



Research article

The improving sequence effect on monetary sequences

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ABSTRACT

Experimental studies reveal a preference for improving income sequences, challenging the axioms of the discounted utility model, such as the present value maximization principle. Through an experiment, we test the existence of this anomaly on short and long-term income sequences, by confirming previous experimental evidence. Although the participants are aware of the present value maximization, they select improving sequences of income mainly to cover their future spending needs, to feel motivation at work, and to receive a signal of success and status. In order to include this sequence effect in a mathematical valuation model, we propose an alternative model to value sequences which outperforms the traditional discounting model by fitting the present value with the preferences of the participants.

1. Introduction

Intertemporal choice refers to decisions that involve tradeoffs between costs and benefits over time. These decisions are mainly analyzed using the discounted utility model, which is simple and general. One of its assumptions is that individuals are impatient, preferring to get the most valuable outcomes as soon as possible, and that their preferences satisfy the independence or separability condition, which states that the value of a sequence is equal to the sum of the value of its components (Samuelson, 1937, Loewenstein and Prelec, 1993).

Nonetheless, experimental studies from economics and psychology illustrate that this process is more complex. Agents sometimes make decisions taking into account some cognitive heuristics that make them contradict principles or axioms of the traditional discounting model. Some examples of such mechanisms are self-control, personal interpretation of a set of choices, and gaining satisfaction or avoiding suffering from expected future events (Berns et al., 2007). These mechanisms lead to a series of anomalies in intertemporal choice. “An empirical result qualifies as an anomaly if it is difficult to rationalize, or if implausible assumptions are necessary to explain it within the paradigm” (Loewenstein and Thaler, 1989).

Loewenstein and Prelec (1991) studies the preferences of 95 Harvard University undergraduates about a dinner at a fancy French restaurant and a dinner at a local Greek restaurant. The results show that 86% of them prefer the French dinner, and 80% of these subjects prefer to have the dinner at the French restaurant in one month rather than in two months. However, when the dinner at a French restaurant is inserted into a sequence with the dinner at a Greek restaurant, 57% of the respondents prefer to have the Greek dinner in one month and the French dinner in two months.

Through this experimental study, they find evidence supporting that people evaluate single outcomes using assumptions of the traditional discounting model. They show positive time preference: they prefer to get the best outcomes as soon as possible. Nevertheless, when considering sequences, people display negative time preference: individuals want to get the best results at the end of the sequence, preferring improving utilities of outcomes over time. This anomaly has been labeled as “improving sequence effect”. It is supported by the experimental framing effect that establishes: “changing the way in which a prospect is represented, holding constant its objective characteristics, can have a significant impact on choice” (Prelec and Loewenstein, 1991).

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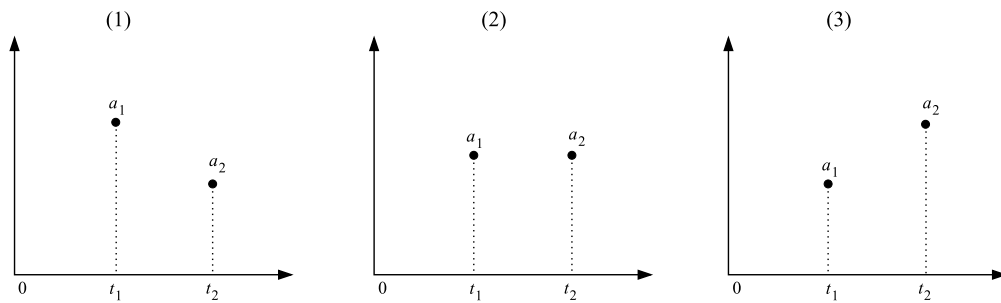


Fig. 1. Decreasing (1), constant (2) and improving (3) sequences for $n = 2$.

Additionally, some other experimental studies demonstrate that this anomaly affects not only enjoyment sequences such as dinners, but also monetary (Loewenstein and Sicherman, 1991, Matsumoto et al., 2000, Duffy and Smith, 2013), health (Chapman, 1996, 2000), and environmental sequences (Guyse et al., 2002).

In this paper, we present a theoretical description and a mathematical characterization of the improving sequence effect on monetary sequences, more specifically on income sequences. The main objective of this research is to support the evidence for this anomaly, previously found in other studies we have just mentioned, through an experiment whose design is based on Loewenstein and Sicherman (1991), Chapman (1996), and Read and Powell (2002), and to understand why most people prefer improving income sequences although they do not maximize their cash flows. We explain the method and the results of this experiment in parts 3 and 4 of this paper. Moreover, in part 2 of this paper, we propose a model to value outcome sequences, alternative to the Discounted Utility (DU) model, which systematizes individuals' preferences for improvement. This new theoretical model is able to explain the experimental evidences regarding the preferences for improving sequences and outperforms the classical DU model when evaluating monetary sequences. We demonstrate this by applying both models to value seven income sequences used in the experiment conducted by Loewenstein and Sicherman (1991).

2. Theoretical framework

2.1. Definition of the improving sequence effect

A sequence is defined as a continuous series composed of similar outcomes, which are regularly spaced over time and are not too far apart from each other (Loewenstein and Prelec, 1991). Formally speaking, a sequence S is a set of n outcomes: $S = \{(a_1, t_1), (a_2, t_2), \dots, (a_n, t_n)\}$, where $t_1 < t_2 < \dots < t_n$. Depending on the relationship among a_1, a_2, \dots, a_n , the sequence can be (see Fig. 1):

1. Decreasing: $a_1 > a_2 > \dots > a_n$.
2. Constant: $a_1 = a_2 = \dots = a_n$.
3. Improving: $a_1 < a_2 < \dots < a_n$.

The improving sequence effect is an anomaly in which individuals prefer sequences of outcomes that increase over time. In other words, people like improvement such that they would prefer to get the best outcomes at the end of the sequence (Cruz-Rambaud and Muñoz-Torrecillas, 2004). This is a violation of the discounted utility model since individuals base their decisions and preferences on cognitive heuristics rather than on the principles of the model. For instance, people prefer improving income sequences because they feel motivated at work, despite the fact they are not maximizing the present value of their cash flows.

Even though there is a general theoretical definition of this anomaly, to the best of our knowledge, a mathematical definition has not been

proposed yet. For this reason, we provide three mathematical definitions, which support the previously given qualitative definition.

Definition 1 (Cruz-Rambaud et al. (2018)). Given an amount S and a period of time n , an intertemporal choice is said to satisfy the improving sequence effect if, for every $d > 0$, the sequence

$$(a, 1), (a + d, 2), (a + 2d, 3), \dots, (a + (n - 1)d, n),$$

where $a = \frac{S}{n} - \frac{n-1}{2}d > 0$, is preferred over the rest of decreasing sequences variable in arithmetic progression whose positive terms mature at $1, 2, \dots, n$, all terms summing up S .

This definition of the improving sequence effect does not completely fit to the idea underlying to this anomaly since in our experimental study (see Section 3) and in other studies presented in Section 2.2, there are some decreasing sequences that are preferred over other improving sequences, whose terms sum up the same amount. Therefore, we provide the following definitions, called semi-strong definitions of the improving sequence effect.

Definition 2 (Cruz-Rambaud et al. (2018)). Given an amount S and a period of time n , an intertemporal choice is said to satisfy the improving sequence effect if, for every $d > 0$, the sequence

$$(a, 1), (a + d, 2), (a + 2d, 3), \dots, (a + (n - 1)d, n),$$

where $a = \frac{S}{n} - \frac{n-1}{2}d > 0$, is preferred over the following decreasing sequence

$$(a + (n - 1)d, 1), (a + (n - 2)d, 2), \dots, (a + d, n - 1), (a, n),$$

all terms summing up S .

Definition 3. Given an amount S and a period of time n , the intertemporal choice is said to satisfy the improving sequence effect if there is a $d > 0$ such that the sequence

$$(a, 1), (a + d, 2), (a + 2d, 3), \dots, (a + (n - 1)d, n),$$

where $a = \frac{S}{n} - \frac{n-1}{2}d > 0$, is preferred over the rest of sequences whose positive terms mature at $1, 2, \dots, n$, and are constant or variable (increasing or decreasing) in arithmetic progression, all terms summing up S .

Observe that these three definitions fit the idea behind the improving sequence effect and that Definition 1 implies both Definitions 2 and 3. Nevertheless, taking into account the results of the experimental analysis on this effect, Definition 3 fits better than the other ones and it also allows a computational treatment when solving analytically the equation leading to the best sequence.

2.2. Previous experimental studies on monetary sequences

Numerous researchers have conducted experimental studies in order to test the existence of the improving sequence effect. Table 1 summarizes most of the previous experimental studies on preferences over monetary sequences. This table presents the main characteristics of these experiments such as the time horizon of the study, material, procedure, characteristics of participants, given incentives, results of preferences for decreasing, constant or improving sequences, and arguments whereby subjects select such sequences.

The study by Loewenstein and Sicherman (1991) first demonstrates that individuals prefer increasing monetary sequences. More specifically, they study preferences for income streams and show that preference for improvement is stronger for wage income than for rent income. This finding challenges the present value maximization principle involved in the traditional discounting model. Even when this argument is presented to subjects, they do not change their choices. The participants state that they select improving sequences mainly because of their pleasure from increase, the inflation over time and their aversion to a decrease in income. Likewise, Gigliotti and Sopher (1997) suggest that the violations of this principle in income choice can be explained by the ignorance about basic financial notions, the lack of self-control to avoid overspending, and the psychological boost that individuals get from the pattern of the outcome and not just from the outcome itself.

Chapman (1996) gets the same results from her experiments. She studies sequences of wage income for different time horizons: short time (1 year) and lifetime (60 years). For both time horizons, the preference for improvement prevails. In this case, preferences are affected by the expectations that subjects have about receiving their wage income. The hypothesis that individuals prefer the sequences they expect is confirmed by Read and Powell (2002). They conclude that participants select improving sequences for wage and lottery income because they find it appropriate (i.e. the sequence corresponds to their consumption pattern) and that appropriateness is highly related to expectations since people usually think that what they expect is appropriate.

Similarly, Duffy and Smith (2013) obtain preferences for increases in wage and lottery income. They conclude that such preferences are moderated by the size of the rewards: the larger the size of the payment, the stronger the preference for improvement.

Matsumoto et al. (2000), however, find out that having present value knowledge seems to be central but not always determinant when individuals value sequences of outcomes. Present value knowledgeable subjects can assign value in conformity with the present value maximization condition, but unknowledgeable individuals are not able to do so. The findings of their study indicate that, in most cases, subjects with present value knowledge prefer being impatient to get the majority of the outcomes as soon as possible rather than seeking improvement when they evaluate several sequences of income. Nonetheless, in few instances, people do not favor impatience and show preference for improving sequences. This suggests that impatience does not always coincide with the desire for maximizing present value and sometimes knowledgeable individuals forgo at least some present rewards to obtain an improvement in the future.

Guysé et al. (2002) also demonstrate that subjects favor decreasing income sequences due to their awareness of present value knowledge maximization. This preference is exhibited for both short (5 years) and long-term (50 years) sequences.

Most authors that study monetary sequences agree that the majority of individuals prefer improving sequences because they do not consider present value maximization when evaluating sequences of outcomes, instead they use alternative arguments (see Table 2). However, a few individuals take this principle into account and select decreasing sequences.

2.3. Understanding preferences over monetary sequences

Preference for improvement is exhibited by most individuals in the experimental studies by Loewenstein and Sicherman (1991), Chapman (1996), Schmitt and Kemper (1996), Gigliotti and Sopher (1997), Matsumoto et al. (2000), Guysé et al. (2002), Read and Powell (2002), and Duffy and Smith (2013). However, some of them also show that this pattern does not always hold and that a few individuals choose constant sequences (Gigliotti and Sopher, 1997) and decreasing sequences (Schmitt and Kemper, 1996, Matsumoto et al., 2000, Guysé et al., 2002).

In order to understand the decisions people make, the reasons for preferences over decreasing, constant and improving sequences are analyzed. They are summarized in Table 2, which indicates the type of sequence that each argument influences.

Below, we give a detailed description of the arguments, as well as an explanation about how each argument affects preferences for certain sequences.

Temporal preference. If it is given more importance to the utility gained during the first periods than to the utility gained during the last periods, a decreasing sequence is selected (Frederick and Loewenstein, 2008).

Saving. People prefer decreasing income sequences so they can separate an amount of money in order to save it for future periods, without considering investment (Read and Powell, 2002).

Preference for getting the best at the beginning. A decreasing sequence allows subjects to avoid the negative feeling from the uncertainty of receiving the outcomes in the distant future. Accelerating the receipt of the majority of the outcomes in the first periods reduces the feeling of risk (Loewenstein and Prelec, 1991).

Age of individuals. The age of individuals may affect their preference over improving or decreasing sequences. Drolet et al. (2011) studied the preferences among sequences of mixed affective events (non-monetary outcomes) and their result was that young adults were influenced by the temporal proximity of positive and negative effects. On the contrary, old adults moderated their preferences by their ability to forestall unwanted emotional experiences. As a result, most of times, young adults preferred to have the best outcomes at the beginning of the sequence, whilst old adults waited until the end of the sequence to get them.

On the other hand, Strough et al. (2019) found that older adults preferred taking the biggest event sooner instead of later, in both monetary and hedonic contexts. Löckenhoff and Samanez-Larkin (2020) also found greater preference for decreasing sequences (of monetary outcomes) among older age subjects.

Certainty/Uncertainty. Preference for improvement implies the risk of losing the best outcomes of the sequences. For instance, a social guaranty, such as a work contract, is a solution to cover this risk. In this case, if a contract exists between an employee and an employer, the employee would be confident about receiving the salary during a committed period (Brunner, 1999). Under this circumstance of certainty, the employee prefers an increasing income sequence (Loewenstein and Sicherman, 1991). On the contrary, if there is no contract, the employee prefers to get most of the money as fast as possible (Brunner, 1999). This means that, under uncertainty that future events will actually occur, the preference for decreasing sequences prevails (Loewenstein and Sicherman, 1991, Frederick and Loewenstein, 2008).

Appropriate sequence. The most appropriate sequence is the one that corresponds to the consumption pattern (Read and Powell, 2002). Individuals prefer decreasing income sequences to cover immediate needs of spending. In contrast, they select improving sequences of income to face the needs of spending in the future periods (Loewenstein and Sicherman, 1991).

Expectations. Preferences are moderated by expectations about how sequences are usually experienced. Supported by the results of three experiments, Chapman (1996) introduced the following relationships between expectations and preferences:

Table 1. Experimental studies on outcome sequences. Source: Modified from Guyse et al. (2002).

Study	Outcomes description	Time horizon	Material	Method to evaluate sequences	Participants	Incentives	Preferred sequences	Reasons for sequence preferences
Loewenstein and Sicherman (1991)	Wage income	6 years	Questionnaire with 7 bar charts	Rank the sequences from 1 (the best) to 7 (the worst)	41 visitors to Museum of Science and Industry in Chicago	\$3.75 per participant	Improving	Pleasure for increase in income, aversion to decrease in income, future needs, insurance against uncertain future, self-control, motivation
Loewenstein and Sicherman (1991)	Rent income	6 years	Questionnaire with 7 bar charts	Rank the sequences from 1 (the best) to 7 (the worst)	39 visitors to Museum of Science and Industry in Chicago	\$3.75 per participant	Improving	Pleasure for increase in income, aversion to decrease in income, future needs, insurance against uncertain future, self-control, motivation
Loewenstein and Sicherman (1991)	Income	6 years	Questionnaire with 2 bar charts and arguments for each one	Select the improving sequence or the decreasing sequence	80 visitors to Museum of Science and Industry in Chicago	\$3.75 per participant	Improving	Pleasure for increase in income, aversion to decrease in income, future needs, insurance against uncertain future, self-control, motivation
Chapman (1996)	Wage income	Lifetime: 60 years, from 20 to 80 years old	Questionnaire with 16 bar charts	Rank the sequences from 10 (perfect) to 1 (very bad)	40 undergraduate students at the University of Illinois	Class credit	Improving	Expectations
Chapman (1996)	Wage income	Lifetime: 60 years, from 20 to 80 years old	Questionnaire with 10 bar charts	Rank the sequences from 10 (perfect) to 1 (very bad)	50 undergraduate students at the University of Illinois	Class credit	Indifferent, improving and decreasing	Expectations
Chapman (1996)	Wage income	1 year	Questionnaire with 10 bar charts	Rank the sequences from 10 (perfect) to 1 (very bad)	50 undergraduate students at the University of Illinois	Class credit	Improving	Expectations
Chapman (1996)	Wage income	Lifetime: 60 years, from 20 to 80 years old	Questionnaire with 10 bar charts	Rank the sequences from 10 (perfect) to 1 (very bad)	79 undergraduate students at the University of Illinois	Class credit	Improving	Expectations
Chapman (1996)	Wage income	12 days	Questionnaire with 10 bar charts	Rank the sequences from 10 (perfect) to 1 (very bad)	79 undergraduate students at the University of Illinois	Class credit	Improving	Expectations
Schmitt and Kemper (1996)	Rewards	Unspecified	Table with 4 improving sequences and 1 constant sequence, with 24 rewards each one	Select the constant sequence or one of the improving sequences	10 college students	\$6 per hour	Exponential improving	Magnitude and change rate of the improve
Schmitt and Kemper (1996)	Rewards	Unspecified	Table with 4 decreasing sequences and 1 constant sequence, with 24 rewards each one	Select the constant sequence or one of the decreasing sequences	10 college students	\$6 per hour	Linear decreasing	Magnitude and change rate of the decrease
Schmitt and Kemper (1996)	Rewards	Unspecified	Table with 4 improving sequences and 1 constant sequence, with 24 rewards each one	Evaluate the improving sequences with respect to the constant one, from 1 (the best) to 9 (the worst)	42 college students	\$6 per hour	Step improving	Magnitude and change rate of the improve

Table 1 (continued)

Study	Outcomes description	Time horizon	Material	Method to evaluate sequences	Participants	Incentives	Preferred sequences	Reasons for sequence preferences
Schmitt and Kemper (1996)	Rewards	Unspecified	Table with 4 decreasing sequences and 1 constant sequence, with 24 rewards each one	Evaluate the improving sequences with respect to the constant one, from 1 (the best) to 9 (the worst)	45 college students	\$6 per hour	Logarithmic decreasing	Magnitude and change rate of the decrease
Gigliotti and Sopher (1997)	Payment stream	6 weeks	Questionnaire with 3 groups of 3 payment streams each	Select between a pair of payment streams within each group	Students of introductory economic classes at the Rutgers University	Unspecified	Constant	Self-control, ignorance about PV maximization and psychological boost from the pattern of the outcome and not just the outcome itself
Gigliotti and Sopher (1997)	Payment stream	5 years	Questionnaire with 3 groups of 3 payment streams each	Select between a pair of payment streams within each group	Students of introductory and intermediate economic classes at the Rutgers University	Unspecified	Improving	Self-control, ignorance about PV maximization and psychological boost from the pattern of the outcome and not just the outcome itself
Matsumoto et al. (2000)	Cash dividends on common stocks and wage income	6 years	Questionnaire with 6 bar charts	Rank the sequences from 1 (the best) to 6 (the worst)	54 undergraduate seniors majoring in accounting at the University of Washington (PV-knowledgeable individuals)	Free cafe latte	Decreasing	PV maximization knowledge
Matsumoto et al. (2000)	Wage income until retirement	Lifetime	Questionnaire with 2 bar charts	Select the improving sequence or the decreasing sequence	54 undergraduate seniors majoring in accounting at the University of Washington (PV-knowledgeable individuals)	Free cafe latte	Decreasing	PV maximization knowledge
Matsumoto et al. (2000)	Wage income and rent income	6 years	Questionnaire with 6 constant cash flow bar charts and 6 constant PV bar charts	Rank the sequences from 1 (the best) to 6 (the worst)	376 undergraduate students from accounting courses at the University of Illinois. Group A: 85 high present value-knowledge participants. Group B: 291 low PV-knowledge participants	Class credit	Group A: decreasing. Group B: improving	PV maximization knowledge
Matsumoto et al. (2000)	Wage income	6 years	Three questionnaire (improving PV, constant PV and decreasing PV) with 6 sequences for each one	Rank the sequences from 1 (the best) to 6 (the worst)	50 undergraduate accounting majors at the University of Connecticut (PV-knowledgeable individuals)	Class credit	Improving	PV maximization knowledge: PV-knowledgeable individuals forgo at least some PV to obtain improvement
Guyse et al. (2002)	Income	5 years	Questionnaire with 7 bar charts	Evaluate the sequences based on the preferences from 0 (unfavorable) to 100 (perfect)	48 graduate business students at the University of California, Irvine	\$5 per participant	Decreasing	PV maximization knowledge

Table 1 (continued)

Study	Outcomes description	Time horizon	Material	Method to evaluate sequences	Participants	Incentives	Preferred sequences	Reasons for sequence preferences
Guyse et al. (2002)	Income	50 years	Questionnaire with 7 bar charts	Evaluate the sequences based on the preferences from 0 (unfavorable) to 100 (perfect)	48 graduate business students at the University of California, Irvine	\$5 per participant	Decreasing	PV maximization knowledge
Read and Powell (2002)	Wage income	1 year	Think-aloud group: 5 bar charts combined into 5 choice pairs. Choice-only group: 5 bar charts combined into 10 choice pairs	Think-aloud group: choose between pairs of sequences and argue the choice. Choice-only group: choose between pair of sequences	Think-aloud group: 40 members of the University of Leeds community . Choice-only group: 25 people from a local amateur orchestra in Leeds	Think-aloud group: £5 per participant. Choice-only group: £4 per participant	Improving	Appropriate sequence. This sequence is the most appropriate, because it corresponds to the consumption pattern
Read and Powell (2002)	Lottery income	1 year	Think-aloud group: 5 bar charts combined into 5 choice pairs. Choice-only group: 5 bar charts combined into 10 choice pairs	Think-aloud group: choose between pairs of sequences and argue the choice. Choice-only group: choose between pair of sequences	Think-aloud group: 40 members of the University of Leeds community . Choice-only group: 25 people from a local amateur orchestra in Leeds	Think-aloud group: £5 per participant. Choice-only group: £4 per participant	Improving	Appropriate sequence. This sequence is the most appropriate, because it corresponds to the consumption pattern
Read and Powell (2002)	Wage income	Lifetime: 60 years, from 20 to 80 years old	Think-aloud group: 5 bar charts combined into 5 choice pairs. Choice-only group: 5 bar charts combined into 10 choice pairs	Think-aloud group: choose between pairs of sequences and argue the choice. Choice-only group: choose between pair of sequences	Think-aloud group: 40 members of the University of Leeds community. Choice-only group: 25 people from a local amateur orchestra in Leeds	Think-aloud group: £5 per participant. Choice-only group: £4 per participant	Improving	Appropriate sequence.: this sequence is the most appropriate, because it corresponds to the consumption pattern
Duffy and Smith (2013)	Wage income	6 years	Questionnaire with 6 bar charts	Select the preferred sequence	105 participants from economics classes at the Rutgers University-Camden	Class credit and \$20 per 25 participants	Improving	The size of the payment: the preference for improving sequences of income is stronger when the payments are larger
Duffy and Smith (2013)	Wage income	6 years	Questionnaire with 6 bar charts	Select the preferred sequence	104 undergraduate and graduate students of psychology at the Rutgers University-Camden	Class credit	Improving	The size of the payment: the preference for improving sequences of income is stronger when the payments are larger
Duffy and Smith (2013)	Lottery income	6 years	Questionnaire with 6 bar charts	Select the preferred sequence	108 undergraduate and graduate students of psychology at the Rutgers University-Camden	Class credit	Improving	The size of the payment: the preference for improving sequences of income is stronger when the payments are larger
Duffy and Smith (2013)	Wage income	7 years	Questionnaire with 6 bar charts	Select the preferred sequence	230 law students at the Rutgers University-Camden	\$50 per 50 participants	Improving	The size of the payment: the preference for improving sequences of income is stronger when the payments are larger
Duffy and Smith (2013)	Wage income	6 years	Questionnaire with 6 bar charts	Select the preferred sequence	166 undergraduate and graduate students of psychology at the Rutgers University-Camden	Class credit	Improving	The size of the payment: the preference for improving sequences of income is stronger when the payments are larger

Table 2. Reasons for preferences over monetary sequences. Source: Modified from Read and Powell (2002).

Arguments	Decreasing sequence	Constant sequence	Improving sequence
Temporal preference	✓		
Saving	✓		
Preference for getting the best at the beginning	✓		
Age of individuals	✓		✓
Certainty/Uncertainty	✓		✓
Appropriate sequence	✓		✓
Expectations	✓	✓	✓
Awareness or ignorance about present value maximization principle	✓	✓	✓
Convenience		✓	
Equitable distribution		✓	
Desire for receiving the same salary over time		✓	
Loss aversion		✓	✓
Self-control		✓	✓
Debt aversion		✓	✓
Motivation and good signal			✓
Preference for leaving the best to the end			✓
Inflation			✓
Reference point and positive utility			✓
Size of outcome			✓
Extrapolation			✓

1. Subjects prefer expected sequences because unusual sequences are so unfamiliar that it is difficult to evaluate their utility.
2. Expectations are influenced by preferences through wishful thinking. A strong preference for improvement induces an expectation of improvement.
3. Expectations are used as reference points. Individuals adapt to their current condition, which becomes a reference point, and prefer improvement relative to it.

Expectations and preferences may vary from the sequence length. On the one hand, people prefer short-term sequences of money with an improving trend; but on the other hand, they prefer lifetime sequences of money with either an improving or a decreasing trend (Chapman, 1996, 2000).

Therefore, based on their own expectations, individuals prefer decreasing, constant or improving sequences. In other words, they choose the sequence they consider as the most realistic one (Read and Powell, 2002).

Awareness or ignorance about present value maximization principle. Subjects with knowledge about present value maximization principle prefer decreasing sequences, since these sequences let them increase their income through investment and interest income (Loewenstein and Sicherman, 1991, Matsumoto et al., 2000, Read and Powell, 2002, Frederick and Loewenstein, 2008).

Nonetheless, based on the conclusions from Gigliotti and Sopher (1997), it is possible that even when people are aware of the present value maximization principle, they select constant or improving sequences. This is because they do not view income as simply a means to an end but instead they give more importance to the pattern of the sequence. Moreover, individuals opt for constant or improving sequences of income to cover their needs if their financial knowledge is bounded. They do not consider present value maximization principle while making decisions for the reason that they are not able to calculate it; the time and effort to even try it are not worthwhile. Also, due to this limitation of knowledge, they do not understand the relationship between income and expenditure: the lower the present value of the income sequence, the lower the resources available for spending.

Convenience. Constant sequences of income are easier to manage. For some people, it is simpler to deal with financial payments and plan their expenditures if the amount of income received every month does not vary (Read and Powell, 2002).

Equitable distribution. The constant sequence allows subjects to select a distribution of income without deliberating deeply about which is the optimal (Frederick and Loewenstein, 2008).

Desire for receiving the same salary over time. Individuals get a psychological boost from the pattern of the outcome and not just from the outcome itself (Gigliotti and Sopher, 1997). Thus, in order to receive outcomes uniformly over time, they would prefer a constant sequence (Frederick and Loewenstein, 2008). This preference for uniform sequences has also been found, in a different domain, in the experimental study by Guyse et al. (2020), where preferences over sequences of lives saved were analyzed.

Loss aversion. Individuals are averse to decrease (Loewenstein and Prelec, 1991, Loewenstein and Sicherman, 1991). Constant and/or improving sequences work as a hedge against the unpleasantness of declining income sequences (Gigliotti and Sopher, 1997).

Self-control. The preference for constant and/or improving sequences, mainly the constant one, is based on the concern of individuals to manage their expenses correctly. Some people choose constant or improving sequences due to the fact that they do not trust themselves to make correct decisions for their own benefit during a specific period of time. This way, they limit their behavior and choices to avoid affecting their *status quo* (Gigliotti and Sopher, 1997). In other words, subjects avoid decreasing sequences because they consider themselves “vulnerable to a tendency to overspend” (Read and Powell, 2002). It is easier for them to restrict themselves from unnecessary expenses if the distribution of the sequence is constant or increasing over time (Loewenstein and Sicherman, 1991).

Debt aversion. It is preferred to receive the salary payment constantly or incrementally to avoid the feeling of “being in debt” when receiving most of the amount at the beginning of the sequence (Read and Powell, 2002).

Motivation and good signal. Even though motivation is different for each person, generally, individuals feel motivation and esteem at their job when their income sequence increases. “They may associate wages with productivity and derive utility from a feeling of mastery when wages increase” (Loewenstein and Sicherman, 1991). The increase in income is a positive signal of success and status (Read and Powell, 2002).

Preference for leaving the best to the end. The improving sequence generates a positive feeling derived from the receipt of most of the biggest outcomes in the future and the increase in utility each period (Loewenstein and Sicherman, 1991). Delaying the outcomes or receiving most of them during the last periods, increases the satisfaction (Loewenstein and Prelec, 1991, Frederick and Loewenstein, 2008).

Inflation. Improving sequence of income is a hedge against inflation. It allows people to protect their standard of living and their consumption through the offset of the increase in price with the increase in income (Loewenstein and Sicherman, 1991).

Reference point and positive utility. People generally adapt to their current situation that becomes a reference point. The gains or losses are relatively evaluated with respect to this reference point (Loewenstein and Prelec, 1991, Chapman, 1996). By selecting improving sequences, the utility of outcomes at an instant of time (reference point) can be compared positively with the utility of other outcomes or events at previous or later times (Frederick and Loewenstein, 2008).

Size of outcome. There is a direct relationship between the preference for improving payments and the size of payments: the preference for improvement is increasing with the size of payments (Duffy and Smith, 2013).

Extrapolation. The increasing distribution is preferred because it is considered that future sequences will follow the same increasing trend (Frederick and Loewenstein, 2008). For instance, individuals think the income they will receive in their next job will be affected by the income they currently receive (Gigliotti and Sopher, 1997).

2.4. Valuation models for monetary sequences

In addition to the discounted utility model by Samuelson (1937), there are some other models, methods and techniques that have been developed to value sequences more appropriately. For example, the one-parameter model by Mazur (1984), the general model for preferences over outcome sequences by Loewenstein and Prelec (1993), the techniques to compute the total utility of sequences of income by Bauccells and Sarin (2007), the model of how individuals choose between time sequences of monetary sequences by Manzini et al. (2010), and the time-tradeoff sequence tool to analyze intertemporal choice by Attema et al. (2010).

In the following sections, we present the most common models to value monetary sequences, the discounted utility model and the one-parameter model, as well as an alternative model to value sequences that is proposed in this paper. These models use ordinary annuities because the salaries in this country are most commonly paid at the end of each month.

2.4.1. Discounted utility model

The discounted utility model developed by Samuelson (1937) is used to evaluate individuals' decisions, assuming these are rational and consistent, and based on stable and well-defined preferences (Loewenstein and Thaler, 1989). This model, based on exponential discounting, assumes that the present value of an amount x , available at a specific moment of time t in the future and at a constant discount rate r , denoted by $PV(x, t)$, can be calculated as:

$$PV(x, t) = \left(\frac{1}{1+r}\right)^t x. \tag{1}$$

This traditional discounting model is used to value not only single outcomes, but also sequences of outcomes, such as $X = (x_1, x_2, \dots, x_n)$, with the following equation:

$$PV(X) = \sum_{t=1}^n \left(\frac{1}{1+r}\right)^t x_t. \tag{2}$$

Using this model, a decreasing sequence has the highest present value if $r > 0$, while an improving sequence gets the highest present value if $r < 0$. Given the condition of the discounted utility model that the discount rate must be positive, it is concluded that this model can not predict preferences for improving sequence (Guyse et al., 2002). Also, this is mathematically proved with Theorem 1.

Theorem 1. *The present value of the annuity $a, a+d, a+2d, \dots, a+(n-1)d$ such that $a+(a+d)+(a+2d)+\dots+(a+(n-1)d) = S$, using the exponential discounting, is decreasing with respect to d .*

2.4.2. One-parameter model

The one-parameter model by Mazur (1984) is the simplest and the most common representation of hyperbolic discounting. This model is used to explain inconsistent behavior of individuals, since it is experimentally observed that the discount rate is not constant over time, as the discounted utility model requires (Frederick et al., 2002, Musau, 2014).

The hyperbolic discount function of this model includes two behavioral features: extreme impatience for rewards takes place in the short term and the discount rate declines over time. Its functional form is represented in Eq (3):

$$F(t) = \frac{1}{1+kt}, \tag{3}$$

where $F(t)$ is the discount function, k is the discount rate, and t is the time of delay.

As stated by Musau (2014), $F'(t) < 0$, that is, $F(t)$ is strictly monotone decreasing. Moreover, Equation (4) shows that the first derivative of the function with respect to k is negative:

$$\frac{d}{dk} \left(\frac{1}{1+kt}\right) = -\frac{t}{(1+kt)^2} < 0, t > 0, k > 0. \tag{4}$$

Thus, to calculate the present value of a sequence using this model, the following equation must be used:

$$PV(X) = \sum_{t=1}^n \frac{1}{1+kt} x_t. \tag{5}$$

Like the discounted utility model, the one-parameter model cannot predict preferences for improving sequences. Theorem 2 proves and generalizes this statement mathematically.

Theorem 2. *The present value of the ordinary annuity $a, a+d, a+2d, \dots, a+(n-1)d$ such that $a+(a+d)+(a+2d)+\dots+(a+(n-1)d) = S$, using any discount function including the hyperbolic one, is decreasing with respect to d .*

2.4.3. An alternative model

In an intertemporal consumption maximization problem, with separable time preferences, concave utility function and a risk-free asset in the economy, it is possible to have an increasing sequence of intertemporal consumptions if the decision maker is patient enough. However, we will first generalize this statement to a concave utility function and arbitrary discount function.

In effect, let u be a concave utility function ($u'' > 0$) and F an arbitrary discount function. In this case, the Net Present Value (NPV) is given by:

$$NPV = \sum_{k=0}^{n-1} u(a+kd)F(k+1).$$

If u is differentiable, one has:

$$\frac{dNPV}{dd} = \sum_{k=0}^{n-1} \left(k - \frac{n}{2}\right) u'(a+kd)F(k+1).$$

Assume that, moreover, u' is continuous. For $d = 0$, one has:

$$\left. \frac{dNPV}{dd} \right|_{d=0} = \sum_{k=0}^{n-1} \left(k - \frac{n}{2}\right) u'(a)F(k+1).$$

Observe that, in the former expression, as $u'(a)$ is constant and F is decreasing, the negative summands are greater, in absolute value, than the positive ones, that is to say:

$$\left| \sum_{k < \frac{n}{2}} \left(k - \frac{n}{2}\right) u'(a)F(k+1) \right| > \sum_{k > \frac{n}{2}} \left(k - \frac{n}{2}\right) u'(a)F(k+1).$$

Therefore,

$$\left. \frac{dNPV}{dd} \right|_{d=0} < 0.$$

For values of d large enough, as $u'(a + kd)$ can increase very rapidly, one has:

$$\left| \sum_{k < \frac{n}{2}} \left(k - \frac{n}{2} \right) u'(a) F(k + 1) \right| < \sum_{k < \frac{n}{2}} \left(k - \frac{n}{2} \right) u'(a) F(k + 1)$$

and, therefore,

$$\frac{dNPV}{dd} > 0.$$

Consequently, by the Theorem of the Intermediate Value, there exists $d_0 > 0$ such that

$$\left. \frac{dNPV}{dd} \right|_{d=d_0} = 0.$$

Observe that this reasoning holds if, in particular, F is exponential discounting.

2.4.4. Another alternative model

Loewenstein and Sicherman (1991) observe that a great number of individuals prefer improving sequences to protect their standard of living and their consumption, and to cover future spending needs. These arguments can be interpreted as: subjects select improving sequences for the reason that they relate the sequence growth rate to a reference growth rate, such as the inflation rate that indicates the expected increase rate of their consumption or the expected increase rate of their salary.

In order to systematize this behavior and include it in sequence evaluations, we develop a new valuation method based on the discounted utility model Samuelson (1937). As shown by Theorem 1 and confirmed by Theorem 2, the present value of an annuity variable in arithmetic progression with common difference d_1 is greater than the present value of the annuity with common difference d_2 if, and only if, $d_1 < d_2$, provided that the terms of both annuities sum up the same amount. Moreover, this statement is valid not only when valuing with the exponential discounting but also with any separable discount function. This makes that the discount function used to assess such sequences has to be non-separable, i.e., of the form $F(x, t)$. Specifically, we propose the following methodology to be applied to this situation.

The first step to value a sequence of outcomes, denoted as $X = (x_1, x_2, \dots, x_n)$, is to calculate the geometric mean (g) of the growth rates between two consecutive outcomes (x_t):

$$g = \prod_{t=2}^n \left(\frac{x_t}{x_{t-1}} \right)^{\frac{1}{n-1}} - 1. \tag{6}$$

This rate is compared to a reference rate in order to find the sequence with a growth rate more similar to the reference rate. Hence, the model computes the relative difference (c) between the so-calculated geometric mean (g) of the sequence and the reference rate (r):

$$c = \left| \frac{1+g}{1+r} - 1 \right| = \left| \frac{g-r}{1+r} \right|. \tag{7}$$

Afterwards, the present value of the sequence is calculated using the difference (c) as the new discount rate:

$$PV(X) = \sum_{t=1}^n \left(\frac{1}{1+c} \right)^t x_t. \tag{8}$$

Once the present values of all sequences are calculated, we observe that the greatest present value would correspond to the sequence with the lowest difference in absolute value (c), which should coincide with the most preferred sequence by subjects. Based on the results of the

mentioned experimental studies, this sequence has an increasing trend.

In order to illustrate the application and the usefulness of this method, we value seven income sequences (Table 3) used in the experiment conducted by Loewenstein and Sicherman (1991), with our alternative model and the discounted utility model. Each of the seven sequences sums up \$150,000, but this amount is distributed differently. Job 1 is decreasing, Job 2 is constant and Job 3 to Job 7 are increasing with different slopes, having the third sequence the slightest slope and the seventh sequence the steepest slope.

On the one hand, Table 3 displays the present value of each sequence using our alternative model. We follow the aforementioned methodology to calculate it. First, g is calculated for each sequence with Eq (6). Subsequently, as shown in Eq (7), c is computed using g and r . The reference rate (r) is equal to 1.10% and calculated as a weighted geometric mean of the Spain's Consumer Price Index (International Monetary Fund, 2015) for 5 years ($t - 1$ periods). Then, PV is computed with Eq (8) using c as the discount rate. On the other hand, Table 3 also exhibits the present value of the sequences using the discounted utility model, defined by Eq (2). The discount rate (k) for this model is 10%, the one used by Loewenstein and Sicherman (1991).

According to the results of our alternative model, the most preferred sequence is Job 3. This result coincides with the experimental findings by Loewenstein and Sicherman (1991) after they showed the arguments to their participants. This implies that subjects mostly prefer the sequences with positive slopes and smaller differences between the growth rate (g) and the reference rate (r). As shown in this example, sometimes individuals prefer a decreasing sequence rather than an increasing sequence if its slope, in absolute value, is slighter than the slope of the increasing sequence. Contrariwise, the discounted utility model does not predict subjects' preferences. In this case, the highest present value corresponds to Job 1 (decreasing sequence), whilst Job 7 (increasing sequence with the sharpest slope) has the lowest present value, as expected.

In summary, our proposed alternative model outperforms the discounted utility model since it better reflects individuals' preferences for improving sequences.

Observe that each sequence has been assessed with a different discount rate. In effect, the discount rate to value the sequence X is $\frac{1}{1+c}$, where c has been built starting from the values of the income included in X . Finally, we have to highlight the following remarks:

1. This valuation model is not puzzling as it uses the Net Present Value (NPV).
2. This is not the only way to classify sequences of outcomes, but, in our opinion, this assessment model presents a strength as it is based on the comparison of growth terms with a benchmark g (e.g., the Consumer price Index: CPI) which is a way of referential decision very usual among people.
3. If the reference rate changes, the preferences derived from the application of the model may also change.
4. Obviously, the reference rate could be the combination of other indexes. For example, we can use Laspeyres' or Paasche's index as the weighted average of several simple price indexes.
5. This model is applicable for both increasing and decreasing sequences. In effect, observe that in Table 4 the utilities of Job 1 (decreasing) and Job 5 (increasing) have been determined and are fairly the same. This is not a contradiction because, given a value g of the reference rate (for example, a CPI equal to 2%), the decision maker could be indifferent between the receipt of a decreasing sequence, which allows him/her little savings now (recall that inflation evolves with interest rates), and the receipt of more wage at the end of the period, which allows him/her further savings for retirement.

Table 3. Present value (in thousands dollar) of income sequences using our alternative model (*) and the discounted utility model (**). Source: Modified from Loewenstein and Sicherman (1991).

Sequence	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	PV*	PV**
Job 1	27.00	26.20	25.40	24.60	23.80	23.00	130.67	109.84
Job 2	25.00	25.00	25.00	25.00	25.00	25.00	144.45	108.88
Job 3	24.00	24.40	24.80	25.20	25.60	26.00	147.33	108.40
Job 4	23.00	23.80	24.60	25.40	26.20	27.00	139.12	107.92
Job 5	22.00	23.20	24.40	25.60	26.80	28.00	131.22	107.44
Job 6	21.00	22.60	24.20	25.80	27.40	29.00	123.61	106.96
Job 7	20.00	22.00	24.00	26.00	28.00	30.00	116.25	106.47

3. Method

The purpose of this experiment is to analyze the preferences for monetary sequences, specifically income sequences, in short and long-term. We aim to test and understand the existence of the improving sequence effect on these sequences. The experimental design of this study is adopted from Loewenstein and Sicherman (1991). Some features of their experiment are modified based on other studies: the method to analyze the reasons for sequence preferences (Read and Powell, 2002), the time horizons and the sequence distributions (Chapman, 1996).

3.1. Participants

The participants are 58 graduate students of three different graduate programs. There are 36 female and 22 male. The age range is from 22 to 54 (mean age: 28). The Faculty of Economics and Business of Almería University approved this study and the participation of their students who volunteered to be surveyed. Students were informed, prior to the survey, that the questionnaires were anonymous and the data would be used for research purposes only. The students did not receive any incentive to participate.

The selection of this sample is in line with the samples used in the experimental studies on outcome sequences reviewed in Table 3, where 22 out of 28 experiments used student samples. In addition, these subjects had some knowledge about present value maximization due to the fact that they were enrolled in master courses in Accounting and Corporate Finance and in Business Administration and they were required to have passed some compulsory courses in Economics. Thus, the experiment is based on the assumption that all participants are aware of the present value maximization principle and that their preference for improving sequences, if any, is based on some other arguments rather than on the lack of this knowledge. This makes the obtained results more robust.

3.2. Material and procedure

The material to perform the study is a pen-and-paper questionnaire composed of three parts and a section to collect socio-demographic information such as age, gender, occupation, marital status and educational attainment (See Questionnaire in Appendix). The experiment was done in three sessions, one for each graduate program. During the sessions, directions and statements of the questionnaire were read aloud. The subjects were asked to answer individually one part at a time and not to read the next part by themselves.

The first two parts were aimed to gather some information related to participants' preferences about income sequences for different time horizons: 6 years (short-term) and 60 years (long-term). The objective of the third part was to show subjects the arguments whereby they select decreasing, constant, and improving sequences of salary payments, and to observe whether their preferences change from the first part.

Part 1 was based on questionnaires from Chapman (1996) and Loewenstein and Sicherman (1991). Participants were asked to imagine they were unemployed and received a job offer for the next 6 years (total salary of €150,000). Later, they were asked to rank eight

salary-payment options shown in decreasing, constant and improving distributions, from 1 (the best) to 8 (the worst).

Part 2 was similar to Part 1, but it was related to lifetime income. It presented nine salary-payment options (total salary of €1,500,000) that individuals had to rank from 1 (the best) to 9 (the worst). Options 1, 2, 3, 4, 5, 6, 7 and 9 had the same distribution than the ones from Part 1. Option 8 was added since it represents the most realistic lifetime distribution that described how income is generally experienced: income increases until retirement (65 years old) and then drops to a constant and lower level (Chapman, 1996).

Part 3 considered the same situation as Part 1, but only three sequences were exhibited: a decreasing, a constant, and an improving sequence. Additionally, some arguments to each sequence were included in order to know the arguments on which they base their decisions. Participants were asked to read these arguments and, based on them, choose the option they prefer and rank the three most persuasive arguments for that alternative, from 1 (the most convincing) to 3. Unlike the experiment by Loewenstein and Sicherman (1991) that only showed arguments for increasing and decreasing sequences related to the present value maximization, this study also included arguments for constant sequences as well as a extended list of arguments for the other sequences (see in Table 2).

4. Results and discussion

For the analysis of the collected information, every questionnaire was reviewed in detail to test whether it was correct. As a result, one questionnaire was removed because the participant's answers did not correspond to what was required. Also, Part 3 of 9 questionnaires was canceled for the same reason. In summary, 57 and 48 questionnaires were used for the first two parts and the third part, respectively.

Subsequently, the ranking values from the three parts were inverted to make the analysis simpler: the highest values must correspond to the most preferred sequences. This ranking order was not asked to subjects in the questionnaire because it was definitely easier for them to assign the number 1 to their most favorite option, as Loewenstein and Sicherman (1991) do in their study. Afterwards, the data analysis and the statistical tests were performed.

4.1. Preferences over 6-year income sequences

In Fig. 2, the preferences for the 6-year income sequences are presented. The chart exhibits the mean ranking that participants give to each option. It is observed that the most preferred sequence is the one with slight increase (6.53), followed by constant (6.28) and moderate increase (5.70). On the other hand, the least preferred distributions are the stepped (2.16), sharp (2.70) and moderate decrease (3.93). In summary, people prefer increasing sequences rather than decreasing ones.

Since there are small differences between the mean ranking of the sequences, an equality of means test is performed in order to validate if the differences are significant or not (Crocker, 1974). First, the Kolmogorov-Smirnov test (Lilliefors, 1967) and the Levene test (Lim and Loh, 1996) are used to prove normality and equality of variance conditions, respectively. The results of these tests show that the condition of homoscedasticity is satisfied, but the assumption of normal

Table 4. Statistical tests for 6-year and 60-year income sequences.

Test	Critical value	p-value	
		6-year	60-year
Kolmogorov-Smirnov test	0.0500	0.0000	0.0000
Levene test	0.0500	0.0864	0.0206
Kruskal-Wallis test	0.0500	0.0000	0.0000

Table 5. Bonferroni test for 6-year income sequences (the number into parentheses indicate the number of the job).

Sequence shape	Constant (5)	Moderate decrease (3)	Moderate increase (7)	Sharp decrease (2)	Sharp increase (8)	Slight decrease (4)	Slight increase (6)
Moderate decrease (3)	0.0000	-	-	-	-	-	-
Moderate increase (7)	1.0000	0.0000	-	-	-	-	-
Sharp decrease (2)	0.0000	0.0059	0.0000	-	-	-	-
Sharp increase (8)	0.0000	1.0000	0.0001	0.0003	-	-	-
Slight decrease (4)	0.0000	0.8165	0.0409	0.0000	1.0000	-	-
Slight increase (6)	1.0000	0.0000	0.3492	0.0000	0.0000	0.0000	-
Stepped decrease (1)	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000

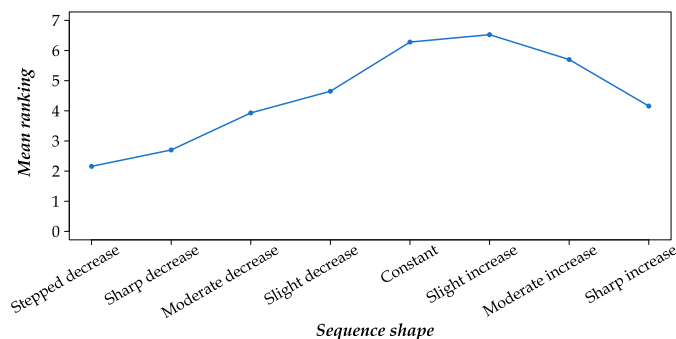


Fig. 2. Mean ranking for 6-year income sequences.

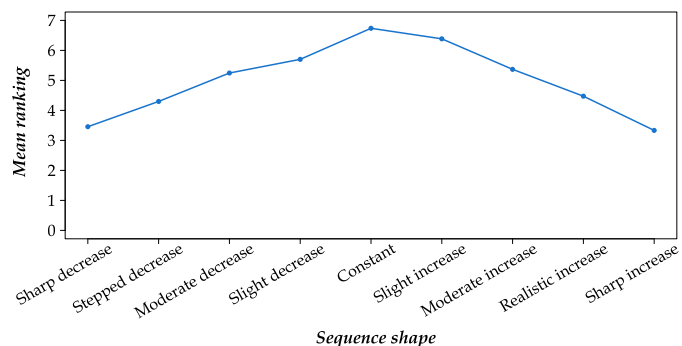


Fig. 3. Mean ranking for 60-year income sequences.

distribution is violated. For this reason, instead of performing Analysis of Variance (ANOVA) test to validate the equality of means (Sierra-Bravo, 1979), the Kruskal-Wallis test is applied. This is a nonparametric alternative to the one-way ANOVA that can be applied to data that are not normally distributed and do not have equal variances (Ostertagová et al., 2014). Table 4 exhibits the results of the tests.

Although the Kruskal-Wallis test indicates differences between the means of the sequences, it does not show specifically which sequences are different or similar. Thus, Bonferroni test (a multiple comparison test) is performed in order to identify the sequences with equal and different means. This is a pairwise test that compares the p-value of each pair of sequences with the critical value (0.05) to accept (p -value > critical value) or reject (p -value < critical value) the null hypothesis: there are not significant differences between the means of the pair of the considered sequences (Bland and Altman, 1995). The results of this test are shown in Table 5.

Based on the Bonferroni test, the preferences of respondents are divided into three groups due to equality of means: (1) the participants prefer as their first options the slightly increasing sequence, constant sequence and moderately increasing sequence; (2) as second options, they choose slightly decreasing sequence, sharply increasing sequence and moderately decreasing sequence; finally, (3) the least preferred sequences are sharply decreasing sequence and stepped decreasing sequence.

4.2. Preferences over 60-year income sequences

The 60-year income preferences show a pattern quite similar to the pattern of 6-year income preferences (Fig. 3). The three options with the

highest ranking are those exhibiting constant, slight increase and slight decrease, with means of 6.74, 6.39 and 5.70, respectively. According to participants, the worst distribution is the one showing sharp increase, followed by the sharp and stepped decrease distributions.

Equality of means test is performed since, like in the 6-year sequences, there are small differences between the mean ranking of the 60-year sequences. In this case, neither normality nor homoscedasticity conditions are satisfied, thus the Kruskal-Wallis test is therefore applied. Table 4 shows the rejection of the null hypothesis: the differences between the means are not significant.

Using the Bonferroni test, it is possible to identify the sequences that are different or similar to each other. The results (Table 6) exhibit that respondents' preferences are divided into three groups: (1) they prefer as their first options the distributions with constant trend, slight increase, slight decrease and moderate increase; (2) they select distribution with moderate decrease as their second options; and (3) the distributions they choose as their last options are those exhibiting realistic increase, stepped decrease, sharp decrease and sharp increase.

4.3. The influence of arguments on preferences over income sequences

After showing the arguments from experts to motivate participants to choose the decreasing, constant, or improving sequences, 60% of respondents select the improving sequence, 21% of them prefer the constant sequence, and 19% like the decreasing sequence. In order to compare these results with the ones from Part 1, the most preferred sequences (sequences rated by individuals as number 1) from the first part are classified into three groups: decreasing sequence (Job 1 to Job 4), constant sequence (Job 5) and improving sequence (Job 6 to Job 7).

Table 6. Bonferroni test for 60-year income sequences (the number into parentheses indicate the number of the job).

Sequence shape	Constant (5)	Moderate decrease (3)	Moderate increase (7)	Sharp decrease (1)	Realistic increase (8)	Sharp increase (9)	Slight decrease (4)	Slight increase (6)
Moderate decrease (3)	0.0261	-	-	-	-	-	-	-
Moderate increase (7)	0.0686	1.0000	-	-	-	-	-	-
Realistic increase (8)	0.0000	1.0000	1.0000	-	-	-	-	-
Sharp decrease (1)	0.0000	0.0019	0.0006	0.7451	-	-	-	-
Sharp increase (9)	0.0000	0.0006	0.0002	0.3446	1.0000	-	-	-
Slight decrease (4)	0.6701	1.0000	1.0000	0.1905	0.0000	0.0000	-	-
Slight increase (6)	1.0000	0.3446	0.7451	0.0006	0.0000	0.0000	1.0000	-
Stepped decrease (2)	0.0000	1.0000	0.5399	1.0000	1.0000	1.0000	0.0524	0.0001

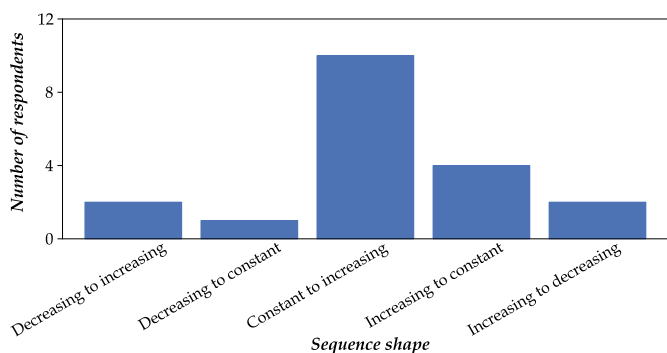


Fig. 4. Detailed changes on preferences.

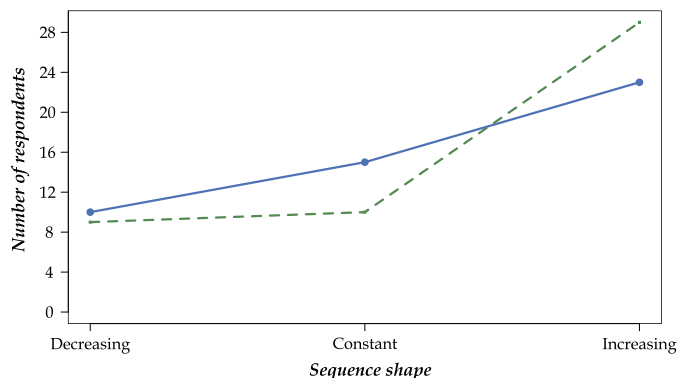


Fig. 5. Total changes on preferences: choices before (—) and choices after (---) showing the arguments.

This classification is made only for the preferences of individuals who respond correctly to Part 3 (48 participants). Comparing the results of both parts, it is observed that 19 of 48 people changed their preferences, as shown in Fig. 4. In total, 6 more people modified their preferences to the improving sequence after reading the arguments (shown in Fig. 5).

Fig. 6 exhibits the total ranking given to the arguments of decreasing, constant and improving sequences. The blue part of each bar represents the ranking provided by respondents who maintain their preferences in Part 3 with respect to their preferences from Part 1, and the yellow one corresponds to the ranking given by the people who modify their choices. In other words, the blue color shows the arguments for which some people choose a sequence and keep their preferences and the yellow color shows the arguments for which some other people are convinced to change their initial choices.

For decreasing sequences (Fig. 6a), overall, the argument that receives the highest ranking is “present value maximization”. However, people who change their preferences to this sequence argue that they

do so mainly because they like to get the best outcomes at the beginning of the sequence.

In general, “debt aversion” is the most popular argument among participants who select constant sequences (Fig. 6b). Moreover, this is the principal argument motivating subjects to modify their choices. Nevertheless, respondents who initially select this sequence argued they do so for the reason that they find it easy to manage (“convenience”).

Since the improving sequence is the most preferred before and after showing the arguments to participants, its arguments get the highest ranking. “Future spending needs” is the most popular argument, overall. This is the principal argument for which respondents choose the increasing sequences and maintain their preferences. However, “motivation” is the argument that causes subjects to modify their choices (Fig. 6c).

4.4. Valuation of 6-year and 60-year sequences

The sequences used in the experimental study to analyze preferences are valued with the three valuation models presented in Subsection 2.4. The objective of this process is to determine which model reflects participants’ preferences most accurately.

Eq (2) is used to calculate the present value of the sequences with the discounted utility model, where the discount rate (r) is 4.50%. The one-parameter model is performed using Eq (5), where the discount rate (k) is 4.50%. Moreover, Eq (6) to Eq (8) are applied to compute sequence values using our proposed alternative model, where the reference rate (r) is 1.10% for 6-year sequences and 1.47% for 60-year sequences. Let us remember that the reference rate (r) is a weighted geometric mean of the Spain’s Consumer Price Index (International Monetary Fund, 2015) for $t - 1$ periods ($t = 6, 60$).

Table 7 presents the results of the valuations for 6-year and 60-year income sequences. It is shown that the model that better fits short and long-term preferences over monetary sequences is our proposed alternative model.

5. Conclusions

Through this research, we aim to test the existence of the improving sequence effect on monetary sequences, as well as to understand why most individuals prefer improving income sequences even though these sequences do not provide the highest present value. Due to this, we also aim to present a valuation model for sequences, which systematizes people’ preferences for improvement.

Although the participants of our experimental study are aware of the present value maximization principle, they show preference for improvement for short and long-term sequences. They also show preference for uniform sequences. More specifically, they mostly prefer the improving sequences with slight and moderate slopes, but they also prefer constant and slightly decreasing sequences rather than sharply increasing sequences. This means they mainly prefer to receive improving income sequences whose first and last payment do not significantly differ from each other.

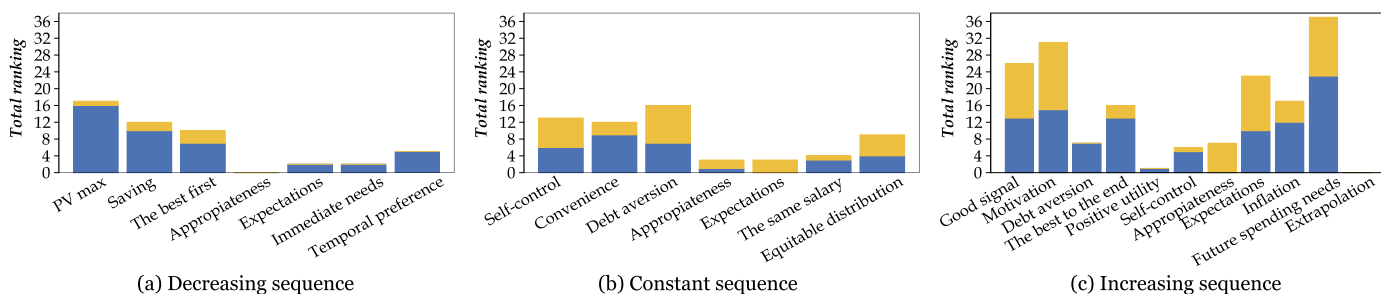


Fig. 6. Reasons for preferences over sequences from people who maintained (■) and modified (■) their choices.

Table 7. Valuation of 6-year and 60-year income sequences (in thousands euro).

Sequence	Discounted utility model		One-parameter model		Alternative model	
	6-year	60-year	6-year	60-year	6-year	60-year
Job 1	130.31	547.11	131.38	738.50	120.16	337.34
Job 2	130.01	515.21	131.11	715.08	119.72	535.28
Job 3	129.48	508.79	130.64	710.58	130.67	497.07
Job 4	129.21	490.04	130.40	696.90	137.15	662.86
Job 5	128.95	471.56	130.17	683.40	144.45	970.18
Job 6	128.68	453.35	129.93	670.10	147.33	1,411.93
Job 7	128.42	435.41	129.69	656.97	139.12	839.80
Job 8	127.89	423.29	129.22	648.82	123.61	781.82
Job 9	-	400.36	-	631.29	-	336.12

We contribute to the literature by compiling an extensive review of the previous experimental studies on monetary sequences and by collecting the arguments on which individuals base their decisions over monetary sequences. We used these arguments in our experiment to understand people preferences. In our experiment, after presenting the arguments to participants, the preference for improvement became stronger since six more subjects selected improving sequences. “Motivation” is the argument that mainly influences these changes; but overall, the most influential arguments on subjects’ preferences over improving sequences are: “to cover future spending needs”, “to feel motivation at job”, and “to receive a good signal of status and success”.

Moreover, we develop an alternative valuation model that reflects subjects’ preferences for improvement and outperforms the discounted utility model when evaluating monetary sequences.

Author contribution statement

M.J.M. Torrecillas, A. Garcia and S.C. Rambaud: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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Appendix. Questionnaire

- Age:
- Gender: (Male) (Female)
- Occupation:
- Marital status:
- Education attainment:

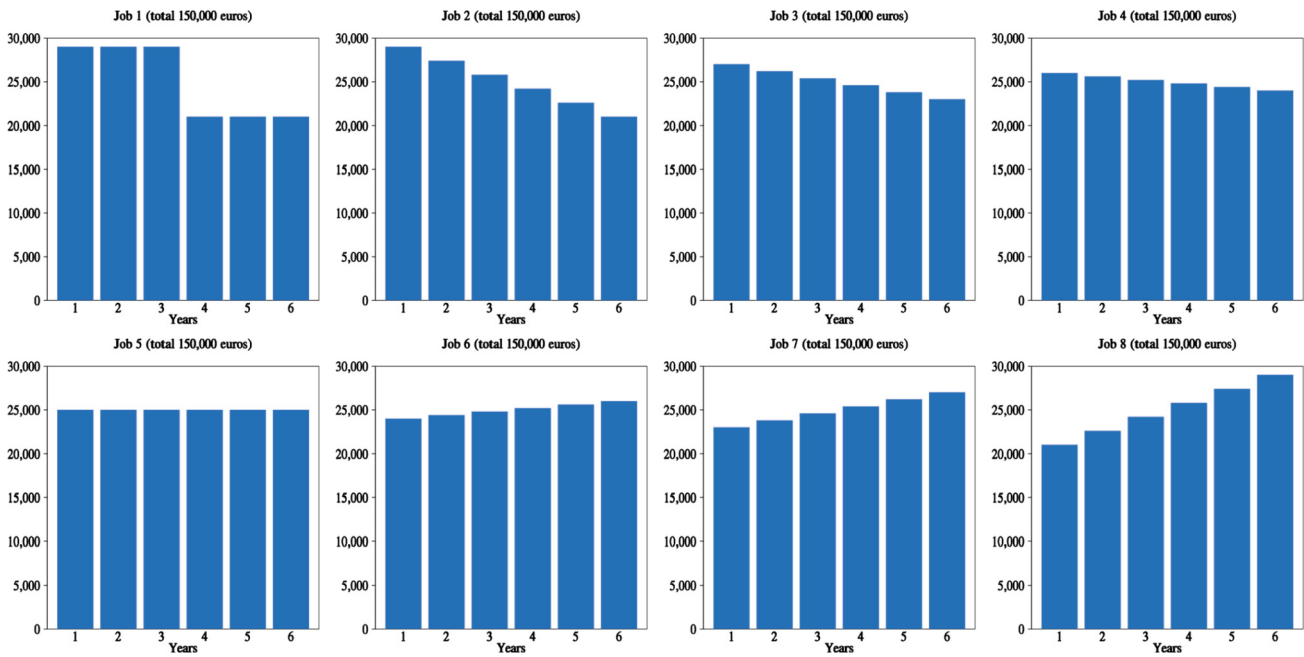
Directions

Below, there are 3 independent statements with specific directions for each one. Please, read them carefully and answer what you are asked for.

Part 1. Wage income for 6 years

Imagine that you do not have a job right now, but you have been offered a 6-year job. You have the option to get the salary payment in 8 different ways. You are completely sure that you will keep the job during the next 6 years. In this period, you will receive a total salary of €150,000. It will be your only source of income. This amount is the same for each payment choice.

Please, rank the following options from 1 (the best option) to 8 (the worst option) according to the way you would like to get your salary over the next 6 years. Do not consider the tax effect. Take into account that the option you select will not affect neither the jobs you will get in the future (from year 7) nor the wage you will receive for them.

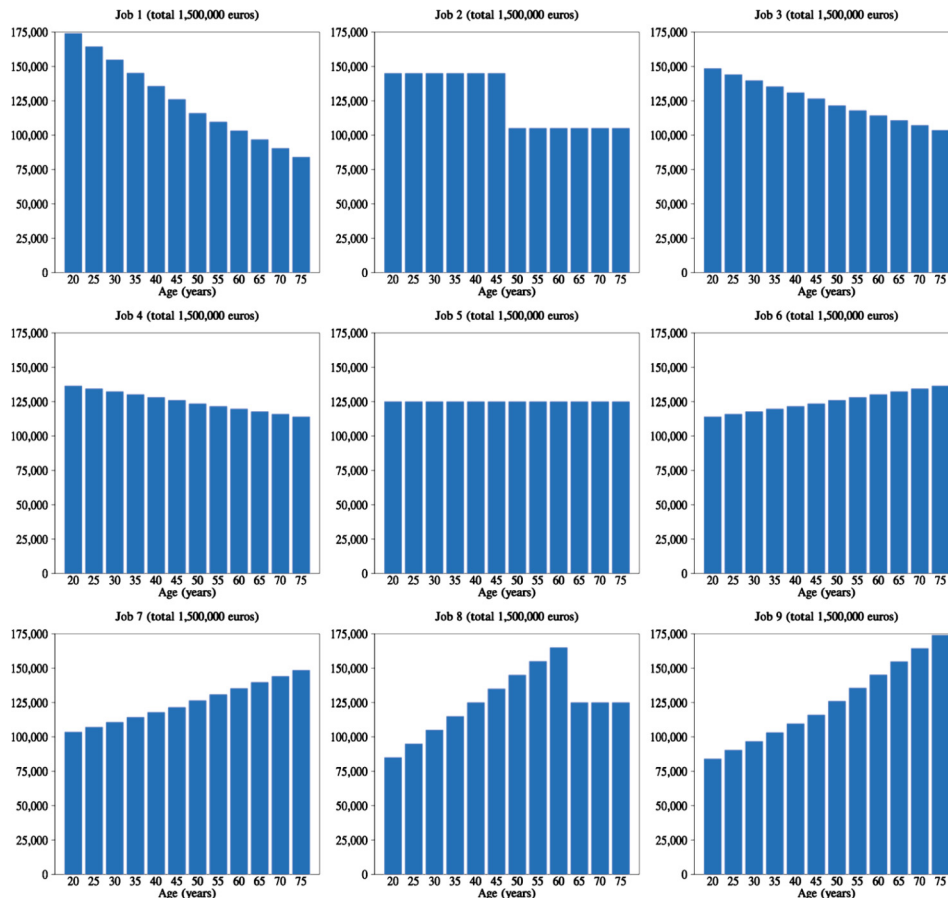


Part 2. Wage income for 60 years

Imagine that you are 20 years old and you would live for 60 more years. Below, there is a group of sequences that shows the salary you will get from 20 to 80 years old. They are presented in groups of five years. Please, consider that the income is constant for the 5 years. Do not consider inflation. Suppose that this salary will be your only source

of income. Each sequence is shown by a 12-bar graph with a total salary of €1,500,000. They distribute this amount in different ways.

Please rank the following options from 1 (the best option) to 9 (the worst option) according to the way you would like to get your salary over the next 60 years.



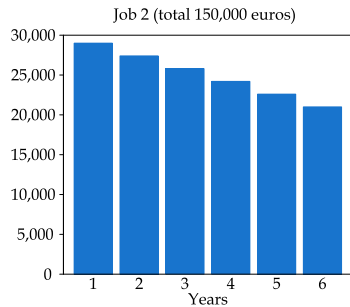
Part 3. Decreasing sequence, constant sequence and improving sequence

Below, there are 3 salary payment options. For each of them, there are arguments from some experts that expose the reasons why they should be selected.

Based on these reasons, choose the option you would prefer and enclose the corresponding graph in a box. Also, select the 3 most persuasive reasons for that alternative and rank them from 1 to 3. Give the number 1 to the most convincing reason.

Decreasing sequence

The following graph shows the decreasing distribution of a total salary of €150,000:

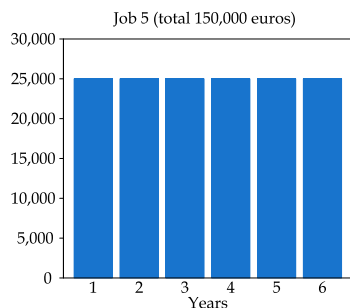


Below, you will find the reasons why you should choose this sequence:

- **Present value maximization.** This sequence lets you increase your income through investment and interest income.
- **Saving.** This sequence lets you separate an amount of money in order to save it for future periods, without considering investment.
- **Preference for getting the best at the beginning.** This sequence lets you avoid the negative feeling derived from the uncertainty of receiving the salary in the distant future. Accelerating the salary payment or receiving most of it in the first periods, reduces the sense of risk.
- **Appropriate sequence.** This sequence is the most appropriate, because it corresponds to my consumption pattern.
- **Expectations.** This sequence corresponds to my future expectations of income.
- **Immediate need of spending.** The distribution of the payment sequence lets you cover the immediate expenses.
- **Temporal preference.** It is given more importance to the utility gained during the first periods than to the utility gained during the last periods.

Constant sequence

The following graph shows the constant distribution of a total salary of €150,000:

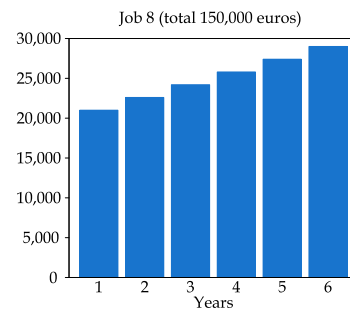


Below, you will find the reasons why you should choose this sequence:

- **Self-control.** It is easier to restrict myself from unnecessary expenses if the distribution of the sequence is constant over time.
- **Convenience.** This sequence of income is easier to manage.
- **Debt aversion.** It is preferred to receive the salary payment constantly to avoid the sense of “being in debt” when receiving most of the amount at the beginning of the sequence.
- **Appropriate sequence.** This sequence is the most appropriate, because it corresponds to my consumption pattern.
- **Expectations.** This sequence corresponds to my future expectations of income.
- **Desire for receiving equal salary over time.**
- **Equitable distribution.** The constant sequence lets you select a payment option without deliberating deeply about the optimal distribution.

Improving sequence

The following graph shows the improving distribution of a total salary of €150,000:



Below, you will find the reasons why you should choose this sequence:

- **Good signal.** The increase in income is a positive signal of success and status.
- **Motivation.** The increase in income is a motivation for the employees.
- **Debt aversion.** It is preferred to receive the salary payment increasingly to avoid the sense of “being in debt” when receiving most of the amount at the beginning of the sequence.
- **Preference for leaving the best at the end.** This sequence generates a positive feeling derived from receiving most of the salary in the future and the increase in income each period. Delaying the payment or receiving most of it during the last periods, increases the satisfaction.
- **Positive utility.** The utility of a payment at an instant of time can be compared positively with the utility of other payments at previous or later instants of time.
- **Self-control.** It is easier to restrict myself from unnecessary expenses if the distribution of the sequence is improving over time.
- **Appropriate sequence.** This sequence is the most appropriate, because it corresponds to my consumption pattern.
- **Expectations.** This sequence corresponds to my future expectations of income.
- **Inflation.** This sequence lets you protect your standard of living and your consumption through the offset of the increase in price with the increase in income.
- **Future need of spending.** The distribution of the sequence lets you cover the need of spending in the future periods.
- **Extrapolation.** The increasing distribution is preferred because it is considered that the future sequences will follow the same increasing trend.

References

- Attema, A., Bleichrodt, H., Rohde, K., Wakker, P., 2010. Time-tradeoff sequences for analyzing discounting and time inconsistency. *Manag. Sci.* 56, 2015–2030.
- Baucells, M., Sarin, R., 2007. Evaluating time streams of income: discounting what? *Theory Decis.* 63, 95–120.
- Berns, G., Laibson, D., Loewenstein, G., 2007. Intertemporal choice – toward an integrative framework. *Trends Cogn. Sci.* 11, 482–488.
- Bland, J., Altman, D., 1995. Multiple significance test: the Bonferroni method. *Br. Med. J.* 310, 170.
- Brunner, D., 1999. Preference for sequences of rewards: further tests of a parallel discounting model. *Behav. Process.* 45, 87–99.
- Chapman, G.B., 1996. Expectations and preferences for sequences of health and money. *Organ. Behav. Hum. Decis. Process.* 67, 59–75.
- Chapman, G.B., 2000. Preferences for improving and declining sequences of health outcomes. *J. Behav. Decis. Mak.* 13, 203–218.
- Crocker, A.C., 1974. Significance. In: *Statistics for the Teacher*. NFER Publishing Company, pp. 59–69.
- Cruz-Rambaud, S., Muñoz-Torrecillas, M.J., 2004. An analysis of the anomalies in traditional discounting models. *Int. J. Psychol. Psychol. Ther.* 4, 105–128.
- Cruz-Rambaud, S., Muñoz-Torrecillas, M.J., García, A., 2018. A mathematical analysis of the improving sequence effect for monetary rewards. *Front. Appl. Math. Stat.* 4, 1–8.
- Drolet, A., Lau-Gesk, L., Scott, C., 2011. The influence of aging on preferences for sequences of mixed affective events. *J. Behav. Decis. Mak.* 24, 293–314.
- Duffy, S., Smith, J., 2013. Preference for increasing wages: how do people value various streams of income? *Judgm. Decis. Mak.* 8, 74–90.
- Frederick, S., Loewenstein, G., 2008. Conflicting motives in evaluations of sequences. *J. Risk Uncertain.* 37, 221–235.
- Frederick, S., Loewenstein, G., O'Donoghue, T., 2002. Time discounting and time preference: a critical review. *J. Econ. Lit.* 40, 351–401.
- Gigliotti, G., Sopher, B., 1997. Violations of present-value maximization in income choice. *Theory Decis.* 43, 45–69.
- Guyse, J.L., Keller, L.R., Eppel, T., 2002. Valuing environmental outcomes: preferences for constant or improving sequences. *Organ. Behav. Hum. Decis. Process.* 87, 253–277.
- Guyse, J.L., Keller, L.R., Huynh, C.H., 2020. Valuing sequences of lives lost or saved over time: preference for uniform sequences. *Decis. Anal.* 17.
- International Monetary Fund, 2015. *World Economic Outlook: Uneven Growth, Short- and Long-Term Factors*.
- Lilliefors, H.W., 1967. On the Kolmogorov-Smirnov test for normality with mean and variance unknown. *J. Am. Stat. Assoc.* 62, 399–402.
- Lim, T., Loh, W., 1996. A comparison of tests of equality of variances. *Comput. Stat. Data Anal.* 22, 287–301.
- Löckenhoff, C.E., Samanez-Larkin, G.R., 2020. Age differences in intertemporal choice: the role of task type, outcome characteristics, and covariates. *J. Gerontol., Ser. B, Psychol. Sci. Soc. Sci.* 75, 85–95.
- Loewenstein, G., Prelec, D., 1991. Negative time preference. *Am. Econ. Rev.* 81, 347–352.
- Loewenstein, G., Prelec, D., 1993. Preferences for sequences of outcomes. *Psychol. Rev.* 100, 91–108.
- Loewenstein, G., Sicherman, N., 1991. Do workers prefer increasing wage profiles? *J. Labor Econ.* 9, 67–84.
- Loewenstein, G., Thaler, R., 1989. Anomalies: intertemporal choice. *J. Econ. Perspect.* 3, 181–193.
- Manzini, P., Mariotti, M., Mittone, L., 2010. Choosing monetary sequences: theory and experimental evidence. *Theory Decis.* 69, 327–354.
- Matsumoto, D., Peecher, M.E., Rich, J.S., 2000. Evaluations of outcome sequences. *Organ. Behav. Hum. Decis. Process.* 83, 331–352.
- Mazur, J.E., 1984. Tests of an equivalence rule for fixed and variable reinforcer delays. *J. Exp. Psychol., Anim. Behav. Processes* 10, 426.
- Musau, A., 2014. Hyperbolic discount curves: a reply to Ainslie. *Theory Decis.* 76, 9–30.
- Ostertagová, E., Ostertag, O., Kováč, J., 2014. Methodology and application of the Kruskal-Wallis test. *Appl. Mech. Mater.* 611, 115–120.
- Prelec, D., Loewenstein, G., 1991. Decision making over time and under uncertainty: a common approach. *Manag. Sci.* 37, 770–786.
- Read, D., Powell, M., 2002. Reasons for sequence preferences. *J. Behav. Decis. Mak.* 15, 433–460.
- Samuelson, P.A., 1937. A note on measurement of utility. *Rev. Econ. Stud.* 4, 155–161.
- Schmitt, D.R., Kemper, T.D., 1996. Preference for different sequences of increasing or decreasing rewards. *Organ. Behav. Hum. Decis. Process.* 66, 89–101.
- Sierra-Bravo, R., 1979. Test de hipótesis. In: *Técnicas de Investigación Social. Teoría y Ejercicios*, pp. 500–544.
- Strough, J., de Bruin, W.B., Parker, A.M., 2019. Taking the biggest first: age differences in preferences for monetary and hedonic sequences. *J. Gerontol., Ser. B, Psychol. Sci. Soc. Sci.* 74, 964–974.