Prospect Theory: Developments and Applications in Marketing

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Abstract

This paper reviews development of Prospect Theory on its four key issues: the editing process, the value function, the probability weighting function, and risk attitude assessment under Prospect Theory. Based on past findings, the author suggests some revisions to Prospect Theory, which allows the assimilation of small gains and losses in the value function and frames gains and losses as percentage gains and losses instead of absolute levels of gain and loss. Existent applications of Prospect Theory in marketing are discussed at the end of the paper. Several under-explored application areas in marketing are presented and possible applications suggested.

Introduction

Prospect Theory was first proposed by Kahneman and Tversky in 1979. Different from traditional utility theory, Prospect Theory suggests that (1) people evaluate a prospect based on gains and losses rather than on final assets. Further, (2) people view gains and losses separately and differently. (3) The decision weight people put on an outcome is a nonlinear function of the probability that the outcome happens.

Prospect Theory aims to explain people's decision under uncertainty, which had been an area dominated by Expected Utility Theory. Expected Utility Theory posits that two prospects with the same expected utility will be given the same preference by rational decision makers. However, it has been found that people's decision making is heavily influenced by the framing of the problem (Diamond 1988; Elliot and Archibald 1989; Loewenstein 1988; Paese 1995; Schurr 1987; Tversky and Kahneman 1981; van Schie and van der Pligt 1995), which directly violates Expected Utility Theory. By using a system of nonlinear value functions and probability weighting functions, Prospect Theory is able to account for such "irrational" behavior.

Prospect Theory has been applied in a variety of areas and has been supported by both laboratory and field data (Chang, Nichols and Schultz 1987; Elliott and Archibald 1989; Fiegenbaum and Thomas 1988; Gooding, Goel and Wiseman 1996; Salminen and Wallenius 1993; Sebora and Cornwall 1995; van Schie and van der Pligt 1995). It has also been theoretically developed into Cumulative Prospect Theory (Tversky and Kahneman 1992) and Prospect Theory under Certainty (Tversky and Kahneman 1991). Thaler (1985) has extended Prospect Theory to another widely used theory - Transaction Utility Theory.

This paper aims to provide a review of developments of Prospect Theory from a marketing researcher's point of view. The three versions of Prospect Theory, the Original Prospect Theory

(OPT), the Cumulative Prospect Theory (CPT) and Prospect Theory under Certainty (PTUC) are first described. Then development by other researchers on Prospect Theory is discussed by centering on its four key issues -- the editing process, value function, probability weighting function, and risk attitude assessment. The controversial issues and counter-arguments of Prospect Theory are also presented. Based on past research, the author proposed two revisions of Prospect Theory, which allow assimilation of small gains and losses and frame gain and loss in percentage rather than absolute term. The paper ends with applications of Prospect Theory in marketing. Some potential but under-explored application areas in marketing are also suggested.

Overview of Prospect Theory

Original Prospect Theory (OPT)

The essence of OPT consists of three parts: the editing process, the value function, and the probability weighting function. According to Kahneman and Tversky (1979), people edit a prospect before they evaluate it. A prospect theory is coded as gains and/or losses relative to some reference point. As human being has a natural tendency to simplify tasks, the editing process helps to make the evaluation task easier. One example is the cancellation process, in which a common outcome for all prospects is canceled out and does not enter the evaluation stage[1].

Following the editing process is the evaluation process. It transforms an edited prospect into value of the prospect. The value of a prospect, denoted by V, is obtained by equation (1).

$$V(x_1, p_1; x_2, p_2) = \begin{cases} v_+(x_1)\pi(p_1) + v_+(x_2)(1-\pi(p_1)) & when \quad x_1 \geq x_2 \geq 0 \\ v_+(x_1)\pi(p_1) + v_-(x_2)\pi(p_2)) & when \quad x_1 \geq 0 \geq x_2 \\ v_-(x_1)\pi(p_1) + v_-(x_2)(1-\pi(p_1)) & when \quad x_1 \leq x_2 \leq 0 \end{cases} \tag{1}$$

[1] See The Editing Process part under Development of Prospect Theory Section for a criticism of this process.

where x_1 and x_2 are the outcome levels; p_1 and p_2 are the probabilities associated with respective outcomes, and $p_1 + p_2 = 1$. $v_+(.)$ is the value function associated with gains, and $v_-(.)$ is the value function for the loss domain. $\pi(.)$ is the probability weighting function.

One important characteristic of the value function is already partly revealed through equation (1), i.e., value functions for gains and for losses are different. The value function is concave in the gain domain, while convex in the loss domain, indicating people are risk-averse to gains and risk-seeking to losses. Furthermore, since people are loss averse, they are more sensitive to losses than to gains, resulting in a value function with steeper slope for losses.

When evaluating a prospect, people also put a decision weight on an outcome based on the probability associated with that outcome. The relationship between the probability and the decision weight is expressed through a nonlinear probability weighting function. The function is non-decreasing. It equals zero when the probability equals zero or is in a small insensitive area around zero (impossible events), then jumps to positive values between 0 and 1 after the insensitive area. At some point very close to 1 (highly probable), people will consider the outcome as almost certain, and the decision weight will be the same as that of a certain outcome, which is equal to 1. Probability weighting function is continuous between the insensitive area and the certainty area.

A major limitation of OPT is that it violates stochastic dominance. One has to assume that stochastically dominated prospects are already ruled out in the editing process to overcome this problem. This imposes considerable constraints on the theory. Furthermore, OPT is not readily expandable to prospects with more than two outcomes. These restraints lead to the development of a more general Cumulative Prospect Theory.

Cumulative Prospect Theory (CPT)

Cumulative Prospect Theory (CPT) is both sign-dependent and rank-dependent. Unlike OPT, it proposes different probability weighting function for gains and for losses. CPT can be applied to any finite prospects. Under CPT, the value of a prospect, V, can be expressed by equation (2).

(2)
$$V(x_1, p_1; x_2, p_2; \cdots; x_n, p_n) = \sum_{i=1}^{m} v_+(x_i)[\pi_+(p_1 + p_2 + \cdots + p_i) - \pi_+(p_1 + p_2 + \cdots + p_{i-1})]$$
$$+ \sum_{j=m+1}^{n} v_-(x_i)[\pi_-(p_j + p_{j+1} + \cdots + p_n) - \pi_+(p_{j+1} + p_{j+2} + \cdots + p_n)]$$

where $x_1 \geq x_2 \geq ... \geq x_m \geq 0$ are the outcome levels coded as gains, $0 \geq x_{m+1} \geq x_{m+2} \geq ... \geq x_n$ are the outcome level coded as losses. $p_1, p_2, ... , p_n$ are the probabilities associated with respective outcomes. $v_+(.)$ is the value function associated with gains, and $v_-(.)$ is the value function for the loss domain. $\pi_+(.)$ is the probability weighting function for the gain domain, while $\pi_-(.)$ is the probability weighting function for the loss domain.

Here, the decision weight of a gain (loss) is defined as the difference between the weight of the total probability of weakly better (worse) outcomes and the weight of the total probability of strictly better (worse) outcomes coded as gains (losses). In this way, the weighting of an outcome becomes rank-dependent. Furthermore, the weighting function for gains is different from that for losses. However, Tversky and Kahneman (1992) study shows that the weighting function is actually very similar.

CPT also postulates that people tend to overweight small probabilities and underweight large probabilities. Following from this is the phenomenon that people are risk-averse for gains with large probabilities and losses with small probabilities, and are risk-seeking for gains with small probabilities and loss with large probabilities.

For prospects containing only two outcomes, OPT and CPT will give the same results since no revision of the weighting scheme will enter into the evaluation process. However, CPT is able to deal with prospects with more than two outcomes and will give much more flexibility than OPT. It allows both pessimism (overweight less favorable outcome) and optimism (overweight more favorable outcome). For example, for a prospect (x_1, p_1; x_2, p_2), $p_1 + p_2 = 1$, pessimism is present if $1 - \pi_+(p_1) > \pi_+(1- p_1)$ and $x_1 \geq x2 \geq 0$. Optimism is present if $1 - \pi_-(p1) > \pi_-(1- p_1)$ and $x_1 \leq x_2 \leq 0$.

Prospect Theory under Certainty (PTUC)

PTUC does not differ much from OPT except it is applied to certainty situations. Tversky and Kahneman (1991) proposed three major properties of decision under certainty. First, people have diminishing sensitivity. The difference between a $10 discount and a $5 discount has a larger impact than the difference between a $105 discount and a $100 discount does. This directly leads to a concave value function in the gain domain and convex in the loss domain. The second property is people are loss averse. People are aversive to losses, resulting in a larger slope of value function for gains than that for losses. Directly flowing from this loss aversion is the third property - people have status quo bias. Status quo bias refers to people's unwillingness to give up things or status they already have. This explains why there is a gap between buyer price and seller price (Tversky and Kahneman 1991). Sometimes a seller will view selling something as a loss and a violation of his status quo. To compensate this diturbance of his status quo, he will ask for a higher price than he would have if he was to buy the product.

Development of Prospect Theory

The Editing Process

According to Prospect Theory, people will edit a prospect before evaluating it (Kahneman and Tversky 1979). This has been proved in various occasions (e.g. Elliot and Archibald 1989). Particularly, people code the outcomes of a prospect into gains or losses according to some reference points. To better understand and predict people's decision-making, we need to find out the position of the reference point. However, Prospect Theory itself does not include much discussion about the reference point. It is the research on reference price that incorporated Prospect Theory and first addressed the issue of the location of the reference point.

Reference price is very useful in marketing research. It has been in existence long before the emergence of Prospect Theory (Winer 1988). Adaptation-Level Theory (Helson 1964) provided the original theoretical basis of this concept. The theory postulates that people have an adaptation level based on their past experiences (e.g., last purchase occasion) and environmental factors (e.g., store displays). When encountering a stimulus (e.g., a sticker price), they will judge it with respect to the adaptation level (reference price), and may also adjust their adaptation level according to the stimulus. Prospect Theory offers a richer understanding of reference price effects. When actual price is above reference price, people will code it as a loss. On the other hand, if the actual price is below the reference price, they will code it as a gain. Prospect Theory has been well incorporated into reference price research, which forms a significant part of marketing application of Prospect Theory (e.g. Kalyanaram and Little 1994; Kalyanaram and Winer 1985; Krishnamurthi, Mazumdar and Raj 1992).

Reference price can be specifically formed for a particular brand or for a product category in general. Literature on reference price has suggested several factors influencing formation of reference price. They can be divided into internal factors and external factors (Briesch et al. 1997; Mayhew and Winer 1992[2]). There are a total of eight internal factors used in past reference price research. They are: (1) price of previously chosen brand (Hardie, Johnson and Fader 1993); (2) observed or purchase price of the particular brand at last purchase occasions (Mayhew and Winer 1992, Kalwani et al. 1990, Krishnamurthi et al. 1992, Rajendran and Tellis 1994); (3) past price trend of the brand (Winer 1986); (4) reference price at last purchase occasion (Lattin and Bucklin 1989); (5) price promotion history of the brand (Greenleaf 1995; Kalwani et al. 1990); (6) household's tendency to buy on deal (Kalwani et al. 1990; Mayhew and Winer 1992); (7) market share of the brand (Winer 1986). External factors influencing reference price are: (1) a random brand's price at current purchase occasion (Briesch et al. 1997); (2) reference brand's current price (Hardie, Johnson and Fader 1993); (3)"regular" shelf price of a brand as listed with promotion price (Mayhew and Winer 1992); (4) store characteristics (Kalwani et al. 1990).

Besides reference price, reference quality is also a form of reference points that is especially applicable to marketing research. According to Prospect Theory, consumers may have a reference quality and will compare the offering quality with it. Although an important concept, reference quality has not received much attention in marketing research (Ong 1994). Ong's 1994 article is the first to investigate the issue of reference quality.

The study found that different advertising claims on quality resulted in different reference quality (measured by subjects' perceived typical quality and reasonable quality). Claim without a comparative quality led to the highest consumer reference quality, followed by claims of plausible-small difference between the comparative quality and the offered quality. Implausible-large difference claims led to the lowest consumer reference quality. This finding suggests that, the same

[2] In Mayhew and Winer 1992 paper, they divided the factors influencing reference price into memory-based factors and stimulus-based factors.

as reference price, reference quality can also be influenced by such external factor as advertising claims.

Further, the study found that, through the change of consumer reference quality, advertising claim resulted in different attitude-toward-the offer (Aoffer) and purchase intention. Higher reference quality from claims without comparative quality led to lower Aoffer and purchase intention than that of plausible-small and plausible-large difference claims. This is consistent with Prospect Theory in that consumers with higher reference quality will code the quality of the offered brand as less gain, thus have lower Aoffer and purchase intention. However, contrary to Prospect Theory, the higher reference quality caused by plausible-small difference claim did not lead to lower Aoffer and purchase intention than that of plausible-large difference claim. This may be due to the imprecise operationalization of plausible-small and plausible-large difference. It is possible that the plausible-large difference used in the study was already perceived as implausible large difference, thus the offered quality was not coded as gain, which led to low Aoffer and purchase intention. The study used ground beef as the stimulus product. Further research may be done for product categories in which quality is a more important factor, such as durable goods.

Compared with reference price, reference quality is more difficult to operationalize and manipulate. However, more research should be done to better understand this concept. In addition, as abundant research has shown that consumers often use price to judge quality (e.g. Etgar and Malhotra 1981; Gerstner 1985; Leavitt 1954), it is reasonable to conjecture that there is some correlation between reference price and reference quality. Further research can be done to explore this relationship.

Although called a "point", it has been found that reference point is actually an area around the traditionally defined single point. According to Assimilation-Contrast Theory (Sherif and Hovland

1958), when people encounter a stimulus, it will be assimilated if it is similar to their original perceptual level, or contrasted if it is different from the original perceptual level to some degree. This theory leads to the notion that reference pint is actually not a single point. Rather, it is an area around the single point. Kalyanaram and Litte (1994) testified that there is such an insensitive reference price area. Price changes within that area will not cause either value increase or value decrease. Furthermore, because people are loss averse, this area tends to be asymmetric around the reference "point", smaller in loss domain and larger in gain domain. They also found that the width of such an insensitive area around reference price depends on the degree of brand loyalty, the base reference price level, and knowledge about prices of the product category. This issue of insensitive area needs further investigation.

All that has been discussed above is concerned with the coding process. Besides this coding process, Kahneman and Tversky (1979) also proposed three other operations used to edit a prospect -- cancellation, segregation and combination. Cancellation has been defined before. Segregation means people will segregate a riskless component from risky components of a prospect. For example, a prospect (100, 0.8; 200, 0.2) will be edited to (100, 1) (a sure gain of 100) and (100, 0.2; 0, 0.8). On the other hand, people will integrate identical outcomes to transform a prospect (100, 0.1; 100, 0.1; -200, 0.8) into (100, 0.2; 200, 0.8). This is called combination.

Although the coding process has found widely support, these other three operations have remained controversial issues in Prospect Theory, especially the cancellation operation. The cancellation process implies branch independence, which states that change of common outcomes in two prospects should have no influence on preference order of the prospects. Several studies have found this branch independence to be questionable (Birnbaum and Chavez 1997; Birnbaum and McIntosh 1996; Payne, Laughhunn and Crum 1984). Payne et al.'s 1984 study showed that cancellation process was unlikely to occur when the level of the common outcomes is high or the probabilities associated with these common outcomes are large. Birnbaum and McIntosh (1996) and Birnbaum and Chavez (1997) partly confirmed this point by the finding that preference order seemed to different when the common outcome is large from when it is small. Birnbaum and McIntosh (1997) also cast doubts on the validity of the integration process. More research is needed to specify the conditions under which the cancellation operation will not be used to edit a prospect and to offer a better understanding of the editing process.

The Value Function

Value function is another important part of Prospect Theory. Based on this value function, Thaler (1985) proposed a later widely used theory - Transaction Utility Theory. It is a combination of traditional utility theory and Prospect Theory. It postulates that for each transaction, there is an acquisition utility and a transaction utility. Acquisition utility is associated with the utility of obtaining the product or service. It is similar to traditional utility theory. Transaction utility, on the other hand, is the utility from the transaction process itself depending on the transaction is coded as a gain or loss. Based on properties of value function, Thaler (1985) proposed four rules of dealing with gains and losses, i.e., (1) segregate gains; (2) integrate losses; (3) integrate mixed gains; (4) segregate mixed losses when the gain part is small.

Transaction Utility Theory has important implications for marketing. For example, marketers can induce a higher reference price in consumers' mind by presenting a high-end image, and thus increase the transaction utility consumers associate with purchasing the product.

One limitation of Transaction Utility Theory is it considers only one attribute at a time. This is also the limitation of Prospect Theory. In real world, most if not all decisions involve more than one attribute. For example, consumers often consider both price and quality when making purchase decisions. It would be very useful to extend these theories to multidimensional decisions.

Although little research has been done on multidimensional value function under Prospect Theory, a rich body of multiattribute utility theories can be drawn upon. In this literature, the simplest and more often used multiattribute utility functional form is additive function. Applied to Prospect Theory, the value of an n-dimensional prospect will be a weighted sum of the values on each single dimension, i.e., $v(x^{(1)}; x^{(2)}; \ldots; x^{(n)}) = \Sigma v_i(x^{(i)})w(i)$, where $v_i(x^{(i)})$ is the value function for the ith dimension, w(i) is the weight of the ith dimenstion. If we use a power value functional form suggested by Kahneman and Tversky (1992), the value of an n-dimensional prospect can be written as equation (3) shown below:

(3) $$v(x^{(1)}; x^{(2)}; \cdots; x^{(n)}) = \sum_{i=1}^{n} [(a-1)\lambda + a] \, | \, x^{(i)} \, |^{b_i} \; w(i)$$

Where a = 1 if $x^{(i)} \geq 0$, a = 0 if $x^{(i)}<0$, λ is normally larger than 1 to denote a steeper slope in the loss domain. This additive functional form is very easy to use and estimate. However, it does not allow interaction between attributes. As we have mentioned earlier, consumer judgments of price and quality are often correlated. Thus, such a functional form may be quite limited.

Further, practical evidence has revealed that when the number of choice options or attributes gets large, such a combination process becomes too complicated for daily use. In such situations, a screening process is more often used (Johnson et al. 1989; Meyer and Johnson 1995; Payne 1976; Russo and Dosher 1983). Using a screening process, the value of an outcome is determined by comparing the outcome level of each single dimension with thresholds for that dimension. Only options meeting such threshold requirements will be considered. Take price for example. In some situations, consumers may have an upper threshold on price gains (discounts). If consumers use price to judge quality, they may consider a too large price cut as a signal of suspicious quality and will not include such products into consideration. At the same time, consumers may also have a lower threshold on price gains. This may be especially true for brand switchers in a market where promotion is frequent. For these switchers, they are looking for bargains expecting to get some minimum amount of price discount. They will only choose among brands that offer discount at least as large as their minimum requirements. On the other hand, brand-loyal consumers more often have a loss threshold. They are loyal to certain brands and are not looking for bargains. They can tolerate a certain amount of price increase or a certain price level higher than their reference prices. They will still choose the brand as long as it is within the tolerable loss threshold.

With the existence of these upper and/or lower gain thresholds and upper loss threshold, the value of an n-dimensional outcome can be formulated by equation (4).

$$(4)\quad v(x^{(1)};x^{(2)};\cdots;x^{(n)}) = \Pr\{\textit{the outcome satisfies all threshold requirments}\}$$
$$= \Pr\{a_1T_{GL}^{(1)} < x^{(1)} < a_1T_{GU}^{(1)} + (a_1-1)T_{LL}^{(1)}; a_2T_{GL}^{(2)} < x^{(2)} < a_2T_{GU}^{(2)} + (a_2-1)T_{LL}^{(2)}; \cdots; a_nT_{GL}^{(n)} < x^{(n)} < a_nT_{GU}^{(n)} + (a_n-1)T_{LL}^{(n)}\}$$

where a = 1 when $x^{(i)} \geq 0$, a = 0 when $x^{(i)} < 0$; T_{GU}, T_{GL} are the upper and lower gain threshold respectively; T_{LL} is the lower loss threshold.

If we assume attribute independence, equation (4) can be written as:

$$(5)\qquad v(x^{(1)};x^{(2)};\cdots;x^{(n)}) = \prod_{i=1}^{n} \Pr\{a_iT_{GL}^{(i)} < x^{(i)} < a_iT_{GU}^{(i)} + (a_i-1)T_{LL}^{(i)}\}$$

Furthermore, if we assume a power probability functional form for each attribute, equation (5) can be simplified into a multiplicative-multiadditive function. Such a functional form is in conformity with value function in Prospect Theory and has interaction terms, which makes it more general than the additive function. However, these two forms may be both applicable to one decision making at two different stages. At the first stages, decision-makers use a screening process where the multiplicative-multiadditive functional form is applicable. At the second stage, a combination process will be used to evaluate those options retained from the previous stage. Here, an additive function may be used.

The parameterization of these functions using experimental or field data is beyond the scope of this article. However, it is a topic worth exploring. Morever, in the above discussion, we assume the probability weighting function is defined on the whole attribute set instead of on each single attribute. It can be argued that probability weighting function may be different across attributes. Further research is needed to determine which argument is more valid under what conditions.

Besides the multiattribute problem, the asymmetric property of the value function is also another important issue. Recall that value function is asymmetric with larger slope in the loss domain than in the gain domain. This property is due to loss aversion. There has been some evidence that the degree of such asymmetry may vary across individuals and different conditions (Greenleaf 1995; Kalyanaram and Winer 1995; Krishnamurthi, Mazumdar and Raj 1992). Using scanner data, Krishnamurthi et al. (1992) found that brand-loyal consumers showed asymmetric response to price gains and losses when making quantity decisions, but the asymmetry disappeared in brand choice decisions. Brand switchers, however, showed asymmetric response in brand choice decisions and mixed results in purchase quantity decisions. Such a varying degree of asymmetry is reasonable since brand-loyals pay more attention to brand image and product quality and less to price. They tend to be less sensitive to price losses. Due to this varying degree of asymmetry, one would expect the attenuation of loss aversion using pooled data. Morever, the asymmetry may also vary across conditions. Greenleaf (1995) found that for brands with very rare or irregular price promotions, consumers might show higher sensitivity to gains (promotion).

Extending the above arguments to multiattribute decisions, it is plausible to conjecture that consumers may have different degrees of loss aversion on different dimensions. Further empirical and theoretical research is needed to address this issue of varying loss aversion.

The Probability Weighting Function

In Original Prospect Theory, Kahneman and Tversky (1979) stated four properties of the probability weighting function. The first one is subadditivity for small probabilities, but not necessarily for large probabilities, i.e., ((rp) (r((p) for $0<r<1$ and small p. This property leads to a concave section of ((p) when p is small. Secondly, small probabilities tend to be overweighed. The third property is called subcertainty, which states that ((p)+((1-p)<1 for all $0<p<1$. Subcertainty requires that ((p) is regressive on p. The last property of probability weighting function is subproportionality. It is defined by equation (6).

$$\frac{\pi(pq)}{\pi(p)} \leq \frac{\pi(pqr)}{\pi(pr)} \quad for \quad 0 < p, q, r \leq 1 \tag{6}$$

This property equals the condition that $d^2\log\pi/d\log p > 0$ (Kahneman and Tversky 1979).

Based on these properties, in their 1992 paper, Tversky and Kahneman proposed a probability weighting function as equation (7). This functional form satisifies all the four properties (requiring a>0.5 to satisfy subproportionality) and reduces to a linear function of p when a = 1. By using certainty-equivalent method, Tversky and Kahneman (1992) estimated the parameter a to be 0.61 for gain and 0.67 for loss.

$$\pi(p) = \frac{p^a}{[p^a + (1-p)^a]^{\frac{1}{a}}} \tag{7}$$

Other researchers have also tried to estimate this weighting function. Wu and Gonzalez (1996) used five ladder sets of gamble pairs with a common outcome being added to both gambles in each rung to estimate the parameter a. A pooled least-squares estimate of a from all 5 ladders was 0.71, which is similar to and somewhat higher than Tversky and Kahneman (1992) estimate. Camero and Ho (1994) also estimated a to be 0.56.

Some other convenient weighting functional forms have also been used. Tversky and Fox (1994) used a two parameter weighting function as equation (8), while in Prelec's 1998 paper, weighting function as equation (9) was presented. Except that equation (8) does not satisfy subproportionality, all these weighting functions satisfy the four properties.

(8) $$\pi(p) = \frac{cp^a}{cp^a + (1-p)^a}$$

(9) $$\pi(p) = \exp\{-(-\ln p)^a\}$$

Parameterization of all three funtions shows that they are indeed very similar to each other (Prelec 1998). They have several common characteristics. They are all inverse-S shaped, concave at small p and convex at large p; they all overweigh small probabilities; the reflection points are all around 0.40. Wu and Gonzalez (1996)'s ladder experiment further confirmed this 0.40 reflection point without any assumption about the functional form of the weighting function. Similar results from these studies suggest that people may evaluate probabilities in a rather consistent way.

Nevertheless, there is also some other research that supported an S-shaped rather than an inverse-S shaped probability weighting function (Birnbaum and Chavez 1997). Birnbaum and Chavez used three-outcome and four-outcome prospects as stimulus to elicit paired comparison data. They used equation (8) as the probability weighting function assuming c = 1. Their estimate of a is larger than 1, which produces an S-shaped probability weighting function. It is interesting to note that while Birnbaum and Chavez (1997) used three-outcome and four-outcome prospects as stimuli, all research supporting an inverse S-shaped weighting function used only two-outcome prospects. It may be true that people use different weighting schemes when faced with simple prospects (two-outcome) from when faced with complex prospects (three or more outcomes).

Risk Attitude Assessment Under Prospect Theory

As having been pointed out by Kahneman and Tversky (1979, p.285), risk attitude under Prospect Theory is determined by both value function and probability weighting function. This is straightforward since the value of a prospect is composed of both v and π.

Risk attitude can have very important strategic implications. However, little research has been done to explore this issue in Prospect Theory. Hilton (1988) has advanced the understanding of risk attitude under Prospect Theory by dividing overall risk premium into Pratt-Arrow risk premium and decision-weight premium. Pratt-Arrow risk premium is associated with the value function, while decision-weight risk premium is determined by the probability weighting function. The overall risk premium of a prospect (x1, p; x2, 1-p), denoted by r, can be derived the following equation:

$$v(px_1 + (1-p)x_2 - r) = v(x_1, p; x_2, 1-p) \tag{10}$$

For a positive prospect (x_1, x_2>0), if we assume $x_1 > x_2 = x_1 - m$, and m is a small positive number, equation (10) can be written as:

$$v(px_1 + (1-p)(x_1 - m) - r) = v_+(x_1)\pi(p) + v_+(x_1 - m)(1 - \pi(p)) \tag{11}$$

It is reasonable to assume that $v_+(x)$ is differentiable at any x>0. Therefore, we can use Taylor-expansion to expand both sides of equation (11) at x_1 and get:

(12) $$v_+(px_1+(1-p)(x_1-m)-r)=v_+(x_1-m+mp-r)=v_+(x_1)+v_+'(x_1)(-m+mp-r)+R_1$$

(13) $$v_+(x_1)\pi(p)+v_+(x_1-m)(1-\pi(p))=v_+(x_1)\pi(p)+[v_+(x_1)-mv_+'(x_1)+\frac{1}{2}m^2v_+''(x_1)+R_2](1-\pi(p))$$

where R_1 and R_2 are the remainder terms. Equating (12) with (13) according to equation (11), we get:

(14) $$r=mp-m\pi-\frac{1}{2}m^2\frac{v_+''(x_1)}{v_+'(x_1)}(1-\pi(p))=m(p-1)+m(1-\pi(p))(1-\frac{1}{2}m\frac{v_+''(x_1)}{v_+'(x_1)})$$

It can be seen that the overall risk premium r decreases with π and increases with $-v_+''/v_+'$. A reasonable measure of overall risk attitude is $(1-\pi(p))(1-v_+''/v_+')$.[3]

In the same way as above, we can derive the Pratt-Arrow risk premium of this prospect define by Hilton (1988, p. 132) from the following equation:

(15) $$v(x_1\pi(p)+(x_1-m)(1-\pi(p))-r_{PA})=v_+(x_1)\pi(p)+v_+(x_1-m)(1-\pi(p))$$

where r_{PA} is the Pratt-Arrow risk premium. We can get:

(16) $$r=-\frac{1}{2}m^2\frac{v_+''(x_1)}{v_+'(x_1)}(1-\pi(p))$$

Here, we can see that r_{PA} is positive in this case since $v''<0$, $v'>0$, $1-\pi>0$. This implies risk-aversion in the gain domain.

Since overall risk premium equals the sum of Pratt-Arrow risk premium and decision-weight premium (Hilton 1988), we can derive decision-weight premium r_{DW} as:

[3] It should be noted that a person A whose overall risk aversion measure is twice as large as another person B does not mean that a is twice overall risk averse as B, but just mean that A is more risk-averse than B.

(17) $$r = m(p - \pi)$$

Equation (17) implies that a person is decision-weight risk-seeking when he overweigh the probability and decision-weight risk-averse when he underweight the probability.

We can see from equation (16) and (17) that, while r_{DW} is determined solely by π, r_{PA} is determined by both π and v. This means that after probabilities have been transformed into decision weights, the weighting function still has an impact on risk judgment. To separate the effects of v and π, I suggest a measure of Pratt-Arrow risk aversion as $-v_+''(x_1)/v_+'(x_1)$, which is essentially the same as the original Pratt-Arrow measure of risk aversion. In the mean time, a plausible measure of decision-weight risk aversion would be $(p-\pi)$.

By assuming m<0, we get a negative prospect. The risk premium is essentially the same except that the value function should be v_-, the value function for the loss domain. Correspondingly, a measure of overall risk attitude is $(1-\pi(p))(1- v_-''(x_1)/v_-'(x_1))$. Pratt-Arrow risk aversion is measure by $-v_-''(x_1)/v_-'(x_1)$, while decision-weight risk aversion is still measured by $(p-\pi)$.[4]

These three measures of risk aversion are easy to compute. Furthermore, the measures of Pratt-Arrow risk aversion and decision-weight risk aversion have a dividing point of zero, with value larger than 0 meaning risk-averse and smaller than 0 meaning risk-seeking. However, with the complex nature of the overall risk attitude, the measure of overall risk aversion does not have a dividing point. Whether a person is locally risk averse also depends on the difference between the two outcomes and the probabilities associated with the more extreme outcome. But the measure can still be well used to compare two persons' risk attitude.

The above measures of risk aversion are for gain domain or loss domain only. For mixed prospects, Hilton (1988) derived a measure of local risk aversion as - $[v+'(0)\pi(p)/v-'(0)\pi(1-p)]$. With enough knowledge of the value function and the probability function, all these measures of risk aversion can be easily derived.

Revisions of Prospect Theory

Assimilation Effect

Recall that according to Assimilation-Contrast Theory, small changes around the reference point will be assimilated and will not be perceived as either gain or loss. Kalyanaram and Little (1994) showed that there is such an insensitive area around reference price. It is reasonable to extend this insensitive area to other dimensions as well.

However, the value function in Prospect Theory does not include such an insensitive area. To deal with such an assimilation situation, it has to assume that a small change has already been coded as zero (no gain and no loss) in the editing process. It would be more general and convenient if we can include such an assimilation effect into the value function itself, thus reduce the assumption about the controversial editing process.

Based on Kalyanaram and Little (1994)'s findings, two properties of the insensitive area is proposed as below. First, the value function within this area is equal to zero. Second, as people have loss aversion in general, the insensitive area around the reference point is asymmetric, larger for gains and smaller for losses. Revising the power value function form, we can get a new value function as equation (19).

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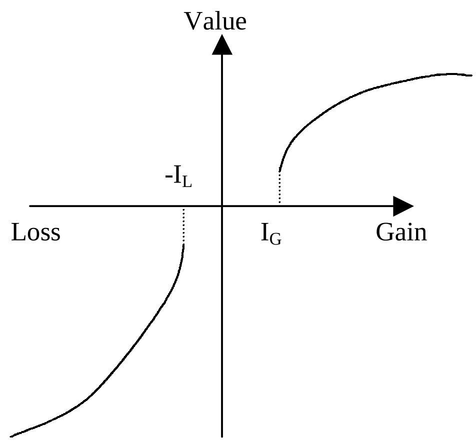
[4] Here we assume that the probability function is the same for gain domain as for loss domain. If one assumes a different weighting function for gains and for losses, all the π in the risk aversion measure should be substituted by π_+ when associated with gain or π_- when associated with loss.

(18) $$v(x) = \begin{cases} 0 \quad when \quad -I_L < x < I_G \\ (x - I_G)^a \quad when \quad x \geq I_G \\ -\lambda(-x + I_L)^a \quad when \quad x \leq -I_L \end{cases}$$

where $(-I_L, I_G)$ is the insensitive area, $0 < I_L < I_G$; $0 < a < 1$; λ is larger than 1 and denotes the larger slope in the loss domain. A graphic presentation of the new value function is shown in Figure 1.

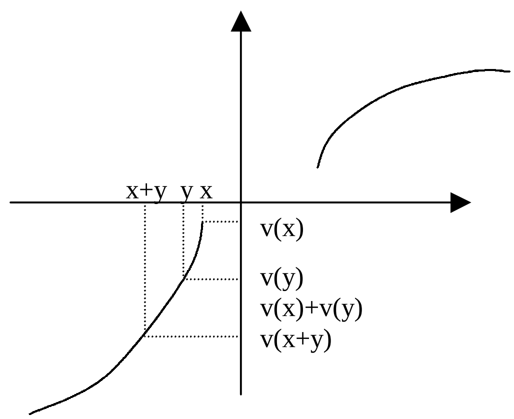
Figure 1. Value Function Including an Assimilation Effect



One thing to be emphasized here is the boundaries of this insensitive area are different from the thresholds mentioned before in the multidimensional value function. Here, the boundaries define the area that people will perceive no change (gain or loss) at all, while the thresholds mentioned before, on the other hand, define the consideration sets in the decision process, either in gain or in loss.

The inclusion of such an insensitive area in the value function has important implications on marketing. For marketers providing benefits (gains) to consumers, such as price discount and extended quality warranty, they must provide a benefit large enough to make the consumers perceive their efforts. On the other hand, if marketers want to increase price, which is perceived as losses to consumers, they should try to keep the increase within the insensitive area so that consumers will not be affected. According to the original value function, losses should always be integrated (Thaler 1985), which leads to the intuitively unappealing conclusion that a $5 price increase (loss) should be fulfilled at one time instead of increasing the price gradually with $1 at a time for 5 times. With the new value function, it is possible to explain this loss segregation. As shown in Figure 2, $v(x+y) < v(x) + v(y)$. Under this new value function, whether to segregate or integrate depends on the width of the insensitive area and the amount of the gain or loss that needs to be segregated or integrated.

Figure 2. Segregate Gains



A disadvantage of this new value function is it adds two more parameters (I_G and I_L) that need to be estimated. Kalyanaram and Little (1994) used a logit calibration method to find out the I_L and I_G that fits the data best. This is a possible way to estimate the two parameters. More research needs to be done on how to estimate the new value function precisely and efficiently. Moreover, empirical studies can be done to compare the new value function with the old one. Such studies will provide evidence on which function fits reality better.

Percentage Effects

So far, all the value functions we have discussed above used the absolute level of gains or losses as independent variable. However, it is clear to us that a \$10 price increase for a \$100 product will be perceived as a much larger loss than the same amount of price increase for a \$1000 product. That is, the percentage change enter into peoples' perception of gains and losses.

This notion has existed for a long time in psychophysics in the form of Weber's Law. It states that the response to a stimulus is proportional to the percentage change in the stimulus (Winer 1988). There has been accumulated evidence of this percentage effects. Kahneman and Tversky (1984) found that subjects were more willing to make efforts to get a \$5 discount on a \$15 calculator than on a \$125 calculator. Darke and Freedman (1993) also reported percentage effects on consumer judgments of price discounts. Krishnamurthi et al.'s 1992 study again provided partly support for this percentage effect, although the purpose of their study is not to test this effect. In their model, they operationalize gain or loss as the difference between logarithmic reference price and real price (lnRP - lnP for gains and lnP - lnRP for losses). This logarithmic difference can actually be translated into a proportion influence (P/RP). Although not exactly the same percentage effect we defined here ((P-RP)/RP), this proportion influence can be easily transformed into the percentage effect. Krishnamurthi et al. found that the coefficient for these logarithmic gain and loss items to be significant.

According to the above evidence, it is plausible to use percentage change, $(x-x_{RP})/x_{RP}$, as the independent variable of the value function. Here, x refers to the actual outcome level of attribute x, and x_{RP} denotes the reference point level on attribute x.

Although such a value function fully captures the percentage effect, it completely ignores the effect of the absolute amount of change. However, it is still premature to totally exclude this absolute amount effect. Darke and Freedman (1993) found that both the absolute amount of saving and the percentage saving effected subjects' perception of a bargain. According to their findings, it may be true that when percentage change is small and absolute amount is salient enough, the absolute amount may influence subjects' perception more. The percentage value function may be more applicable in some occasions, while the absolute-amount value function may be more appropriate in others. Sometimes an integration of the two may even be needed. As mentioned above, one factor influencing the appropriateness of each function may depend on the salience of the independent variable. Further research is needed to address the issue of when one of the functions should used instead of the other and when an integration is needed.

Applications of Prospect Theory in Marketing

Prospect Theory has been applied in a variety of areas including economics, finance, decision sciences, organization management, and energy management. It has also been applied to marketing, although such studies are relatively few compared with other application areas. In this section, we will concentrate on existent and other underexplored but possible applications of Prospect Theory in marketing. The applications are divided into advertising, price promotion, new product positioning, and salesforce compensation.

Advertising

According to Prospect Theory, when faced with a brand, consumers often compare its actual price with reference prices in their mind. Actual price higher than reference price will be coded as loss and will have negative impact on consumer choice. On the other hand, actual price lower than reference price will be perceived as a gain and will positively influence consumers to choose the brand. Therefore, it would be desirable for marketers to keep a relatively high reference price for their products in consumers' minds (Fraccastoro, Burton and Biswas 1993; Thaler 1985).

Advertising is one of the tools that can be used to accomplish this goal. Biswas and Blair (1991)'s experimental study showed that advertising can influence subjects' reference price. Ong's 1994 study we mentioned before also supported the influence of advertising claims on subjects' reference points. By presenting the product in the advertisements as a high-quality product, or a symbol of luxury, marketers can create a high-end image of the product, which will be associated with a higher reference price. However, marketers should be cautious when using this technique. When consumers can discern the actual quality of the product through using it, a too high claim may lure consumers to buy the product once. But when they encounter a product that cannot offer such a high quality, they will feel a severe loss and may never repurchase the product.

One thing to be emphasized here is higher reference price does not always mean better. The best reference price a marketer should keep depends on its target market. The reference price should be within the acceptable range of the target population.

Not only does Prospect Theory has implications on how advertisers should advertise, but also can predict how advertisers make decisions and can provide advice on how advertising agencies should market their service to advertisers. Lee (1994) has explored this issue. By using a longitudinal field design in US brewing industry, the researcher came to the conclusion that firms with poor past performance tend to be risk-seeking and spend more on advertising. West and Berthon (1997)'s survey research also revealed that firms with poor performance relative to their aspiration level were more willing to take advertising risk. The implication for advertising agency is that for a low-performance client, advertising agency should present a relatively riskier advertising plan, while a relatively riskier plan may be more acceptable for a high-performance client.

Salesforce Compensation

Salesforce compensation has long been an important managerial issue. Through compensation plan, firms can manipulate the efforts salespersons put into the company. An optimal compensation plan helps a firm to maximize profit. Such an optimal plan depends on both internal and external factors such as the easiness of monitoring sales effort, salespersons' risk attitude, and uncertainty of the market (e.g. Basu et al. 1985).

A variety of theories have been used to address the issue of salesforce compensation. The contribution of Prospect Theory lies in that it greatly improved understanding of human risk attitude. Prospect Theory proposes that people are risk-averse when faced with gains and risk-seeking when faced with losses, where gains and losses are defined relative to a reference point. Such a pattern of risk attitude has important implications on optimal salesforce compensation plan and salespersons' risk-taking behavior. However, little research has been done in this aspect.

A central point here is the reference point. By finding or defining the appropriate reference point, the firm is able to examine and manipulate the risk attitude of its salesforce, and design compensation plans according to it. For example, past research has suggested that when a salesperson is risk-averse, a compensation plan with relatively larger proportion of salary is more suitable. If the salesperson is risk-neutral or risk-seeking, a compensation plan with relatively larger proportion of commission will be more appropriate. Thus, if a salesperson's sales are below his reference level, he will tend to be risk-seeking. A plan with more commission should be in place. On the contrary, if his sales are above reference level, he will be more risk-averse and will demand a larger proportion of fixed salary.

Some of the most commonly used reference points in organization and marketing literature are industry's average performance, company's past and current performance, anticipation of company's future performance, and company's performance target or aspiration level (Bowman 1982; Hartman and Nelson 1996; Gooding, Goel and Wiseman 1996; Lee 1994; Wiseman and Gomez-Mejia 1998). Applied to salesforce compensation, some of the reference points a salesperson may use can be proposed: (1) the company's salespersons' average sales; (2) the salesperson's own sales fulfilled in the past; (3) the salesperson's anticipated sales for the future; (4) the company's sales quota.

Among these four, the company has most control over the last one, the company's sales quota. It has been a normal practice for companies to set some kind of sales quota for their salespersons and relate their compensation plan to the quota. Companies can use this quota to manipulate salesforce's risk attitude. If a company would like its saleforce to be more risk-seeking, the company can set a relatively high sales quota, making the salesforce more likely to be below target (loss) and become risk-seeking.

New Product Positioning

New product positioning is a key issue to the product's success. From Prospect Theory's point of view, new product positioning actually sets the initial reference point in consumers' mind. This reference point involves various dimensions including price, quality and overall image. Although a marketer can always try to change the reference point later on, it is very costly to do so. Thus, the correct setting of this initial reference point can give a marketer strategic advantage. It has long term influence on the product's future.

Take the price dimension as an example. A new product can basically choose to position as a low-price product, a medium-price product, or a high-price product. While a low-price product can penetrate the market quickly, it is hard to increase price later on. Recall that a same amount of price increase will result in larger perceived loss in low-price products than in high-price products. A small price increase of a low-price product will be readily perceived as loss and can negatively influence consumer choice. However, by the same token, a low-price product has the advantage of offering just a small amount of discount to attract consumers' attention. The advantages and disadvantages of a high-price product are just the opposite. The position of this reference point depends on the desirability of current cash flow for the firm and the firm's long-term strategy.

Price Promotion

Price promotion is usually coded as gains by consumers and encourages consumers to try a brand or to purchase larger quantity of a product. However, as consumers' reference price shift with past purchase price or observed price, it is possible that after promotion, consumers' reference price will go down. When the price goes back to its regular level, consumers will perceive it as a loss, which may lead to a decreased sale in the future. The profitability of a promotion depends on the tradeoff between this loss in future sale and gain in current sale (Greenleaf 1995). By using scanner data, Greenleaf (1995) suggested that irregular promotion might result in a higher sensitivity to gains among consumers and thus increase profit.

Lattin and Bucklin (1989) proposed a promotion reference point, which refers to the degree consumers perceive a product as an often-promoted product. If a consumer perceive a product as being often promoted, the non-promotion interval will result in a loss feeling for the consumer and negatively influence the products' sale. Although Lattin and Bucklin referred to nonprice promotion in their 1989 paper, this concept of promotion reference point can be easily extended to price promotion. Marketers offering frequent promotions should especially pay attention to the effect of this promotion reference point.

Conclusion

In this paper, I have reviewed major developments of Prospect Theory, a theory of decision making under uncertainty. The discussion has been centered on the editing of prospects before evaluation, the value function, the probability weighting function, and the assessment of risk attitude under Prospect Theory.

By combining behavioral aspects of human decision making with traditional economic theory, Prospect Theory is able to account for many phenomena that cannot be explained by traditional utility theories. However, there are still some controversial issues in Prospect Theory, such as the validity of the cancellation operation in the editing process and the shape of the probability weighting function. Prospect Theory itself is also incomplete. This paper suggested two revisions to Prospect Theory, which allows the assimilation effect and uses percentage gains and losses as the independent variable of the value function. Much research still needs to be done on Prospect Theory as having been suggested throughout the paper.

To date, Prospect Theory has found its applicability in a variety of areas. In this paper, I have concentrated on possible applications of Prospect Theory in marketing. It is obvious that marketing researchers and practitioners have not paid enough attention to this theory. It is hoped that the discussion in this paper will stimulate more research on Prospect Theory in marketing area.

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