The Influence of Framing on the Measurement of Time-Inconsistency

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Abstract

Several actors in business life and in the public sector have an interest in attaining more knowledge about how framing can influence a person's time-inconsistency. This knowledge can be used to set up systems that are able to direct people into the direction that is best for themselves or most profitable for business life. This paper provides an examination of the existence of the delay-speedup asymmetry when using the measure of irrationality of Rohde (2008). The research is conducted by making use of a graphical analysis on the one hand and the statistical sound method of SPSS on the other. When reading this paper it becomes evident that this is an interesting topic to conduct further research on.

1. Introduction

Recently, there is a trend shifting the attention from constant discounting to hyperbolic discounting. This is basically the same as that more and more people are convinced that people are not behaving in a time consistent way.

When a person has the choice between getting 1 chocolate bar today or two tomorrow, he or she may be induced to choose the one chocolate bar today. When the same person is asked to choose between 1 chocolate bar in 50 days or two in 51 days, he or she will be much more willing to wait one extra day for one more chocolate bar, than in the first choice.

This pattern applies to consumption goods as well as to money. That is the reason why people always show the intention to save in the future, but when the decision to save actually has to be made, they are spending their money instead of saving it.

This paper conducts a research on a specific form of hyperbolic discounting as it investigates whether the choice behavior of people changes as the reference point changes. The ultimate goal of this paper is to see how the framing of intertemporal choice affects people's choice behavior, and in particular how it influences their level of rationality as defined by Rohde (2008).

It is very important to get to know more about the effects that the framing of intertemporal choice has on the behavior of people, as businesses could make a profit out of it. They are very eager to learn about how to direct people into the directions that are most profitable for the business. For example, an employer is willing to learn how to get rid of an employee at the lowest cost possible and bank salesman are willing to learn how to guide people to the investment option for which they get the highest provision.

As there is more and more evidence that the framing of intertemporal choice and, especially, the delay-speedup asymmetry are found in real life, it shows a very interesting and important subject to conduct more research on.

2. Background

To get a complete view on this subject some attention will be given to constant discounting first. Constant discounting has been a popular view in the past on the way people make decisions between different time periods (Frederick et al.). Following constant discounting people show time consistent behavior, which means they do not revise their choice when some time has past and that they carry out their plans. The formula that captures this logic is:

$$D(t) = \frac{1}{(1+r)^t} = \delta^t$$

and this is the discount factor. As can be seen, the discount factor depends on the discount rate and the time period in which the receipt or payment takes place. The time-consistency can be seen by seeing the choice between getting two chocolate bars tomorrow or one today and the choice between getting two chocolate bars in 50 days or one in 51 days. Both show the same discount rate r and so when a person chooses for getting one chocolate bar today in the first choice he or she has to make, he or she should also choose getting one chocolate bar in 50 days in the second choice he or she has to make and vice versa.

After some period people became aware that it was not as obvious as stated above that people show time consistent behavior (Frederick et al.). In several occasions decreasing impatience was found when people had to make decisions between different time periods. This is the reason why the (quasi)- hyperbolic discounting theory got more followers. Hyperbolic discounting has a different approach towards the discount rate. The theory states that the discount function is:

$$D(t) = \begin{cases} 1 \; if \; t = 0 \\ \beta\delta^t \; if \; t > o \end{cases}$$

with $\beta < 1$ and $\delta > 0$. Hyperbolic discounting leads to time inconsistency as it shows different discount rates when moving from 0 to 1 and when moving from t-1 to t, on the condition that t >1. As β has a smaller value than 1, the discount rate from time 0 to 1 is larger than that from time t-1 to t and this implies decreasing impatience.

Taking the same example of the chocolate bars we see that when a person is indifferent between having one bar today or two bars tomorrow, he satisfies

U(1 bar)=$\beta\delta$U(2 bars)

Multiplying both sides by δ^{50} yields

δ^{50}U(1 bar) = $\beta\delta^{51}$U(2 bars)

As β has a value smaller than 1, we have

$\beta\delta^{50}$U(1 bar) < $\beta\delta^{51}$U(2 bars)

It follows that the person is not indifferent between getting 1 bar in 50 days and 2 bars in 51 days. This shows that people are not making time consistent decisions and that their behavior is marked by decreasing impatience.

By understanding this logic, we can also make a great step in explaining why people show the intention for saving (in the future) but do not carry out their plans when the time has passed. The example above can be directly translated to the savings problem by replacing the chocolate bars by euros (or a certain amount of euros).

Rohde (2008) introduced a method to measure the degree of deviation from constant discounting. The method is as follows: a person is getting a receipt x in a certain time period (s: x), then he or she can delay the receipt (or speedup the receipt) in exchange for a larger (smaller) receipt (t: y). Time t or s is adjusted to yield indifference. So to put it into one formula:

$$(s{:}\,x) \sim (t{:}\,y)$$

Next, the receipt a person gets will take place further in the future $(s + \sigma{:}\,x)$, and the person again can delay the receipt (or speedup the receipt) in exchange for a larger (smaller) receipt $(t + \tau{:}\,y)$. The following formula captures this:

$$(s + \sigma{:}\,x) \sim (t + \tau{:}\,y)$$

The degree of deviation from constant discounting, or the degree of irrationality of a person, can be measured by $\tau - \sigma$. We expect to find positive values for $\tau - \sigma$ as we expect to find decreasing impatience.

Another infringement of constant discounting theory is the existence of a delay-speedup asymmetry. The delay-speedup asymmetry states that the behavior of people depends on the reference point to which they make their decisions. In other words, people have different discount rates for delay and acceleration from some temporal reference point.

This paper will investigate the existence of a delay-speedup asymmetry when using the method of Rohde.

For investigating the existence of a delay-speedup asymmetry it is important to see whether a person shows a different $\tau - \sigma$ when responding to a delay-formulated Questionnaire or a speedup-formulated Questionnaire.

3. Methods

3.1 General

For conducting my research I have chosen for a questionnaire carrying four questions. These four questions consist of two main questions on which my further research is based, and two fill up questions. In the questionnaires A and B (Appendix A and Appendix B) question 2 and 4 are the main questions in which we are interested.

As can be seen, the two fill up questions contain considerable similarities with the two main questions. The first reason for this is that the connection between the two main questions is less visible by introducing questions that look very much alike. The second reason is that by answering the fill up questions, the experiment group is made familiar with the way in which they have to make their decision at the core questions.

This experiment is conducted in an experiment group of considerable heterogeneity. Both Questionnaire A and Questionnaire B have 15 respondents of differing age, education and financial independence. The decision to do this was very dependent on my opinion that the people or organizations that want to make use of this thesis are interested in the behavior of the population at large. For example investment banks have an interest to direct people to the investment opportunity that is most advantageous for them, for example due to a high commission. For doing this they are interested in the behavior of the population at large, because they want to address as many potential customers as possible.

3.2 Form of the questions

As we are interested in the delay-speedup asymmetry, it is important to have one questionnaire that takes a reference point of receiving something in the future and the possibility of delaying this receipt (in exchange for a higher receipt). In our case this is Questionnaire A. The other questionnaire, Questionnaire B, takes a reference point of receiving something in the future and the possibility of speeding up this receipt (in exchange for a lower receipt). I will now further explain how the questionnaires are developed.

3.2.1 Questionnaire A

In Questionnaire A we are interested in the delay premium for which people are willing to delay their receipt. When working with the formulative form already stated above, question 2 is as follows:

$$(s: x) \sim (t: y)$$

with s, x and y already given. People have to state the t for which they are indifferent. When working with the same formula, question 4 is as follows:

$$(s + \sigma : x) \sim (t + \tau : y)$$

with s, σ, x and y already given. People have to state the t+τ for which they are indifferent. As we know t from question 2, we can calculate the value of τ. When people are behaving in a constant discounting manner, $\sigma = \tau$. By knowing σ and τ, we are able to measure the rate of irrational behavior of persons, by calculating $\tau - \sigma$.

3.2.2 Questionnaire B

In questionnaire B we are interested in the speedup cost people are willing to pay for a speedup of their receipt. Again, we worked with the same formula for question 2:

$$(s : x) \sim (t : y)$$

with x, t and y already given. People have to state time point s for which they are indifferent. Question 4 is based on the following:

$$(s + \sigma : x) \sim (t + \tau : y)$$

with x, t, τ and y already given. People have to state the s+σ for which they are indifferent. We know the value of s from question 2 and thus the value of σ can be calculated. The rate of irrational behavior by persons can be calculated by $\tau - \sigma$.

3.3 Indentifying stimuli

3.3.1 Defining time points

For determining the values of s, t σ and τ considerable attention is needed. The values of the delays (σ and τ) are chosen in a way that makes them comparable in size to the values of the time values (s and t). Also, it is best to have the time values not too far in the future. When people need to make decisions about receiving a certain amount of money far in the future, it will feel to them as unrealistic and difficult to imagine. Taking all of this into consideration I came up with the following values:

s = 6 months

t = 12 months

σ (or τ) = 6 months

3.3.2 Defining monetary values

It is a well-known fact that people prefer to have a certain monetary amount sooner than later. To be indifferent between two different time points, the monetary amount received further in the future thus needs to be larger than that which is received earlier. As we can see s is smaller than t, and thus x needs to be smaller than y. To me there are two criteria that need to be fulfilled when choosing the monetary amounts:

- The monetary amount needs to be large enough to force the experiment group to make serious decision
- The monetary amount needs to be small enough to be realistic. When the monetary amounts are a lot larger than the experiment group usually copes with, people will find it hard to make decent decisions. An example of this is that people will be inclined to safeguard the money as soon as possible.

Originally, I picked the following values: for x I chose €100 and for y I chose €120. When handing the questionnaires out to people, it came forward that people thought the difference of €20 was too large for a difference of time of 6 months (question 2 of Questionnaire B) and so they were not able to state their value of s.

I had to come up with a different value of y and I chose €105. I chose this amount because when taking the interest rate and the inflation rate into account, people will be able to make a decision somewhere in between tomorrow and 6 months for which they are indifferent. So:

x = €100

y = €105

I am aware that this may incline people to make less serious decisions and there may even be a Petty cash effect, which states that people are inclined to make unrealistic decisions about very small amounts of money. However, for my experiment it was necessary to adjust to my experiment group.

4. Results

4.1 Comparison Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B

In the search for detecting a delay-speedup asymmetry in Rohde's measure of irrationality, the first comparison that is made is between Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B. The comparison is made by making use of the following hypotheses:

> H_0 hypothesis: there is no difference between the measure of irrationality of Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B
>
> H_A hypothesis: there is a difference between the measure of irrationality of Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B

The start of the search for the delay-speedup asymmetry in Rohde's measure of irrationality is an analysis of the graphs below and by this we can see whether some pattern is found that could point out the existence or non-existence of the delay-speedup asymmetry in this measure. Later, a more statistical sound approach is executed by which we can conclude whether there is a statistical significant difference between the measure of irrationality of Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B.

4.1.1 Histograms

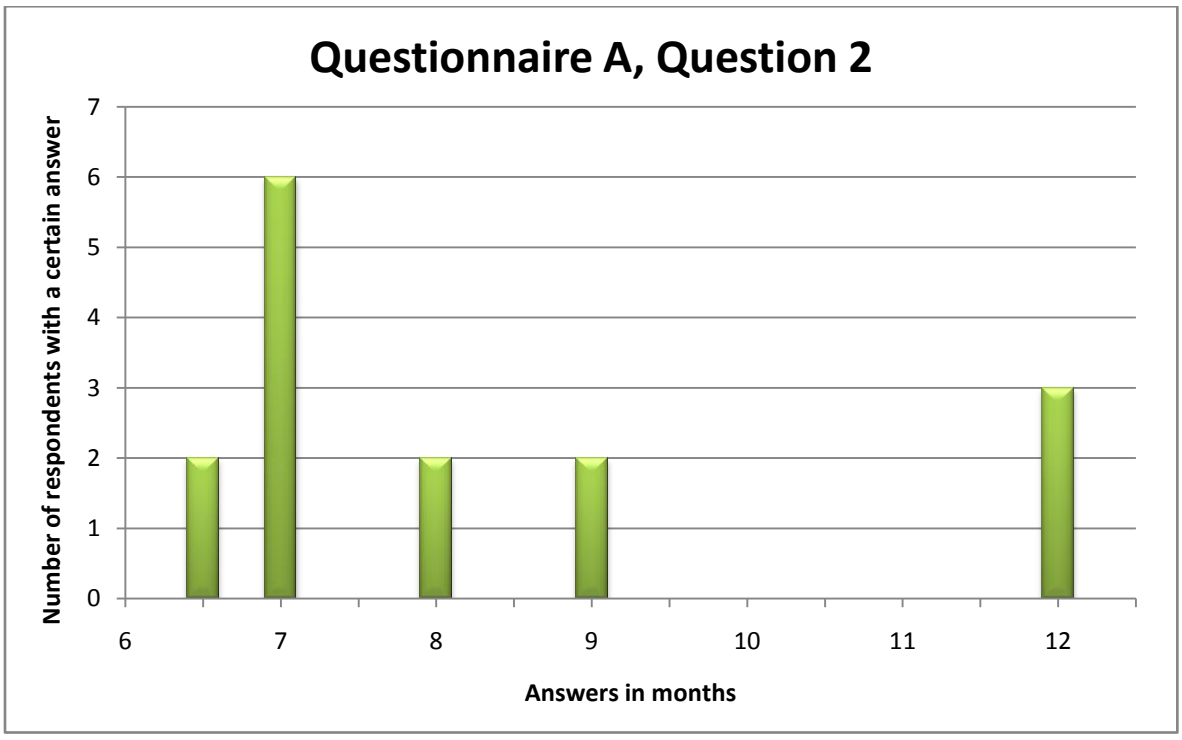

Figure 1. Answers on Question 2 of Questionnaire A

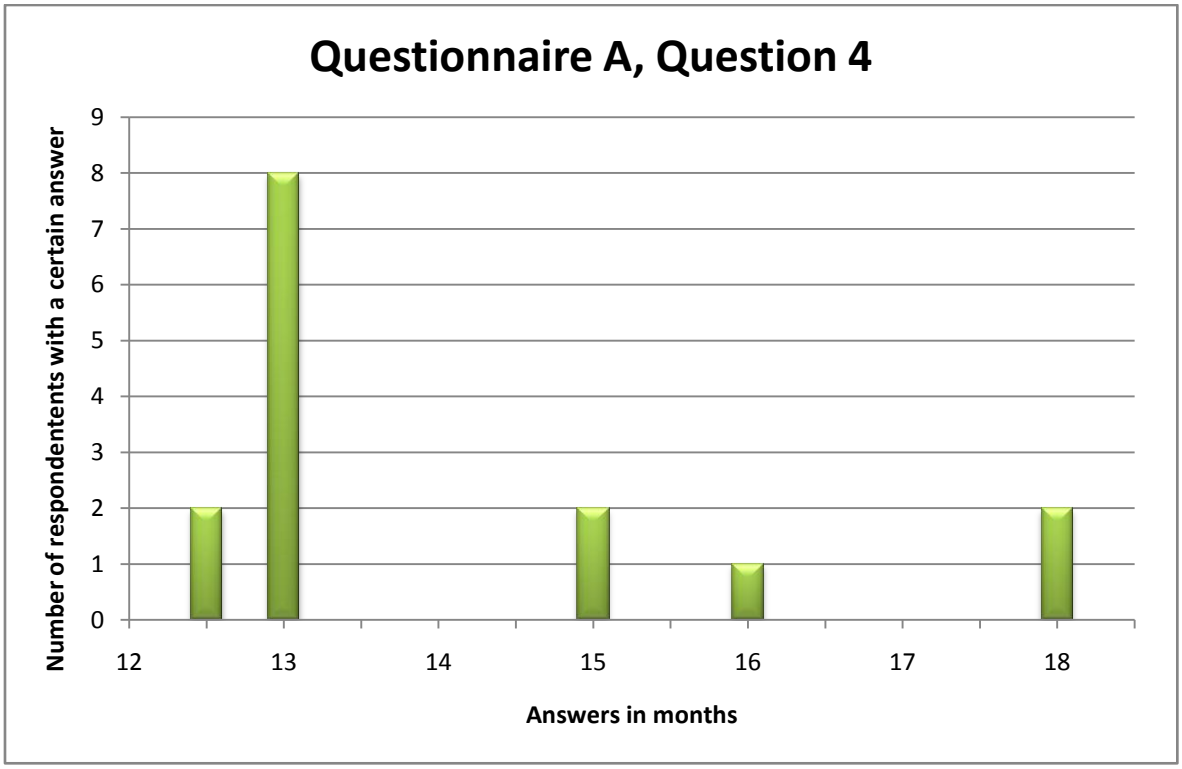

Figure 2. Answers on Question 4 of Questionnaire A

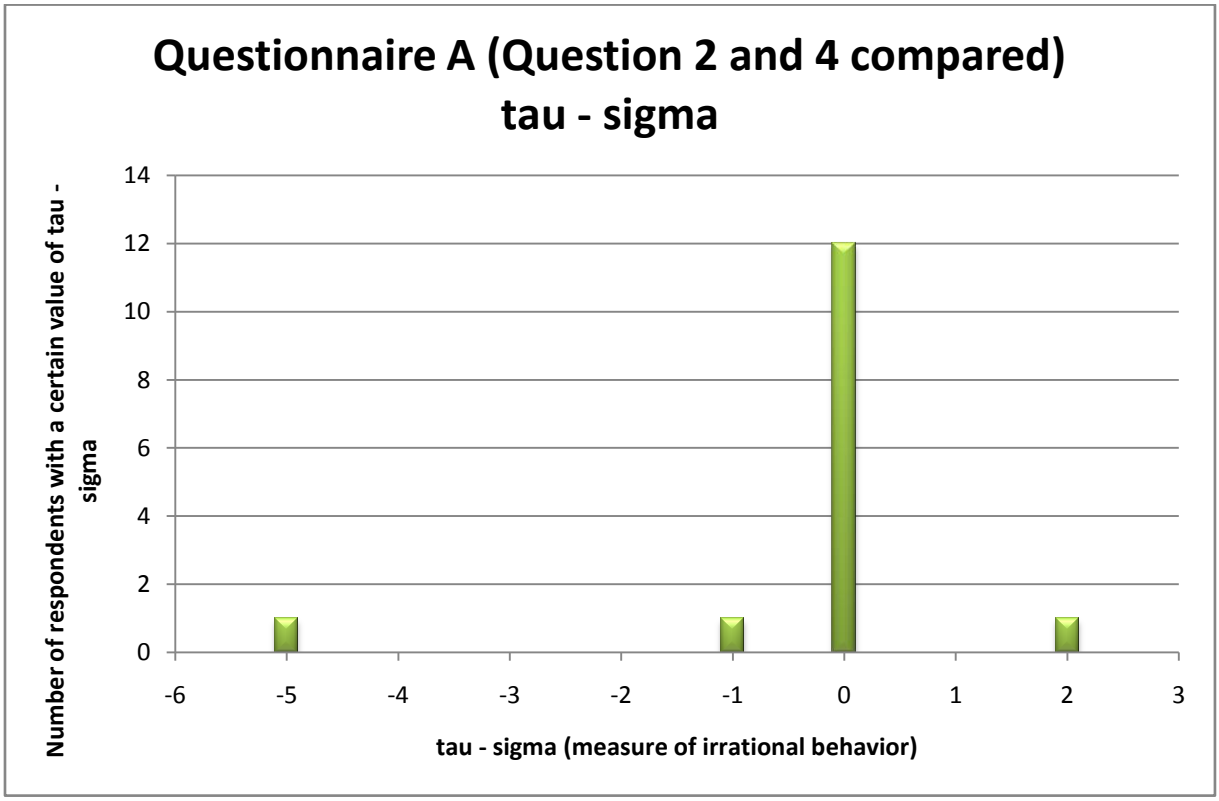

Figure 3. Measuring $\tau - \sigma$ through comparison Question 2 and 4 of Questionnaire A

As can be seen in figure 1, most people are willing to delay a receipt one extra month to receive €5 extra. They are getting €100 in 6 months and are willing to delay this receipt one month to receive €105. Also 1/5 of the respondents is willing to delay the receipt 6 months for receiving €5 extra.

When asking the same question to the respondents with the only exception being that the receipt will take place further in the future (figure 2), namely receiving €100 in 12 months instead of in 6 months, we see that again most people are willing to wait one extra month for receiving €5 more. When comparing figures 1 and 2, we see that the two figures are roughly the same. In figure 2 there are more people that are willing to wait one extra month and less that are willing to wait longer than in figure 1, but the pattern is not strikingly different, which implies the behavior of the respondents is following constant discounting theory.

In figure 3 we see that by far most people have a value for $\tau - \sigma$ of 0, which means that they are behaving in a constant discounting way. We see one positive value for $\tau - \sigma$, referring to a respondent which is willing to wait longer when the receipt takes place further in the future. Furthermore, we see two negative values for $\tau - \sigma$ of which one is very large. This refers to respondents who are willing to wait less when the receipt takes place further in the future.

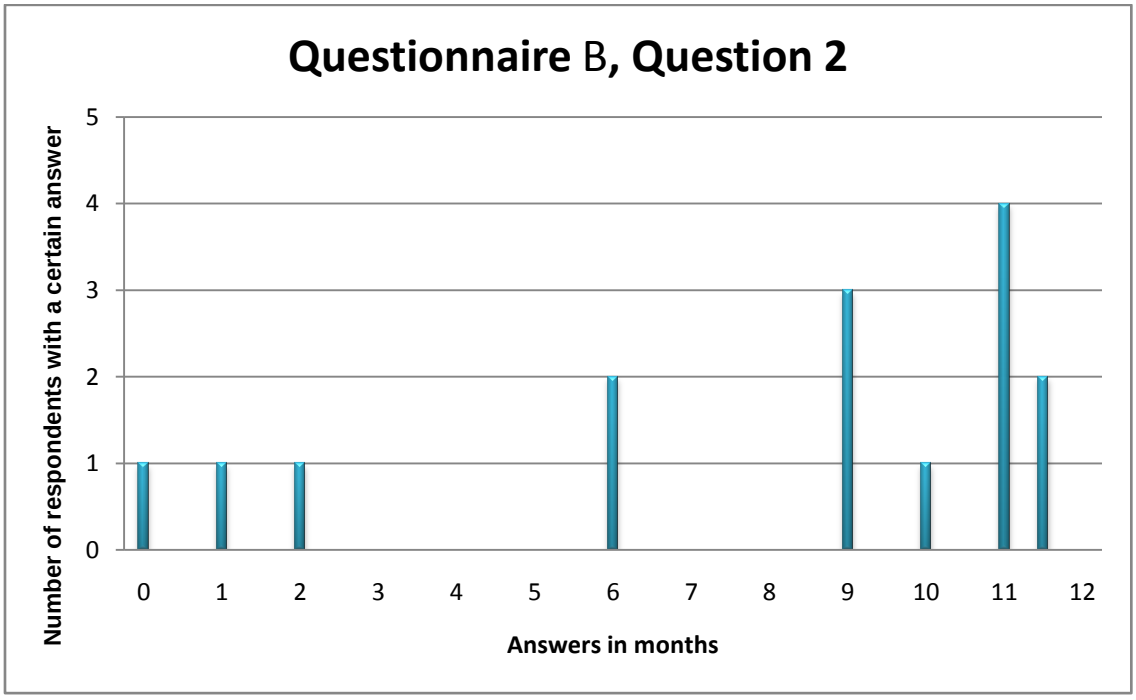

Figure 4. Answers on Question 2 of Questionnaire B

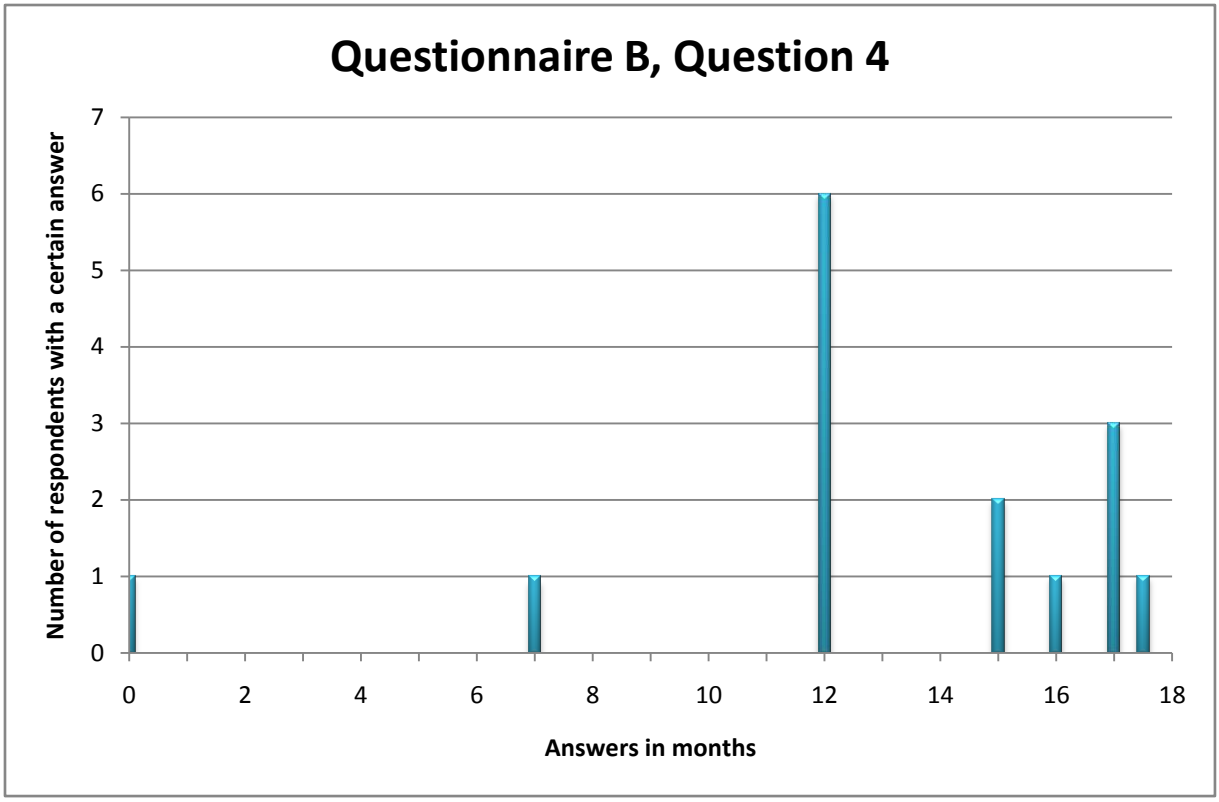

Figure 5. Answers on Question 4 of Questionnaire B

When people are asked questions in a speed-up formulation, their answers seem to be more diverse. When comparing figure 4 and figure 5 with figure 1 and figure 2, we see a big difference as in the former two the answers are spread over a time span of 12 and 18 months and the latter two have answers spread over a time span of 6 months.

When comparing figures 4 and 5 with each other, other interesting points come to mind. The most given answer on Question 2 of Questionnaire B is 11 months. So most people feel like they are willing to speed up the receipt of a payment one month when paid €5 less. However, as you can see the figure shows a long tail to the left, which means people are induced to not be willing to accept the receipt of €5 less unless the monetary amount is paid a lot of months earlier. The most given answer on Question 4 of Questionnaire B is 12 months, so people want to be compensated for receiving €5 less by receiving the payment 6 months earlier. The other answers are mostly to the right of 12 months, and so for them the speeded up receipt has to come less than 6 months earlier in order for them to be indifferent. The fact that in Question 2 most people are willing to accept €5 less when being paid one month earlier and in Question 4 by being paid 6 months earlier, goes completely against the constant discounting logic.

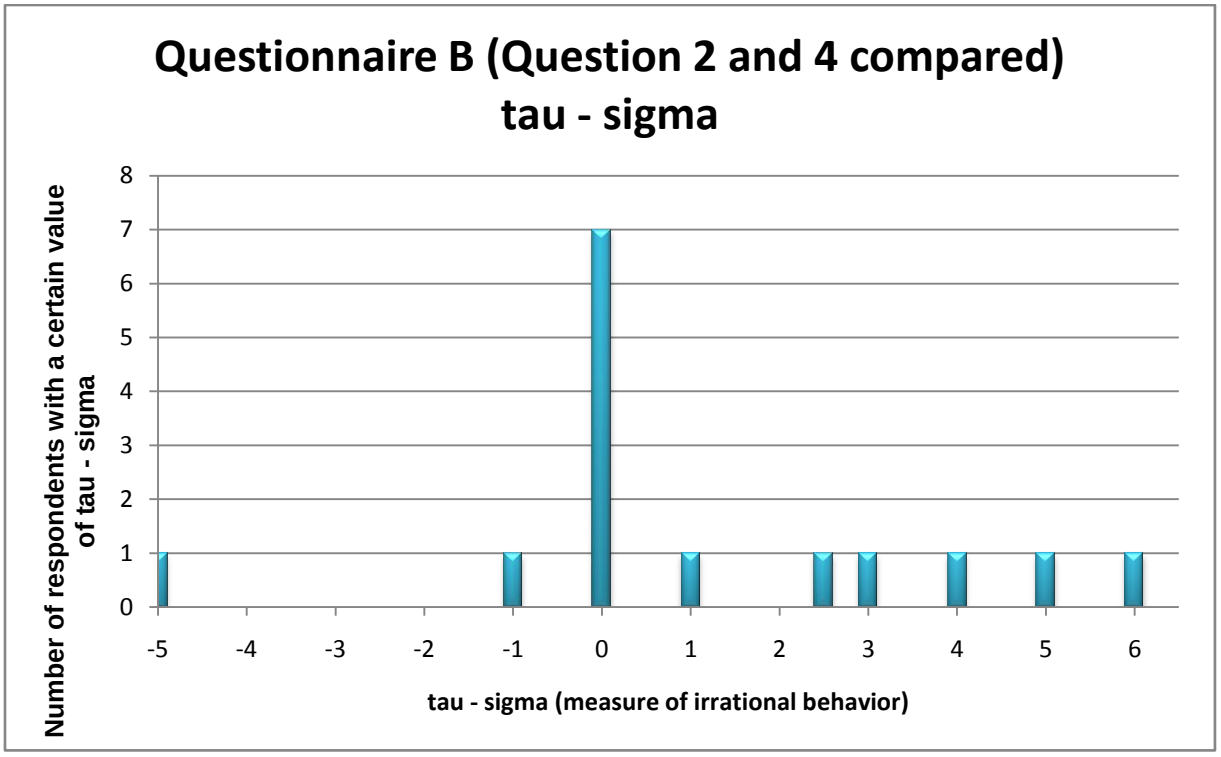

Figure 6. Measuring $\tau - \sigma$ through comparison Question 2 and 4 of Questionnaire B

As can be seen in figure 6, again (as in figure 3) most people are following a constant discounting logic as their $\tau - \sigma$ is zero. This shows severe contradiction with the conclusions drawn above. As $\tau - \sigma$ remains the overriding measure of irrationality, the conclusion we can draw is that there is a considerable amount of rationality (people following the constant discounting logic), though some patterns in figures 4 and 5 cannot be explained by constant discounting theory.

4.1.2 SPSS

In Table 1 and Table 2 of Appendix E a comparison is made between Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B. This is done by conducting an independent T-test in SPSS, because the Questions 2&4 of Questionnaire A are not influenced by Questions 2&4 of Questionnaire B and vice versa.

Questions 2&4 of Questionnaire A were grouped as dummy variable 2 and Questions 2&4 of Questionnaire B were grouped as dummy variable 3. The dummy variables were used as grouping variables and the values of $\tau - \sigma$ were used as test variables.

The level of significance used is $\alpha = 0{,}05$, which means that we are prepared to reject the null hypothesis when a value is found that has a chance of occurring in our test population of less than 5%.

The means found for $\tau - \sigma$ of Questionnaire A (Questions 2&4) and Questionnaire B (Questions 2&4) are respectively, -.2667 and 1.0333. So the mean of the first is slightly negative, while the mean of the second shows a positive value.

For being able to read Table 2, the Levene's test has to be conducted first. It shows that at a level of $\alpha = 0{,}05$ the hypothesis of equal variances can be rejected. For finding the answer on the question about which of the basic hypotheses stated above is right, we have to look in the second row of Table 2. A P-value of .116 is found and thus the H0 hypothesis cannot be rejected and the conclusion is that there is no significant difference between the measure of irrationality of Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B.

4.2 Comparison Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A

The next comparison that is made in the search for detecting a delay-speedup asymmetry in Rohde's measure of irrationality is between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A. The comparison is made by making use of the following hypotheses:

> H_0 hypothesis: there is no difference between the measure of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A
>
> H_A hypothesis: there is a difference between the measure of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A

4.2.1 Histograms

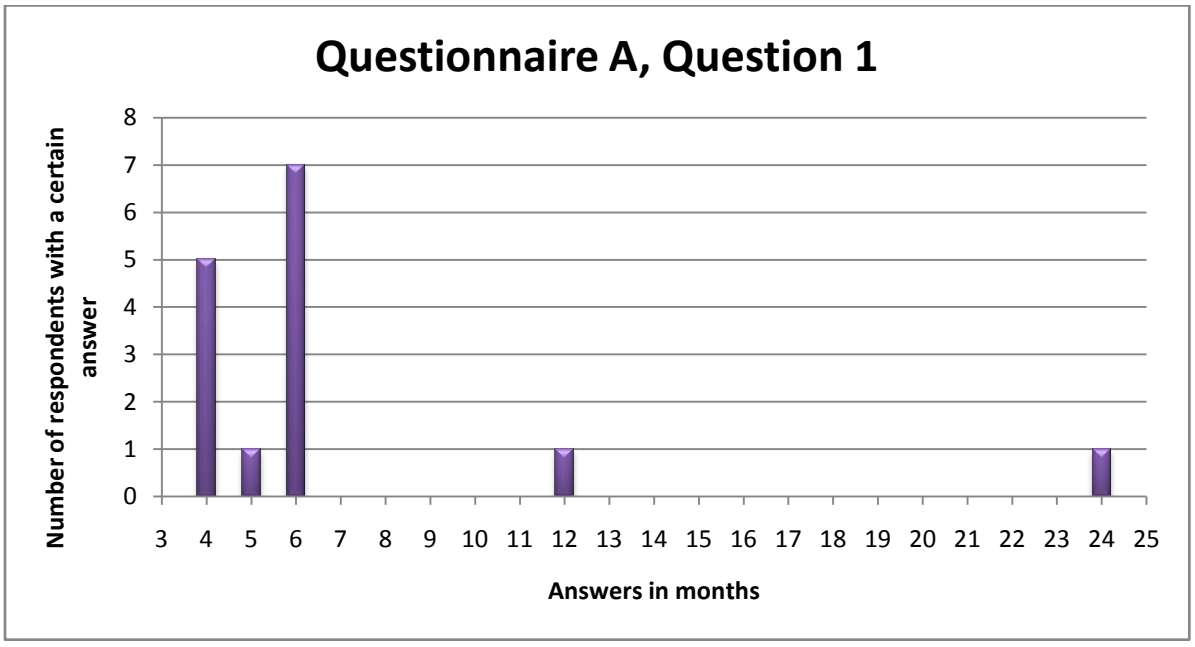

Figure 7. Answers on Question 1 of Questionnaire A

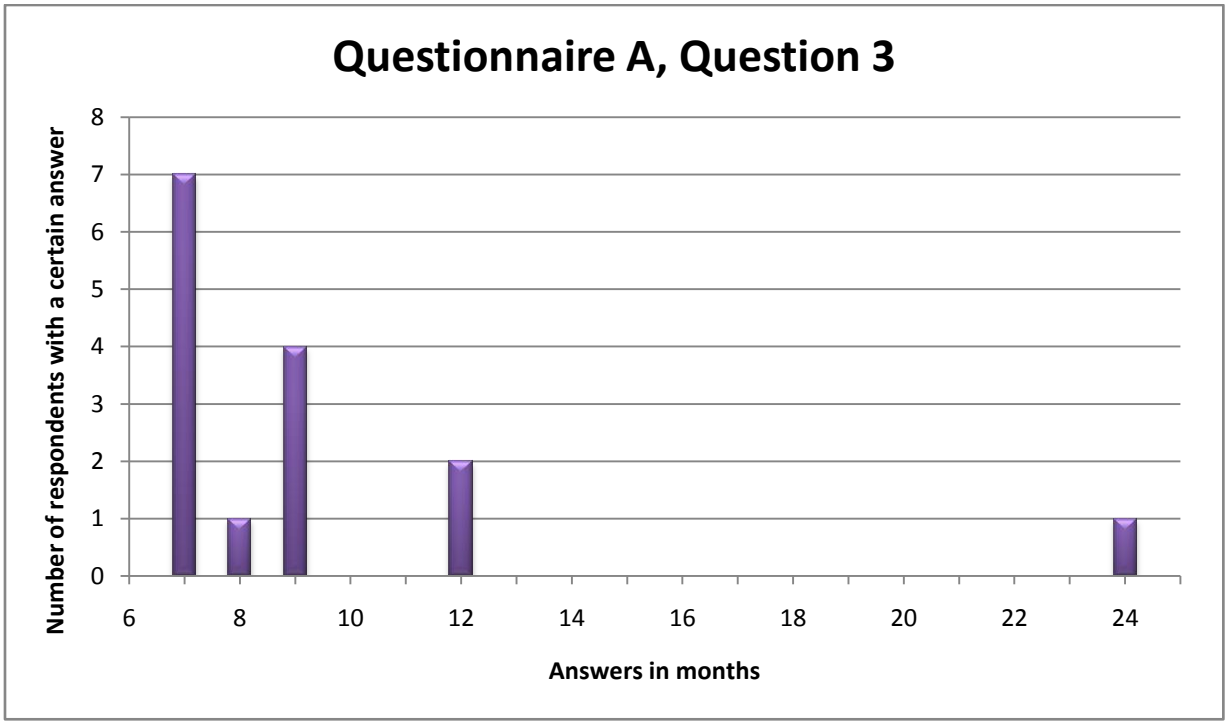

Figure 8. Answers on Question 3 of Questionnaire A

Questions 1 and 3 are originally only used as fill up questions, but it seems interesting to analyze the answers on these questions and compare the results with those of Questions 2 and 4. The results of this comparison we can use as reference point to which we compare the results of the comparisons of the delay and speedup questionnaire.

When taking a closer look at figure 7 one can derive that people are willing to wait 3 extra months for receiving €10 more. In this figure we see that the person that was willing to wait the most, was willing to wait 21 extra months (for receiving €10 more).

When analyzing figure 8 we see that here most people are willing to wait one extra month for receiving €10 extra. This is contradicting to the constant discounting theory when compared to the answers on Question 1 of Questionnaire A.

When making the comparison with Question 1, the point that strikes the eye immediately is that when receiving €90 in 3 months, most people are willing to wait three extra months for receiving €10 extra (7 of the 15 respondents), followed by people that are willing to wait one extra month (5 of the 15 respondents). In figure 8, this pattern is the other way around. When receiving €90 in 6 months, most people are willing to wait one extra month for receiving €10 more (7 of the 15 respondents), followed by people that are willing to wait three extra months (4 of the 15 respondents). This implies that people do not use constant discounting, when the receipt of a certain amount of money takes place at different points in time.

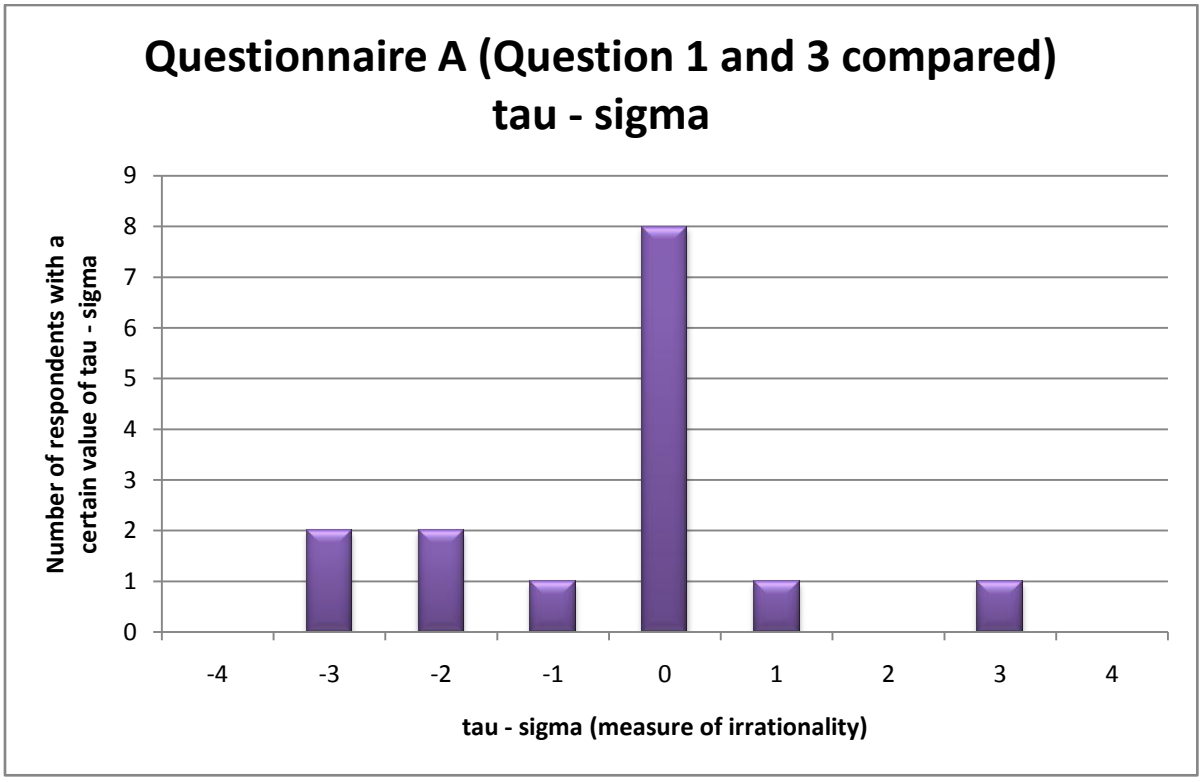

Figure 9. Measuring $\tau - \sigma$ through comparison Question 1 and 3 of Questionnaire A

In figure 9 again (as in figure 3 and figure 6) we see that most people have a value of 0 for $\tau - \sigma$, which means their behavior is following the constant discounting logic. This is somewhat contradicting to earlier conclusions, as mentioned above people do not use constant discounting, when the receipt of a certain amount of money takes place at different points in time. $\tau - \sigma$ can be seen as the overriding measure of irrationality and thus an appropriate conclusion is that overall people show a considerable amount of rationality, though there are some patterns in figures 4 and 5 that cannot be explained when following constant discounting.

Furthermore, it can be noted that in figure 9 (compared to figure 3) less people have a $\tau - \sigma$ of 0 and more have values of lower and higher than 0 (though not as extreme as -5 in figure 3). Two respondents have a positive value for $\tau - \sigma$, which corresponds to people that are willing to wait longer when the receipt is further in the future. However, more respondents have a negative value for $\tau - \sigma$, which corresponds to less patience when the receipt of the payment takes place further in the future. We already saw this in figure 3, where most of the people that didn't follow the constant discounting logic ($\tau - \sigma$ is not zero) had a negative value for $\tau - \sigma$.

Thus, it seems that most people are following a constant discounting behavior when confronted with a Questionnaire formulated as a delay of receivable payments. However,

most of the people that are not following the constant discounting logic, have a negative $\tau - \sigma$, which means that they are less patient when their receipt takes place further in the future.

4.2.2 SPSS

In Tables 3 and 4 of Appendix E the statistical results are shown for the comparison between the measures of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A. The mean found for $\tau - \sigma$ of Questions 1&3 of Questionnaire A is -.4667. Comparing these with the means already found above, the thing that catches the eye immediately is that both means of the measures of irrationality of Questionnaire A (delay formulation) are negative, while that of Questionnaire B (speedup formulation) is positive. This may show some proof for the existence of a delay-speedup asymmetry.

By conducting the Levene's test the hypothesis of equal variances assumed cannot be rejected and so for finding the answer on the question about which of the basic hypotheses stated above is right, we have to look in the first row of Table 4. A P-value can be seen of 0.717 which again is not significant. The conclusion is that there is no significant difference between the measure of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A.

4.3 Comparison Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B

The last comparison that is made in the search for detecting a delay-speedup asymmetry in Rohde's measure of irrationality is between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B. The comparison is made by making use of the following hypotheses:

> H_0 hypothesis: there is no difference between the measure of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B
>
> H_A hypothesis: there is a difference between the measure of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B

4.3.1 Histograms

As all figures are already introduced, no histograms are present in this section. However, there are comparisons that are not yet made and are very relevant for detecting a delay-speedup asymmetry in Rohde's measure of irrationality in this comparison.

When comparing figures 4 and 5 with figures 7 and 8 there is a less striking difference than when comparing figure 1 and 2 with figures 4 and 5 as the answers are spread over a time span of 21, and respectively 18 months. However, when not taking into account respondent number 8 which answered 24 months in both Question 1 and Question 3 (see Appendix C), which can be seen as an extreme outlier, we again find the immense difference in variety between the answers given on a delay-formulated questionnaire and those given on a speedup-formulated questionnaire.

When figures 3 and 9 are compared to figure 6, a big deviation can be seen as the people that are not following the constant discounting path in figure 6, are having a positive $\tau - \sigma$. In the other two figures this is the other way around.

As people facing the delay formulated Questionnaire A show many more respondents with a negative value of $\tau - \sigma$ than people facing the speedup formulated Questionnaire B, and people facing the speedup formulated Questionnaire B show many more respondents with a positive value of $\tau - \sigma$, we may conclude a pattern exists. Apparently, the way in which questions are asked, are of influence to the answers respondents give. People facing the delay Questionnaire become less patient when their receipt is delayed and people facing the speedup Questionnaire become more patient when their receipt is delayed.

It should be noted however, that the overriding conclusion of this paper is that there is no delay-speedup asymmetry and this can be seen by the large amount of rationality under the respondents. However, when taking a closer look at the people that are not behaving following a constant discounting logic (those with $\tau - \sigma$ not equal to 0) some proof can be found for the delay-speedup asymmetry.

4.3.2 SPSS

In Table 5 and Table 6 of Appendix E a comparison is made between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B. The conducted Levene's test shows that the equal variance assumed hypothesis cannot be rejected and thus for our answer about which of the two above stated hypotheses is right there has to be looked in the first row of Table 6. The P-value here is 0.074 and this means that H0 cannot be rejected and there is no difference between the measure of irrationality of Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B

When comparing the three P-values with each other, we can see that the P-value of the comparison of Questions 1&3 and Questions 2&4 of Questionnaire A is the largest (0.717). This means that there is strong evidence that the null hypotheses is true and thus that there

is no difference between the measure of irrationality of Questions 1&3 and Questions 2&4 of Questionnaire A.

We see that the other two P-values show a much lower value. The comparison of Questions 2&4 of Questionnaire A and B leads to a P-value of 0.116 and that of Questions 1&3 of Questionnaire A with Questions 2&4 of Questionnaire B shows a P-value of 0.074.

Especially the last P-value deserves some further attention. For this research a level of significance is used of $\alpha = 0{,}05$ and so the null hypothesis cannot be rejected at this significance level. When a level of significance was used of $\alpha = 0{,}10$, the null hypothesis would be rejected and our conclusion would be that there is a significant difference between the measures of irrationality of Questions 1&3 of Questionnaire A compared to Questions 2&4 of Questionnaire B.

It is important to note that the lower P-values of the comparison of Questionnaire A with Questionnaire B (with respect to the P-value of Questions 1&3 of Questionnaire A compared with Questions 2&4 of Questionnaire B) shows that there is a less sound foundation for not rejecting the null hypothesis. This could also be interpreted as a more sound foundation for rejecting the null hypothesis and accepting the alternative hypothesis. The conclusion may be that there is more reason to believe that there is a significant difference between the measures of irrationality when comparing the delay and speedup Questionnaire with each other, than when comparing different Questions of the delay Questionnaire. The framing of questions could induce people to make decisions on another level of rationality.

5. Discussions

Further research on this subject may be very interesting. In this research the overall result is that there is no significant difference between the values of $\tau - \sigma$ of the delay Questionnaire and the speedup Questionnaire. However, the observation that the P-values of the comparison of Questionnaire A with Questionnaire B are a lot smaller than the P-value of the comparison of Questions 1&3 and Questions 2&4 of Questionnaire A, and this leaves some room for discussion about the existence of a delay-speedup asymmetry when using the method of Rohde.

Also, in the graphical illustrations you can detect some kind of pattern that cannot be explained with the constant discounting logic.

Further, more elaborated, research may thus come with very interesting and applicable (in the business life and also in the guiding of persons to the option that is best for them by for instance the government) results. When using the example earlier used in the background section of the inducement of people to save more by the government, this can be seen as well. Before being able to guide people to save more, research has to be done on how to achieve the best results. Information is needed about how long in advance the contract has to be struck for the saving in the future, what kind of contract is most effective and efficient, etc. Further research is therefore necessary.

For further research some recommendations may be of considerable importance. First, the results of research may be more representative when a larger response group is chosen. Also, it may be interesting to divide the respondents into various groups depending on their education and financial independence and see whether there are differences between the various groups. This may be very interesting specifically for the business sector as they can offer, and guide clients to, custom-made options. Second, further research may take several different time points and monetary amounts to see whether this has an effect on the choice behavior of people. Third and last, a random allocation to the order in which the questions are asked may make the result more reliable.

6. Conclusions

The overall conclusion that can be drawn from this paper is that in this small research no strong evidence for the existence of a delay-speedup asymmetry can be found using the method of Rohde, but some patterns that are found may induce people to believe some form of the delay-speedup asymmetry is also found when using the method of Rohde. This conclusion can be backed by several findings throughout this paper.

The figures presented in Appendix E, which has been produced by using computer programme SPSS, show that there does not exist sound evidence for the existence of a delay-speedup asymmetry using the method of Rohde. Both the measures of irrationality of Questions 1&3 and that of Questions 2&4 of Questionnaire A are not significantly different from the measure of irrationality of Questions 2&4 of Questionnaire B. From this we may conclude that the framing of intertemporal choice does not (significantly) influence people's choice behavior measured by Rohde's measure of irrationality. Also we see from these figures that the means of the values of $\tau - \sigma$ are close to zero and thus contribute to constant discounting theory in all cases.

However, when taking a closer look at these figures we see that both means of $\tau - \sigma$ of Questionnaire A are negative, while that of Questionnaire B is positive. This could be assigned to the delay-speedup asymmetry but as the figures are not very convincing, further research on this subject needs to be done.

The figures (histograms) also show a pattern that cannot be explained with constant discounting. In Figures 3, 6 and 9 it can be seen that most respondents are following the constant discounting logic as they are showing a value of 0 for $\tau - \sigma$. However the persons that are not following the constant discounting logic are behaving differently under the delay than under the speedup Questionnaire. In the delay Questionnaire there are more negative than positive values of $\tau - \sigma$, and in the speedup Questionnaire more positive than negative values of $\tau - \sigma$. Also, there is more variation in the values of $\tau - \sigma$ in the speedup Questionnaire. These facts show that there is a foundation for believing that some form of the delay-speedup asymmetry is found when the method of Rohde is used. To get sound evidence for the delay-speedup asymmetry using this method and to see what size the delay-speedup asymmetry has, more research needs to be done.

Appendix A

Try to focus as much as possible on your own questionnaire and try to avoid contact with others making this questionnaire, while completing your form.

1. Because of a tax windfall revenue you will receive €90 in 3 months. The tax collectors office offers you to delay this receipt. You are offered a higher amount then, namely €100.
   If you could receive the €100 in 3 months and one day, you would prefer to receive the €100 in 3 months and one day instead of the €90 in 3 months.
   If you could receive the €100 in 60 years, you would prefer to receive the €90 in 3 months instead of the €100 in 60 years.
   Somewhere in between the 3 months and one day and 60 years there is a time point at which you don't care whether you get €100 at that time point or €90 in 3 months: you are indifferent between receiving €100 at that time point and €90 in 3 months.
   What is that time point for you? Write down your answer in the sentence beneath.
   You are indifferent between receiving €90 in 3 months and receiving €100 in ……. months.

2. Now imagine a tax windfall revenue which takes place further in the future. You will receive €100 in 6 months. Again you can delay this receipt and you are offered a higher amount, namely €105.
   You are indifferent between receiving €100 in 6 months and receiving €105 in ……. months.

3. Now imagine a tax windfall revenue of a smaller amount. You will receive €90 in 6 months. Again you can delay this receipt and you are offered a higher amount, namely €100.
   You are indifferent between receiving €90 in 6 months and receiving €100 in ……. months.

4. Now imagine a tax windfall revenue which takes place further in the future. You will receive €100 in 12 months. Again you can delay this receipt and you are offered a higher amount, namely €105.
   You are indifferent between receiving €100 in 12 months and receiving €105 in ……. months.

Appendix B

Try to focus as much as possible on your own questionnaire and try to avoid contact with others making this questionnaire, while completing your form.

1. Because of a tax windfall revenue you will receive €100 in 6 months. The tax collectors office offers you to speed up this receipt. You are offered a lower amount then, €95.
   If you could receive the €95 in 5 months and 29 days (6 months minus one day), you would prefer to receive the €100 in 6 months instead of the €95 in 5 months and 29 days.
   If you could receive the €95 already tomorrow, you would probably prefer to receive the €95 tomorrow instead of the €100 in 6 months.
   Somewhere in between tomorrow and 5 months and 29 days there is a time point at which you don't care whether you get €95 at that time point or €100 in 6 months: you are indifferent between receiving €95 at that time point and €100 in 6 months. What is that time point for you? Write down your answer in the sentence beneath.
   You are indifferent between receiving €100 in 6 months and receiving €95 in ……. months.

2. Now imagine a tax windfall revenue which takes place further in the future. You will receive €105 in 12 months. Again you can speed up this receipt and you are offered a lower amount then, namely €100.
   You are indifferent between receiving €105 in 12 months and receiving €100 in ……. months.

3. Now imagine a tax windfall revenue of a smaller amount. You will receive €100 in 12 months. Again, you can speed up this receipt and you are offered a lower amount then, namely €90.
   You are indifferent between receiving €100 in 12 months and receiving €90 in ……. months.

4. Now imagine a tax windfall revenue which takes place further in the future. You will receive €105 in 18 months. Again, you can speed up this receipt and you are offered a lower amount then, namely €100.
   You are indifferent between receiving €105 in 18 months and receiving €100 in ……. months.

Appendix C

Questionnaire A

Respondents	*Question 1*	*Question 2*	*Question 3*	*Question 4*
1	*4*	*8*	*8*	*16*
2	*4*	*6,5*	*7*	*12,5*
3	*4*	*7*	*7*	*13*
4	*6*	*7*	*7*	*13*
5	*6*	*7*	*9*	*13*
6	*12*	*12*	*12*	*13*
7	*6*	*8*	*9*	*13*
8	*24*	*12*	*24*	*18*
9	*6*	*7*	*7*	*13*
10	*6*	*12*	*12*	*18*
11	*6*	*9*	*9*	*15*
12	*6*	*9*	*9*	*15*
13	*4*	*7*	*7*	*13*
14	*5*	*7*	*7*	*13*
15	*4*	*6,5*	*7*	*12,5*

Appendix D

Questionnaire B

Respondents	***Question 1***	***Question 2***	***Question 3***	***Question 4***
1	*4*	*9*	*10*	*12*
2	*0*	*6*	*6*	*12*
3	*5*	*11,5*	*11*	*15*
4	*5*	*10*	*6*	*12*
5	*0*	*6*	*0*	*12*
6	*0,5*	*1*	*0*	*12*
7	*0*	*0*	*0*	*0*
8	*5*	*11*	*11*	*17*
9	*3*	*9*	*6*	*15*
10	*5*	*11*	*9*	*12*
11	*5*	*11*	*11*	*17*
12	*1*	*2*	*2*	*7*
13	*5*	*11,5*	*10,5*	*17,5*
14	*3*	*9*	*2*	*16*
15	*5*	*11*	*6*	*17*

Appendix E

Group Statistics

	Question	N	Mean	Std. Deviation	Std. Error Mean
Answer	rationality question 2 and 4 Questionnaire A	15	-.2667	1.43759	.37118
	rationality question 2 and 4 Questionnaire B	15	1.0333	2.71548	.70113

Table 1. Group statistics about the comparison of the measure of irrationality between Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Answer	Equal variances assumed	5.910	.022	-1.639	28	.112	-1.30000	.79333	-2.92505	.32505
	Equal variances not assumed			-1.639	21.276	.116	-1.30000	.79333	-2.94851	.34851

Table 2. Independent T-test on the comparison of the measure of irrationality between Questions 2&4 of Questionnaire A and Questions 2&4 of Questionnaire B

Group Statistics

	Question	N	Mean	Std. Deviation	Std. Error Mean
Answer	rationality question 1and 3 Questionnaire A	15	-.4667	1.55226	.40079
	rationality question 2 and 4 Questionnaire A	15	-.2667	1.43759	.37118

Table 3. Group statistics about the comparison of the measure of irrationality between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Answer	Equal variances assumed	1.103	.303	-.366	28	.717	-.20000	.54627	-1.31899	.91899
	Equal variances not assumed			-.366	27.837	.717	-.20000	.54627	-1.31928	.91928

Table 4. Independent T-test on the comparison of the measure of irrationality between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire A

Group Statistics

	Question	N	Mean	Std. Deviation	Std. Error Mean
Answer	rationality question 1and 3 Questionnaire A	15	-.4667	1.55226	.40079
	rationality question 2 and 4 Questionnaire B	15	1.0333	2.71548	.70113

Table 5. Group statistics about the comparison of the measure of irrationality between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Answer	Equal variances assumed	3.059	.091	-1.857	28	.074	-1.50000	.80760	-3.15430	.15430
	Equal variances not assumed			-1.857	22.267	.077	-1.50000	.80760	-3.17370	.17370

Table 6. Independent T-test on the comparison of the measure of irrationality between Questions 1&3 of Questionnaire A and Questions 2&4 of Questionnaire B

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