

BACHELOR THESIS

Preferences for Sequences

Testing Loewenstein and Prelec's Two Findings on
Sequence Preferences

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Abstract

This research paper aims to test the robustness of two of Loewenstein and Prelec's findings from the article "Preferences for Sequences of Outcomes": The preference of individuals to spread outcomes over time and the preference to have a sequence with improving outcomes. By modifying their initial study, a questionnaire is constructed and through it the preferences for sequences of 120 students is collected. The results provide the basis for testing the applicability of the two theories proposed by Loewenstein and Prelec (1993). Graphical and statistical analysis is used in this paper to derive conclusions.

Introduction

The manner in which individuals determine their choices is often subjective and can be complex in nature. Traditional economics summarizes individuals as being rational and therefore primarily acting in order to maximize their expected and discounted utility. There has been much debate as to whether or not these assumptions are just, giving rise to the field of behavioral economics, which attempts to model behavior that deviates from traditional economic assumptions. To better understand the different decision-making processes of individuals it might be enlightening to observe actual behavior in terms of preferences, and subsequently model these preferences so as to determine the mechanism in accordance to which they work.

Intertemporal choice models attempt to capture individual preferences throughout time with the aim of determining when, how and why individuals behave or choose a certain way. More specifically, intertemporal choice models focus on the relationship between the valuation of an outcome at present compared to the valuation of that same outcome at some predefined point in the future. Since people are confronted daily with decisions which unavoidably have an impact on not only the present but also the future, it is understandable that recently immense focus is placed on this topic by experts of both psychology and economics. As author Richard Bach (1984) once said: "Some choices we live not only once but a thousand times over, remembering them for the rest of our lives".

In 1993, George F. Loewenstein and Drazen Prelec wrote a joint article for the *Psychological Review* titled "Preferences for Sequences of Outcomes". In this article, the authors challenge the existing models of intertemporal choice. The two underlying assumptions of impatience and independence are being restricted by the authors to apply more accurately when individuals are faced with single outcomes. When, however, outcomes are presented in the formation of a sequence, both of these assumptions seem to be violated. These conclusions were made by the authors after numerous empirical researches were conducted in order to capture individuals' behavior when dealing with a sequence of outcomes. Furthermore, Loewenstein and Prelec did not only disagree with existing assumptions but filtered out two alternative behavioral traits of individuals facing intertemporal choices which they refer to as the preference for spreading and improving sequences (Loewenstein and Prelec 1993). The research conducted as a basis for their article, will be modified for this paper in order to test

the robustness of their alternative findings. Therefore, the purpose of this paper is to answer the following research question:

How robust are Loewenstein and Prelec's findings to changes in outcomes of sequences?

This paper aims to answer the above question by examining specific instances of outcome sequences chosen by a sample of 120 individuals and how these sequences, their components and the outcome types may affect the assumptions and processes on which individuals base their preference selection. Firstly, this paper will provide a theoretical background of intertemporal models and their assumptions in order to gain an understanding of their key properties. In the methodology section, an overview is given of how the research is conducted and what tools are used for analyzing the results. This leads to the research findings, which will explore the subjects' preferences and compare them to Loewenstein and Prelec's findings (1993). Furthermore, in the evaluation an assessment of the application of the outcome is given, recommendations are made and topics for further studies are being presented. This will be followed by a conclusion summarizing the findings of this paper.

Theoretical Background

i) Intertemporal Choices

“Intertemporal choices” concern tradeoffs between outcomes at different points in time (Frederick, Loewenstein & O’Donoghue 2002). As this definition is relatively abstract, the following examples aim to give a clearer understanding of situations where a decision influences both today’s and future utilities, known as intertemporal choices:

- *When to buy a new car and when to save?*
- *Whether one should pursue a university study?*
- *What to have for dinner?*
- *Go play tennis or go see a movie?*

In all these cases, the individual is confronted with a choice between a certain outcome now, which tends to be relatively smaller and a certain outcome later in time, which tends to be larger. For instance, the time invested in studying at university for 3 years should be more than compensated by the higher earnings of your future job. By applying this line of thinking, it can be concluded that a certain value of an outcome now will decrease if being delayed. This phenomenon is known as “positive time discounting” and provides the basis from which the discounted utility model is derived.

ii) Discounted Utility Model

The discounted utility model (DU model) is one of the most popular frameworks within the area of intertemporal choice. The model was introduced by the economist Paul Samuelson in 1937 in order to create a simple model which allows comparing costs and benefits occurring at different times. This is done by discounting future utilities by a specific constant factor (Goldin 2007). As a numerical example, consider an individual with a discount factor of 80% per month. In this case, an individual would be indifferent between receiving 80€ now and 100€ in one month, when the individual’s utility is linear. The DU model is able to determine the overall utility of an intertemporal choice by multiplying each utility by the given discount factor, however, the assumption that the utility of an option is equal to the sum of its utility in each individual time period must hold. The relationship of the DU model can be represented by the following formula:

$$U^t(c_t, \dots, c_T) = \sum_{k=0}^{T-t} D(k)u(c_{t+k}) \quad \text{where } D(k) = \left(\frac{1}{1+p} \right)^k$$

In the formula above $D(k)$ is considered the individual's discount function (where p is the individual's discount rate) and $u(c_{t+k})$ is regarded as the instantaneous utility received from the outcome in period $t+k$ (Read 2003). This formula illustrates that besides the varying utilities, the entire decision process of intertemporal choices is being determined by a single factor, the discount rate, when applying the discounted utility theory. Although it is precisely this simplicity that made the DU model so popular, it inevitably resulted in being incapable of including the main psychological factors that play a role in an individual's intertemporal decision. As already its founders clearly indicated, the DU model only aims to identify that individuals, under some strictly specified conditions, are bound to possess positive time preferences (Frederick, Loewenstein and O'Donoghue 2002). These specified conditions, however, seem to drastically diverge from reality in numerous cases so that they provide the bases for the discrepancy between the DU model and observed behavior.

iii) Assumptions of Discounted Utility Model and Their Violations

There are several conditions that the DU model considers as core assumptions to assure its feasibility to analyze intertemporal choices. It is necessary to highlight these assumptions in order to gain an understanding of the shortcomings of the DU model in case of their absence. The key assumptions paired with their inconsistencies are as follows (Frederick, Loewenstein and O'Donoghue 2002):

- *Constant Discounting*

The DU model assumes a constant discount rate for every period. Hyperbolic discounting seems to be an accepted alternative to this condition as it means that an individual has a declining discount rate over time on the basis of decreasing impatience over time.

- *Independence of Discounting from Consumption*

The DU model assumes that all forms of consumption are discounted by the same function. However, there is significant evidence that gains are discounted more than losses. In addition to this, small outcomes seem to be discounted relatively more than large outcomes.

- *Positive Time Preference*

Individuals focus consumption in the present because they are assumed to be impatient. However, when sequences of outcomes are being examined, research has shown that individuals prefer an improving sequence instead of a decreasing one, which contradicts positive time preference.

- *Consumption Independence*

This assumes that an individual's utility at point $t+k$ is independent of its consumption at any other point in time. Contrary to this, research on preferences over sequences has shown that individuals tend to favor spreading consumption over the entire time period which strongly disapproves with the assumption of independence.

As the above points indicate, every major assumption on which the validity of the DU model is based can be violated by different conditions. Research has extracted these to be more in agreement with the actual behavior of individuals when it comes to making intertemporal choices. Two of these observed violations, namely preference for improvement and preference for spreading, are particularly interesting as they seem to not only contradict the assumptions of the DU model, but also each other, and hence are elaborated on in more detail below.

iv) Preference for Improvement

Impatience provides the basis to positive time preference and is an accepted assumption when it comes to choices between single outcomes. Regarding sequences of outcomes, however, actual behavior seems to show a different trend, a tendency towards negative time preference. Since this opposition in trends is caused by the nature of the outcome, the partition between single outcome and sequence needs to be established.

Outcomes can be regarded as single if they seem to be impossible to compare or are spread over exceedingly long time intervals. If, however, outcomes are related to one another or within a reasonable time scope, they can be considered to be in sequence. As stated by Loewenstein and Prelec (1993), "the greater the 'integrity' of a series of outcomes, the greater should be its likelihood of being evaluated as an integral sequence" (Loewenstein and Prelec 1993).

The boundaries of a sequence of outcomes have now been set and it can be explored why impatience is being outweighed by the preference for improvement when outcomes are presented within a sequence and not in isolation.

- *Anticipatory Utility*

This is one explanation for the preference of improvement because present consumption only creates consumption utility, whereas future consumption causes both consumption utility and anticipatory utility (which is added utility caused by pleasure of awaiting future rewards) (Caplin and Leahy 2001).

- *Loss Aversion*

First brought about by Kahnemann and Tversky (1991), loss aversion is referred to as the behavior of an individual to be more impacted by a loss than by a gain of equal size. Referring to time sequences this means that individuals who would be faced with a decreasing sequence would encounter continuous losses, and every further loss would be increasingly unattractive. Therefore, increasing sequences are preferred over decreasing ones, since increasing ones create incremental gains while decreasing gains present a series of losses. An example of this can be the preference for an increasing wage profile.

- *Recency Effect*

If an individual considers the last outcome in a sequence to be slightly higher in importance since it is freshest in his mind when considering the entire sequence, then he will place more emphasis on a strong positive ending to his sequence thus preferring an improving sequence (Frederick, Loewenstein and O'Donoghue 2002).

v) Preference for Spreading

Preference for spreading of outcomes is the phenomenon which opposes the assumption of independence. Research, including Loewenstein and Prelec's (1993), shows that the shape or construction of the outcomes in a sequence has an effect on the preference of an individual. Individuals are influenced by the degree of evenness in which positive or negative outcomes are spread across a given time period.

One plausible explanation for this violation of the independence assumption seems to be found in habit formation models. This implies that the utility derived from current consumption can be altered by the level of past consumption (Pollak 1970). For example, if an individual has consumed pizza for the past five days, the utility of consuming pizza on the following day may be less due to previous consumption. This leads to the idea that the assumption of independence may not hold as individuals receive greater utility through variation within a sequence of outcomes.

Although research is still scarce on this topic, a tendency has already filtered through. Individuals when faced with more than two outcomes prefer outcomes of same valence to spread relatively evenly over the entire time period (Loewenstein and Prelec 1993). The following sections of this paper aim to contribute to the understanding and validity of precisely this phenomenon.

Methodology

i) Loewenstein's Experiment

The purpose of this paper's research is to evaluate the theory brought up by Loewenstein and Prelec (1993) of preference for spread and improvement. In order to test the robustness of these theories, a study conducted by Loewenstein in 1987 and used as evidence within Loewenstein and Prelec's article is being modified in several ways. The original experiment had the following setup:

Option	This Week	Next Week	Two Weeks from now	Choices
A	Fancy French	Eat at home	Eat at home	16%
B	Eat at home	Fancy French	Eat at home	84%
C	Fancy French	Eat at home	Fancy Lobster	54%
D	Eat at home	Fancy French	Fancy Lobster	46%

To further explain the experiment illustrated in the table above, 37 subjects were asked which option for dining they preferred between A and B, and later, between C and D. To clarify, the Fancy French is an upper class French restaurant and the Fancy Lobster is seen as an even more extravagant seafood restaurant. According to discounted utility, an individual should prefer either both A and C, or B and D, as the outcome of the first two weeks are identical in those cases and only a common new option was introduced to C and D in week three. In order to clarify the prediction of discounted utility, it is being represented formulaically below:

$$DU(\text{Option A}) = D(0)U(\text{French}) + D(1)U(\text{Home}) + D(2)U(\text{Home})$$

$$DU(\text{Option B}) = D(0)U(\text{Home}) + D(1)U(\text{French}) + D(2)U(\text{Home})$$

$$DU(\text{Option C}) = D(0)U(\text{French}) + D(1)U(\text{Home}) + D(2)U(\text{Lobster})$$

$$DU(\text{Option D}) = D(0)U(\text{Home}) + D(1)U(\text{French}) + D(2)U(\text{Lobster})$$

If an individual prefers option A to B, discounted utility theory predicts that $D(0)U(\text{French}) + D(1)U(\text{Home}) > D(0)U(\text{Home}) + D(1)U(\text{French})$ since the $D(2)U(\text{Home})$ is equivalent in both options and

can therefore be excluded when comparing. If this is the case, it can be concluded that DU (Option C) > DU (Option D) as they are identical to the first two options except for an alternative option for week three. Since this is common to both option C and D it would increase or decrease the DU equally for the two options and therefore does not affect the relative preference between the two options. The same explanation applies for option B and D: if B is preferred to A, discounted utility theory predicts that the individual also prefers D to C.

The percentages of choices, however, do not comply with the predictions of the DU model. Although 84% preferred option B, only 46% preferred option D. Loewenstein used these results to highlight a fault within the DU model and concluded that the choice behavior of the subjects can better be explained by the preference for spreading. In option B, chosen by 84%, the Fancy French was in the second week, bracketed by two dinners at home in the first and third week. Even though DU predicted D to be chosen equally many times, in this option the Fancy French in week two was followed by the Fancy Lobster in week three. Because of this, individuals preferred option C because in this case the Fancy French and the Fancy Lobster were separated by a weekend of eating at home, clearly indicating the preference for having good outcomes spread over the time period available rather than clustering it into one section of the sequence.

ii) Design of Questionnaire

In order to test the robustness of Loewenstein and Prelec's findings of the preference for spreading, the above mentioned experiment had to be modified to evaluate its applicability to a wider range of outcomes. Because of the absence of a lot of time and money, a questionnaire gives the opportunity to gather the preferences of a large sample of individuals in a fast and free way, and is therefore the chosen method to conduct the research for this paper. The questionnaire consists of 6 questions, each presenting two options of which the individual has to select one. Similar to the original experiment by Loewenstein, subjects are being presented with options of how to design their coming three weekends by being presented various sequences. The three weekends in each sequence are attributed to a certain activity referred to as outcome. It is a modification in outcomes and their placement within the sequence which create a deviation from Loewenstein's experiment. In addition to using more applicable activities to a European student sample, the following two major modifications have been made:

- *Modification 1:*

The common activities of the third weekend are positive, neutral and negative in nature, aiming to test the theory also for negative outcomes.

- *Modification 2:*

The common outcomes are being placed in weekend three for three questions but are then moved to weekend one for the three remaining questions in order to evaluate the impact of such a change in the setup.

Using these modifications as a guideline, the “Survey for Sequence Preferences” was constructed (the full version can be found in Appendix 1). For further understanding of this paper, however, it is important to clarify the setup of the sequences in each question. Therefore the six questions are included and color-coded below:

Table 1: Summary of Outcomes in Questionnaire

Qu.	Option	This Weekend	Next Weekend	Two Weekends from now
1	A	Go to your favorite restaurant and concert	Have free time at home	Have free time at home
	B	Have free time at home	Go to your favorite restaurant and concert	Have free time at home
2	A	Go to your favorite restaurant and concert	Have free time at home	Go on a two day trip to Paris
	B	Have free time at home	Go to your favorite restaurant and concert	Go on a two day trip to Paris
3	A	Go to your favorite restaurant and concert	Have free time at home	Be sick for 24 hours due to a virus
	B	Have free time at home	Go to your favorite restaurant and concert	Be sick for 24 hours due to a virus
4	A	Have free time at home	Go to your favorite restaurant and concert	Have free time at home
	B	Have free time at home	Have free time at home	Go to your favorite restaurant and concert
5	A	Go on a two day trip to Paris	Go to your favorite restaurant and concert	Have free time at home
	B	Go on a two day trip to Paris	Have free time at home	Go to your favorite restaurant and concert

6	A	<i>Be sick for 24 hours due to a virus</i>	Go to your favorite restaurant and concert	Have free time at home
	B	<i>Be sick for 24 hours due to a virus</i>	Have free time at home	Go to your favorite restaurant and concert

The above table summarizes the outcomes within each question. The colors are just used within this paper in order to give an overview of the setup. Four types of outcomes are being used in the experiment: neutral (blue), positive (green), extremely positive (yellow) and negative (red). Furthermore, one column's outcomes are held constant within each question, and are being indicated by cursive writing in the table above.

As can be seen in the table above, the sequences in the questions follow a specific pattern. For questions 1 until 3, option A has the sequence {positive – neutral – common} and option B follows the sequence {neutral – positive – common}. The commons change within each question; in question 1 the commons are a neutral outcome, in question 2 they are an extremely positive outcome and in question 3 they are a negative outcome. For questions 4 through 6 an equal setup applies, with one important difference: the outcomes of the third weekend, the commons, are being moved to the first weekend, with the other two columns shifting back respectively.

The above summarized experiment should help determine if people have specific preferences when it comes to determining the order of a sequence of events. There are multiple combinations of these events and the specific setup of the experiment should identify a clear preference for a certain order within the sequence. Different outcomes would confirm one of the two theories in question: preference for improvement and preference for spreading outcomes over time.

Preference for Improvement would suggest that the subjects prefer sequences which increase in utility over time. For instance, beginning with the negative event for the first weekend, continuing with the neutral event for the second weekend and finishing with the positive event in the last weekend. This theory is being tested by the outcomes of question 2, 4 and 6. For these three questions, the outcomes of their option B are increasing and its choice would indicate preference for improvement.

Preference for spreading intends to reveal the preferences for spreading outcomes over a certain period of time. The above experiment should help identify if the subjects had specific preferences for the spreading of more than one same-valence event (questions with only neutral and positive

outcomes) and what the effect is of adding a negative event. The theory of spreading same-valence events is being tested in option A of questions 2 and 4, and in option B of 1 and 5

The foundations of the questionnaire lie within the initial experiment performed by Loewenstein in 1987. However, both the choice of activities and their positioning within the sequence, as they are to be found in this questionnaire, are the key to testing the effectiveness of the theories put forth by Loewenstein and Prelec (1993). Two distinct modifications were established influencing the entire design of the questionnaire.

iii) Data Collection and Subject Pool

In the case of this paper's research, the data collection process and subject pool are closely related. All decisions done with respect to these two items were under the goal of saving time and collecting enough data to draw valid conclusions. The set target was to collect the responses of 100 subjects within a time span of one week.

The subject group had to be determined first, as the design of the questionnaire had to be fit accordingly. The questionnaire aims to explore the behavioral traits and choices of individuals, and therefore it is essential for the validity of the results, that the subjects can refer to the options presented to them. Students seem to be the most accessible for this study, and therefore promise the highest participation. Once the target group was established, the outcomes for the sequences were determined by using events which are applicable and relevant to students.

Furthermore, the questionnaire was answered anonymously and did not require stating any personal information like age, gender, nationality. This was done to enable students to answer more honestly to the questions and therefore obtain results which come closer to their actual behavior. The primary limitation of this questionnaire is that it is a fixed set of questions with options A or B, and therefore leaves little room for participants to express alternative thoughts. For the purpose of this research, however, it is useful to have these fixed schemes in order to apply calculations and compare them throughout the results to establish a concluding theory.

As mentioned before, the questionnaire consists of 6 independent questions. Since each individual was required to answer all 6 questions, the order in which the questions were posted had to be taken into consideration. In order to eliminate any effect of order, ideally the order should have been randomized,

so that every subject was faced with a different order. As time was of the essence, however, this would have been impossible to monitor, therefore two versions of the survey were made, number 1 going from question 1 to 6, and number 2 in reverse order, question 6 to 1. The aim was to present half the subject pool with Survey 1 and the other half with Survey 2.

Another aspect of this research needing to be mentioned is the distribution process of the questionnaire. As students were the subject pool, initially the 2 versions of the questionnaires were printed on paper and handed out at the Erasmus University Rotterdam. However, the distribution in this manner was slow and the success rate lower than expected. For this reason, an online survey (Appendix 2) was created using www.thesistools.com. Again 2 versions were made and the website links in order to access them were distributed to students by email. This method of distribution made it possible to collect data quickly and exceed the target number of subjects by 20. To conclude, a complete set of data was collected from 120 subjects within 8 days.

iv) Analyzing Tools

In order to summarize and analyze the data collected, both excel and a statistical program called SPSS is used. Once all questionnaires are returned, the data is entered into an excel sheet. For each question a column is made stating the 120 responses separately, one in each row. The responses either receive the number 1, if option A is selected as the preferred answer, or the number 2, if option B is preferred. By using the resulting excel sheets, for each question the responses with equal numbers from all students could be summed up in order to calculate how many subjects preferred which option. From this data, the percentages for each option are computed and a two-columned bar graph is designed in order to represent the outcomes graphically.

SPSS is a statistics software which is used for this research to calculate if the number of responses for the two options within a question differ significantly. In order to determine which statistical test to use, the nature of the data has to be identified. For this research, it refers to the data having a non-normal distribution, so a non-parametric test had to be used. Furthermore, the variables were nominal, meaning they can be divided into categories, which in this case means the choice of option A or B for a question. Since the test has to be both non-parametric and applicable to nominal variables, the Binomial test or the Wilcoxon Sign Rank test seem to be the correct choice to analyze the data (as results were equivalent for both tests, only the Binomial test will be referred to from now on). The Binomial test is

used for each question in order to test if the proportion of individuals in the sample falling in each category (either option A or option B) differs from the pre-specified probability of falling into these categories (<http://elderlab.yorku.ca/~aaron/Stats2022/BinomialTest.htm>). In the case of this research, the probability being tested is 0.5 as all individuals had a 50% chance of choosing either option A or option B. Therefore, the null hypothesis for the binomial test for each question is $H_0 = 0.5$ and the alternative hypothesis is therefore $H_a \neq 0.5$. The significance was tested at a 1% level.

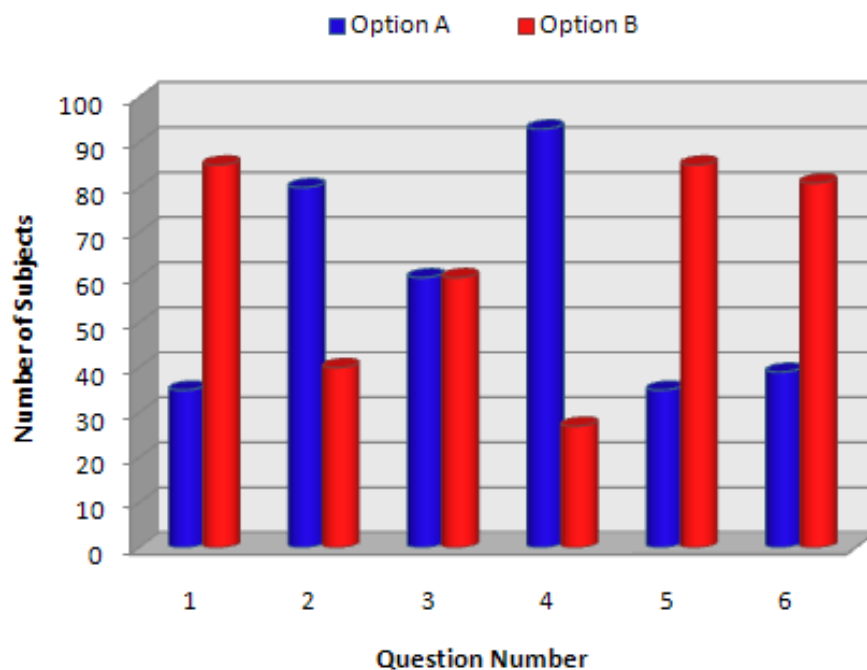
Concluding, combining both statistical and graphical analyzing tools should help in finding trends and patterns within the results in order to identify the dominant behavior within the sample pool.

Research Findings

i) Outcomes

When having received the responses of all 120 subjects, the initial step is to sum up the amount of individuals who chose option A and option B for each question. The findings are being represented both numerically and in the form of a bar graph below:

Graph 1: Results of Choices for Sequences



Qu	Opt	Choice	%
1	A	35	29.2
	B	85	70.8
2	A	80	66.7
	B	40	33.3
3	A	60	50
	B	60	50
4	A	93	77.5
	B	27	22.5
5	A	35	29.2
	B	85	70.8
6	A	39	32.5
	B	81	67.5

As can be seen in the bar graph above, in five out of the six questions one of the options was clearly preferred by the subjects over the other option. Only in question number 3 both options were chosen equally frequently, 60 subjects each. In order to evaluate if the amount of subjects choosing one option is significantly higher than for the other option in the remaining five questions, the SPSS output for the Binomial test has to be viewed:

Table 2: SPSS Output for Binomial Test

		Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
1	Group 1	1,00	35	,29	,50	,000(a)
	Group 2	2,00	85	,71		
	Total		120	1,00		
2	Group 1	1,00	80	,67	,50	,000(a)
	Group 2	2,00	40	,33		
	Total		120	1,00		
3	Group 1	1,00	60	,50	,50	1,000(a)
	Group 2	2,00	60	,50		
	Total		120	1,00		
4	Group 1	2,00	27	,23	,50	,000(a)
	Group 2	1,00	93	,78		
	Total		120	1,00		
5	Group 1	2,00	85	,71	,50	,000(a)
	Group 2	1,00	35	,29		
	Total		120	1,00		
6	Group 1	2,00	81	,68	,50	,000(a)
	Group 2	1,00	39	,33		
	Total		120	1,00		

The Binomial test confirms for questions 1, 2, 4, 5 and 6 that the amount of subjects choosing one option significantly differs from the amount of subjects choosing the other option. For these five questions, the significance level is 0.000 and therefore the null hypothesis $H_0 = 0.5$ can be rejected for each. Using this assumption, the option being chosen more frequently is being referred to as the one preferred by the majority of subjects and therefore is seen as the general preference from now on.

ii) Interpretation

In order to interpret the results from the research, first the result for each question is considered separately and later with relation to each other (refer to Table 1 with color-coding for sequences of positive, neutral and negative events):

- *Question 1*

Option B is preferred by 71% of the subject, indicating the preference for spreading as the sequence is (neutral – positive – neutral), suggesting that the 2 neutrals are being spread by the insertion of a positive event in the 2nd weekend. Option A, in contrast, has the two neutrals adjacent to each other.

- *Question 2*

Option A is preferred by 67% of the subjects, which is a sequence of (positive – neutral – very positive), signifying a spreading of the two positive events by the placing of a neutral in between. Option B is one of the improving sequences, however, the results suggest that the subjects prefer the spreading over the improving sequence in this question. Unless the subjects do not recognize it as such since they place the positive and very positive outcome on the same level and therefore the sequence in option B would not be strictly increasing.

- *Question 3*

In this case, there is no preference for either option by the subjects, each was chosen exactly by 50 % of the subjects. Option A of this question has the sequence (positive – neutral – negative). A preference for this option would have suggested that events of any valence, so both positive and negative, are preferred to be spread out within a sequence. Furthermore option A is strictly decreasing, and to support the theory of improving sequences, it would be expected that option B is preferred instead. Since there was no clear preference, however, neither one of the above theories are supported. The reason for this may be that the two effects cancelled each other out or that the sequence pattern was not clear enough. In general the results for this question are therefore inconclusive and are not further considered in testing the robustness of the two theories in focus.

- *Question 4*

This question had the strongest preference for one option of all six questions. Option A was preferred by 78% of the subjects. Its sequence is identical to that of option B in question 1 being (neutral – positive – neutral). Since the preference for this one is higher, however, the difference may be caused by the change within the alternative option. Option B in this question is a partially improving sequence, as it progresses from two neutrals into a positive event in the third weekend. The preference for option B is very low however, suggesting that the subjects either did not perceive it as an increasing sequence or clearly prefer spreading over improving.

- *Question 5*

Option B is preferred by 71% of the subjects and is therefore another outcome which suggests preference for spreading since the sequence is (very positive – neutral – positive). Contrary to this, option A is a strictly decreasing sequence, which poses the question why the preference for option B is not higher as the two theories complement each other in this question: the spread in

option B should attract subjects and in addition, the worsening sequence in option A should make option B even more appealing in comparison.

- *Question 6*

Option B is the dominant choice for this question, with 68% of the subjects preferring this option over the other. The sequence of option B is strictly increasing (negative – neutral – positive), suggesting that if the alternative does not display spread within the sequence, that an improving sequence is the second best alternative. As option A does not follow a spreading pattern, it can be concluded that an improving sequence is preferred as an alternative when the possibility for spreading is absent. A different reasoning for the preference of option B may lie in the events used within the sequence. It could be the case that the negative outcome at the beginning of the improving sequence is necessary in order for subjects to recognize it as such and only then make it their preference. However, solely the outcome from this question is not enough to support this theory and therefore is subject to further research.

After examining the results for each question individually and drawing first conclusions, the analysis of the results can be extended by creating links between them. The relationship between the questions will be explored by referring back to the discounted utility model. This suggests that the preference for questions 1, 2 and 3 should be the same option and also the preference for questions 4, 5 and 6 should be equal, as only a common third option is replaced in each triplet of questions.

- *Questions 1, 2 and 3*

In question 1, option B was preferred by the majority of subjects. Since the common event in the last weekend was changed from the neutral in question 1, to a common positive in question 2 and finally to a common negative in question 3, the DU model predicts that option B is preferred for all three questions. However, from question 1 to question 2 the majority shifted from option B to option A (and question 3 is inconclusive) since both represent a sequence in which positive events are spread over the time period. From this it can be concluded, that the theory on preference for spreading is more accurate in predicting behavior than the DU model in this case.

- *Questions 4, 5 and 6*

In these questions, the common event shifted to the first weekend, however, the predictions of the discounted utility model are the same: if option A is preferred for question 4, this

option will also be preferred for questions 5 and 6. Option B is preferred in both these questions, however, which is not consistent with the predictions of the DU model. The change in preference between questions 4 and 5 can be better explained by the theory suggesting a preference for spreading. The change in choice to option B in question 6, can be accounted for by the second theory in question in this research; the preference for improvement.

iii) Link to Article by Loewenstein and Prelec

Summarizing, this research shows that both of Loewenstein and Prelec's theories (1993) seem to better predict the choice behavior of the subjects than does the DU model, even though modifications have been made to their initial study.

In terms of modification 1, which introduces negative outcomes into the sequences, no conclusions could be made concerning the theory of spreading outcomes. The aim was to expand the proposed theory by Loewenstein and Prelec (1993) from only being applicable to same-valence outcomes to also being applicable to a mixture of positive and negative outcomes. Question 3, testing this theory, obtained inconclusive results. Nevertheless, this does indirectly confirm Loewenstein and Prelec's theory of preference for spreading as they limited it to same-valence outcomes and a differing setup was proven wrong in this research, strengthening their theory. Although this means that their theory is not proven robust when negative events are included within the sequence, it is subject to further studies to investigate if their theory holds when exclusively negative outcomes are mixed with neutral ones and spread over a certain time period, since this would be consistent with their assumption of outcomes having to be of same valence. If this were the case, then Loewenstein and Prelec's theory of preference for spreading would also hold for negative events as long as they are treated in isolation, as they suggest through their same-valence assumption.

Although no conclusion could be made from modification 1 concerning the theory for spread in sequences, results did produce valuable output concerning the theory for improving sequences. In question 6 option B was strictly increasing and was the only one of the three options with improving sequences which was preferred by the majority of subjects. The difference between this and the other two improving sequences is that it goes from negative, over neutral to positive, and the others only from neutral to positive. This suggests that in order for subjects to identify it as an improving sequence, a negative event needs to be included, and only then is this sequence being preferred over spread

within the sequence. This would explain why only this improving sequence is preferred and neither the other two within this research, nor the one present within the initial study conducted by Loewenstein in 1987. Concluding, this suggests that the modification actually allowed for Loewenstein and Prelec's theory of improving sequences to be valid even when competing with a spreading sequence.

It has to be mentioned, however, that there might be a second reason for the preference of the improving sequence in question 6, not relating to modification 1. In the other two questions with an improving sequence, the alternative was preferred and both of them were sequences with spread. In question 6, however, the alternative to the improving sequence did not display the properties of a spreading sequence. Because of this, the question arises if it is not the negative outcome of the first weekend that made the difference, but rather that the subjects consider the improving sequence to be important if spreading outcomes is not possible. This could mean that individuals use a ladder system to make their choices. As long as spreading is an option, subjects will prefer that over any other sequence. As soon as spreading is not one of the options, they show preference for the second best outcome, which is an improving sequence. Although the results of this research are not extensive enough to prove this theory, they do provoke further research to be done in order to explore the relationship between spreading and improving sequences.

Modification 2 moved the positions of the common outcomes from the last weekend in the sequence to the first. Concerning this modification, the theory for the preference for spread proved to be robust, since subjects still preferred the options which provided spread within the sequence. Therefore, the placement of the common outcomes does not decrease the predicting power of the theory brought up by Loewenstein and Prelec (1993) that individuals prefer more than one same-valence outcome to be spread out over a certain time period.

In general, the results obtained from this research seem to clearly support Loewenstein and Prelec's theory for preference of spreading outcomes within a sequence. The robustness was tested and verified by using a different order and different events from those used in the sequences of the original study conducted by Loewenstein. The results testing the robustness of the theory for improving sequences have concluded in some unexpected findings. It seems that two factors can influence the preference for this by the subjects. One factor is that the sequence has to be clearly increasing in order for the subjects to show preference for it. The other factor is that an improving sequence is only preferred if the alternative sequence does not represent with spread. In order to identify the validity of these two

factors for the improving sequence theory, further studies need to be done with each factor individually and then also in combination.

Although the research is limited, the results obtained are valuable in order to answer the research question of this paper. The results have shown the robustness of the theory of preferences for spreading against two modifications within the setup of the study. Concerning the theory for improving sequences, the results obtained from the research for this paper do not fully contribute to this specific research. The research has, however, revealed other interesting relationships which are subject to further studies.

Evaluation

i) Shortcomings and Recommendations

This research has generally been valuable in order to answer the research question; however, there are several shortcomings and possible improvements which have to be mentioned.

Starting with the questionnaire, most weaknesses have been caused by the limitations of time and resources. Following issues need to be pointed out:

- *Questionnaire*

As already addressed in the methodology section, 2 versions of the survey were used. However, ideally the order of questions should be completely randomized, so that each subject receives a different questionnaire in order to eliminate any influence on the subjects. Through the process of cancellation, any effect created by the order of the questions will be removed. Adding on to this, there is a clear pattern within each question and throughout the survey. The pattern was revealed with the color-coded table in the methodology. If the subjects detected this pattern, they might have been influenced in their preferences. This could be because they want to seem most rational in their answers or want to prove that they understand the testing behind the questions. In both cases, the subjects' sincere behavior and therefore choice preferences are not revealed and conclusions drawn from the results may be faulty. In order to prevent this in future research, off-topic questions could be inserted in between the main research questions in order to disturb the pattern.

- *Distribution Channels*

Another criticism to the questionnaire concerns the distribution channels. Since some questionnaires were filled out in person with the research conductor present and others in private over the computer, the subjects may have responded differently in each case. The benefit for collecting data in person is that subjects may take it more seriously, as they feel observed by the research conductor. On the other hand, when approaching people in person they might be in a rush or feel bothered by the research conductor and the quality of their responses might suffer. Distributing the questionnaire online poses both advantages and disadvantages. The main advantage is that it is possible to reach a large subject pool in a very short time. Furthermore the

subjects can decide when to complete the survey and will complete it once they have time and feel ready for it which will lead to more accurate results. On the contrary, since no one is observing and monitoring the subjects, the subjects may chose to skip through the questions carelessly and select random answers, which will negatively influence the validity of the results.

- *Subject Pool*

Due to availability and access, the subject pool consisted of students exclusively. Since students, especially in the field of business and economics are used to these questionnaires and patterns of thinking, it might have been easier for them to distort the answers away from their personal choices. Furthermore, in order to draw conclusions about the entire population, it is necessary to create a subject pool which is mixed on several levels, for instance income, occupation, education, age and race. Only if the subject pool is a good representation of society as a whole, will the results be conclusive about the behavior of the general population. Furthermore, the size of the subject pool is relatively small. In order to produce more significant results, the number of subjects can be increased to one thousand if time and resources permit it. Therefore, the research can be improved by having a larger and more varied subject pool.

- *Modifications*

Adding negative outcomes into sequences and varying the position of the common outcome were the two main modifications from Loewenstein's original study which shaped the research conducted for this paper. Varying the positions of the common outcome has proven to be a very efficient modification to test the robustness of the theory for spreading. Introducing negative outcomes, however, did not produce as strong results. Especially the equivalent frequency for both options in question 3, where a negative was introduced, proves that this modification was not useful in the way it was used in this research. Therefore, it seems that it would have been of greater value to this research if a different modification was used instead. One suggestion for a better modification might be to increase the time period of the sequence and with this increase the number of same-valence outcomes within the sequences. With a longer time period, there is more room to change the order of the sequences and therefore Loewenstein and Prelec's theory could be tested in more detail. Another modification could be to introduce sequences with only negative and neutral outcomes in order to specifically test if the same-valence also applies for negative outcomes or only for neutral and positive ones, as has been proven until now by Loewenstein's study and this research.

ii) Further Studies

When regarding the extent to which this research can be improved or modified, it seems clear that further studies need be conducted in order to answer the research question more accurately. Besides repeating this research and incorporating the above recommendations, there is one specific aspect unanswered which calls for a completely new research to be composed. The goal of this research paper is to test the robustness of the two theories brought forth by Loewenstein and Prelec (1993): Preference for Improvement and Preference for Spreading within a sequence. As the results of this research show, in two out of three questions which had one option resembling a sequence with spread outcomes and the other an improving sequence, the sequence of spread outcomes was preferred by the majority of subjects. Furthermore, the improving sequence which did receive the most choices was the only one in the triplet which was strictly increasing from negative over neutral to positive outcomes. These observations pose the following two questions for further research:

- 1) When being presented the choice between a spread sequence and an improving sequence of the same outcomes, what does the individual prefer? Is there a ranking between these two theories which individuals refer to when making choices?
- 2) In order for the strictly improving sequence to be regarded as one by the individual, does it need to follow the general trend of negative over neutral to positive outcomes? And if this is the case, does the preference for improvement then dominate the preference for spreading behavior?

In general, this research project lays the foundations to interesting topics for further studies which aim for more stable and thorough conclusions to be drawn.

Conclusion

The two findings, Preference for Spreading and Preference for Improving Sequences, of Loewenstein and Prelec's article "Preferences for Sequences of Outcomes" provide the basis for this research paper. In order to evaluate the validity of these two findings, which present alternative theories for choice behavior of individuals to the discounted utility model, this paper aims to answer the following research question: *How robust are Loewenstein and Prelec's findings to changes in outcomes of sequences?*

With the use of a six-question survey, a modified version of Loewenstein's initial study of 1987, preferences for sequences from 120 students were collected. Each question presented the subject with a choice between option A and B; 2 different sequences of events for the coming three weekends. In an excel spreadsheet the data was compiled and both graphical tools and SPSS were used to analyze the data.

The results show that Loewenstein and Prelec's findings are robust to the modifications of outcomes made in this research. The theory for preference of spreading outcomes throughout a time period proves to be specifically stable for same-valence outcomes. The theory on preference for improving sequences seems to apply to sequences which show rather steep improvements and if the alternative for choosing a spreading sequence does not exist. However, the results are not extensive enough to fully validate this reasoning and therefore further study is needed on this area for validation.

Concluding, Loewenstein and Prelec's two theories on sequence preferences seem to be valid for a wider range of outcomes than those used in their studies. The validity of their findings was tested by applying various modifications to their initial study and the results of this research proved a strong robustness of Loewenstein and Prelec's assumptions.

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Appendix 1: Questionnaire Version 1

Survey for Sequence Preferences

Imagine that you have to decide how to spend your next three weekends (ignore any personal scheduling considerations or current plans). There will be 6 questions, each giving two options of available activities for the coming three weekends and the order in which they can be done. From each pair of activity sequences below, you must indicate which one you would prefer (eg. Option A or Option B). Use a X (cross) in the furthest right column to indicate which sequence you prefer.

- 1) From the first two options of activities for the 3 coming weekends, which one would you prefer (A or B)?

Option	This Weekend	Next Weekend	Two Weekends from now	Your preference (Indicate with X)
A	Go to your favorite restaurant and concert	Have free time at home	Have free time at home	
B	Have free time at home	Go to your favorite restaurant and concert	Have free time at home	

- 2) Now you are faced with another pair of sequences, which one would you prefer from the two choices below?

Option	This Weekend	Next Weekend	Two Weekends from now	Your preference (Indicate with X)
A	Go to your favorite restaurant and concert	Have free time at home	Go on a two day trip to Paris	
B	Have free time at home	Go to your favorite restaurant and concert	Go on a two day trip to Paris	

3) Ignoring the above choices, which sequence do you prefer from the options below?

Option	This Weekend	Next Weekend	Two Weekends from now	Your preference (Indicate with X)
A	Go to your favorite restaurant and concert	Have free time at home	Be sick for 24 hours due to a virus	
B	Have free time at home	Go to your favorite restaurant and concert	Be sick for 24 hours due to a virus	

4) And again, please indicate if you prefer sequence A or B.

Option	This Weekend	Next Weekend	Two Weekends from now	Your preference (Indicate with X)
A	Have free time at home	Go to your favorite restaurant and concert	Have free time at home	
B	Have free time at home	Have free time at home	Go to your favorite restaurant and concert	

5) Now consider the new option A or B, and indicate your preference.

Option	This Weekend	Next Weekend	Two Weekends from now	Your preference (Indicate with X)
A	Go on a two day trip to Paris	Go to your favorite restaurant and concert	Have free time at home	
B	Go on a two day trip to Paris	Have free time at home	Go to your favorite restaurant and concert	

6) And now the last two options, please indicate the sequence of weekend activities that you prefer.

Option	This Weekend	Next Weekend	Two Weekends from now	Your preference (Indicate with X)
A	Be sick for 24 hours due to a virus	Go to your favorite restaurant and concert	Have free time at home	
B	Be sick for 24 hours due to a virus	Have free time at home	Go to your favorite restaurant and concert	

Thank you for your participation. All data is being collected anonymously and will only be used for research purposes.

Appendix 2: Screenshot Online Survey

ThesisTools
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This survey aims to reveal your preferences for certain sequences. Imagine that you have to decide how to spend your next three weekends (ignore any personal scheduling considerations or current plans). There will be 6 questions, each giving two options of available activities for the coming three weekends and the order in which they can be done. From each pair of activity sequences in this survey, you must indicate which one you would prefer.

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1.

From the first two options of activities for the 3 coming weekends, which one would you prefer? (WED: this weekend. WE1: next weekend. WE2: 2 Weekends from now.)*

WED: Go to your favorite restaurant and concert/ WE1: Have free time at home/ WE2: Have free time at home

WED: Have free time at home/ WE1: Go to your favorite restaurant and concert/ WE2: Have free time at home

[Next Question](#)

ThesisTools
Create and distribute your online survey for free at www.thesisools.com

2.

Now you are faced with another pair of sequences, which one would you prefer from the two choices below?*

- WE0: Go to your favorite restaurant and concert/ WE1: Have free time at home/ WE2: Go on a two day trip to Paris
- WE0: Have free time at home/ WE1: Go to your favorite restaurant and concert/ WE2: Go on a two day trip to Paris

Next Question

3.

Ignoring the previous choices, which sequence do you prefer from the 2 options below?*

- WE0: Go to your favorite restaurant and concert/ WE1: Have free time at home/ WE2: Be sick for 24 hours due to a virus
- WE0: Have free time at home/ WE1: Go to your favorite restaurant and concert/ WE2: Be sick for 24 hours due to a virus

Next Question

4.

And again two options, please indicate your preference for one or the other below. *

- WE0: Have free time at home/ WE1: Go to your favorite restaurant and concert/ WE2: Have free time at home
- WE0: Have free time at home/ WE1: Have free time at home/ WE2: Go to your favorite restaurant and concert

Next Question

5.

Now consider these new options, and indicate your preference.*

- WE0: Be sick for 24 hours due to a virus/ WE1: Go to your favorite restaurant and concert/ WE2: Have free time at home
- WE0: Be sick for 24 hours due to a virus/ WE1: Have free time at home/ WE2: Go to your favorite restaurant and concert

Next Question

6.

And now the last two options, please indicate the sequence of weekend activities that you prefer.*

- WE0: Go on a two day trip to Paris/ WE1: Go to your favorite restaurant and concert/ WE2: Have free time at home
- WE0: Go on a two day trip to Paris/ WE1: Have free time at home/ WE2: Go to your favorite restaurant and concert

Submit

Your participation in this study is appreciated, also on behalf of ThesisTools!

Would you like to receive the results of this study?

- Yes, and I would not mind to complete other studies in the future. Yes
- ThesisTools will ask the report from the student. However, since this is voluntarily, we cannot promise you that we will always be able to sent you the study results.
- No, but I would not mind to complete other studies in the future. No

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