A Review of Researches on the Influence of Reference Points on Newsvendor Behavior Decision

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Abstract

This article reviews the related literature on the impact of reference points on newsvendor behavior decision-making, including two parts: related research on reference effects and research on newsvendor behavior decision-making. Research shows that decision makers are affected by reference points when making decisions, such as status quo (SQ), minimum requirement (MR), and goal (G). At the same time, in the inventory management scenario, decision biases can occur due to the existence of reference points. In addition, each reference point has different influences on the behavior decision of the newsvendor.

Keywords

Newsvendor Decisions, Reference Points, Decision Bias, Status Quo, Minimum Requirement, Goal

1. Introduction

The newsvendor problem is one of the fundamental models in stochastic inventory theory. The newsvendor's objective is to choose an optimal order quantity to balance his cost (or disutility) of ordering too many against his cost (or disutility) of ordering too few. The traditional newsvendor model takes Expected Utility Theory (EU theory) as the premise. It is assumed that the decision maker is a rational person and that it chooses the optimal order quantity to maximize the expected profit. Relevant research finds that people are bounded rational (Simon, 1955). Experiments and practice show that when decision makers decide ordering decisions, they usually systematically deviate from the theoretical

optimal value. The root cause is that the decision maker is not completely rational, which leads to decision bias. Therefore, in recent years, scholars have added reference points to the context of management decision-making. As one of its branches, behavior management has become one of the popular research areas.

2. Reference Effect Related Research

2.1. Single Reference Point

Since Kahneman and Tversky (1979) proposed the prospect theory and modified the expected utility theory, and the reference dependence theory developed rapidly. According to the prospect theory, decision makers divide the outcome into two value intervals based on the status quo (SQ) reference points. Below the reference point is the "loss" and above the reference point is the "gain". As shown in Figure 1, when facing the prospect of loss, there will be risk seeking, and when facing the prospect of gain, there will be risk adverse tendency; the prospect theory gives a value function V (x) to represent the subjective value of the decision maker. The function of the loss interval is steeper than the function of the gain interval, indicating the asymmetry of the loss and return preferences. Tversky and Kahneman (1992) used a nonlinear regression method to give a specific value function form, the value function is S-shaped, and the corresponding parameters are given in the function to represent risk attitude and loss aversion.

In recent years, researches on the reference point have expanded from two perspectives: from fixed points (reference points are fixed constants) to random points (reference points are related to probability distribution), and from exogenous points (reference points have nothing to do with decision making) Endogenous points (reference points are related to decision making). Shalev (2000) considered the optimization decision problem under the endogenous reference point (the reference point is determined by the decision maker himself). Koszegi and Rabin (2006) proposed that reference points are rational expectations of
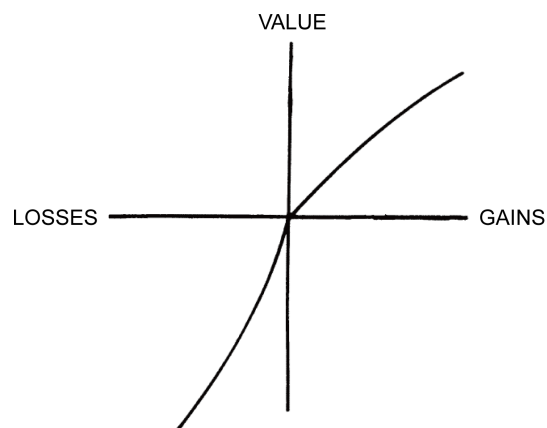

Figure 1. A hypothetical value function.

decision-makers based on past experience. Therefore, reference points are both endogenous and random points. When the reference point is the same as the status quo, it is equivalent to the prospect theory and loss aversion newsvendor model.

A basic assumption of the prospect theory is that there is a fixed current status quo reference point. Although it is widely accepted, more and more studies showed that when people make decisions, reference points other than status quo (SQ) can also have a significant impact on decision behavior. Yates and Stone (1992) classified multiple reference points into two categories: one is the status quo reference point, such as the current financial or performance level; the other is the non-status quorum, such as expectations and goals. In the literature on motivation, Locke and Latham (2006) considered the goal is a process of difference creation, which produces "dissatisfaction with a person's current situation and a desire for a goal or result", which reflects the goal as a reference point. The concept provides a point of comparison for assessing current performance. In a series of laboratory studies, Heath et al. (1999) proposed that the goal can be used as a reference point, proving that the characteristics of the value function of the prospect theory can explain the effort and satisfaction of the goal reference point in completing the task, and also found the support of diminishing sensitivity, which means that changes closer to the goal have a greater impact than changes farther from the goal. In a large-scale field study of marathon runners, Markle et al. (2018) found that the goal was to serve as a reference point to form the final utility of the contestants. They asked marathon runners to predict or report their satisfaction with the goals above or below the competition. The predicted satisfaction and actual satisfaction are consistent with the loss aversion and diminishing sensitivity. Camerer et al. (1997) found that taxi drivers in New York City worked longer hours on days with lower hourly wages and completed work earlier when hours were higher. They believe that the driver will determine the daily income goal and compare its cumulative income with that goal, and the income below the goal is considered a loss, causing the driver to make more efforts to achieve the goal. Crawford and Meng (2011) and Farber (2008) further support income goals as reference points. Hoffmann et al. (2013) experimentally investigated the importance of aspiration as a reference point in the context of multi-period decision-making, and found that the level of individual desire is their main reference point in the early stages of decision-making. In addition, related scholars have studied the influence of the minimum requirement point. Kacelnik and Bateson (1996), Stephens and Krbes (1986) pointed out that the minimum demand has an important role in the risk preference research of animal foraging behavior. In addition, Raiffa (1982) found minimum requirement thinking is important in the negotiation and negotiation activities of enterprises.

2.2. Multiple Reference Points

Research on reference effects has shown that people consider multiple reference

points simultaneously when making decisions. Tversky and Kahneman (1992) pointed out that there may be competition or cooperative research issues between multiple reference points, and proposed that each possible reference point can affect people's evaluation of results at the same time. In other words, utility arises from truly complex emotions or ambivalence, which can be seen as gains relative to one reference point and losses relative to another reference point.

Some empirical studies support the notion that multiple reference points affect people's utility and satisfaction simultaneously. Sullivan and Kida (1995) experimental results found that when performance is between two reference points, there will be a mixed state of risk aversion and risk seeking. Ordóñez et al. (2000) found in the experiment that the degree of satisfaction of the subject was related to two independent operating reference points: one was that the subject would be satisfied with the expected salary offer, and the other was when the subject's salary was between two colleagues, satisfaction is reduced. In the study of animal foraging theory, Hurly (2003) found that when deciding to find food, animals will consider both the hunger threshold (MR) and the reproductive energy threshold (G). When the minimum demand (MR) is just exceeded, in order to avoid death animals are risk-avoidant, and animals below MR seek risk in order to survive. Similarly, near reproductive threshold (G), animals seek risk in order to surpass this biologically significant reference point. Larsen et al. (2004) showed that a result may produce a truly complex feeling or ambivalence, and it is considered as a gain relative to one reference point and a loss relative to another reference point.

Through experiments, Koop and Johnson (2012) found that there are three specific reference points (MR, SQ, and G) that can jointly regulate human decision-making behaviors in the same decision-making context. Finally, Wang and Johnson (2012) proposed a three-reference points(TRP) theory for risk decision making, explicitly considering three reference points that influence decision-making: the minimum requirement (MR), the status quo (SQ), and the goal (G). The three reference points divide the decision result into four intervals of failure, loss, gain, and success. And based on the prospect theory, the value function curve is derived into double S-shaped curves that span different intervals; at the same time, according to the psychological weight order of three reference points: minimum requirement> goal> status quo, the slope of the value function of each interval is different to explain the asymmetry of the two preferences of loss-benefit and failure-success. On this basis, Wei et al. (2017) and Wei et al. (2019) explored the impact of the minimum requirement and the status quo on inventory decisions. The results of the study indicate that the minimum requirement and the status quo of will reduce the order quantity.

In addition, people will set multiple goal reference points for the same attribute. Research on multiple goals mainly includes two aspects. The first is to set multiple goals in a variable. For example, Markle et al. (2018) proved the effect of multiple goals on running time satisfaction, including optimal completion

time, personal goals, and recent completion. Sullivan and Kida (1995) found that managers' corporate investment decisions are influenced by the company's current performance and goal performance. The other is that a single goal exists in multiple variables, and multiple goal reference points will also be generated. Schmidt et al. (1984) proposed that when people set a specific goal for an activity, they usually pay more for efforts on an activity and less effort on another activity. Dhar and Simonson (1999) show that after making some progress on the first priority goal, people will try the second goal, a process called "balance (Balancing)". Fishbach and Dhar (2005) found that the balance process is more likely to occur when people think that success on key goals is possible or impossible. However, when people continue to pursue one focus goal instead of the second, the process is called "highlighting", and people often see their efforts at the focus goal as a commitment. Weingarten et al. (2018) investigated how people feel about their progress on two goals (two variables: academic and fitness). The study found that loss aversion and diminishing sensitivity have an impact on each variable respectively, and it also finds that in the emotional integration of the results, the additivity is violated, and success on one goal and failure on another goal are more than both the joy and pain of each goals added together make it even worse.

3. Research on Newsvendor Behavior Decision

The newsvendor model is one of the classic inventory management models. The traditional newsvendor model is based on the assumption of a rational person and uses the theory of utility maximization to obtain the optimal order quantity. However, in practice, the newsvendor decisions have a deviation from the theoretical optimal value. For example, in one year International Business Machines produced $700 million of excess inventory of their Value Point line, but in another year they under produced their Aptiva PC line, and lost potential revenues of more than $100 million. Eeckhoudt et al. (1995) proved that the order quantity of risk-averse newsvendors would be lower than the optimal order quantity by establishing the framework of expected utility theory. Schweitzer and Cachon (2000) take zero-profit as the reference point, and by introducing experimental economics research methods, the order quantity of experimental subjects will systematically deviate from the order quantity that maximizes expected utility. That is, the actual order quantity of the decision maker is distributed between the average demand distribution and the optimal order quantity. This phenomenon is called the pull-to-center (PTC) effect. After that, a large amount of literatures also found the PTC effect in different decision fields. Bolton et al. (2008) expanded the sample on the basis of Schweitzer and Cachon (2000) and found that the PTC effect is more significant. Katok & Wu (2009) found that when supply chain coordination, the retailer also showed the decision-making behavior of mean value; Bolton et al. (2012) researched the inventory decision behavior of enterprise managers, and found that enterprise man-

agers also showed PTC phenomenon in actual decisions. The model proposed by Ho et al. (2010) includes a key part: when the product demand is known, compared with the order quantity, there will be psychological negative effects of reference dependence caused by shortage or multiple orders. Based on the theory of bounded rationality for the first time, Su (2008) constructed a newsvendor model with limited rationality for decision makers, and discovered decision bias.

Nagarajan and Shechter (2013) showed that the prospect theory cannot verify the PTC effect by setting a zero-profit reference point. However, Zhao and Geng (2015) commented on Nagarajan and Shechter (2013), and concluded that the zero-profit reference point set in the article was inappropriate, and that appropriate reference points should be selected for research, meanwhile, the prospect theory can predict the PTC effect. Long and Nasiry (2014) used appropriate endogenous status quo reference point, introduced optimism coefficients (parameters expressing the optimism of decision makers), and assumed the status quo reference points as the weighted average of maximum profit and minimum profit. It was found that the model can predict the PTC effect. What is known is that reference points play a central role in predicting newsvendor behavior.

Wang and Webster (2009) extended the loss aversion newsvendor model of Schweitzer and Cachon (2000), assuming that the loss aversion newsvendor has a fixed and exogenous reference point, and added the cost of stockout to characterize the loss aversion newsvendor model. Studies have found that if the cost of stock-outs is high, loss aversion newsvendors will place more orders than risk-neutral newsvendors, and the optimal order quantity for loss aversion newsvendors will increase with wholesale prices, and decrease with retail prices, and it indicates that there is a decision bias. Herweg (2013) used expectations as a reference point and established an expectation-based loss aversion newsvendor model. The study found that, like the standard risk aversion newsvendor model, expectation-based loss aversion newsvendors would place fewer orders than risk-neutral newsvendors.

At the same time, there are related studies to explore the impact of multiple reference points on behavioral decision-making for newsvendors. Wei et al. (2017) based on the traditional newsvendor model, considering the influence of decision makers on the minimum requirement and status quo reference points, discussing the issue of order decision bias, and setting both the minimum requirement and status quo reference points as exogenous references points, build a newsvendor model based on the minimum requirement and the status quo dual exogenous reference points. The analysis results found that the order quantity of the newsvendor based on the minimum requirement and the status quo reference points is related to the size of the stockout cost. At high stockout costs, the order quantity of newsvendors based on the dual reference points is greater than that of risk-neutral newsvendors. And at low stockout costs, the order quantity of newsvendors based on the minimum requirement and status quo reference points is less than that of risk-neutral newsvendors. In addition, the

optimal order quantity of newsvendors based on the minimum requirement and the status quo reference points increases as the cost of stock-outs. With no stock-out costs, the optimal order quantity is reduced relative to risk-neutral newsvendors. Wei and Xiong (2019) based on this, considering the status quo as an endogenous point, construct a dual-reference points newsvendor model based on the endogenous status quo and the exogenous minimum requirement, and explore the relationship between the endogenous status quo point and the exogenous minimum requirement point, and the impact of the two reference points on the newsvendor's ordering decision. As a result, it is found that the endogenous status quo point and the exogenous minimum requirement point jointly affect the newsvendor decision-making. Based on the dual reference point model, the PTC effect is verified under certain conditions.

4. Management Inspiration and Future Research

This article reviews the literatures on reference effects and newsvendor behavior decision-making, and gives relevant managements inspirations. It can be found that there are three reference points that will have important effects on newsvendor behavior decision-making, namely the status quo (SQ), minimum requirement (MR), and goal (G). In the field of inventory management, due to the existence of reference points, decision deviations can occur. Therefore, newsvendors can consider the impact of reference points on decision making in order to make better ordering decisions. In addition, there are some shortcomings in this article, such as the limited literatures. Therefore, the following research prospects are proposed: 1) Constructing a three reference points model and expansion to the supply chain environment; 2) Combining the reference points newsvendor model with experiments and to make the model more general and practical; 3) At the same time, this paper finds that there are very few studies on the impact of goal reference points and three reference points on the behavior of newsvendors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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