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# The Effect of Consumers' Loss Aversion on Pioneering Advantage

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**ABSTRACT**

The present study provides a theoretical investigation on pioneering advantage based on reference dependence and loss aversion effect under prospect theory (Kahneman and Tversky, 1979). Behavioral explanations for pioneering advantage are provided from two different perspectives: one based on the prototypicality and the other on the utility uncertainty of the option. A pioneer brand creates the product category and makes a strong impression in customers' mind, and thus becomes the most representative or prototypical option of the category. In addition, the pioneer brand becomes the first option to be experienced by the majority of consumers in the product category, thus has the lowest level of utility uncertainty compared with the late movers. This study integrates the previous accounts for pioneering advantage by showing that consumers have higher preferences for the most prototypical and the least uncertain option based on loss aversion and reference dependence effect. This study suggests that firms should carefully analyze the consumers' loss aversion and perceived uncertainty and prototypicality of their products in order to develop effective market entry strategies.

Keywords: Pioneering Advantage, Loss Aversion, Prospect Theory

## 1. Introduction

One of the most effective ways of occupying a competitively distinctive position in the target customers' mind is to create a new product category, that is, to become a pioneering brand (Carpenter and Nakamoto, 1989; Kardes and Kalyanaram, 1992; Ries and Trout, 2001). Numerous empirical findings report market share advantages to pioneers and early entrants (Urban, Carter, Gaskin, and Mucha, 1986; Kalyanaram and Urban, 1992). Pioneering advantage or the first-mover advantage is attributed to

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various causes including economic factors, preemption factors, technological factors, and behavioral factors (Kerin, Varadarajan, and Peterson, 1992; Lieberman and Montgomery 1988). Many studies in marketing focus on the behavioral aspects of the first-mover advantage. Carpenter and Nakamoto (1989) propose that pioneering advantage is due to the pioneer's forming the consumers' preference structure and its competitive distinctiveness. Other studies predict that consumer risk aversion (Schmalensee, 1982) and consumer learning (Kardes and Kalyanaram, 1992) can aid the market pioneering. Kerin, Varadarajan, and Peterson (1992) summarize that behavioral factors related to the pioneering advantage can be categorized as the following four elements: (1) switching costs, (2) prototypicality and product-specific reputational advantage, (3) communication good effect and information, and (4) consumption experience asymmetries.

This study integrates previous behavioral accounts for pioneering advantage using the loss aversion effect implied by prospect theory (Kahneman and Tversky, 1979) as a theoretical pivot. A pioneering brand can define a product category as a whole and thus become the "prototype" against which all later entrants are judged (Alpert, 1987; Howard, 1989; Carpenter and Nakamoto, 1989). In addition, the first-mover, with a high degree of consumer awareness and experiences, becomes the option with the least level of perceived risk (uncertainty) (Schmalensee, 1982; Hoch and Deighton, 1986). This study analytically shows why consumers prefer the most prototypical option and the least uncertain option based on the loss aversion effect. The mathematical demonstrations are based on the following assumptions derived from the previous empirical studies:

① The pioneer brand becomes the most prototypical option in the product category it creates.
② Brands are evaluated not independently but in comparison with competing brands.
③ The pioneer brand becomes the reference point for evaluating the later entrants.
④ The pioneer brand becomes the option with the least level of perceived uncertainty (or often no uncertainty) when the late movers enter the market.

Analysis 1 is based on Assumptions 1 and 2, and Analysis 2 on Assumptions 2, 3 and 4. The related literatures will be provided with more detailed discussions on the issue in the following sections.

## 2. Analysis 1: The Prototypicality Effect and Preference for the Middle Option

Prototypicality is the degree to which an object is representative of a category and is often operationalized as an alternative's average similarity to other category members or its similarity to the central tendency (average, median or mode) of the category members (Tversky, 1977; Rosch and Mervis, 1975; Smith, Shoben and Rips, 1974). Pioneering increase a brand's centrality (Schwarz and Tversky, 1980) thus making its brand as highly similar to more brands. Therefore, the pioneer is perceived as more prototypical, which shields it from competitors and yields it a significant advantage in relative preference (Carpenter and Nakamoto, 1989). In this study, the prototypicality effect refers to the advantage of the most representative or prototypical alternative of the category in terms of preference and choice.

Many empirical studies show a positive correlation between an option's prototypicality and its preference across product categories (Loken and Ward, 1990; Veryzer and Hutchinson, 1985; Barsalou, 1985; Whitfield and Slatter, 1979) and there exist various explanations for it. Prototypical items are more preferred because of their high frequency of exposure and familiarity (Rosch and Mervis, 1975; Gordon and Holyoak, 1983; Zajonc, 1968), the ease of learning and classification (Rosch, 1973; Posner and Keele, 1968; Kaplan, 1973), and their being coded by mental representations capable of greater activation (Martinedale and Moore, 1988). Other explanations hold that highly prototypical category members have more valued attributes (Loken and Ward, 1990) or more aesthetic value (Veryzer and Hutchinson, 1985). The ability of a prototypical object to represent the category as a whole may have some information value in and of itself (Rosch, 1978).

This study focuses on the effect of loss aversion (Tversky and Kahneman, 1991) on the prototypicality effect. Let's assume that there are $n$ competing alternatives in the choice set S, thus let $S = \{1, 2, \cdots, n\}$ be a finite set that includes all the options under study. In a two-dimensional (attribute) space, alternative j is assumed to have the coordinate values of $(x_j, y_j)$ as shown in Figure 1.

This study rules out the differences in quality or overall utility in order to focus on the effects of prototypicality and uncertainty only. In Figure 1, the straight line passing through all the alternatives is the iso-utility line. The utility of alternative j can be represented by the multi-attribute utility model (Fishbein and Ajzen, 1975).

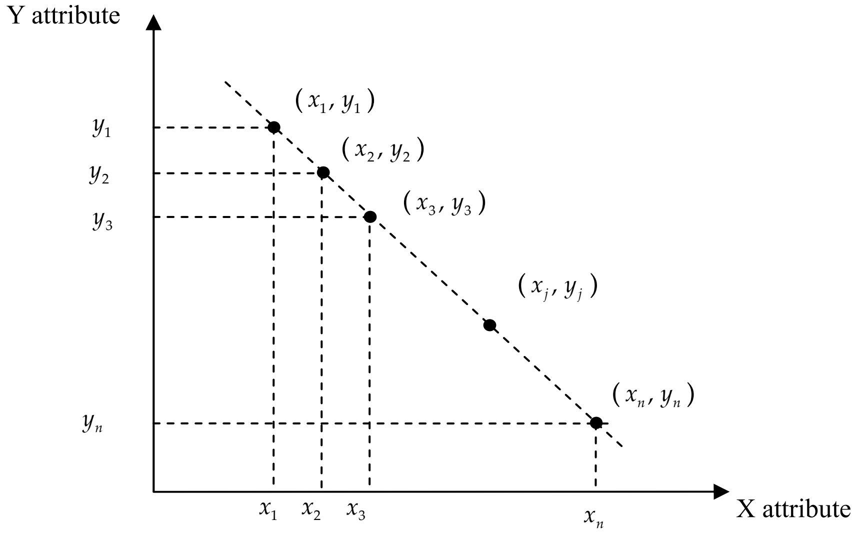


Figure 1. Distribution of Alternatives on the Iso−utility Line in Two Dimensional Space

$$U(j) = w_X x_j + w_Y y_j = k \quad \text{for all} \quad j \in S \quad (j = 1, 2, \cdots, n) \tag{1}$$

where k stands for a positive constant, $w_X$ and $w_Y$ the importance weights of attributes X and Y respectively ($w_X > 0,\ w_Y > 0$). However, this study assumes that a brand is not evaluated independently (as represented by the multi-attribute model) but is evaluated in comparison with the competing brands (reference dependence). In addition let's assume that there is loss aversion in comparative evaluation processes (Tversky and Kahneman, 1991).

Let one of the alternatives in the choice set be the focal alternative denoted as i. RV(i, j) denotes the *relative value* of i compared to j, one of the competing alternatives. Following the tradition of the previous studies (Tversky and Kahneman, 1991; Hardie, Johnson, and Fader, 1993; Tversky and Simonson, 1993; Tversky, 1969), RV (i, j) is defined as

$$RV(i, j) = \alpha w_X (x_i - x_j) + \beta w_Y (y_i - y_j) \quad \text{when} \quad (x_i - x_j) \geq 0, \quad (y_i - y_j) \leq 0 \tag{2}$$

$$= \beta w_X (x_i - x_j) + \alpha w_Y (y_i - y_j) \quad \text{when} \quad (x_i - x_j) < 0, \quad (y_i - y_j) > 0 \tag{3}$$

where $\alpha$ and $\beta$ are gain and loss parameters respectively ($\beta > \alpha > 0$). It is defined that $RV(i, i) = 0$. For notational convenience, let's divide the domain of $x_j$ and $y_j$ into two mutually exclusive subsets.

$$A^+ = \{j \mid (x_i - x_j) > 0,\ \ and\ (y_i - y_j) < 0\} \tag{4}$$

$$A^- = \{j \mid (x_i - x_j) < 0,\ \ and\ (y_i - y_j) > 0\} \tag{5}$$

Note that $A^+ \cup A^- \cup \{i\} = S$. RV(i, S), the average relative value of an alternative i, compared to *all* the other alternatives in set S, is defined as

$$RV(i, S) = \frac{1}{n-1}\sum_{j\in S} RV(i, j) \tag{6}$$

$$= \frac{1}{n-1}\{\alpha w_X \sum_{j\in A^+}(x_i - x_j) + \beta w_X \sum_{j\in A^-}(x_i - x_j) + \alpha w_Y \sum_{j\in A^-}(y_i - y_j) + \beta w_Y \sum_{j\in A^+}(y_i - y_j)\}$$

The proposed relative value model is similar to the relative advantage model by Tversky and Simonson (1993). From Equation (1), $U(i) - U(j) = w_X(x_i - x_j) + w_Y(y_i - y_j) = 0$, for all $i,\ j \in S,\ i \neq j,$ thus

$$RV(i, S) = \frac{(\alpha - \beta) w_X}{n-1}\{\sum_{j\in A^+}(x_i - x_j) - \sum_{j\in A^-}(x_i - x_j)\} \tag{7}$$

As the effect of loss aversion becomes greater ($\beta$ becoming larger relative to $\alpha$), the relative value becomes smaller for any alternative in set S. Likewise, the value RV(i, S) becomes larger as the value of $\sum_{j\in A^+}(x_i - x_j) - \sum_{j\in A-}(x_i - x_j)$ decreases. Let Z(i, S) denote $\sum_{j\in A^+}(x_i - x_j) - \sum_{j\in A^-}(x_i - x_j)$, then Z(i, S) is reduced to

$$Z(i, S) = \sum_{j\in S} \mid x_i - x_j \mid \tag{8}$$

The value of $\frac{Z(i, S)}{n-1}$ represents i's average similarity to all the other options in the choice set, which is the prototypicality of i with respect to the set (Tversky, 1977; Rosch and Mervis, 1975). The smaller the value of $Z(i, S)$, the greater the prototypicality of i. The value of $x_i$ minimizing $Z(i, S)$ maximizes $RV(i, S)$. For a simple illustration, let's assume that all the alternatives are located at the same distance from the adjacent alternatives. Let $n^-$ and $n^+$ denote the numbers of alternatives in sets $A^-$ and $A^+$ respectively. Z(i, S) can be calculated from the equation for the arithmetic sequence summation.

$$Z(i, S) = \Delta_X[\frac{n^-\{2+(n^- -1)\}}{2} + \frac{n^+\{2+(n^+ -1)\}}{2}] \quad (9)$$

where $\Delta_X$ is a constant representing the value difference in attribute X between two adjoining alternatives. Simple calculations show that Z(i, S) is minimized when $n^- = n^+ = \frac{n-1}{2}$ (Note that $n^+$ can be substituted by $n-1-n^-$). To make a more rigorous theoretical generalization, let's assume a hypothetical choice context where there are infinitely many competing alternatives uniformly distributed along the iso-utility line. The calculations show that the middle option has the greatest relative value as shown in Appendix I.

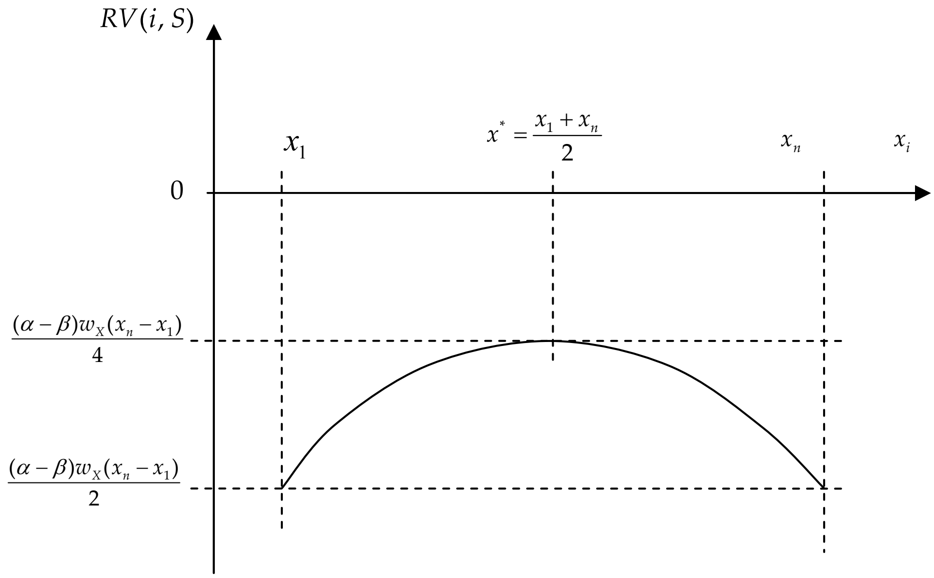


Figure 2. $RV(i, S)$ for All the Options Continuously Distributed along the Iso-utility Line

The relative value of an option is greatest when the attribute values of the option are $x_{i^*} = \frac{x_1 + x_n}{2}$ and $y_{i^*} = \frac{y_1 + y_n}{2}$. The results of the analysis can be summarized as the following two rules. First, the middle option or the most prototypical option has the greatest preferential advantage among the alternatives of the same utility level. Previous studies show that an extreme option or the option distant from the category center tends to be at a disadvantage to the middle option (Simonson, 1989, Simonson and Tversky, 1992) in a high preference uncertainty situation. The prototypicality effect can explain other market phenomena such as the compromise effect (Simonson, 1989), lone alternative effect (Kahn, Moore, and Glazer, 1987), the extremeness aversion effect (Simonson and Tversky, 1993). The pioneer brand may not be located at the central place in the actual attribute space, but it is likely to be so in consumers' minds.

Second, the relative value for any one of the equally attractive options (i.e., options with equal utility values) is always less than zero, unless compared only to itself (in this case zero). If there is no loss aversion effect ( $\alpha = \beta$ ), the relative value of any alternative compared to its competitors along the iso-utility line is zero. Loss aversion effect makes the relative values of the alternatives negative (Refer to Appendix I). This is quite similar to the comparative loss aversion phenomenon whereby comparisons between options make each option less attractive (Brenner, Rottenstreich, and Sood, 1999). In the subsequent section, I will discuss the pioneer brand's advantage due to its being perceived as the option with the least uncertainty.

## 3. Analysis 2: Status Quo Bias and Uncertainty Aversion

The pioneer brand is a beneficiary of consumers' habitual buying behaviors (Jeuland 1979) or status quo bias (Samuelson and Zeckhauser, 1988). The first brand introduced into the market received disproportionate attention in the consumers' mind (Lieberman and Montgomery, 1988) and likewise, it induces trials by the majority of potential customers before rivals do. By the time new entrants become available in the market, it is most likely that the first mover has already become the industry standard (Carpenter and Nakamoto, 1989, Howard, 1989) and the 'default option' with the least level of, or hypothetically no utility uncertainty (Schmalensee, 1982; Kerin, Varadarajan, and Peterson, 1992).

This section will introduce the concepts of loss aversion and reference dependence into the stochastic utility context. Let i denote the pioneer brand and j one of the later entrants. Let's assume that the utilities of the alternatives can be represented as probabilistic distributions and have the same level of expectation.

$$E[U(j)] = E[U(i)] = k, \quad for\ all\ j \in S^{-} \tag{10}$$

Let S denote the choice set including current option (pioneer) and all the later entrants (S = {i} $\cup$ $S^{-}$). Consumers appear to organize product knowledge around prototypical examples, using them as cognitive reference (Medin and Schaffer, 1978; Rosch, 1975; Carpenter and Nakamoto, 1989). Unlike the assumption of the previous section, this section assumes that the current option (Option i) is the only reference point for evaluation of new alternatives. If alternatives i and j have the stochastic utilities of $u_i (= U(i))$ and $u_j (= U(j))$ respectively, the relative value is j compared to i is also a random variable and can be defined as (Tversky and Kahneman, 1991)

$$\begin{aligned} RV(j, i) &= \alpha(u_j - u_i), \quad if \;\; u_j > u_i \\ &= \beta(u_j - u_i), \quad if \;\; u_j < u_i \end{aligned} \tag{11}$$

where $\alpha$ and $\beta$ are gain and loss parameters respectively ($\beta > \alpha > 0$). This section applies stochastic distributions to the concept of relative values, thus assumes that consumers choose the alternative with the greatest *expected relative value* (ERV). The expectation of j's relative value to i is defined as follows:

$$ERV(j, i) = \beta \int_{-\infty}^{0} \delta_{ji} \cdot f(\delta_{ji}) d\delta_{ji} + \alpha \int_{0}^{\infty} \delta_{ji} \cdot f(\delta_{ji}) d\delta_{ji} \tag{12}$$

where $\delta_{ji} = u_j - u_i$ and $f(\delta_{ji})$ is the probability density function of $\delta_{ji}$. If we assume a symmetric distribution for the random variable $u_j$ thus for $\delta_{ji}$ such as normal or logistic distribution (McFadden, 1973), for any option j in the choice set S, it is defined that

$$ERV(j) = ERV(j, S) = ERV(j, i) = (\alpha - \beta)\int_0^{\infty} \delta_{ji} \cdot f(\delta_{ji}) d\delta_{ji} \quad (13)$$
$$= \frac{(\alpha - \beta)}{2}\int_{-\infty}^{\infty} |\delta_{ji}| \cdot f(\delta_{ji}) d\delta_{ji}.$$

If there is no loss aversion effect ( $\alpha = \beta$ ), $ERV(j) = 0$. Consumers feel certain of the utility of the alternative they have been using, while being uncertain about the ones they had no experience with. Thus, it is assumed that the current option is the one with no perceived uncertainty. For analytical convenience, this study will use the *mean deviation* (MD) instead of the standard deviation as a measure of the perceived uncertainty.

$$MD(u_j) > 0, \quad \textit{for all } j \in S^- \quad (14)$$

$$MD(u_i) = 0 \quad (15)$$

The value of $\int_{-\infty}^{\infty} |\delta_{ji}| \cdot f(\delta_{ji}) d\delta_{ji}$ in Equation (13) represents the mean deviation of the random variable, $\delta_{ji}$, where

$$MD(\delta_{ji}) = \int_{-\infty}^{\infty} |\delta_{ji}| \cdot f(\delta_{ji}) d\delta_{ji} = \int_{-\infty}^{\infty} |u_j - k| \cdot f(u_j) du_j = MD(u_j) \quad (16)$$

From Equation (13),

$$ERV(j) = \frac{1}{2}(\alpha - \beta) MD(u_j) < 0, \textit{ for all } j \in S^- \quad (17)$$

$ERV(i) = ERV(i, i) = 0$, because MD( $u_i$ ) is zero. The expected relative value of an uncertain option is *always* negative. Because $ERV(j) < ERV(i) = 0$, for all $j \in S^-$, the option with the greatest expected relative value is the current option, i, with no utility uncertainty. The expected relative value of an option is a decreasing function of its utility uncertainty as well as of the degree of loss aversion. Trial rewards for market pioneers can arise from consumer risk (uncertainty) aversion (Schmalensee 1982). However, this study shows that if there is no loss aversion ( $\alpha = \beta$ ), the degree of uncertainty has no impact on choice.

$$\frac{dERV(j,\, i)}{dMD(u_j)} = \frac{\alpha - \beta}{2} < 0 \tag{18}$$

$$\frac{dERV(j,\, i)}{d\beta} = -\frac{1}{2}\int_0^{\infty} \delta_{ji} f(\delta_{ji}) d\delta_{ji} = \frac{-MD(u_j)}{2} < 0 \tag{19}$$

$$\frac{dERV(j,\, i)}{d\beta dMD(u_j)} = -\frac{1}{2} < 0 \tag{20}$$

Because the utility uncertainty will decrease dramatically as consumers' experiences with the brand accumulate, the most experienced option will have the greatest ERV and most likely to be adopted in subsequently purchase occasion. The status quo bias or preference for the safe option is the direct outcome of loss aversion. If a consumer weighs gains more heavily than losses ( $\alpha > \beta$ ), he or she will show a risk taking tendency and thus a variety seeking behavior (cf. McAlister and Pessemier, 1982). Tversky and Kahneman (1991) mention the relationship between loss aversion and the status quo bias, but have not clarified the interaction effect between perceived utility uncertainty and the degree of loss aversion (Equation 20). The increased uncertainty magnifies the impact of loss aversion on brand evaluation. If there is no utility uncertainty related to the new option, there will be a dramatic decrease in the magnitude of pioneering advantage.

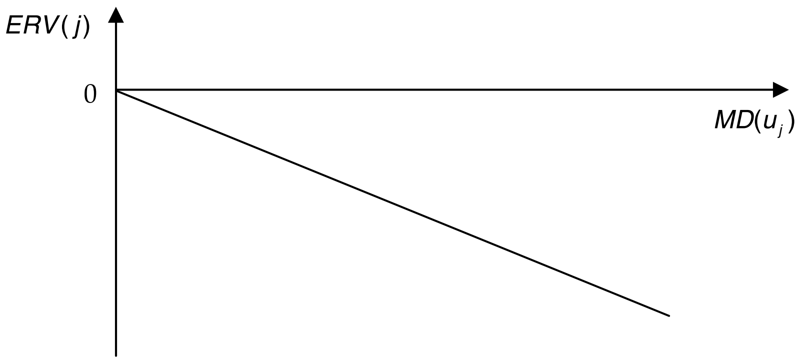


Figure 3. The Relationship between $ERV(j)$ and $MD(u_j)$

This study assumes that there is no difference in expected utilities between the pioneer and the late mover. However, it is often the case that a late entrant attacks the pioneer with a better quality or/and lower price product. Consumers will choose the newly introduced option, j, if ERV(j) > ERV(i) = 0. In order to gain an advantage over the pioneer, the later mover's expected utility should be greater than that of the pioneer, $E[U(j)] > E[U(i)]$ as shown in Figure 4. However, option j's having a greater expected utility does not guarantee that it has a greater expected relative value. In order to show it, let D denote the difference in expected utilities, $E[U(j)] - E[U(i)] = D$. In Equation (12), the larger value of D increases $\alpha\int_0^\infty \delta_{ji} \cdot f(\delta_{ji})\,d\delta_{ji}$, but decreases $-\beta\int_{-\infty}^0 \delta_{ji} \cdot f(\delta_{ji})d\delta_{ji}$, and thus increase ERV (j, i). Let $D^*$ denote the value of D where ERV(j, i) = 0, then

$$\frac{\int_0^\infty \delta_{ji} \cdot f(\delta_{ji})d\delta_{ji}}{-\int_{-\infty}^0 \delta_{ji} \cdot f(\delta_{ji})d\delta_{ji}} = \frac{\beta}{\alpha} \quad \text{at } D^* \tag{21}$$

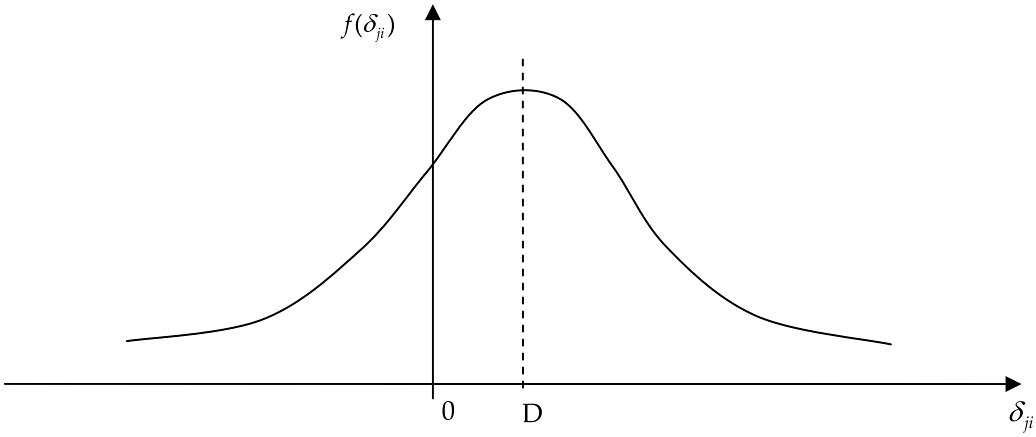


Figure 4. Probability Distribution of $\delta_{ji}$ with D > 0 ( $E[U(j)] > E[U(i)]$ )

It can be inferred that ERV(j, i) can still be negative even with a positive value of D. The late mover's simply having a greater expected utility than the pioneer is not enough to overcome the pioneer's advantage. The late mover should excel the pioneer by a substantial amount of difference in expected utility (a threshold level of $D^*$ ). The threshold level is positively related to the perceived utility variance and the degree of consumers' loss aversion (calculations omitted). The pioneering advantage will be huge in the market where both consumers' perceived uncertainty and loss aversiveness are very high. It is compatible with Muthukrishnan's (1995) study showing that the incumbent brand establishes an advantage over the attack brand when the decision environment is ambiguous.

## 4. Conclusions and Implications

Some scholars negate the existence of the pioneering advantage based on the fact that there are many examples of late movers' successes (Golder and Tellis, 1993, Kerin, Varadarajan, and Peterson, 1992). Lieberman and Montgomery (1988) argue that profits earned by first-movers are fundamentally attributable to proficiency and luck, rather than 'pioneering' per se. This study proposed that the profits earned by the pioneers are fundamentally attributable to its greater prototypicality and reduced uncertainty combined with consumers' loss aversion as show in Figure 5.

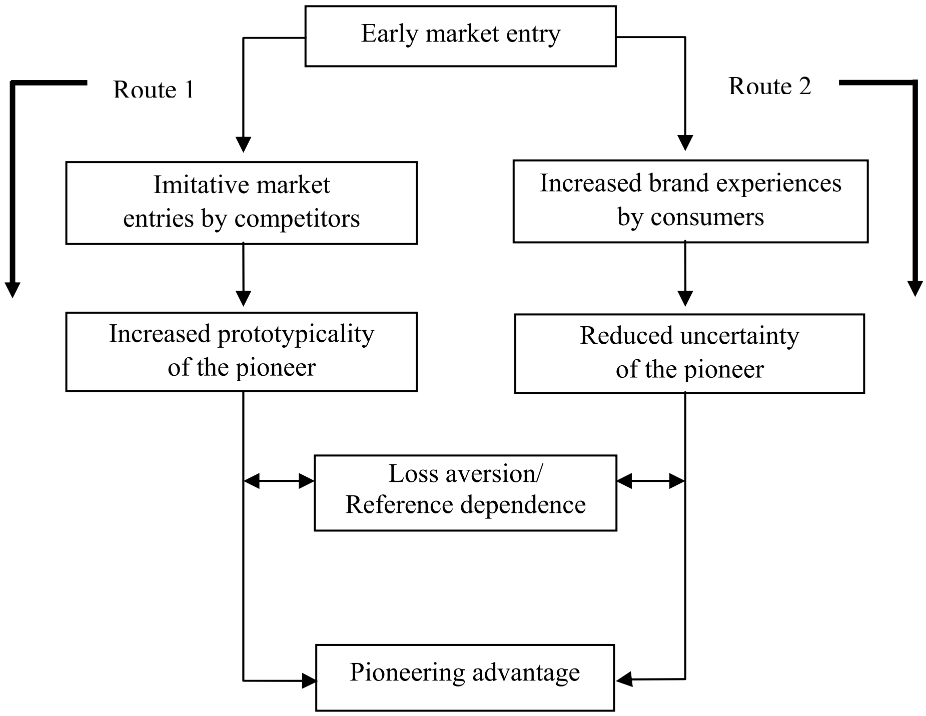


Figure 5. Behavioral Explanations for the Pioneering Advantage Based on Prospect Theory

*Managerial implications*. Market pioneering only provides opportunities for achieving positional advantages and market share dominance. From a behavioral perspective, to be a pioneering brand is important only as much as it contributes to being the most prototypical and the least uncertain option in the market of high preference uncertainty. Firms can become the most prototypical brand of the product category by creating the category. However, the later entrant can become the most prototypical option by entering the major market with an option of a dominating quality and price (Golder and Tellis, 1992). Pursuing a high prototypicality strategy is to target the mass consumer market which is the most attractive but also the most competitive market, thus it is a high risk/high return strategy for a later mover. Firms should try to become the most widely purchased and experienced brand, thus become the option with the least level of utility uncertainty. Low uncertainty strategy can be adopted by the late movers with superior quality. The low uncertainty strategy by the late movers should be accompanied by heavy advertising and sales promotion campaigns at the introduction stage. On the other hands, the pioneer can benefit from increasing consumers' perceived uncertainty, when faced with a strong competitor (cf. Hoch and Deighton, 1986).

If consumers evaluate brands simply based on intrinsic utilities, there cannot be such a phenomenon as pioneering advantage. Understanding consumers' loss aversive tendency and perceived uncertainty as well as the similarity (prototypiclity) structures of the market is crucial in devising effective marketing strategies. A late mover should be much prudent when entering the market where consumers are highly loss aversive and their perceived uncertainty is very high. In such a market, the pioneer's advantage is so great that the later mover may as well look for an opportunity to create a new market, unless the late mover's market offering is distinctively superior to the incumbent and can be perceived as so.

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## Appendix I

Let $f(x_j)$ and $f(y_j)$ be the probability density functions of the uniformly distributed random variables $x_j$ and $y_j$ respectively (i.e., $f(x_j) = \frac{1}{x_n - x_1}$). In the continuous distribution case, $x_1$ and $x_n$ simply represent the two extreme values (the smallest and the largest values) of x in the hypothetical choice set, where n does not indicate the number of alternatives as in the discrete distribution case. The same notations are used in order to maintain notational consistency. The calculations show that the average relative value of the focal alternative i is a decreasing function of Z (I, S).

$$
\begin{aligned}
RV(i, S) &= \int_{x_1}^{x_i} \alpha w_X (x_i - x_j) f(x_j) dx_j + \int_{y_1}^{y_i} \beta w_Y (y_i - y_j) f(y_j) dy_j \\
&+ \int_{x_i}^{x_n} \beta w_X (x_i - x_j) f(x_j) dx_j + \int_{y_i}^{y_n} \alpha w_Y (y_i - y_j) f(y_j) dy_j \\
&= \int_{x_1}^{x_i} \alpha w_X (x_i - x_j) f(x_j) dx_j - \int_{x_1}^{x_i} \beta w_X (x_i - x_j) f(x_j) dx_j \\
&+ \int_{x_i}^{x_n} \beta w_X (x_i - x_j) f(x_j) dx_j - \int_{x_i}^{x_n} \alpha w_X (x_i - x_j) f(x_j) dx_j \\
&= \frac{(\alpha - \beta) w_X}{(x_n - x_1)} Z(i, S) \qquad \text{(A-1)}
\end{aligned}
$$

where

$$
\begin{aligned}
Z(i, S) &= \int_{x_1}^{x_n} | x_i - x_j | dx_j = \int_{x_1}^{x_i} (x_i - x_j) dx_j - \int_{x_i}^{x_n} (x_i - x_j) dx_j \\
&= x_i^2 - (x_1 + x_n) x_i + \frac{(x_1^2 + x_n^2)}{2}. \qquad \text{(A-2)}
\end{aligned}
$$

If we find the solution for the equation, $\frac{dZ(i, S)}{dx_i} = 0$, the value of $x_i$ which gives the greatest value of $RV(i, S)$ is $\frac{(x_1 + x_n)}{2}$, which is the average value of the uniformly distributed $x_j$'s in the choice set S. Note that $Z(i, S) = \frac{(x_n - x_1)^2}{4}$ (minimum), when $x_i = \frac{x_1 + x_n}{2}$ and $Z(i, S) = \frac{(x_n - x_1)^2}{2}$ (maximum), when $x_i = x_1 \; or \; x_n$.

Once the value of optimal of $x_i$ (denoted as $x_i^*$) is determined, the value of $y_i^*$ is determined as well ($y_i^* = \frac{1}{w_Y}(k - w_X x_i^*)$). In this case, $y_i^* = \frac{1}{2}(y_1 + y_n)$.

$$RV(i, S) = 0, \qquad if \quad \alpha = \beta \tag{A-3}$$

$$RV(i, S) = \frac{(\alpha - \beta) w_X Z(i,S)}{(x_n - x_1)} < 0, \qquad if \quad \alpha < \beta$$

As the degree of loss aversion becomes greater, the relative value of any alternative in the choice set become even smaller.

$$\frac{dRV(i, S)}{d\beta} = \frac{-w_X Z(i, S)}{(x_n - x_1)} < 0 \tag{A-4}$$

$$\frac{dRV(i, S)}{dZ(i, S)} = \frac{(\alpha - \beta) w_X}{(x_n - x_1)} < 0 \tag{A-5}$$

The decrease in the relative value of the focal brand due to loss aversion is even greater if the brand's average distance with competing alternatives, $Z(i, S)$, becomes larger. Thus, firms should avoid their offerings being the extreme options in the market where consumers are highly loss aversive.

$$\frac{d^2 RV(i, S)}{d\beta dZ} = \frac{-w_X}{(x_n - x_1)} < 0 \tag{A-6}$$