which would give an additional incentive for the firm to use post-purchase effort. This would not change main qualitative results on the optimal pricing, but could reduce the threshold of the market growth necessary to make post-purchase efforts optimal.

[9] It could be that the probability of posting a review is higher (or lower) for dissatisfied consumers. However, this would not affect any results if we adopt a rational-expectation assumption that the ratio of probabilities of posting the review given positive and negative satisfaction is known to the second-period consumers.

[10] For example, in the late 1990's, it was a common practice for internet merchant to send a T-shirt or some other free gift with purchase, an extra they did not mention at the time of the order. Consistently with the model predictions, established (not growing fast) companies inform the potential consumers of the free gifts with purchase (such as cosmetics brands), while the start-ups (such as emerging online retailers in the 1990's who were expecting to grow fast) sometimes do not.

such a value, it is unexpected by the first-period consumers for the purpose of their purchase decision, but can not be negative (due to legal constraints).[11] We consider the possibilities that the firm may or may not be able to provide post-purchase value to consumers. If the firm provides post-purchase value (service) s_t, customer utility then becomes

$$U_i = h_i + \eta + \varepsilon_i - p_t + s_t. \tag{1}$$

We assume that second-period consumers do not observe s of the first period, but form rational expectations of it, while the first-period consumers do not expect s. The point of providing s after the purchase is to make it unexpected. Empirically, exceeding expectations, i.e., providing unexpected surplus, has been shown to be beneficial for the investor stock valuations (see Bartov et al. 2002) and has been suggested as a possible strategy by the marketing literature (e.g., Oliver et al. 1997, Rust et al. 1999). Section 3.3.4 discusses how the implications change if the first-period consumers have rational expectations on s. We normalize the marginal cost of the product to 0, assume that the firm can set time-dependent, but not consumer-dependent p_t and s_t, and use subgame-perfect Nash equilibrium as the solution concept.

3 Model Analysis

Since customer satisfaction rating depends on the common component η, the second-period consumers update their expectation of the common component η through their (rational) beliefs about how η affects the customer satisfaction rating. Since ε_i is distributed independently across consumers, the second-period consumers use 0 for the expected value of ε_i, just as the first-period consumers did.

The number of satisfied consumers depends on the price, since if the price is lower, there are more consumers who are not marginal in their buy/not buy decision. Hence, one instrument a firm may use in affecting customer satisfaction rating is the first-period price. The effect of the first-period price on second-period consumer expectations of η will depend on whether the second-period consumers observe the first-period's price or not. We will consider both possibilities. We will then consider the possibility of post-purchase activities to increase customer satisfaction

[11] Section 4 discusses the possibility and implications of this decision being expected by the first-period consumers. In Section 3, we also provide the interpretation of the solution when $s \geq 0$ is a binding constraint.

under observed and unobserved price history, and see when the firm would optimally use these and how the observability of the price history changes implications for optimal pricing.

To simplify the analysis, we assume that $\varepsilon < 1$. However, Section 4 discusses what would change when $\varepsilon > 1$ (and shows that main results are the same). The interpretation of $\varepsilon < 1$ condition is that it is possible (e.g., when η is at the highest level) that the product will not come short of expectations for any consumer.

We start the model analysis by considering, in Section 3.1, the benchmark case of the firm maximizing single-period profits in each period, and show that this case leads to the same outcome as when the firm maximizes the full two-period profit when the first-period price is observed by the second-period consumers and the firm is unable to provide post-purchase value. Section 3.2 considers the case when the firm is only able to use price to affect the customer satisfaction rating, but when the first-period price is not observed by the second-period consumers. Section 3.3.1 considers the case when the first-period price is observed by second-period consumers, but the firm is able to provide unobserved, but expected by the second-period consumers, post-purchase value to the first-period consumers. Section 3.3.3 considers the case when the first period price is not observed by the second-period consumers, and the firm may use post-purchase value to affect customer satisfaction ratings. Finally, Section 3.3.4 discusses how the implications would change if the first-period consumers had rational expectations of the post-purchase effort.

3.1 Benchmark Case: Single-Period Profit Maximization

First, consider single-period profit maximization. Since s_t, being unobserved by the consumers of period t, does not affect the demand. Therefore, even if it is a decision variable, the firm will set $s_t = 0$ in each period. Note that by the same rationale, a forward looking firm will also set $s_t = 0$ during the final period. The expected consumer valuation in the first period is h_i, which is uniformly distributed on $[0, V]$. Therefore, the optimal price is $p_1 = V/2$ leading to the first period profits of $V/4$ with realized demand of $1/2$.

We have that a first-period customer rates the product at 1 if and only if $h_i + \eta + \varepsilon_i \geq p_1$, where h_i is uniformly distributed on $[p_1, V]$ (given that the consumer purchased at price p_1), and ε_i is uniformly distributed on $[-\varepsilon, \varepsilon]$. Therefore, the overall customer satisfaction rating is the

probability (across consumers) of the rating being equal to one given purchase, i.e.,

$$\mathrm{CSR}(\eta, p_1) = \mathrm{Prob}(h_i + \eta + \varepsilon_i \geq p_1 \mid h_i \geq p_1). \tag{2}$$

Derivation of this conditional probability for each possible value of η results in the following expression of the customer satisfaction rating (see the Appendix for details):

$$\mathrm{CSR}(\eta, p_1) = \begin{cases} 1, & \text{if } \eta \geq \varepsilon; \\ 1 - \frac{(\varepsilon-\eta)^2}{4\varepsilon(V-p_1)}, & \text{if } \eta \in (-\varepsilon, \varepsilon); \\ 1 + \frac{\eta}{V-p_1}, & \text{if } \eta \leq -\varepsilon. \end{cases} \tag{3}$$

Therefore, customer satisfaction rating, as a function of η given price p_1, is continuously and monotonically increasing in η. However, it is only strictly monotone when $\eta < \varepsilon$. Therefore, if the second-period consumer knows p_1, which is the case when the second-period consumer observes first-period price directly or can derive it through his/her knowledge that the firm is a profit-maximizing agent, the second-period consumer can backup η from CSR precisely as far as CSR < 1. On the other hand, if $CSR = 1$, the second-period consumer only deduces that η must be above ε. In this case, updating his/her prior belief that η is distributed uniformly on $[-1, 1]$, the second-period consumer arrives at the posterior belief of η as uniformly distributed on $[\varepsilon, 1]$, and thus, uses $(1 + \varepsilon)/2$ as the expected value of η.

Thus, the second-period consumer expected valuation of the product is $\mathrm{E}\hat{\eta}(\eta) + h_i$, where

$$\mathrm{E}\hat{\eta}(\eta) = \begin{cases} (1+\varepsilon)/2, & \text{if } \eta \geq \varepsilon \\ \eta, & \text{if } \eta \leq \varepsilon \end{cases} \tag{4}$$

is her expectation of η as a function of its actual value. Therefore, the optimal second-period price is $(V + \mathrm{E}\hat{\eta}(\eta))/2$ leading to the demand of $M(1 + \mathrm{E}\hat{\eta}(\eta)/V)/2$ and profit

$$\pi_2(\eta) = \frac{M(V + \mathrm{E}\hat{\eta}(\eta))^2}{4V}.$$

The expected profit in the second period over all realizations of η is

$$\begin{aligned} \mathrm{E}\pi_2 = M \int_{-1}^{1} \frac{(V + \mathrm{E}\hat{\eta}(\eta))^2}{8V}\, d\eta &= M \int_{-1}^{\varepsilon} \frac{(V+\eta)^2}{8V}\, d\eta + M \int_{\varepsilon}^{1} \frac{\left(V + \frac{1+\varepsilon}{2}\right)^2}{8V}\, d\eta \\ &= M\left(\frac{V}{4} + \frac{(1+\varepsilon)(7 - 4\varepsilon + \varepsilon^2)}{96V}\right). \end{aligned} \tag{5}$$

Note that the second-period (and the total) expected profit is increasing in ε. This is because higher ε allows the second-period consumers to be more certain about η, and the firm may adjust prices based on the consumer expectations.

Now consider forward-looking firm maximizing joint first- and second-period profits and consumers in the second period being able to observe first-period price. Although CSR depends on p_1, Equation (4) shows that the expectation $\mathrm{E}\hat{\eta}(\eta)$ does not depend on p_1 as far as p_1 is observed by the consumers prior to forming expectations. This is because the range where CSR can be inverted (solved for η), and the expected η given that CSR can not be inverted, do not depend on p_1. Therefore, forward-looking firm will not find it optimal to adjust first-period price away from the one optimal for single-period profits. Note that this result relies on the rational consumer behavior in the following sense. Decreasing p_1 increases CSR. Therefore, if the second-period consumers would be forming expectations of η without taking into account all information available (namely, the first-period price), their beliefs about η may have been updated upwards if the firm where to reduce p_1. This would give the firm incentive to reduce the first-period price. However, if the second-period consumers realize that the increased CSR is due to lower prices, then the incentive to reduce price disappears.

3.2 Affecting the Customer Satisfaction Ratings Pre-Purchase

We now consider the the case when the second-period consumers do not observe the first-period price, but form rational expectations of it from expecting two-period profit-maximizing behavior of the firm. In this section, we do not allow the possibility of the firm affecting customer satisfaction through any post-purchase actions.

Although a second-period consumer does not observe the first-period price, he/she should have expectations of the first-period price, which should be correct in the equilibrium. Let $\hat{p}$ be the first-period price that the second-period consumer expects (and which is equal to the actual first-period price as far as the firm does not deviate from the equilibrium). Then, inverting Expression (3) while assuming that $p_1 = \hat{p}$, a second-period consumer forms the expectation of η as follows:

$$\mathrm{E}\hat{\eta}(CSR) = \begin{cases} \frac{1+\varepsilon}{2}, & \text{if CSR=1;} \\ \varepsilon - 2\sqrt{\varepsilon(1-\mathrm{CSR})(V-\hat{p})}, & \text{if } 1 - \frac{\varepsilon}{V-\hat{p}} < \mathrm{CSR} < 1; \\ (\mathrm{CSR}-1)(V-\hat{p}), & \text{otherwise.} \end{cases} \tag{6}$$

If the second-period consumers correctly expect the first-period price, then, as already discussed in the previous section, they precisely deduce the true η as far as CSR < 1. However, if the firm (deviating from the equilibrium) sets price p_1 in the first period and p_1 is not equal to the

second-period consumer expectations, consumer expectation of η will not be equal to η even when CSR < 1. In fact, the second-period consumers, solving Expression (3) for expectation of η while assuming that $p_1 = \hat{p}$, arrive at the following expected η as a function of η:

$$\mathrm{E}\hat{\eta}(\eta) = \begin{cases} \frac{1+\varepsilon}{2}, & \text{if CSR=1;} \\ \eta + (\varepsilon - \eta)\left(1 - \sqrt{\frac{V-\hat{p}}{V-p_1}}\right) = \varepsilon - (\varepsilon - \eta)\sqrt{\frac{V-\hat{p}}{V-p_1}} & \text{if } 1 - \frac{\varepsilon}{V-\hat{p}} < \text{CSR} < 1; \\ \max\{-1, \eta + \frac{p_1-\hat{p}}{V-p_1}\eta\} = \max\{-1, \frac{V-\hat{p}}{V-p_1}\eta, \} & \text{otherwise.} \end{cases} \tag{7}$$

The optimal second-period price given the second-period-consumer expectation of η as $\mathrm{E}\hat{\eta}$ is still $(V + \mathrm{E}\hat{\eta})/2$, resulting in the second-period demand $M(V + \mathrm{E}\hat{\eta})/(2V)$. Therefore, the expected second-period profit is

$$\begin{aligned} \mathrm{E}\pi_2 = M \int_{-1}^{1} \frac{(V + \mathrm{E}\hat{\eta}(\eta))^2}{8V}\, d\eta = \\ = \frac{(1-\varepsilon)(2V+\varepsilon+1)^2 M}{16V} + \frac{2\varepsilon(3V^2 + 6V\varepsilon - 6V\mathcal{F}\varepsilon + 3\varepsilon^2 - 6\mathcal{F}\varepsilon^2 + 4\mathcal{F}^2\varepsilon^2)M}{12V} \\ + \frac{(1-\varepsilon)(\mathcal{F}^4\varepsilon^2 - 3V\mathcal{F}^2\varepsilon + \mathcal{F}^4\varepsilon + 3V^2 - 3V\mathcal{F}^2 + \mathcal{F}^4)M}{12V}, \end{aligned} \tag{8}$$

where we used $\mathcal{F} = \sqrt{\frac{V-\hat{p}}{V-p_1}}$ to make the expression readable. The first-period profit, given price p_1 is $\pi_1 = p_1(V - p_1)/V$, and the total expected profit is $E\pi = \pi_1 + E\pi_2$.

First order conditions on the profit maximum together with the condition that $\hat{p} = p_1$, yield the following equilibrium first-period price (see Appendix for more details in derivation):

$$p_1 = \frac{3V}{4} - \frac{1}{12}\sqrt{9V^2 + [9(1+\varepsilon^2)V - 6]M}. \tag{9}$$

Note that since the second-period consumer expectation on the first-period price are correct in the equilibrium, the second-period consumer expectation of η and the second-period profits in this case are the same as in the previous section. However, the expectation of η and second-period profits would be lower if the firm would be setting the first-period price as in the previous section, but consumers would be expecting the firm to maximize the total profit rather than single-period profit only.

Comparing the prices in the case of this section to the prices in the previous section, one can see that the first-period price is always lower in the case of this section, but the second-period price is the same. Furthermore, the amount of downward distortion of the first-period price is increasing in the consumer idiosyncratic variability of satisfaction (ε) and the market growth rate M. The relative amount of price distortion is decreasing in V. This is not surprising, as η

becomes relatively less important when V is large. However, the absolute level of price distortion is increasing in V.

The following proposition summarizes the main results of this and the previous sections.

Proposition 1. *If the firm does not engage in the post-purchase activities to increase customer satisfaction ratings then:*

1. *If price history is observed by the second-period consumers, the optimal price is set to optimize single-period profits.*

2. *If the price history is not observed by the second-period consumers, the optimal price in the first period is lower than the optimal price for single-period profit maximization (even if $\varepsilon = 0$ and M is arbitrarily small). Furthermore, this downward distortion from single-period profit maximizing price is greater if ε or M is larger.*

The intuition for the downward price distortion is that lowering price increases the total demand and reduces the ratio of consumers that are nearly indifferent between buying and not buying (these consumers may regret the purchase if the uncertain part turns out to be negative) to the consumers who expect a large surplus from buying, and therefore, can not regret the purchase decision.[12] The effect of larger growth rate M on the amount of price distortion is straightforward: if there are more consumers in the second period, it is more important to affect their judgement, but the effect of ε is less intuitive: higher ε imply that the idiosyncratic consumer uncertainty is greater, but not the part of the uncertainty that is correlated across the consumers. The intuition for the higher price distortion when ε is larger is that when ε is larger, the disappointed consumers are more likely to be disappointed due to low ε_i rather than low η, and therefore, the variability of CSR as a function of η is greater. This implies that a given change in CSR has a stronger effect on the second-period consumer perception of η when ε is larger, which gives the firm a stronger incentive to affect CSR and ultimately results in a lower price.

Note that since the profit of the firm is lower in the case of unobserved price history than in the case of the observed price history, the firm should prefer to make the price history observed by the second-period consumers. However, this result depends on the sophistication of the second-period consumers in the sense that if the second period consumers were to assume that price of

[12] It may be interesting to note that this result of optimal price being lower than the myopic one is the same as in the Bass model with experience cost function (Bass and Bultez, 1982).

the first period is the same as the one they are observing in the second period, then the firm can increase the total profit (relative to the benchmark case of the previous section) by reducing the first-period price.

3.3 Affecting the Customer Satisfaction Ratings Post-Purchase

We now consider the possibility that the firm may influence consumer satisfaction through post-purchase effort that is as valuable to a consumer as it is costly to the firm. Whether the firm is able to use post-purchase efforts to affect customer satisfaction may depend on the nature of the product as well as on the capability of the firm. Examples of post-purchase efforts could be allowing more flexible product return (i.e., free return postage, envelope and label, which may eliminate some angry reviewers), better post-sales support (which is more of an issue/possibility in high-tech industries and service marketing), better or faster handling of rebates (if the firm uses them), gifts or extra value with purchase (i.e., when a consumer comes to a hotel room and discovers a free toothpaste or a free candy bar) or after purchase (send an exclusive offer/discount to the prior customer and make it known that the offer comes because of the prior purchase). While it could be technically possible for consumers to find out whether some of these perks are offered, it could be difficult to do so. Furthermore, even if the consumer knows that some of these were offered to prior consumers, the consumer still needs to use her expectations about whether the firm will still offer them to her. Note that if any of the above features are part of the contract (such as, for example, a "breakfast included in the price" of a hotel, or a promise to send the order with postage-paid return mailer from an internet seller), we would consider them as a part of the product rather than part of the post-purchase effort. The definition of post-purchase effort is that the firm is not committed to offer it at the time of the purchase transaction.

In this section, we consider three possibilities of post-purchase management of customer satisfaction: a) the firm does not use the first-period price to affect customer satisfaction ratings, i.e., the firm sets the single-period optimal price (this case is mostly for benchmark purposes); b) the firm sets the optimal prices and post-purchase activities, but the first-period price is observed by the second-period consumers, and c) the firm sets the optimal prices and post-purchase activities, and the second-period consumers do not observe either of these. These possibilities

are considered in Sections 3.3.2, 3.3.1, and 3.3.3, correspondingly (the order of consideration of the first two possibilities is switched because the solution of the second possibility turns out to be a special case of the solution to the first one). Again, note that the firm has no benefit of providing s_t in the final (second) period, since it is unobserved by the final period's consumers and the satisfaction of the final period's customers does not affect profits. Therefore, $s_2 = 0$. The non-trivial question is what the optimal s_t is in the first period. We will therefore simplify the notation by denoting $s = s_1$. Following the arguments of Section 3.1, one could hypothesize that when the first-period price is observed by the second-period consumers, the firm has no incentive to distort the first-period price from the single-period optimal one. However, the incentives to invest in post-purchase activities, and therefore, the second-period consumer expectations of the CS efforts, depend on the first-period price, as it affects the shape of CSR response to post-purchase activities. As we will see in Section 3.3.1, this leads to the optimal first-period price that is different from the first-period profit-maximizing price of Section 3.1.

3.3.1 Observed Price History

In order to solve this case, we first consider the optimal level of post-purchase activities given the first-period price observed by the second-period consumers and solve for the equilibrium of this subgame. Then, we solve for the optimal first-period price given that it will result in the derived post-purchase activities and second-period consumer expectations of them.

Since the amount of post-purchase effort is unobserved by the first-period consumers prior to purchase, it does not change the purchase decision by the first-period consumers. Furthermore, η and post-purchase effort s enter the consumer utility as a sum. Therefore, the effect of providing effort $s > 0$ on customer satisfaction ratings is the same as the effect of having η higher by s. In turn, second-period consumers discount the post-purchase effort they expect of the firm by subtracting their expectation $\hat{s}$ of s from the expectation η they would have under the assumption that $s = 0$. In other words, whenever CSR < 1, so that the second-period consumers knowing s and p_1 should be able to derive the true η precisely, the effect of s on the second-period consumer expectation of η is $E\hat{\eta}(\eta, s) = \eta + (s - \hat{s})$. When $\eta + s - \varepsilon > 0$, all customers are satisfied, leading to CSR=1. Therefore, the second-period consumers expect η to be $\mathrm{E}\hat{\eta} = (1+(\varepsilon-\hat{s}))/2$, whenever they observe CSR=1. Thus, the effect of post-purchase effort on the second-period consumer

expectation of η is

$$\mathrm{E}\hat{\eta}(\eta, s) = \begin{cases} \frac{1+(\varepsilon-\hat{s})}{2}, & \text{if } \eta + s > \varepsilon; \\ \max\{-1, \eta + s - \hat{s}\}, & \text{otherwise.} \end{cases} \tag{10}$$

The second-period profits are calculated from the above expectations as before, and the first-period profits are $(1 - p_1/V)(p_1 - s)$, which accounts for the cost of the effort s spent on each customer. Note that while the first-period price, when observed, does not affect the second-period consumer expectations of η directly, it does affect the incentive of the firm to spend on post-purchase satisfaction as it changes the cost of these activities to the firm.

First order condition on the optimal s together with the equilibrium condition of rational expectations ($\hat{s} = s$) lead to the optimal post-purchase effort of (see the Appendix for a detailed derivation)

$$s = \min\left\{1 + \varepsilon,\ \max\left\{0,\ 2V + 1 + \varepsilon - 2\sqrt{(V-1)^2 + 8(V - p_1)/M}\right\}\right\}. \tag{11}$$

As one can easily see from the above, the optimal post-purchase effort increases in the market growth M and the first-period price p_1, and is not always positive. In fact, the optimal s is positive if and only if

$$M > \frac{32(V - p_1)}{(3 + \varepsilon)(4V - 1 + \varepsilon)}. \tag{12}$$

On the other hand, when M is very large and p_1 close to $V/2$, the optimal s tends to $1 + \varepsilon$, i.e., the firm strives to make sure that all customers are satisfied no matter what the realizations of uncertain variables are. Also, the market growth rate necessary to make it optimal for the firm to engage in the post-purchase customer-satisfaction activities, decreases in ε. In other words, somewhat counter-intuitively, a market with more idiosyncratic (rather than product-specific) uncertainties results in higher incentive for the firm to provide post-purchase customer-satisfaction efforts. This may be considered as counter-intuitive since when the unknown component of the utility is less correlated across consumers, one might have hypothesized that consumers should pay less attention to the customer satisfaction ratings, and then, the firm should care about CSR less. To illustrate the results, we have, for example, that if $p_1 = V/2$, $\varepsilon = 0$, and V is large, optimal s is positive when $M > 4/3$, whereas if $p_1 = V/2$ and $\varepsilon = 1$, optimal s is positive when $M > 1$ (i.e., if and only if the market is growing). We also have the following result: forward-looking firm is interested in providing unexpected to the first-period

consumer extra effort only if $M > 1$. The market growth necessary to make it optimal for the firm to provide extra service increases when ε or V decreases.

Coming back to the equilibrium, we need to find the optimal p_1 for the firm to set. Substituting the optimal s given p_1 into the total profit of the firm and differentiating it with respect to p_1, we obtain the first order condition on p_1. While the solution is too cumbersome to state here, it implies that whenever equilibrium $s > 0$, the optimal price p_1 is below the price $V/2$ which the firm would set if it were maximizing the first-period profit only. Summarizing the main results of this section, we have the following proposition:

Proposition 2. *A positive market growth ($M > 1$) is a necessary condition for the firm to find it optimal to provide post-purchase activities s directed at increasing customer satisfaction. Furthermore, the market growth necessary to make it optimal for the firm to engage in such activities is*

$$M^* = \frac{32(V - p_1)}{(3 + \varepsilon)(4V - 1 + \varepsilon)},$$

where p_1 is the first period price. The optimal first-period price p_1 is below the price $V/2$, which the firm would set if it were maximizing the first-period profit only, if and only if equilibrium $s > 0$. The optimal s is given by Equation (11) and is increasing in M and ε.

Proof. See Appendix. □

The intuition for optimal first-period price p_1 being below the single-period optimal price $V/2$, is that since the second-period consumers correctly predict the firm's expenditure on s given the observed p_1, the firm's spending on s is wasteful from the total profit point of view. Therefore, the firm would like to set lower s as far as consumers know that it is setting a lower s. Since lowering p_1 results in a lower (and expected by the second-period consumers lower) s, the firm prefers to lower p_1 relative to the first-period profit maximizing price. The lower price implies that for s to be positive in the equilibrium, we must have the market growth M higher than the values we considered above under the condition that $p_1 = V/2$. The intuition for optimal s increasing in ε is the same as the intuition for the price distortion (when post-purchase activities are not an option) increasing in ε discussed after Proposition 1.

3.3.2 Benchmark: Case of Price Set to Optimize Single-Period-Profits

Besides being a natural benchmark for the decision on s, this case could also be interesting to consider as it provides insight in how the firm's manager should try to affect customer satisfaction

post-purchase for the long-term profit maximization when the price is set by somebody who chooses to concentrate on the short term profits only. Substituting $p_1 = V/2$ in the equations of the previous section, we obtain that the optimal post-purchase service is

$$s = 2V + 1 + \varepsilon - 2\sqrt{(V-1)^2 + 4V/M}, \tag{13}$$

whenever the right-hand side is between 0 and $1+\varepsilon$. Therefore, we have the following corollary:

Corollary 1. *If price history is observed, the amount of optimal post-purchase effort is higher when first-period price is set to optimize the single-period profits than when the price is set to be optimal for total profit maximization.*

The intuition for this result is that since the second-period consumers expect the firm's post-purchase efforts of the first period, it is best to set prices such that consumers expect post-purchase efforts to be less (and therefore, such that the actual incentive for the post-purchase efforts is lower, which ultimately results in the lower post-purchase efforts).

3.3.3 Case of Price History Not Observed by the Second-Period Consumers

We now consider the model, where the firm can increase customer utility post-purchase (unexpectedly to the first-period consumers), the second-period consumers do not observe the first-period price, but have rational expectations about both the first-period price and the post-purchase effort by the firm. Note that the firm will not offer any post-purchase effort in the last (second) period, so the question is to find the optimal first-period post-purchase customer satisfaction effort level s and price p_1, such that even as the second-period consumers correctly expect these, the firm will not want to deviate.

In this case, the second-period consumers invert the customer satisfaction ratings using their expectations of the post-purchase activity level $\hat{s}$ and the first-period price $\hat{p}$ as (see Appendix)

$$\mathrm{E}\hat{\eta}(\eta, s, p_1) = \begin{cases} \frac{1+\varepsilon-\hat{s}}{2}, & \text{if CSR} = 1; \\ \varepsilon - (\varepsilon - (\eta+s))\sqrt{\frac{V-\hat{p}}{V-p_1}} - \hat{s}, & \text{if } 1 - \frac{\varepsilon}{V-\hat{p}} < \text{CSR} < 1; \\ \frac{V-\hat{p}}{V-p_1}(\eta+s) - \hat{s}, & \text{otherwise.} \end{cases} \tag{14}$$

Substituting the above into the second period profit function, adding $(1-p_1/V)(p-s)$ for the first period profits, and differentiating thus obtained total profit function with respect to p_1 and s, we obtain first-order conditions on the optimal s and p_1. Substituting into them the

equilibrium conditions $\hat{s} = s$ and $\hat{p} = p_1$, we obtain two equations on the optimality of p_1 given s and s given p_1 with two unknowns (s and p_1). Their simultaneous solution determines the equilibrium values of s and p_1. Although the system is analytically solvable, the solution is too complex to report here. Instead, we report the following partial equilibrium results to provide some insight into the optimal firm behavior: The optimal first-period service as a function of the equilibrium first-period price is given by

$$s^e(p_1) = \min\left\{1+\varepsilon,\ \max\left\{0,\ 2V+1+\varepsilon-2\sqrt{(V-1)^2+8(V-p_1)/M}\right\}\right\}, \tag{15}$$

and the optimal first-period price as a function of the equilibrium first-period service is

$$p_1^e(s) = \frac{3V+s}{4} - \frac{1}{12}\sqrt{9(V-s)^2+3(1-s)^2(3V-2-s)M+9(V-s)\varepsilon^2 M}, \tag{16}$$

if $s+\varepsilon \leq 1$ and is

$$p_1^e(s) = \frac{3V+s}{4} - \frac{1}{24}\sqrt{36(V-s)^2+6(1+\varepsilon-s)^2(3V+\varepsilon-2-s)M}, \tag{17}$$

if $s+\varepsilon > 1$.[13] Note that the optimal service as a function of the first-period price is the same as in the case of observed price history (Section 3.3.1). In other words, the optimal service as a function of price is the same whether the price is observed or not. Also, optimal service increases in the price. The intuition for the latter result is that higher price leads to lower first-period demand, and therefore, offering post-purchase service is less costly to the firm (in terms of the total cost).

The following proposition summarizes the main qualitative results of this section:

Proposition 3. *When the firm engages in post-purchase activities to increase customer satisfaction ($M > 1$ is still a necessary condition for this to happen) and the price history is not observed, the price is higher than in the case of observed prices (the per-customer post-purchase effort is higher as well), and may even be higher than the single-period optimal price of $V/2$ (which may happen for high enough M).*

Proof. See Appendix. □

An implication of the above proposition is that when the market growth rate is high and the price history is not observed, the firm shifts the customer satisfaction efforts from pre-purchase

[13] The two cases arise because when $s+\varepsilon > 1$, the third case of Equation (14) disappears. The equations coincide when $s+\varepsilon = 1$.

value provision (distortion of initial prices downward) to post-purchase follow-up activities. Note also that the effect of price history observability on prices switches to the opposite from the case when $s > 0$ is not feasible and the case when $s > 0$ is both feasible and chosen by the firm: in the former case, first-period prices decreased from single-period optimal ones if and only if the price history was not observable, whereas in the latter case (when $s > 0$), the first-period price is lower in the case of the observable price history than in the case the price history is unobserved. This is because the reason for the price change when $s = 0$ was to affect the customer satisfaction rating, whereas when consumers know that the firm is likely to affect the customer satisfaction rating through setting $s > 0$, the firm would like to convince consumers that customer satisfaction ratings are not "manipulated."

The intuition for this result is that if price history is not observed, then while increasing the price decreases the customer satisfaction rating, as discussed in Section 3.2, increasing the price also makes it easier for the firm to affect the customer satisfaction ratings through post-purchase activities. The balance of this two effects determines the effect on price. When the market growth rate is not very high, the firm prefers to use both the price reduction (relative to the single-period optimal price) and post-purchase activities to affect CSR, but when the market growth rate is high, the second effect dominates, and the firm prefers to affect the customer satisfaction ratings through the post-purchase activities (since they turn out to be more effective in this case), and foregoes some of the first-period profits that could have been captured with a lower first-period price. The intuition for the result that when the firm engages in the post-purchase effort, the price is always lower when the price history is observed vs. unobserved is that when the price history is unobserved, the motivation for price reduction to convince the second period consumers that the post-purchase effort would not be used to manipulate CSR, is absent.

A managerial insight is that when market is growing very fast, it could be best to start with higher prices in order to be able to fully insure that initial customers are satisfied through post-purchase follow-up and customer satisfaction management. Note that this is only possible when post-purchase satisfaction effort is feasible, i.e., for example, when the firm keeps track of its customers through a customer relationship management (CRM) program.

3.3.4 First-Period Consumer Expectation of Post-Purchase Efforts of the Firm

In the model setup, we have postulated that first-period consumers do not expect post-purchase customer satisfaction effort s and therefore act as if it were 0. The natural question arises of how the results would change if first-period consumers had rational expectations about s. A related question is whether first-period consumers or an outside observer should expect s to be positive. To answer these questions, note that when the model predicted $s = 0$, first-period consumers already *had* the correct expectations of s, and therefore, rational expectations of first-period consumers would not change any results ($s = 0$ would still be optimal and the optimal price will remain the same). A consequence of this is that the statement of Proposition 2 about the minimal value of the market growth (M^*) required for the firm to provide post-purchase effort remains valid when first-period consumers have fully rational expectations.

On the other hand, if the original model predicted that s should be positive, then it will also be positive in the model with fully rational expectations. To see this, consider the contrary. Suppose with fully rational expectations by the first-period consumers optimal s becomes zero. Then, first-period consumers, having rational expectations, should expect s to be zero, i.e., act as in the original model. But then, the previously derived results states that the solution implies $s > 0$. A contradiction. Therefore, the optimal s is greater than zero.

This is not to say that the model results do not change at all between the cases when first-period consumers do not consider s (i.e., count it as 0) and when they have fully rational expectations about s. When $s > 0$, the actual value of s will be influenced by the difference of consumer behavior between these two models. Hence, only the condition under which $s > 0$ is the same.

An interesting consumer application of the result when $s > 0$ is whether first-period consumers should expect the firm to do something extra after the purchase or should expect the firm to try to shirk: if the market is not growing, consumers should be skeptical of the firm who does not put promises in writing, whereas if the firm is expecting the market to grow, consumers may believe that the firm will try hard to please them even after the purchase, and in the ways not required by the sales contract. Recently, corporate growth is more and more cited as important objective. This paper suggests that in view of this, it is not coincidental that recently, customer satisfaction became more of a concern as well.

4 Discussion

This paper considers how a firm's decisions should change from single-period profit optimizing ones when future demand depends on the current customer satisfaction ratings through the information it brings to the future consumers about the likelihood of them being satisfied. It is frequently noted that the short-term profit maximization leads to different decisions of the firm being optimal relative to the long-term profit maximization. While hardly anybody would disagree that the long-term profit maximization should be the preferred objective of many firms, the optimal decisions for short-term optimization are usually much easier to figure out. Therefore, it is valuable to try to find short-term measures, maximizing which would lead to a higher long-term profit than maximizing short-term profits. Customer satisfactions has been frequently suggested as, if not the most important, one of the most important variables to optimize for a firm with long-term profit horizon. This paper contributes to this effort by suggesting that short-term profit maximization may indeed lead to sub-optimal level of customer satisfaction for the firm, and thus short-term profits should be weighed together with customer satisfaction in the objective function of the firm. It also suggests how specifically the firm should deviate from short-term profit maximization decisions in prices and post-purchase efforts in order to better approach long-term profit maximization.

Our analysis provides insights into the optimal behavior by the firm if consumers observe and use the customer satisfaction rating of prior customers and at least one of the following two conditions are present: 1) the past prices are not fully observed by the current customers, or 2) the firm is able to affect customer satisfaction post-purchase.

One of the results is that, as compared to the optimal for the single-period profit, the firm may want to decrease current price. This can be interpreted as the penetration strategy or the firm trying to provide "best value for consumers," in effect, shifting to maximizing the current sales from maximizing the current profits. As we have seen, there are two boundary conditions for this effect: First, if the price history is observed by the future consumers, and the future consumers are rational enough to see how the lower price affects the customer satisfaction ratings, then changing current price may not be effective in changing beliefs of future consumers.

Second, when the price history is not observed, but the firm uses post-purchase management of customer satisfaction, in effect paying the customers to be satisfied, then the beneficial effect

of lowering price on customer satisfaction ratings may be counter-acted by the negative effect of making it more expensive for the firm to pay for customers to be satisfied (just because there are more customers). This can lead to the optimal price being *higher* than the single-period profit optimizing one. This can be viewed as the firm shifting to maximizing customer satisfaction strategy from the maximizing current profits strategy. In this strategy, the firm is effectively paying the current (early) customers to be satisfied. Note that this can only be profitable if the market is growing. The intuition for this is simple: if the market is not growing, it is more effective to just offer a discount to the second-period potential customers instead of paying the first-period customers. These results may be viewed as having the following rule-of-thumb management rule when price history is not well observed: augment short-term profit maximization with market share maximization when the market growth rate is not very high, and with customer satisfaction maximization when the market growth rate is very high. On the consumer side, these results provide insight about when to expect the firm to try to shirk on its promises, and when this is not a concern.

We considered consumer uncertainty about the product value that has an idiosyncratic component (ε_i *i.i.d.* across consumers), and correlated across consumers component (product-specific component η, the same across consumers). Consumers are interested in learning customer satisfaction ratings because they can learn from them about the part of their utility that is correlated across consumers. They can not possibly learn anything about their idiosyncratic component. However, one of the results is that customer satisfaction ratings become more important (affect consumer decision more) when the idiosyncratic component is larger. The intuition for this result is that as customer satisfaction ratings do not depend on η as much, consumers perceive small changes in CSR as related to large changes in η. Services, such as hotel stays, presumably, have a high idiosyncratic component, because consumer satisfaction may depend very much on the weather, a particular experience with room service, the neighboring customer, as well as on the particular state of mind of the customer at the time he/she is staying at the hotel, etc. In line with the model predictions, hotels are very concerned about customer satisfaction ratings.

The model assumed that the amount of the idiosyncratic uncertainty (ε_i) is small relative to the uncertainty about product (i.e., $\varepsilon < 1$). In the case $\varepsilon > 1$, the derivations are similar, and

the qualitative results are the same. In particular, Proposition 1 still holds without changes.[14] However, it turns out that the firm only wants to use s at a level that makes it possible for CSR to become 1. In other words, if $s > 0$, then $s > \varepsilon - 1$ (if $s = 0$ then the optimal price is the same as if setting $s > 0$ is not feasible).[15] An implication for this is that the rationale for firm's post-purchase customer satisfaction efforts comes from the benefit of achieving 100% customer satisfaction. This seems to be consistent with the industry practice when customer satisfaction goal (if set) is stated as "strive for 100% customer satisfaction".

While we largely abstracted from particular ways post-purchase customer satisfaction can be influenced, it may be interesting to consider some of the possibilities. To increase a consumer's value of the transaction, a firm may offer for example, a follow-up gift or a special offer on future services. If the intention of the firm providing the post-purchase rather than pre-purchase effort is indeed to not attract marginal consumers (who are more likely to be dissatisfied), it is important for the firm to a) make the follow-up effort unexpected, but b) still have consumers to incorporate the value of this follow-up offer in their consumer-satisfaction rating. Thus, it is important to consider how the different possibilities of post-purchase efforts will be perceived by consumers, and what is the value to consumers relative to the cost to the firm and relative to the possibility that consumers are dissatisfied.

It could also be interesting to consider some of the psychological issues and time discounting as related to how long after the purchase to give gifts. On one hand, allowing some time to pass may reduce the overall strength of the customer feelings about the purchase, which increases the effect of the delayed gift. On the other hand, it is important that a) customer has not yet made the final judgement of the purchase or provided the rating, and b) customer will take the gift into account when constructing his/her satisfaction rating rather than thinking about the gift as an independent event or inappropriate for including it in her customer satisfaction rating. With wide-spread adoption of CRM, this question is of increasing practical importance.

[14] The optimal price when price history is unobserved under condition $\varepsilon > 1$ becomes $p_1 = \frac{3V}{4} - \frac{1}{12}\sqrt{9V^2 + 18MV\varepsilon - 6M}$, which coincides with the Equation (9) when $\varepsilon = 1$.

[15] If $s > \varepsilon - 1$ is optimal, the optimal s and p as functions of the equilibrium p and s, correspondingly, are the same as the ones in Equations (15) and (17), correspondingly.

Appendix

Derivation of the Customer Satisfaction Rating (Equation (3))

If $\eta \geq \varepsilon$, we have: $\eta + \varepsilon_i \geq 0$; therefore, $CSR(\eta, p_1) = \Pr(\eta + h_i + \varepsilon_i \geq p_1 \mid h_i \geq p_1) = 1$.

If $\eta \in (-\varepsilon, \varepsilon)$, then $\varepsilon - \eta > 0$. Consider two cases: $h_i - p_1 \geq \varepsilon - \eta$ and $0 \leq h_i - p_1 < \varepsilon - \eta$. In the first case, which has across-consumer probability $\frac{V-p_1+\eta-\varepsilon}{V-p_1}$ conditional on purchase (i.e., conditional on $h_i \geq p_1$), customers are satisfied. In the second case, a customer is satisfied when $\varepsilon_i \geq p_1 - h_i - \eta$; i.e., in the second case, a customer is satisfied with probability $\frac{\varepsilon-p_1+h_i+\eta}{2\varepsilon}$ (the condition of the second case implies that this number is between 0 and 1 for all $\eta \in (-\varepsilon, \varepsilon)$). Aggregating CSR across these two cases, we obtain that the average CSR is $1 - \frac{(\varepsilon-\eta)^2}{4\varepsilon(V-p_1)}$.

If $\eta \leq -\varepsilon$, then consider three cases: $h_i - p_1 \geq \varepsilon - \eta$, $-\varepsilon - \eta < h_i - p_1 < \varepsilon - \eta$, and $0 \leq h_i - p_1 < -\eta - \varepsilon$. In the first case, which again has probability $\frac{V-p_1+\eta-\varepsilon}{V-p_1}$ conditional on purchase, the customers are always satisfied. In the second case, which has probability $\frac{2\varepsilon}{V-p_1}$, consumers are satisfied with probability $\frac{\varepsilon-p_1+h_i+\eta}{2\varepsilon}$. In the third case, consumers are never satisfied. Aggregating across these three cases, we obtain that the average CSR is $1 + \frac{\eta}{V-p_1}$, and thus, all the cases of Equation (3) are derived.

Optimal First-Period Price (Equation (9)) in Section 3.2

Differentiating $\mathrm{E}\pi = \pi_1 + \mathrm{E}\pi_2$ with respect to p_1, where $\pi_1 = \frac{p_1(V-p_1)}{V}$ and $\mathrm{E}\pi_2$ is given by Equation (8) with $F = \frac{V-\hat{p}}{V-p_1}$ substituted in, one obtains the first order condition on p_1 (this equation is easy to obtain by symbolic differentiation, but it is too long to make displaying it here practical). In the equilibrium, $\hat{p} = p_1$. Substituting this in the first order condition and simplifying the resulting equation, one obtains the following equation on p_1:

$$\frac{24V^2 - 3VM\varepsilon^2 - 72Vp_1 - 3MV + 2M + 48p_1^2}{24(V-p_1)V} = 0.$$

Selecting the solution of the above equation that is strictly below V immediately results in Equation (9). QED.

Derivation of Equation (11)

Consider $s \in (0, 1+\varepsilon)$. In this range, the expected second-period profits of the firm are

$$\begin{aligned} \mathrm{E}\pi_2 &= M \int_{-1}^{1} \frac{(V + \mathrm{E}\hat{\eta}(\eta))^2}{8V}\, d\eta = \\ &= M \int_{\varepsilon - s}^{1} \frac{(V + (1+\varepsilon-\hat{s})/2)^2}{8V}\, d\eta + M \int_{-1}^{\varepsilon - s} \frac{(V + (\eta + s - \hat{s}))^2}{8V}\, d\eta \\ &= \frac{M(2V + 1 + \varepsilon - \hat{s})(1 - \varepsilon + s)}{32V} \\ &\quad + \frac{M(1 - s + \varepsilon)[3(V - 1 + \varepsilon + s - \hat{s})(V - \hat{s}) + \varepsilon^2 + (1-s)(1-s-\varepsilon)]}{24V}, \end{aligned} \tag{18}$$

whereas the first-period profits are $\pi_1 = (1 - p_1/V)(p_1 - s)$. Differentiating $\pi_1 + \mathrm{E}\pi_2$ with respect to s and substituting $\hat{s} = s$, a necessary condition for the rational expectations of the second-period consumers about s, we obtain the following first order condition on optimal s:

$$M(3 + \varepsilon - s)(4V - 1 + \varepsilon - s) = 32(V - p_1). \tag{19}$$

Therefore, the first order condition on s gives

$$s = s^* \equiv 2V + 1 + \varepsilon - 2\sqrt{(V-1)^2 + 8(V - p_1)/M}. \tag{20}$$

Note that since we are considering the case of $s < 1 + \varepsilon$, we only chose the solution with the negative sign in front of the root as a possibility for optimal s. Furthermore, the second derivative of the profit function is negative in the neighborhood of that solution. Note that by assumption, s must be non-negative, and $s > 1 + \varepsilon$ can not be optimal because in that case $\mathrm{E}\pi_2 = M \int_{-1}^{1} (V + (1 + \varepsilon - \hat{s})/2)^2/8V\, d\eta$ does not depend on s. Therefore, $s = s^*$ is the optimal s as far as it is within the range $(0, 1+\varepsilon)$; the optimal s is 0 if $s^* \leq 0$ and the optimal s is $1 + \varepsilon$ if $s^* = 1 + \varepsilon$. QED.

Proof of Proposition 2

Given the derived Equation (11), the condition on M for positive s immediately follows. It remains to prove that when the equilibrium s is positive, the optimal p_1 is lower than the single-period optimizing $V/2$. Note that in the equilibrium, consumers have correct expectations of η. Therefore, the spending on s is wasteful from the profit point of view. Therefore, if something can be done to reduce equilibrium s (or, more precisely, the second-period consumer expectations of the first-period s), it may be worth doing. As Equation (11) shows, reducing p_1 by a small

amount reduces s by the same order of magnitude, but the (negative) effect of reduction in p_1 on the first-period profits is quadratic in the amount of the reduction (when p_1 is close to the first-period optimal value of $V/2$). Therefore, the firm strictly benefits from reducing p_1 (as far as the second-period consumers observe this reduction) when $s|_{p_1=V/2} > 0$. Therefore, $p_1 < V/2$ whenever $s > 0$, and even possible that $p_1 < V/2$ when $s = 0$ (but when s would be positive if p_1 were equal to $V/2$). QED.

Derivation of Equation (14)

This equation follows from Equation (7) as follows. Since η and s enter the first-period consumer utility function additively and hence, unexpected s is equivalent to unexpectedly higher η by the same amount, the customer satisfaction rating (given η and s) is the same as if η is replaced by the sum of the two and s is replaced by 0. In other words, $CSR(\eta, s, p_1) = CSR(\eta + s, 0, p_1) \equiv CSR(\eta + s, p_1)$, where $CSR(\eta + s, p_1)$ is given by Equation (3). Therefore, the second-period consumers can solve for $\eta + s$ according to Equation (6), and thus, the second-period consumer expectation of $\eta + s$, whenever it is a point estimate (i.e. when CSR < 1) is given by the right hand side of Equation (7) with η replaced by $\eta+s$. Finally, the second-period consumers subtract their expectation $\hat{s}$ of s from $\eta + s$ to obtain their expectation of η. Thus, the second-period consumer expectation of η as a function of true η and s is $\mathrm{E}\hat{\eta}(\eta, s) = \mathrm{E}\hat{\eta}(\eta + s) - \hat{s}$, when CSR < 1 and where $\mathrm{E}\hat{\eta}(\cdot)$ is given by Equation (7). Equation (14) is the immediate result of this substitution and averaging values of η which give CSR $= 1$. QED.

Proof of Proposition 3

To see the first claim (that when the price history is unobserved, the price is lower than if price history were observed), it is sufficient to note that the beneficial effect of price reduction in the proof of Proposition 2 above is absent, while price increase now has the benefit of increasing s being not as costly due to the lower first-period demand (since s is a per-first-period-customer expense). To see the possibility that the first-period price may be higher than the single-period optimal $V/2$, it suffices to show this for a particular set of parameter values. For example, take $V = 10, \varepsilon = 0, M = 1.5$ Then, the equilibrium equations yield $p_1 = 5.04067 > 5 = V/2$ (while $s = 0.2684$). For comparison: if the price was observed, it would be optimally set to 4.5156 to make $s = 0$ optimal and expected by the second-period consumers (resulting in the expected profit of 6.2375 instead of 6.1260). QED.

References

Anderson, Eric, and Duncan Simester (1998) "The Role of Sale Signs," *Marketing Science* **17**(2), pp.139-155.

Anderson, Eugine, Claes Fornell, Sanal Mazvancheryl (2004) "Customer Satisfaction and Shareholder Value," *Journal of Marketing* **68**(October) pp.172185.

Anderson, Eugine, and Mary Sullivan (1993) "The Antecedents and Consequences of Customer Satisfaction for Firms," *Marketing Science* **12**(2), pp.125-143.

Bagwell, K., and Michael Riordan (1991) "High and Declining Prices Signal Product Quality," *American Economic Review* **81**(1), pp.224-239.

Balachander, Subramanian (2001) "Warranty Signalling and Reputation," *Management Science* **47**(9), pp.1282-1289.

Balachander, Subramanian, and Kannan Srinivasan (1998) "Modifying Customer Expectations of Price Decreases for a Durable Product," *Marketing Science* **44**(6), pp.776-786.

Bartov, Eli, Dan Givoly, and Carla Hayn (2002) "The Rewards to Meeting or Beeting Earnings Expectations," *Journal of Accounting and Economics* **33**, pp.173-204.

Bass, Frank, and Alain Bultez (1982) "A Note on Optimal Strategic Pricing of Technological Innovations," *Marketing Science* **1**(4), pp.371-378.

Chen, Yubo, and Jinhong Xie (2005) "Third-Party Product Review and Firm Marketing Strategy," *Marketing Science*, **24**(2), pp.218-240.

Chu, Wujin, and Preyas Desai (1995) "Channel Coordination Mechanisms for Customer Satisfaction," *Marketing Science* **14**(4), pp.343-359.

Danaher, Peter, and Roland Rust (1996) "Indirect Financial Benefits from Service Quality," *Quality Management Journal* **3**(2) pp.6375.

Desai, Preyas (2000) "Multiple Messages to Retain Retailers: Signaling New Product Demand," *Marketing Science 19*, pp.381-389.

Desai, Preyas, and Kannan Srinivasan (1995) "Demand Singalling under Unobservable Effort in Franchising: Linear and Nonlinear Contracts," *Management Science* **41**(10), pp.1608-1623.

Fudenberg, Drew, and Jean Tirole (1986) "A 'Signal-Jamming' Theory of Predation," *The RAND Journal of Economics* **17**(3), pp.366-376.

Hauser, John, Duncan Simester, and Birger Wernerfelt (1994) "Customer Satisfaction Incentives," *Marketing Science* **13**(4), pp.327-350.

Hogan, John, Katherine Lemon, Barak Libai (2003) "What is the True Value of a Lost Customer?" *Journal of Service Research* **5**(3), pp.196208.

Inman, J. Jeffrey, James Dyer, and Jianmin Jia (1997) "A Generalized Utility Model of Disappointment and Regret Effects on Post-Purchase Valuation," *Marketing Science* **16**(2), pp.97-111.

Iyer, Ganesh, David Soberman, and J. Miguel Villas-Boas (2005) "The Targeting of Advertising", *Marketing Science* **24**(3), pp.461-476.

Kalra, Ajay, Surendra Rajiv, and Kannan Srinivasan (1998) "Response to Competitive Entry: A Rationale for Delayed Defensive Reaction," *Marketing Science* **17**(4), pp.380-405.

Milgrom, Paul, and John Roberts (1986) "Price and Advertising as Signals of Product Quality," *Journal of Political Economy,* **94**, pp.796-821.

Moorthy, Sridhar, and Kannan Srinivasan (1995) "Signaling Quality with Money-Back Guarantee: The Role of Transaction Costs," *Marketing Science* **14**, pp.442-446.

Oliver, Richard (1980) "A Cognitive Model of the Antecedents and Consequences of Satisfaction Decisions," *Journal of Marketing Research* **17**(November), pp.460-469.

Oliver, Richard, Ronald Rust, and Sajeev Varki (1997) "Customer Delight: Foundations, Findings, and Managerial Insight," *Journal of Retailing* **73**(3), pp.311-336.

Rust, Roland, J. Jeffrey Inman, Jianmin Jia, and Anthony Zahorik (1999) "What You Don't Know About Customer-Perceived Quality: The Role of Customer Expectation Distributions," *Marketing Science* **18**(1), pp.77-92.

Simester, Duncan, John Hauser, Birger Wernerfelt, and Roland Rust (2000) "Implementing Quality Improvement Programs Designed to Enhance Customer Satisfaction: Quasi-experiments in the U.S. and Spain," *Journal of Marketing Research*, **37**(2), pp.102-112.

Thaler, Richard (1985) "Mental Accounting and Consumer Choice," *Marketing Science* **4**(Summer), pp.204-212.

Wernerfelt, Birger (1988) "Umbrella Branding as a Signal of New Product Quality: An Example of Signalling By Posting a Bond," *The RAND Journal of Economics* **19**, pp.458-466.

Wolinsky, Asher (1983) "Prices as Signals of Product Quality," *Review of Economic Studies* **19**, pp.458-466.

Zeithaml, Valarie, Leonard Berry, A. Parasuraman (1996) "The Behavioral Consequences of Service Quality," *Journal of Marketing* **60**(April), pp.3146.

Zhao, Hao (2000) "Raising Awareness and Signaling Quality to Uninformed Consumers: A Price-Advertising Model," *Marketing Science* **19**(4), pp.390-396.