Effect of Alternative-set Information on Sequential Observation and Selection Behaviors

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Abstract. Based on the completely rational decision-maker, it implies that no influence of alternative-set information on search behavior for the optimal search model of sequential observation and selection. However, in the real life the search number would be regular verify because of the uncertainty perception of alternative-set information for decision-maker. By the method of laboratory experiment, and based on the bounded rational decision-maker, we found that people tend to more search under the situation of knowing smaller alternative-set than that knowing bigger one. When we know alternative-set is a finite situation, will tend to more search than that an infinite scenario. However, when we feel the situation along with a higher uncertainty degree of alternative-set information, there is not a significant difference of search number than that a lower one, and this means it is far beyond our ability of information processing and probabilistic calculating.

Introduction

Frequently, the decision information is always sequentially and not simultaneously appeared, and Decision-maker (DM) is likely to lose some opportunities of the optimal choice when waiting for the additional information. There are many decision situations similar to the example as follows: marriage problem; dating problem; dowry problem; searching job; house selling (hunting); adopting new technology; and so on. These decision situations what about when to stop searching information and relative sequential decision problems have been customarily labeled with the so-called “secretary problem” (SP) [1].

Based on DM’s completely rational assumption, Lindley [2] demonstrated the optimal cutoff rule that is one method to use cutoff form to solve this kind of decision problem. Specially, the cutoff threshold equal to r^*, which means DM will reject the observed r^* -1 alternatives and accept the first one later that better than all of anterior applicants. By calculating, when the number of option $n \rightarrow \infty$, $r^* \approx 37\%\ n$. And so select, the maximum probability of chosen optimal alternative achieves about 37%.

It can be seen that the optimal cut-off law assumes that DM is able be two basic conditions. First, DM must have full capacity for rational will, in the process of sequential observation is not affected by the temptation interference of "noise" and. Second, DM knows exactly the number of all the alternatives or assumes alternative-set scale tends to infinity; otherwise it is difficult to calculate the precise number of the optimal search. Real decision-making situations, however, is difficult to meet the two conditions. Especially people usually find it difficult to know exactly what alternative-set scale of how many, and in most situations the number of alternatives is not tends to infinity (such as choosing a marriage partner; graduates looking for work).

Based on prospect theory, by the method of laboratory experiment and questionnaire research, this study discusses effect of DM’s regret and loss experience in the process of sequential observation and selection and deviating from the optimal choice behavior.

Research Literature Review

Loose the hypothesis of classical secretary problem, by DM “knows the number of applicants is limited” instead of “I don't know the number of applicants how much, but know the distribution

probability of options" [3]. The results showed that the DM generally using the cut-off law to choose, but to fine-tune cut-off value.

It assumes that people are rational ability completely for the optimal cut-off principle search model; and only focus on the number of search and "ignores" the interference of noise information of optional features and options sets etc in the process of search. But in reality people tend to have only limited rational decision-making [4], this kind of "noise" is often important clues to policy makers to make decision heuristic [5], and the result is the often deviate from the optimal decision behavior [6 ~ 7).The study also found that characteristics of alternative value and present sequence influence sequential observation and selection behavior [8 ~ 9].

Based on consumers know price distribution, search costs, constant, the number of search infinite and can recall decision situation, Sonnemans (1998) [10] has found that the participants focus on total revenue is more of a search, rather than the marginal returns; At the same time also found that the participants search too little. Cox and Oaxaca (2000) [11] was studied in the case of not know unit of choose and employ persons pay distribution, process of job-seekers find work. The results come as a surprise to most people expected; it shows that some low wages of the company may be higher than wages by job seekers are more likely to choose.

For the consumer behavior in the department store to buy goods, Chun and Sumichrast [12]abstract looking for goods for a search process, the probability of every product in a department store is known in advance, and aim to maximize the net income for consumers. Research shows that consumers in the store size are to search the optimal strategy. Shepherd et al. (2002) [13] to business opportunities will be long-term presence or business opportunity when will disappear completely known as precondition, studies the marginal profit, opportunity cost, product upgrading of products and competitors influence factors such as speed, to improve product performance level and the influence of the market in time. Wu Guohua et al. (2005) [14] with business opportunities will disappear and when it will disappear unknown the premise condition, study the decision makers in the face of an important business opportunities.

To sum up, it is a more important decision variable for DM's perception of alternative-set scale information. The scale of existing research is mainly based on alternative-set scale for "set" of the situation, and alternative-set scale (n) is know as a definite value either don't know for DM. Of course, there are researches the difference between set n =40 and n = 80 [6], and the difference between n = 20 and n = 60 [7]. But the results found that search behavior is not existing significant differences between the alternative-set scale with larger and smaller situation.

On the basis of these studies, these studies further explore information of alternative-set scale whether there is any influence on decision-making behavior and earnings. Different from existing research, our research is based on the real options value of this research situation; and is divided alternative-set scale into four kinds of situations, namely, DM does not know how many alternatives, knows less alternatives, know exactly what alternatives more, know that there are an infinite number of alternatives and so on four kind of situations.

Theoretical analysis and hypotheses

From the rational decision-making model to analyze to sequential observation and selection, the information of alternative-set scale will not affect DM's search behavior. Regardless of the alternative-set scale (n) with the situation of larger or smaller, the cut-off value is a constant $1/e \times n$ according to the optimal cut-off laws. For example, when n = 100, cut-off value is about 37; and when n = 50, the value is about 19. However, according to the behavioral decision theory, in these two kinds of situation DM can make a big difference with cognitive judgment and emotion decision.

In the paper, independent variable is refers to DM's holding information of alternative-set scale before sequential observation and selection. We first divided into DM's knowing exactly alternative-set scale and no knowing with two kinds of situations. Among them, knowing exactly what alternative-set scale could be divided into know alternative-set scale is limited, and knows that alternative-set scale is infinite. Finally, know that the limited options will be divided into the two kinds of situations with less and more.

Hansen [15] found that purpose of searching for information is to reduce the uncertainty of decision-making tasks. But there is also research thought [16, 17] that the uncertainty of decision tasks

will reduce the search number. Further research also found that the uncertainty of knowledge (i.e., uncertainty about option attribute) has a weak effect on reduction search number. And uncertainty (i.e., uncertainty about which to choose) is significantly improved the search number [18].

In fact, DM's information gained in the order is decreasing that from exactly knowing the number of alternative-set to infinite, and don't know the number of alternative-set. In generally, the decision-making information means that uncertainty perception of decision task was increased. Urbany (1989) [19] found this uncertainty perception belongs to the knowledge uncertainty rather than choice uncertainty, and it will lead DM tend to reduce the search behavior when knowledge uncertainty degree was perceived to increasing. Especially, it could exacerbate the search behavior due to the effects of loss aversion and regret aversion. Therefore, we put forward the following hypotheses:

H1:When DM knows alternative-set scale is a finite situation, his search number is more than know it is an infinite scenario.

H2:DM's search number is more under the situation of knowing alternative-set number as a certain than that not knowing how many of alternative-set number.

Some papers explored the effect of number of alternative-set between more and less on search behavior [6, 7, 19], and the results showed that no significant effect on search behavior between more and less alternative-set number (such as n = 40 and 80; or n = 20 and 60). However, these studies were discussed based on the relative values of sequential appearance alternative rather than real values. Based on heuristic cognitive process, we will discuss the separation effect (i.e., input bias) that may be more prone to being when DM knows that less alternative-set number.

That is to say, even if DM clearly knows that may to choose based on the current disclosure information, but still tends to continue to search alternative. It is naturally leading to the appearance of input bias when the less alternative-set number rather than more alternative-set number. Moreover, DM would be apt to effect the control illusion of" easy to select the optimal" under the situation of less alternative-set number. This is because the situation of less alternative-set number means the decision-making information to invisible increasing relative to the situation of more alternative-set number. The result can easily lead DM to believe that uncertainty degree was decreased under the situation.

In a word, the decreasing degree of knowledge uncertainty would be to improve search behavior. Therefore, we put forward the following hypothesis:

H3: DM's search number is more under the situation of knowing smaller alternative-set than that knowing bigger alternative-set.

But on the other hand, the number of alternative-set is only relative. If the number of alternative-set is very big or small (such as set n = 10 and n = 1000), perhaps it is another kind of phenomenon. This is because it is clear that the cognitive effort of Decision-maker should to pay is bigger under the situation of n = 1000 than that n = 10. In other words, from the view of DM's cognitive ability, the situation of "n = 1000" similar to that DM knows alternative-set scale is an infinite situation.

Research methods and data collection

We adopt the methods of laboratory experiment in the paper. The experimental materials used are the size of numeric value to expressing quality of alternatives. By operating alternative-set size, the subjects were divided into four test groups. Among them, the test set based on the content of the research hypotheses are sometimes in the control group and experimental group.

First of all, for example, we created a set of test set n = 100, see it as DM knows alternative-set number for an infinite number of scenarios. In theory, it is not about "an infinite number of situations, but from the experiment on the procedure of practical operation, the size of alternative-set must have a limit. Otherwise, researchers can't operate in the experiment. Finally, especially comparing the decision benefits subjects also must set a limit. Of course, you need to tell the participants that situation is " an infinite alternative-set number before DM to testing ".

Then, this research take the top 30 of set n = 100 as "DM does not know alternative-set number of how many" of the situation. Namely, "set n = 30, and options don't change in the order." At the same time, set n = 30 as a "DM know how" alternative-set to compare the number of situations, and options in order don't change. Finally, set n = 30 under the situation of 10 top options, as "DM knows alternative-set

number of less" situation. Similarly, the option in order will not change. That is to say, set $n = 30$ has the meaning of two kinds of situations, one is "DM knows that number of options set for more", the other one is "DM does not know the alternative-sets number of how many".

Experimental procedures done through self-developed computer control platform. Experimental situation as a "stock decision", that is, in the price of (no repeat price, in order to control the factors that may affect) sold at its peak in a certain time. The subjects of two college with sophomore and senior students at Xi 'an, and Taiyuan in China. There are106 participants attending in the two experiments, the preliminary analysis to obtain valid 89 experiment data and 99 questionnaires. Namely, situation A (fewer alternative-set number) has 19 data, situation B (more alternative-set number) has 25 data, situation C (alternative-set number is infinite) has 28 data, and situation D (don't know alternative-set number) has 17 data.

Effect testing of alternative-set information

Because it is unequal to the experiment data of situation A (19), B (25), C (28), and D (17), and is also difficult to make a comparative analysis to search number of four groups subjects, we firstly take standardization of search number for four situations. The method of standardized processing is that search numbers of each situation were divided by their respective situations alternative-set number.

Then, the descriptive statistical results show the standardized mean search number of four situations A, B, C, and D was respectively 0.6368, 0.3974, 0.1254 and 0.4052. Variance analysis showed that the mean search number of these four situations has significant difference ($p = 0.000 < 0.01$, $N = 89$).

It shows that there are impacts on DM's search number for the information perception of different alternative-set size. Among them, the post hoc T test shows that average number of search has significant difference between the situation A and B ($p = 0.04 < 0.05$, $N = 44$). And the mean search number of situation A (0.6368) is bigger than the mean search number of situation B (0.3974). This means that DM's search number is more under the situation of knowing smaller alternative-set than that knowing bigger alternative-set. Therefore, the research hypothesis *H3* is validation support.

It is the situation of know exactly alternative-set to limited for the common features of situation A and B. Then the two situation comparing with C situation, it is explaining that be or no difference of between finite and infinite alternative-set. The valid experiment data of situation A and B is 44 (19 + 25 = 44), and situation C is 28. Variance analysis is done to 44 and 28 data, and the first descriptive statistics result show the standardized mean search number of situation n (finite) and n (infinite) was respectively 0.5008 and 0.1254. Variance analysis showed that the mean search number of the two situations has significant difference ($p = 0.000 < 0.01$, $N = 72$). And the mean search number (0.5008) of situation n (finite) is significantly larger than number (0.1254) of situation n (infinite). This means that when DM knows alternative-set scale is a limited situation, the search number is more than know it is an infinite scenario. Therefore, hypothesis *H1* was verified support.

Finally, it is the situation DM knows exactly alternative-set number being a certain because the common features of situation A, B and C. So these three situations compared with D situation, explain the decision makers know exactly alternative-set for a certain number, and don't know alternative-sets the number of how many situation for both the number of search whether there is a difference.

Then the three situation comparing with situation D, it is explaining that be or no difference of between don't know how many of number and knows exactly alternative-set number being a certain. The valid experiment data of situation A, B, and C is 72(19 + 25 + 28 = 72), and situation D is 17. Variance analysis is done to 72 and 17 data, and the standardized mean search number of situation *n* (know) and *n* (don't know) was respectively 0.3458 and 0.4052. Variance analysis showed that the mean search number of the two situations has not significant difference($p=0.564>0.05$,$N=89$. This suggests that information of alternative-set number with decision makers know and don't know is no obvious impact on the mean search number. Therefore, the hypothesis *H2* didn't get support.

Conclusion and implication

By mainly the method of laboratory experiment, we found that DM's search number is regularly verifying with the change of information of knowledge uncertainty. To be specific, DM's search number is more under the situation of knowing smaller alternative-set than that knowing bigger alternative-set.

When decision-maker knows alternative-set scale is a limited situation, his search number is greater than know it is an infinite scenario. However, when decision-maker feels the situation along with a higher uncertainty degree, his search number is not a significant difference than that a lower uncertainty degree.

Existing research think [17], the purpose of searching decision information is to reduce the uncertainty of decision task perception, but there are also studies suggest [17, 18] decision task uncertainty will reduce the search behavior. Urbany (1989) [18] further study found that increasing knowledge uncertainty perceptual degree leads DM less search, but the increasing choose uncertainty perceptual degree leads DM more search. According to Urbany [18], the perceptual uncertainty of alternative-set size information belongs to knowledge uncertainty. This means that search number is different between uncertainty perception degree of two situations for less and more alternative-set number.

Based on heuristic decision theory, when DM is difficult or impossible to process information and probability calculation, will helplessly tend to heuristic simplify and editing information, then be prone percept the situation of knowledge uncertainty degree equal to zero. Or say, this decision-making behavior situation is similar to the optimal solution strategy, and "deliberately" ignored the noise effect of alternative-set size information.

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