Consumer price effects: Loss aversion in value vs. in demand

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Abstract

It has been established that consumers are often loss averse in the sense that perceived value decreases to a greater extent as a result of a price increase than what it increases as a result of an equal price decrease. We examine a previously scarcely studied question: how is the change in a product's perceived value following a price change reflected in the product's market demand? To complement the notion of loss averse (vs. gain seeking) price behavior in perceived value, we provide a definition for loss averse (vs. gain seeking) price behavior in demand. We discover that loss aversion in value does not necessarily lead to loss averse market demand, but can also lead to market demand being gain-seeking. We examine the boundary conditions for loss averse vs. gain seeking demand. Assuming that consumer preferences are given by a random utility model and the choice model is McFadden's conditional logit, we develop a simple formula to check the character of the price behavior. This provides novel insights by revealing an unexpected key determinant: the market share of the product under consideration. Finally, we consider the optimal price changes and what kind consumer behavior in demand they are related to.

Keywords: reference price, loss aversion, conditional logit, brand choice

1. Introduction

How to set the price point of a product with respect to certain reference levels remains a challenging problem. Indeed, firms commonly set their prices with reference to the prevailing market prices used by competitors, or with reference to the firm's own regular or earlier price levels. Special tactics are often used as well. On the one hand, some tactics entail decreasing the product's price from the reference level, such as price promotions, discounts, and price cuts. On the other hand, there are tactics that involve a heightened price relative to the benchmark: price increases, price premiums, price hikes, and the skimming pricing approach, for example (see e.g., Monroe, 2003).

From a managerial strategic point of view, a particularly interesting issue related to reference prices is, how buyers will respond to price changes around a certain reference level and, especially, whether buyers react in a symmetric way to price decreases and price increases. Concerning this issue, classic studies in cognitive psychology and behavioral economics (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991; Camerer and Loewenstein, 2003) as well as in marketing (see e.g. the review by Mazumdar, Raj and Sinha, 2005) have widely demonstrated that buyers typically react to price increases stronger than price decreases. Such an asymmetric buyer behavior is commonly described as loss averse, because buyers' perception of loss in value tends to be greater when the price is increased than their perception of gain in value when the price is decreased with an equal amount.

The existing research has, however, one shortcoming when it comes to the managerial or strategic point of view. Namely, while the existing research has concentrated on modeling asymmetric changes in buyers' *value* due to price changes around the reference price, very little research exists on asymmetric changes in *demand*, resulting from such price changes. Yet, for managerial decision-making, it is essential to understand the potential asymmetric effects of pricing around the reference price on the product's demand especially, and not only the effects on the buyers' perceived value. What we essentially demonstrate in this article is that, surprisingly enough, buyers' loss aversion in value does not necessarily result in their loss aversion of demand. We, moreover, analyze the optimal pricing strategies related to value functions of the prospect theory type.

Relatedly, Güler, Bilgic and Güllü (2015), He, Xu, Xu and Wu (2016), Ma, Xue, Zhao and Zeng (2016) and Zhou, Kahn and Wong (2018) among others, have previously considered certain demand reflections of buyers' asymmetric reactions to reference prices - but have not investigated the potential non-correspondence between asymmetric value effects and asymmetric demand effects. Timing issues related to price changes have also been a much studied topic (see, e.g Yang, Guo and Wang, 2018; Mandal, Kaul and Jain, 2018 and Lee,Choi and Cheng, 2015). Optimal pricing has been previously studied both in the cases when market demand is more sensitive to losses (Nasiry and Popescu, 2011; Popescu and Wu, 2007; Fibich, Gavious and Lowengart, 2005) and gains (Hu, Chen and Hu, 2016). Very few studies investigate whether demand changes resulting from price changes are asymmetric or not (Hu et al., 2016; Hu and Nasiry, 2018; Halme and Somervuori, 2013). Yet, even these studies have not addressed the fundamental question, or mechanism, of why asymmetries around the reference price may arise in the first place, or under which conditions the demand (as opposed to value) will be loss averse vs. gain seeking.

The purpose of this article is, hence, to contribute to the literature on asymmetric reference price effects by addressing the above research gaps. To do this, we firstly aim to analytically model and prove the conjecture implied above: That buyers' loss averse (vs. gain seeking) behavior in value around a reference price does not necessarily lead to loss averse (vs. gain seeking) behavior in demand. That is, even if buyers are loss averse in value, demand can be gain seeking, and vice versa. Our analysis also discovers the important role of the market share in determining the loss averse vs. gain seeking nature of market demand.

Secondly, we develop a simple test for checking if the price behavior in a given market is loss averse or gain seeking in demand. In the formula developed, the product's market share plays again a significant role. In contrast, we also demonstrate that somewhat surprisingly, the well-known prospect theory plays only a relatively minor role in understanding loss aversion in demand, as opposed to loss aversion in value.

Thirdly, we assess price changes that maximize profit. Based on this assessment, we conclude, for instance, that price decreases may be optimal in both the cases of loss averse and gain seeking in demand behavior, in case the value function is of prospect theory type.

The rest of the article is organized as follows. Section 2 starts by reviewing how consumers' utility and choices are commonly modeled with the conditional logit model. Then, loss averse and gain seeking buyer behavior around the reference price are defined – distinguishing between value effects and demand effects, respectively. Thereafter, we examine the conditions under which buyers' price behavior will be loss averse vs. gain seeking in demand, accompanied by illustrative examples. In Section 3, we further examine the implications of our results in two special cases of value functions. In the first case, the value functions are based on the prospect theory. In the second case, linear and smooth value functions are considered. In Section 4 we study prices that optimize profit and what kind of changes in price behavior of consumers they are related to assuming their value function is either of prospect theory type or linear. Finally, in Section 5, we discuss the theoretical and managerial implications of our research.

Notice that all our analyzis employ McFadden's popular conditional logit model for consumers' choice behavior. Nevertheless, generalization to other models (see e.g., McFadden and Train, 2000), such as individual-level multinomial logit models, would be straightforward.

2. Modeling utility changes and choice around reference price

In this section, we provide a review of how consumers' utility and choices are commonly modeled. We also define loss averse and gain seeking behavior in value, as caused by price changes or deviations from a reference level. Following the conditional logit model for consumer choice by McFadden (1974), consumer choice is modeled under price variations of a given product. This initial model essentially provides the basis for the subsequent modeling of the demand changes that result from changes in utility (due to deviations from the reference price level).

2.1 Consumer utility and choice

Consider consumers in a given population facing a finite set of alternative choices $i = 0, 1, 2, \ldots$. For $i > 0$, the alternatives refer to products which are substitutes to each other. Alternative $i = 0$ refers to not choosing any of the products.

Consumers are denoted by $\omega \in \Omega$, where Ω is the entire population under consideration. Herein, population Ω can be interpreted as a market segment. Each consumer in the segment makes a choice either to buy one of the products ($i > 0$) or not to buy any ($i = 0$).

Consumer preferences are assumed to be specified by an *additive random utility* model as follows. For each consumer $\omega \in \Omega$, the utility $u_i(\omega)$ from choosing alternative i is given by

$$u_i(\omega) = v_i + e_i(\omega), \tag{1}$$

where v_i is common to all consumers in Ω, and $e_i(\omega)$ accounts for individual preferences.

Component v_i refers to the *value function* of the random utility, whereas components $e_i(\omega)$ refer to realizations of a random variable ϵ_i in Ω. According to McFadden (1974), it is assumed that the random variables ϵ_i are independent and identically Gumbel distributed[1], for all i. Furthermore, it is assumed that both the common value component v_i and the individual components $e_i(\omega)$ may depend on product prices but the distributions of random terms ϵ_i are independent of prices.

Given the utility functions in equation (1), alternative i is preferred by the consumer ω over other alternatives $j \neq i$ if

$$u_i(\omega) \geq u_j(\omega) \quad \text{for all } j \neq i.$$

Following this, the probability that a randomly chosen consumer $\omega \in \Omega$ chooses product i is given by

$$P_i = \frac{\exp(v_i)}{\sum_j \exp(v_j)}. \tag{2}$$

As (2) indicates, the choice depends on the perceived value of the products to the consumers. Moreover, P_i can be interpreted as expected *relative demand*. It is not exactly the (expected) market share since the choice alternatives also include the

[1] One might assume normal distribution instead of Gumbel distribution. In this case only numerical analysis is possible instead of the main result in (2).

alternative $i = 0$, that is, the alternative that the consumer does not choose any of the products. Therefore, the expected market share, among the product alternatives, is $P_i/(1 - P_0)$.

2.2 Value and price changes

Next, we consider how the price changes of product i ($i > 0$) from the reference price level affect the product's value to the consumer. Moreover, we define loss averse and gain seeking behavior in value, according to common notions.

We assume that a product's perceived value to a consumer depends on its price. Let prices p_K, with $K = N, H, L$, denote three alternative price levels for product i. Here, p_N refers to the reference price level, which is commonly the competitive market price in the product category. In turn, p_H refers to a price that is higher than the reference level, and p_L to a price that is lower than the reference level. With these price alternatives, we can refer to value v_i of product i, common to all consumers, by v_N, v_H and v_L, respectively.

While keeping the prices constant for other products $j \neq i$, we can now define the gain in consumer value obtained from the focal product consequent on its price decrease as well as the loss in value consequent on its price increase. For notational convenience, let us contrast price increases $p_H - p_N$ with equally large price decreases $p_N - p_L$. The gain in value due to price increase and loss due to price increase are:

$$\delta_L = v_L - v_N \quad \text{and} \quad \delta_H = v_N - v_H \tag{3}$$

where we assume that $\delta_L > 0$ and $\delta_H > 0$. Notably, the difference of these is:

$$\delta = \delta_H - \delta_L, \tag{4}$$

With these assumptions, we can define a market segment of consumers as loss averse, gain seeking, and symmetric in value as follows:

Definition A. Given δ in (4), market segment Ω is *loss averse in value* with respect to price changes of product i if $\delta > 0$, *gain seeking in value* if $\delta < 0$, and *symmetric in value* if $\delta = 0$.

Notably, this definition is consistent with, for example, that of Bell and Lattin (2000) – only with the exception that we add the terms "in value". This is to distinguish definition A from gain seeking and loss averse price behavior "in demand", which is our focal phenomenon of interest and will be introduced in the following section.

2.3 Demand and price changes

While the previous section defined changes in value caused by price changes from the reference level, we can now outline the changes that such price changes cause in demand.

Given price levels N, H and L for focal product i, the expected relative demand of product i, as derived from from (2), is denoted by P_N, P_H and P_L. We calculate changes in the expected relative demand, given a price increase or decrease in the focal product, when the prices of other products in the market remain unchanged.

Let $\Delta_H = P_N - P_H$ now denote decrease in demand and $\Delta_L = P_L - P_N$ increase in demand, due to price increase and decrease, respectively. Further, denote

$$\Delta = \Delta_H - \Delta_L = 2P_N - P_H - P_L. \tag{5}$$

With these notations, we can now define a market segment of consumers as loss averse, gain seeking, and symmetric in demand as follows:

Definition B. Given Δ in (5), market segment Ω is *loss averse in demand* with respect to price changes of product i if $\Delta > 0$, *gain seeking in demand* if $\Delta < 0$, and *symmetric in demand* if $\Delta = 0$.

Given this definition, we can outline the conditions for price behavior that is loss averse vs. gain seeking in demand. As logical, the changes in demand caused by changes in price are a function of the changes in value caused by the price change. In the following proposition, the proof of which can be found in Appendix A, we present the changes in demand as a function of changes in value.

Proposition 1. *Define*

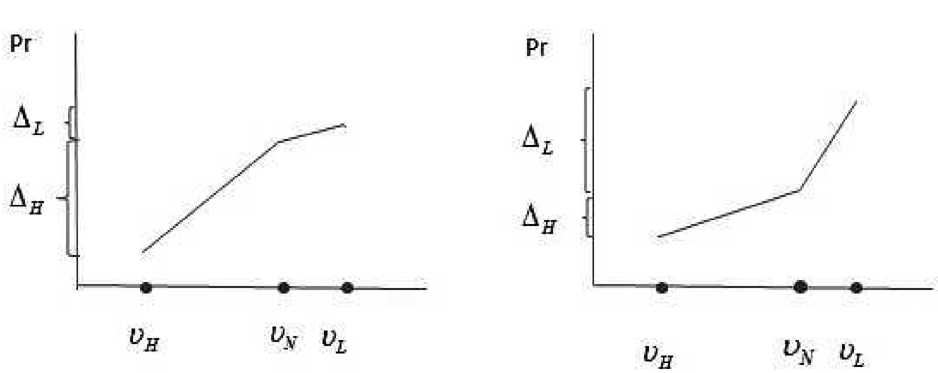
$$P^* \equiv \frac{\exp(\delta_H) + \exp(-\delta_L) - 2\exp(\delta_H - \delta_L)}{2[\exp(\delta_H) - 1][1 - \exp(-\delta_L)]}. \tag{6}$$

Then the price behavior of market segment Ω is loss averse in demand if $P_N > P^*$, gain seeking in demand if $P_N < P^*$, and symmetric in demand if $P_N = P^*$.

Proposition 1 essentially shows that the market share of the product with prevailing prices has a substantial effect on whether the price behavior of a market segment is loss averse or gain seeking in demand for a focal product. To understand this, recall that the market share of the product under consideration is $P_N/(1-P_0)$, where P_0 is the expected share of population which chooses not to buy any of the products. By Proposition 1, the segment is loss averse in demand with respect to the focal product if its market share is larger than $P^*/(1-P_0)$; otherwise, it is gain seeking in demand. For example, if $P_0 = .80$ and $P^* = .1$, then a market share larger than $.1/(1-.8) = 50\%$ implies loss averse behavior in demand, while any market share below 50% implies gain seeking behavior in demand. Note that it may occur that the observed values of δ_H and δ_L lead to $P^* > 1$ which means that the price behavior is always gain seeking independent of the market share.

Figure 1 illustrates the two cases that can occur specifically in the case when v_L-v_N < v_N -v_H. That can lead to both kinds of price behavior: loss averse in demand and gain seeking in demand.

Figure 1: Two cases of loss aversion in value in accordance with prospect theory: (i) loss aversion in demand with $P_N > P^*$ and (ii) gain seeking in demand with $P_N < P^*$.



Examples of situations when price behavior is always either gain seeking or loss averse in demand can be seen in Table 1, which presents the values of P^* when $\delta_L =$

.35.[2] Considering $\delta_H = 0.2$ and $\delta_L = 0.35$, then $P^* = 1.57$, which means that the market segment is gain seeking in demand. It is also possible that $P^* < 0$ (Table 1, $\delta_H = 0.65$ and $\delta_L = 0.35$) which always leads to price behavior that is loss averse in demand.

Table 1: Values for Pr^* for different levels of value loss δ_H given the value gain $\delta_L = 0.35$.

δ_H	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65
Pr^*	1.57	1.07	.74	.50	.32	.19	.08	-.01	-.08	-.15

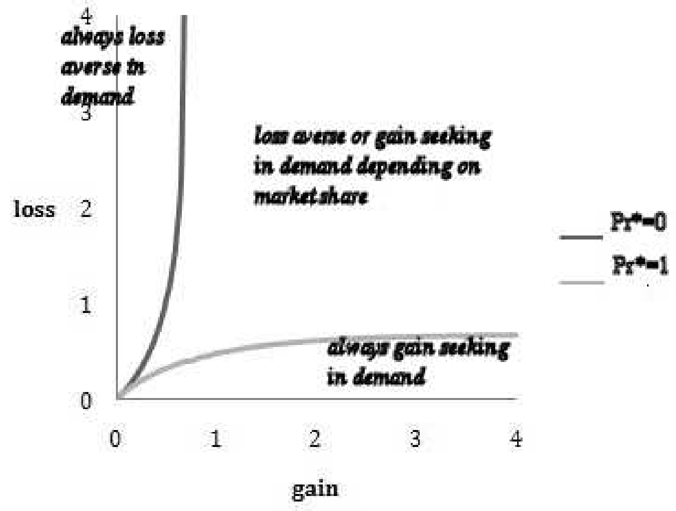
The range $0 < P^* < 1$ is of special interest for us because there the type of behavior depends on the market share with the prevailing price. Figure 2 illustrates the values of δ_L and δ_H for P^* between zero and one. For $P^* = 0$, (6) yields $\delta_L = \log[2 - \exp(-\delta_H)]$. Hence, δ_L increases with δ_H and approaches $\log 2$ for large δ_H. Symmetrically for $P^* = 1$, (6) yields $\delta_H = \log[2 - \exp(-\delta_L)]$, so that also δ_H approaches $\log 2$ for large δ_L. We illustrate the result in more detail by Examples 1, 2 and 3.

Example 1. Consider a hypothetical baseline case in Table 1, wherein $\delta_H = \delta_L = 0.35$ and the market segment is symmetric (i.e., not loss averse or gain seeking) in value. Moreover, we set $P_0 = 0$, so that the choice alternative $j = 0$ is non-existent, meaning that all the consumers choose one of the product alternatives and the expected relative demand P_N is the market share of product i. In this case, even if the market segment is not either loss averse or gain seeking in value, it will be loss averse in demand if the market share P_N with the prevailing price exceeds $P^* = .5$ (albeit that such a high market share is rare in real markets). In contrast, with $P_N < .5$, the price behavior of the market segment will be gain seeking in demand.

Example 2. Let us look at the case in Table 1 where the loss δ_H is strictly larger than the gain δ_L. That is, the consumers' price behavior is loss averse in value, as often assumed and found in real markets. By intuition, one might expect that the market

[2]The interpretation of the levels of value gain δ_L and loss δ_H relates to the standard deviation of the Gumbel distributed random variable ϵ_i in the utility model (1). To obtain the conditional logit formula (2) from the utility function (1), the standard deviation of ϵ_i is $\sigma = \pi/\sqrt{6} \approx 1.28$. Hence, $\delta_L = .35$ refers to a value loss, which is about 27 percent of the standard deviation 1.28.

Figure 2: Levels of value loss δ_H and gain δ_L with $0 \leq P^* \leq 1$.



segment's price behavior is, in such case, loss averse in demand as well. However, this depends on the value of P^*, and in fact, the behavior may again well end up being gain seeking in demand. For example, in case $\delta_H = .5 > \delta_L = .35$, Table 1 yields $P^* = .08$. Consequently, the price behavior is loss averse in demand only if $P_N > .08$, and in the opposite case it is gain seeking in demand. Hence, if the market share is small ($P_N < .08$), a price decrease raises the demand more than an equal price increase decreases it even if the price increase causes a value loss δ_H greater than the value gain δ_L in the price decrease

Example 3. Finally, consider the case $\delta_H = .3 < \delta_L = .35$, wherein the price behavior is gain seeking in value. Now, from Table 1, we get $P^* = .74$. Again, against intuition, we conclude that the price behavior is loss averse in demand if $P_N > .74$. Hence, for a (near-monopolistic) brand with three fourths of market share, the market demand is more sensitive to an increase in the price than to a price decrease – even if value loss from price increase is smaller than value gain from price decrease.

3. Considerations with different value functions

Proposition 1 is valid for all kinds of value functions. Nevertheless, a question that remains is: In case we assume something more restrictive about the value function, is it possible to get a stronger result with respect to loss averse/gain seeking behavior in demand? We consider first value functions that are in accordance with the prospect theory and then linear or smooth value functions.

3.1 Value function in accordance with prospect theory

If we employ the normal price p_N as the reference price for product i, then prospect theory suggests that the marginal value of component v_i jumps down at the normal price. Hence, given small values of $\delta_H = v_N - v_H$ and $\delta_L = v_L - v_N$, prospect theory suggests

$$\delta_H > \delta_L \tag{7}$$

so that the behavior in loss averse in value. Of course, Proposition 1 applies in this case as well. Because (6) does not imply that $P^* \leq 0$, it is possible to observe gain seeking behavior even if the value function conforms to prospect theory. For δ_H and δ_L small, we employ first order Taylor approximation for the exponent functions in (6) and obtain

$$P^* \approx \frac{[\delta_L - \delta_H]}{2\delta_H \delta_L}. \tag{8}$$

Because $\delta_L - \delta_H < 0$ by (7), loss aversion condition $P_N > P^*$ always holds here. Consequently, we have the result:

Proposition 2. *If δ_H and δ_L are small (i.e., the price changes are small), then prospect theory implies loss aversion in demand for market segment Ω.*

Thus with $\delta_H > \delta_L$ as in prospect theory, and with δ_H and δ_L small, the price behavior is never gain seeking in demand.

This result, however, concerns utmost small price changes only. It is easy to calculate and check the entire price range of price changes for which prospect theory implies loss aversion for any level of P_N; that is, $P^* \leq 0$ in Proposition 1. As a simplified example, consider a piece-wise linear value function with a kink at the reference price (approximating the value function of prospect theory). As in Section 2, let the standard deviation of the scaled utility function be $\sigma \approx 1.28$. Let θ denote the relative price change, and suppose the loss is $\delta_H/\sigma = 8\theta$ and gain $\delta_L = \delta_H/2.6$. Hence, the marginal utility jumps by a factor 2.6 at the reference price. The top-left region in Figure 2 reveals combinations (δ_L, δ_H) of gain and loss such that $P^* \leq 0$; i.e., combinations for which the market is loss averse for any P_N. In algebraic form, $P^* \leq 0$ if and only if $\delta_L \leq \log[2 - \exp(-\delta_H)]$. This condition holds in our example if the price change up and down is at most 15%. If the marginal utility jump factor is reduced from 2.6 to 2.3, the condition requires the price change to be at most 12%. Hence, for larger price changes than that, prospect theory does not imply that the market is loss averse in demand.

3.2 Linear or Smooth Value Function

As further cases, we consider other important types of value functions, the smooth and linear ones in an attempt to see if the assumption of the smooth and linear value functions extend the results of loss averse or gain seeking behavior in demand (in Proposition 1).

Assume v_i is a linear function of the price of product i. Then the marginal value with respect to price is constant, and consequently, the behavior is symmetric in value with $\delta_H = \delta_L$. In this case applying (6) leads to $P^* = .5$ and loss aversion condition reduces to

$$P_N > .5. \tag{9}$$

Next, consider the case where v_i is differentiable with respect to price and consider v_i at the normal price. Then for small price variations $\delta_H \approx \delta_L$ holds, and again, loss aversion condition $P_N > P^*$ reduces to (9). Hence, we conclude the following:

Proposition 3. *For market segment Ω, if the value function is smooth and the price changes are small or if the value function is linear, then $P_N > .5$ implies loss averse, $P_N < .5$ gain seeking, and $P_N = .5$ symmetric behavior in demand.*

By Proposition 3, the segment is loss averse if the market share of the product under consideration is larger than $.5/(1-P_0)$. Hence, for $P_0 = .20$, a market share larger than $.5/(1 - .2) = 62.5\%$ implies loss aversion in demand, while all smaller, more typical market shares imply gain seeking in demand.

4. Optimal profit considerations

In this section, we consider the impact of price changes on the firm's profits. For simplicity, assume that the marginal cost of a given product i is constant, and let m_i denote profit margin per unit of product i, given the reference price level p_N. Let ν denote a change in the price of i so that $\nu > 0$ refers to a decrease in the price (i.e., in the profit margin per unit, assuming the constant cost per unit) and $\nu < 0$ to an increase. Due to the price change, the value component v_i in (1) is incremented by $\delta(\nu)$, suppressing i in δ. If v_i denotes the value of product i at the reference price, then after the price change, the value becomes $v_i + \delta(\nu)$ with $\delta(0) = 0$. Assume now that $\delta(\nu)$ is concave, strictly increasing in ν and differentiable for all ν except possibly at $\nu = 0$; as is the case when the value function is based on prospect theory. For other products $j \neq i$, the value v_j is independent of the price of product i; that is, we assume that there are no price responses of products $j \neq i$.

After the price change ν the expected profit of product i is $\pi(\nu) = (m_i - \nu)|\Omega|P(\nu)$ where $|\Omega|$ is the total number of potential customers under consideration and $P(\nu)$ is the expected share of the population choosing product i. Using (2) for $P(\nu)$, the expected profit is

$$\pi_i(\nu) = (m_i - \nu)|\Omega| \; \frac{\exp[v_i + \delta(\nu)]}{\exp[v_i + \delta(\nu)] + \sum_{j \neq i} \exp(v_j)}. \tag{10}$$

Next, consider a price change that optimizes the profits of product i, assuming that prices of other products remain unchanged. For $\nu \neq 0$, let $\delta'(\nu)$ denote the derivative, and for $\nu = 0$, let $\delta'(0)$ denote a sub-derivative of δ. Using (10), after some algebra, the optimality condition for $\nu = \nu^*$ is written as

$$\delta'(\nu)(m_i - \nu) = 1 + \frac{P_i}{1 - P_i} \; \exp[\delta(\nu)] \tag{11}$$

where δ' is the (sub)derivative of δ evaluated at $\nu = \nu^*$ and $P_i = P(0)$. Given that $\delta(\nu)$ is strictly increasing and concave, the optimal price change ν^* is uniquely determined by (11). Denote $\alpha = \inf_{\nu<0} \delta'(\nu)$ and $\beta = \sup_{\nu>0} \delta'(\nu)$. Then $\alpha \geq \beta > 0$ and it follows from the condition (11) that

$$\beta m_i > \ 1/(1-P_i) \qquad\qquad \Rightarrow \nu^* > 0 \tag{12}$$

$$\alpha m_i < \ 1/(1-P_i) \qquad\qquad \Rightarrow \nu^* < 0 \tag{13}$$

$$\beta m_i \leq \ 1/(1-P_i) \leq \alpha m_i \quad \Rightarrow \nu^* = 0 \tag{14}$$

Example 4. Consider product i and five competing products j. The no choice option is excluded, so the consumer always choose one of the products. For $j \neq i$, values v_j are randomly drawn from a uniform distribution in (2,5). Then, given the market share $P_i = \exp(v_i)/[\exp(v_i) + \sum_{j>1} \exp(v_j)]$, we solve for v_i. In this setting, consider a price change of product i holding other prices unchanged. For product i, the price elasticity of demand is denoted by $\hat{e}$ for a price increase from the reference level and by $\bar{e}$ for a price decrease. Let the reference price of i be the currency unit. Then we have

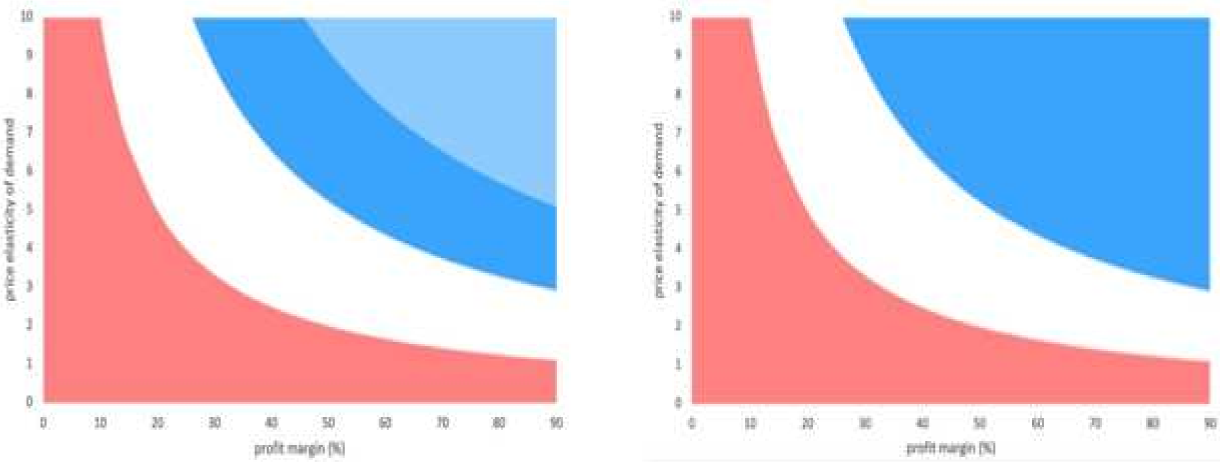
$$\hat{e} = -\alpha(1-P_i), \quad \bar{e} = -\beta(1-P_i) \ \text{ and } \ \hat{e}/\bar{e} = \alpha/\beta = \rho \tag{15}$$

with some $\rho \geq 1$. We consider the values of $-\hat{e}$ in the range from 0 to 10, where large values imply a heavy price competition among products, such that individual product's demand is highly sensitive to its price change. Given $\hat{e}$ and ρ, values of α and β are obtained from (15). For profit margin m_i we consider values from 0 % to 90 %. For the value increment δ, we discuss three cases (i), (ii) and (iii).

Case (i). Assuming from the prospect theory that $\alpha = 2.6 \times \beta$ ($\rho = 2.6$), Figure 3 illustrates optimal ν^* for two cases of the market share, 10 % and 70 %. By (12), for $m_i\beta > 1/(1-P_i)$ we have $\nu^* > 0$ (blue and light blue regions), by (13), for $m_i\alpha < 1/(1-P_i)$ we have $\nu^* < 0$ (red regions) and otherwise by (14), $\nu^* = 0$ (white regions). The value function of prospect theory type might make the reader to anticipate that the optimal pricing decision is rather to decrease the price than to raise it. However, as shown in Figure 3, for suitable combinations of price elasticity and profit margin, increasing price from the reference level can be optimal. If either the profit margin or the price elasticity of demand (or both) is small, then a price increase is favorable; in the opposite case, a price decrease is optimal.

Case (ii). Let δ be a piece-wise linear and concave function $\delta(\nu) = \alpha\nu$ for $\nu \leq 0$ and $\delta(\nu) = \beta\nu$ for $\nu \geq 0$ with $\alpha = \rho\beta$ and $\rho > 1$. Also in this case, Figure 3 illustrates

Figure 3: Illustration of optimal price changes ν^* for two cases of the market share P_i. The horizontal axis is the profit margin (%) and the vertical axis is the (negative of) price elasticity of demand related to price increase at the normal price. Blue and light blue indicate an optimal $\nu^* > 0$ (price decrease), red refers to an optimal $\nu^* < 0$ (price increase), and white shows cases with the optimal $\nu^* = 0$ (price unchanged).



$P_i = 10\%$ $P_i = 70\%$

optimal ν^* in case $\rho = 2.6$. Given an optimal ν^*, consider price changes $|\nu^*|$ up and down. Under such changes, all cases in Figure 3 relate to loss averse price behavior in value; all cases in the red and bright blue regions refer loss averse price behavior in demand; and the cases in the light blue region refer to gain seeking price behavior in demand.

- Consider the red area below in Figure 3. When the profit margin is low, the optimal profit is achieved by raising the price even with high values of price-elasticity of demand. The higher the profit margin, the lower does the elasticity of demand have to be in a situation that leads to a price increase being optimal.

- When the price elasticity of demand is low enough, it is not optimal to raise the price even with high profit margin percentages; instead it becomes optimal to maintain the regular price, which is indicated by the white area.

- However, with high profit margin percentages, and high elasticity of demand, it again pays off to change the price, in this case decrease it. This corresponds to the blue areas. Note that there are two blue areas above the curve when the market share is $P_i = 0.1$; the bright blue is related to the consumer being loss averse in demand, and the light blue to gain seeking in demand - the latter takes place when both the profit margin and the price elasticity of demand are high. In Section 3.2 we considered exactly the same value function of prospect theory ($\rho = 2.6$) and concluded that with price changes greater than 15 % gain seeking price behavior in demand can occur. In the light blue region of area of Figure 3, all the optimal price changes fulfill this requirement.

- It can be shown that gain seeking price behavior in demand is not possible if (a) $P_i > 0.5$ or (b) $P_i < 0.5$ and $\nu^* < 0$ (price increase optimal) and $\rho > r\hat{h}o$ where the treshold $r\hat{h}o \approx 1.87$.

Case (iii). Consider a piece-wise linear value function with $\alpha = \rho\beta$ and let ρ converge to 1 from above. Then the hyperbolic boundaries of the region (in Figure 3) with $\nu^* = 0$, converge to a single hyperbolic curve. Thus, for a linear value function with $\rho = 1$, we have $\nu^* > 0$ above the curve, and $\nu^* < 0$ below the curve. For the market share $P_i = 10$ %, all cases are gain seeking in demand, and for $P_i = 70$ %, all cases are loss averse in demand. This conforms with Proposition 3. On the line separating cases $\nu^* < 0$ and $\nu^* > 0$, we have an optimal $\nu^* = 0$. Note that this line is the same as the line in Figure 3 separating cases $\nu^* < 0$ and $\nu^* = 0$.

5. Conclusions

5.1 Contributions to research

Whilst researchers in multiple fields have extensively studied consumer reactions and behavior with respect to price changes around reference price levels, they have so far mostly concentrated on changes in consumers' perceived value (or utility) due to the price changes. Given this focus on value, there have been very few studies addressing the asymmetric patterns in consumer demand, as a result of price changes. Thus, this article contributes to the reference price literature by focusing on the changes in consumer demand that result from price changes around the reference level.

As our contribution, we introduced the notions of loss averse vs. gain seeking price behavior *in demand*, based on responses in expected demand due to price changes. We contrasted these notions with the conventional notions of loss aversion vs. gain seeking price behavior *in value*, which previous research has focused on. We employed the random additive utility model with conditional logit, and derived general conditions for a consumer or market segment to be loss averse or gain seeking in demand. A simple formula was developed to check the character of price behavior and its interpretation was discussed. Two special cases of value functions were considered: the value function consistent with prospect theory and the linear and smooth value functions.

As an important finding of ours, we noted that even when the value function is consistent with the prospect theory and exhibits loss aversion in value, loss aversion in demand does not necessarily occur. Furthermore, we found and demonstrated that the firm's market share for the product, prevailing at the reference price level, acts as a crucial determinant of whether the demand is loss averse or gain seeking, in response to price changes.

In addition, we analyzed the optimal price changes under conditions of various price elasticities of demand and different profit margins. These analyses underlined – in accordance with our findings on loss averse vs. gain seeking price behavior in demand - that even if consumers' utility function conformed with the prospect theory, the optimal price change may involve further price increases. Also both loss averse and gain seeking behavior in demand can occur.

5.2 Managerial implications

In general, our findings have substantial practical relevance for managers concerned about market reactions to price changes. Indeed, with our focus on the tangible notion of demand – rather than the abstract and theoretical notion of value or utility – our research holds the promise of providing valuable insights to managers.

The key lesson for managers is that the current market share of a firm's products is a substantial determinant of whether consumer demand reacts more strongly to price increases than equal price decreases (i.e., is loss averse in demand), reacts more strongly to price decreases than price increases (i.e., is gain seeking in demand), or is equally sensitive to price increases and decreases. This information can be valuable when the firm plans for temporary or permanent price promotions, discounts, and price cuts – or price increases, premiums, or price hikes. In summary, the finding that the product's market share is an important determinant of the overall effect of a price change on the market demand is, of course, not entirely surprising. It is, after all, intuitively logical that tweaking the price and consumer value to a certain extent has a different effect on demand in the cases of a very low vs. very high market share. It seems, for instance, plausible that a low market share can easily be boosted by a price decrease whereas it is tough to push up a market share already exceeding 50 per cent. Nevertheless, the value of our research to managers lies also in the formulas and examples presented, which enable more exact analysis and prediction of how the consumer demand is likely to react to price changes, given the current market share of a given firm's product. These formulas are rather simple to apply in varied real-life situations.

If the prospect theory holds for consumers' value functions, our analysis shows that the pricing decision faced by a manager is complex: it can be optimal to raise the price, to keep it unchanged or to decrease the price. The right choice depends on the product's market share, profit margin and price elasticity of demand.

Appendix A: Proof of Proposition 1

For brevity, denote $r = P_N > 0$, $q = 1 - r > 0$, $x = \exp(\delta_H) > 1$ and $y = \exp(-\delta_L) < 1$. Then, given the normal price level N for product i, (2) yields expected relative demand P_N for product i, and $q/r = (1 - P_N)/P_N = \sum_{j \neq i} \exp(v_j)/\exp(v_N)$. Hence, for any price level K ($K = N, H, L$) of product i, (2) yields expected relative demand $P_K = 1/[1 + \exp(-v_K) \sum_{j \neq i} \exp(v_j)] = r/[r + q \exp(v_N - v_K)]$. Consequently, with (3) and (5) we get $\Delta = r[2 - 1/(r + qx) - 1/(r + qy)]$. Here, $\Delta > 0$ if and only if $2(r + qx)(r + qy) - (r + qx) - (r + qy) = (r + qx)(r + qy - 1) + (r + qy)(r + qx - 1)$ $= (r + qx)q(y - 1) + (r + qy)q(x - 1) > 0$ or $[r(1 - x) + x](y - 1) + [r(1 - y) + y](x - 1)$ $= r[2(x - 1)(1 - y)] - x - y + 2xy > 0$. Because $(x - 1)(1 - y) > 0$, this implies the loss aversion condition $r = P_N > P^*$ in Proposition 1. Similarly, $P_N < P^*$ implies gain seeking behavior, and if $P_N = P^*$, the price behavior is symmetric.

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