The relationship between overconfidence and Anchoring

An empirical analysis

Bachelor Thesis

Economics and business economics

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Date: 21-7-2016

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1. Introduction

"We are normally blind about our own blindness. We're generally overconfident in our opinions and our impressions and judgments. We exaggerate how knowable the world is" - Daniel Kahneman
(Luscombe, 2011)

Since the introduction of judgmental heuristics in economic decision making by Kahneman and Tversky (1974), there has been an enormous amount of research done on the behavioral aspects of economic decision making. Several biases in human behavior where discovered indicating that a human does not make decisions as rationally as assumed in classic economic theory. Two of these judgemental heuristics introduced are the Overconfidence bias and the Anchoring and adjustment Hypothesis. Where the Overconfidence bias is the phenomenon that people tend to be overconfident in their own abilities, and the anchoring and adjustment hypothesis states that people will include any random given variable presented before a decision in the decision making process (Tversky & Kahneman, 1974; Kahneman & Tversky, 1977).

Empirical implications for the overconfidence bias can be found in research on overconfidence. One of the main implications is the research on the overconfidence of manager's (Doukas & Petmezas, 2007; Malmendier, Tate & Yan, 2007). The anchoring and adjustment hypothesis finds one of its main implications in the research on consumer behavior that can be biased by presenting anchor values (Northcraft & Neale, 1987; Wansink, Kent & Hoch, 1998). These are just some of the examples of the wide applicability of these two behavioral heuristics. However, there is not a great extent of research done on the interaction between these two phenomena. Research by Block & Harper (1991) found no empirical evidence for a direct relation between the anchoring and adjustment hypothesis and the overconfidence bias. However this research was based on an inaccurate definition of overconfidence as overconfidence was later more elaborately defined (Moore & Healy, 2008). This gives reason to reinvestigate the relation between the two phenomena. If there is an interaction existent between the two, it would have widely applicable useful implications. For instance on both of the two mentioned areas, anchor values can then be used to influence the overconfidence behavior of both managers and consumers.

This paper will conduct a research on the existence of a relation between these two behavioral anomalies. First the theoretical basis of both the anchoring and adjustment hypothesis and the overconfidence bias is discussed. Based on the theory found on the subjects, combined with the research of Block & Harper, a testing framework is constructed via three hypotheses. Secondly a survey is conducted in order to generate the data needed to test whether the hypotheses can be rejected. Next a statistical analysis is conducted upon the data. At last based on the statistical results derived from the data a conclusion is made on the presence of a relation between anchoring and overconfidence.

2. Theory

2.1 Anchoring

In order to investigate a relation between the anchoring-and-adjustment-hypothesis (in the rest of the paper referred to as anchoring) and overconfidence (in the rest of the paper referred to as overconfidence) it is necessary to first look at these phenomena separately.

One of the first definitions and investigations on the anchoring effect was conducted by Tversky and Kahneman (1974). They stated that in many situations people make estimates by starting from an initial value, and adjust that value to give their definite estimation. This initial value can be given by an external source for instance the formulation of the problem, or it can be the result of partial computation by the subject itself. This causes a bias towards the given initial value in people's estimations. This phenomenon is defined as anchoring.

They continued with a confirmation of their theory by conducting a simple experiment. Subjects were asked to estimate the percentage of African countries in the United Nations. They first had to spin a wheel of fortune that would generate a value between 0-100, and accordingly they had to estimate a percentage by moving upward or downward from the generated value. Although the generated value held no information on the actual percentage of African countries in the United Nations, the test has showed that subjects with a starting point of 10 had a median estimated value of 25%, whilst subjects with a starting point of 65 had a median estimated value of 45%. Giving an initial value prone to an estimation thus caused subjects to adjust their estimation in the direction of the initial value (Tversky & Kahneman, 1974).

One of the underlying causes of the anchoring effect is explained in a more recent study. Epley and Gilovich (2006) give one explanation for the underlying principle of the anchoring effect. They explain that the adjustment process starting at the Anchor-value continues until a plausible estimation value is reached. A person will start to deviate from his anchor value until he has reached a value that in his mind is in the range of possible values. Because adjusting from the anchor value is effortful as a process, a person will stop as soon as he reaches one of the two extremes of his possibility frontier, whilst the actual value tends to be closer to the mean of this interval. This causes people to have a bias in direction of the anchor that is provided either by themselves or by an external source.

An anchor can either be given by an external source (e.g. the researcher conducting the experiment) or can be self-generated. A self-generated anchor is an anchor constructed by the decision maker. This self-generated anchor is equal to a subject's initial point of estimate (Block & Harper, 1991). When asking a subject to formulate an anchor value, the subject will take this value into account when further questions are asked. A no-anchor situation is described as a situation where there is not specifically asked to make an initial estimate, in this case the subject is more likely to not take this anchor-value into account.

It is determined that adjusting from the anchor value is effortful and thus this indicates that adjustments can be stimulated by giving incentives to make more effort when estimating the true value. This causes people to deviate more from the anchor value, and thus brings them closer to the mean value of their range interval. Giving incentives to increase the effort when estimating a value based on an anchor-value only worked in cases the anchor was self-generated. In cases the anchor is provided by the experimenter, incentives are unable to increase the deviation from the anchor-value (Epley & Gilovich, 2005).

2.2 Overconfidence

The first to publish an article on the overconfidence effect were Kahneman and Tversky (1977). They have defined the concept of overconfidence as a phenomenon that shows how people tend to be overconfident when they are asked to specify a certain confidence interval for an estimation on an unfamiliar object. There also seems to be a positive relation between overconfidence and ignorance; this relation came forward in the fact that people are more overconfident on their estimates when they know less about the true value of the estimated object (Kahneman & Tversky, 1977).

An investigation on the confidence intervals given by weather forecasters indicated that overconfidence does not occur if there is a certain level of expertise on the subject of estimation (Murphy & Winkler, 1977). The claim that knowledge on the subject at matter (i.e. expertise) excluded an overconfidence effect was explored and redefined with an optimal knowledge level of 80%. If a subject had a knowledge level of more than 80%, it turned out that the subject became prone to underconfidence. The 80% parameter in the experiment was defined as knowing with 100% certainty the answer on 80% of the questions asked. In addition to that, the experiment conducted also showed that subjects' overconfidence increased with task difficulty. Logically subjects also tend to be underconfident on tasks that are very easy. This follows from the fact that an easy task inherently indicates great knowledge (i.e. that makes it easy). This relation is called the hard-easy effect (Lichtenstein & Fischhoff, 1977).

The overconfidence effect is also tested and confirmed with different methods than used by Kahneman and Tversky. In a different experiment subjects were asked questions and were given two possible answers. The subject then had to give the answer he thinks is most likely to be correct and had to choose a confidence decile (e.g. the subject thinks it is 80% to 90% certain he is right thus chooses the 8th decile). At the end of the experiment the amount of correct answers is compared to the given confidence range, with no overconfidence these two numbers are the same. The result of the experiment brought evidence that there is an overconfidence bias and that overconfidence increases with question difficulty (Gigerenzer, Hoffrage, & Kleinbölting, 1991).

The overconfidence-effect to which all the articles until thus far refer to is overconfidence in a generalized aspect. That is: the possible differences in the existing forms of measured overconfidence are not taken into consideration. Instead overconfidence is generalized as a situation where a subject is overly confident in the precision of his own estimate. The first to distinctively discuss the different forms of overconfidence where Moore and Healy (2008). They deduced three forms of overconfidence based on the existing literature.

Overconfidence could be separated in the following three forms.

1. Overestimation of one's actual performance;
2. Overplacement of one's performance relative to others;
3. Excessive precision in one's beliefs.

Overestimation and overprecision are often used simultaneously or contradicting in conducted experiments without consideration (Moore & Healy, 2008). This paper will consider the different forms of overconfidence and will take them into consideration for the experiment.

-Overestimation

"Overconfidence in the form of overestimation is defined as overestimation of one's actual ability, performance, level of control, or chance of success." If thus a subject who took a 10-question survey thinks he answered correctly five times when, in fact, he only answered correct 3 times then he overestimated his score. It was found that on tasks where the performance of a person is high (i.e. an easy task) there is a tendency to underestimate ones performance. On the other side, people tend to overestimate their performance when the performance is actually low (Moore & Healy, 2008).

-Overplacement

Overconfidence in the form of overplacement shows when "people estimate their performance to be better than that of others", for instance, more than 50% of the people may rate themselves as better-than-average. The phenomenon of overplacement is commonly referred to in literature as 'the-better-than-average effect' (Moore & Healy, 2008). Solid evidence for the existing of the better-than-average effect was found when 1 million American students were asked to place themselves in comparison to the other students on the characteristics of: leadership ability, athletic ability and social ability. The results showed that 70% of the students were convinced their leadership ability was above the mean, for athletic ability 60% of the student placed themselves above the mean and for social ability 85% of the students rated their social abilities better than average (Alicke & Govorun, 2005). In contradiction to the relation between task difficulty and overestimation, for overplacement it is shown that people tend to show more underplacement on hard tasks and more overplacement on easy tasks (Larrick, Burson, & Soll, 2007; Moore & Small, 2007).

-Overprecision

The third form of overconfidence, overprecision, is defined as "excessive certainty regarding the accuracy of one's beliefs". Overprecision is investigated in the literature by conducting experiments were subjects were asked to generate a numerical estimation on a given object. After giving the numerical estimation the subject is then asked to give a confidence interval wherein he thinks the true value of his estimated object lies (Moore & Healy, 2008). In the literature the most frequently used confidence intervals are 90% and 50%-confidence intervals. Multiple results show that these confidence intervals estimated by a subject tend to be too narrow, 90%-confidence intervals contain the correct answer in less than 50% of the cases (Alpert & Raiffa, 1982; Klayman, Soll, Gonzalez-Vallejo, & Barlas, 1999; Soll & Klayman, 2004).

2.3 The relation between overconfidence and Anchoring

Block and Harper (1991) where the first to analyze directly the link between the overconfidence effect and the anchoring and adjustment hypothesis. Their study provides clear insight in the relation between these two phenomena. Block and Harper conducted multiple experiments in which they sought to confirm their suspicions about the relationship between anchoring and overconfidence. In 4 experiments they explicitly tested the relation between an anchor and the overconfidence of subjects of which 3 experiments are relevant for this paper. In one of the experiments they compared two groups of subjects that were asked to estimate a 50%-confidence interval for their estimated value. So they had to give a range of which they were 50% sure that it contained the actual value of the estimated object. The two groups were divided into two conditions: group 1 had to give an estimation on both 19 familiar and unfamiliar objects directly (i.e. unfamiliar objects are objects of which the subjects do not have any informational value before participating in the experiment). Group 2 was asked to make the same estimations but only after first providing a self-generated anchor value. The results of this experiment indicated that subjects were less overconfident in self-anchor situations than in no-anchor situations. The second experiment tested the relation between self-anchor subjects and other-anchor subjects. This experiment was conducted similar to the previously described experiment only this time one group was asked to estimate 23 unfamiliar objects after estimating an anchor value, whilst the other group where given an anchor value before they estimated there 50%-confidence interval for these 23 unfamiliar objects. The results of this experiment indicated that self-anchor subjects were less overconfident than other-anchor subjects. In the third experiment Block and Harper tested whether no-anchor subjects were less overconfident than other-anchor subjects, however this notion was rejected (Block & Harper, 1991).

3. Testing Framework

3.1 Hypothesis

Block and Harper (1991) referred in their article to the overconfidence effect, but using the definitions given in the literature by Moore & Healy (2008), they are actually conducting an experiment only on the overprecision bias. In their experiments subjects are asked to estimate a value where after they have to give a 50%-confidence interval. Block and Harper draw conclusions based on the results following these 50%-confidence intervals given by the subjects, thus they are only testing the relationship between anchoring-and-adjustment hypothesis and what is defined as the overprecision effect. In order to give a complete conclusion on the relation between anchoring and overconfidence all three forms of overconfidence are to be investigated separately in relation to the anchoring-and-adjustment hypothesis.

This research will focus on the relation between overconfidence and anchoring by dividing overconfidence into three definitions mentioned above. The research question of this thesis:

'Is there a relationship between anchoring and three types of overconfidence?'

This research will attempt to answer the research question by dividing the research into three separate relations between anchoring and overconfidence

Hypothesis 1: *'Giving an anchor before a subject makes an estimation on an unfamiliar object has no influence on the overestimation of a subject's estimation'.*

On the basis of the literature this hypothesis will not be rejected if giving an anchor does not give a subject the idea he has more information on the matter and thus giving an estimate becomes easier. If however a subject does include the anchor value in the known relevant information regarding the subject, the anchor will increase the underestimation because the task will seem less difficult than in a no-anchor situation. The literature suggests that there is an anchoring effect, and thus that a subject uses the anchor value as valuable information for his estimate. Combining this with the theoretical implication that a subject shows more underestimation on an easier task, it is reasonable to predict that people with an anchor will be less prone to overconfidence in their estimation. This would reject the first hypothesis.

Hypothesis 2: '*Giving an anchor before a subject makes an estimation on an unfamiliar object has no influence on the overplacement of a subject's estimation"*

As the literature states that for overplacement there tends to be more overplacement on easier task it follows that here, with the same reasoning as for hypothesis 1, the theoretical implications predict that there will be a positive relationship between overplacement and anchoring, people with an anchor will be more prone to overplacement of their precision, thus rejecting the hypothesis.

Hypothesis 3: "*Giving an anchor before a subject makes an estimation on an unfamiliar object has no influence on the overprecision of a subjects estimation*"

This hypothesis will actually be a small reproduction of the article by Block and Harper. They already concluded that there is no increase in overprecision when subjects were giving an anchor before estimating an unfamiliar object. There is an empirical implication that states there is no relation between the anchor and the degree of overprecision. Thus it is expected that the third hypothesis will not be rejected. In addition, reproducing this investigation will be a useful test to see if the experiment is in line with previous findings, increasing its validity.

3.2 Survey

To obtain the data required to test the hypotheses of this thesis, a survey will be conducted amongst students at the Erasmus University. The survey will provide the data to conclude whether there is reason to reject the hypotheses. The survey will require the participants to make an estimation on certain unfamiliarity's. To get the clearest results with the survey, it is important that all the estimates made by the participants are of equal difficulty. If a participant has more knowledge on one estimation object relatively to the other estimation objects, theory predicts that the participant will be more prone to underconfidence when reflecting on his overall performance due to the relatively easy question. Indicating that the results will show a smaller overconfidence bias than is actually present. For this reason the survey will only ask for estimations on unfamiliar objects. Unfamiliar objects in this case are objects of which the true value is presumed to be unknown for any random sample of participants. In this way the difficulty of the estimation will be as equal as possible for all participants.

For the survey, a treatment group and a control group will be made. Participants of both groups will be first asked to make 9 estimations on the value of an unfamiliar object, such as the total surface of the Dutch city Maastricht. An error margin of 10% will be allowed – any estimate which is no more than 10% off the true value is considered correct. After answering the 9 estimation questions the participants will be asked a series of questions, such as how many correct answers they have given, how they compare themselves to the rest of the participants, and a 50%- and 90%-confidence interval for the number of correct answers. Answers to these questions will be used to construct measures of overconfidence in their performances.

The survey thus will exist of a total of 13 questions. This research assumes this will be sufficient in order to detect an overconfidence bias among the sample. Adding more questions could make the survey too long, which affects the effort participants are willing to put in their answers. Using a method where the overconfidence is measured on an aggregated level will be sufficient to investigate whether there is a deviation from the mean and if this deviation is influenced by adding an anchor to the survey.

The nine estimation assignments that will be used in the survey are drafted using a similar line of reasoning as used in the experiment conducted by Block and Harper (1991). Questions are estimation assignments on unfamiliar quantities. These quantities are for instance the size of a population or the total surface of a city. The survey will be conducted upon students at the Erasmus University of Rotterdam. The survey will be administrated via social media, thus the selection of participants will be limited to a group of people acquainted to the conductor of the survey. The participants will still be uninformed about the merits of the survey, so they will form a representative sample. Assignment to the treatment or the control group of the survey will be random with a 50-50 distribution.

4. Data

The data collected from the survey will provide an insight in the overconfidence of the participants. The survey asks for 9 unfamiliar estimation assignments, indicating high level of difficulty. This predicts that the average number of correct answers given by participants will be low. If one of the nine questions is answered correctly far more often than the other questions, it will indicate that this questions is actually an easy assignment with low difficulty. Given the theory this will affect the overconfidence of a participant. The difficulty of the test questions will be tested to determine whether all of the nine questions are qualified as difficult questions. In the survey the participant had a 50% chance he/she had to implement an other-generated anchor based on his phone number[1]. Based on this anchor the sample group can be divided into two separate groups. The Anchor group: consisting of all participants exposed to an anchor, and a control group: consisting of all participants not exposed to an anchor. Some data included in the survey is not directly relevant for this study but serves for structural purposes in the survey as well as a possibility to get more insight in the participants of the survey. The following data will be used in order to investigate the research question of this thesis:

The anchor value
In this survey an anchor is randomly introduced to 50% of the participants to generate two groups. A participants has either an anchor value being the last two digits of their phone number, or no anchor value. The value of the anchor could thus be any number between [0 – 99] for the group where an anchor value is introduced.

Actual Score
For every correct answer given by the participant he will receive one point. Over 9 questions it is possible to score a minimum of 0 points and a maximum of 9 points.

Estimated score
This is the number of correct answers the participants thinks he has given on the 9 estimation assignments. This number has a minimum of 0 and a maximum of 9.

Actual percentile ranking
Based on their actual score participants are divided into groups. These groups are defined by the percentage of other participants that performed better than the participants in the particular group. A percentile ranked group consist of a number of participants that have given the same amount of correct answers. The score is the total percentage of participants that answered more questions correctly based on their score.

Estimated percentile ranking

[1] Although the participant uses his on phone number the anchor cannot be seen as self-generated due to the fact that the conditions on which the anchor value is generated are determined through the survey question.

Participants are asked to give a percentage to indicate how they performed relative to the other participants. This percentage is defined as 'the percentage of other participants that performed better than you'. This percentage is a number between 0-100.

50%-confidence interval
The 50%-confidence interval is an estimation by the participants. It shows the interval of which the participants believe that it contains their score with a probability of 50%. The interval can be any interval within the range [0-9]

90%-confidence interval
The 90%-confidence interval is an estimation by the participants. It shows the interval of which the participants believe that it contains their score with a probability of 90%. The interval can be any interval within the range [0-9]

Overestimation score [actual score – estimated score]
The level of overestimation is measured with an overestimation score. This value is calculated by deducting the score from the estimated score. If the overestimation score gives a positive value, it is an indication for overconfidence. If the overestimation score gives a negative value, it is an indication for underconfidence.

Overplacement score [actual score relative to other participants - Estimated score relative to other participants]
The overplacement score gives an indication of the level of overplacement the participants show. The overplacement score is calculated by subtracting the estimated score relative to other participants from the score relative to other participants. This gives a score that indicates with how many percentage points a participant over- or underplaces his performances. A positive value being overplacement and a negative value being underplacement.

Overprecision score
Overprecision is measured on the basis of the intervals given by the participants. The 50%- and 90%-confidence intervals are compared to the score of the participants. If the score is within the interval, the participants shows overprecision. If however the score is outside the interval the participant show underprecision. For the 50%-confidence interval the score should be within the interval for 50% of the participants. For the 90% confidence interval it follows that for 90% of the participants the score lies within the interval.

4.1 Descriptive statistics

The statistics collected by conducting the survey can be divided into three groups.

1. The sample Group: containing all the data in the sample
2. The Anchor Group: containing all the data of participants exposed to an anchor
3. The control Group: containing all the data of participants exposed to an anchor

For each of the three groups above the following descriptive statistics can be found for the variables that will be used to draw a conclusion on the hypotheses stated in this thesis. The descriptive statistics give a general overview of the data collected via the survey

Table 3.1

Descriptive statistics

This table contains the descriptive statistics of the sample used. It contains the mean, standard deviation, median, minimum and maximum.

Variable	*Group*	*Mean*	*Standard deviation*	*Median*	*Min*	*Max*
Overestimation score	Sample Group	1,75	1,71	2	-2	6
	Anchor Group	1,58	1,94	1,5	-2	6
	Control Group	1,96	1,48	2	0	6
Overplacement score	Sample Group	-9,30	23,64	-9,18	-52,67	39,90
	Anchor Group	-8,00	21,14	-9,18	-40,10	39,90
	Control Group	-9,20	25,69	-8,57	-52,67	37,90
Overprecision score (at 50%)	Sample Group	0,94	0,23	1	0	1
	Anchor Group	0,92	0,27	1	0	1
	Control Group	0,96	0,20	1	0	1
Overprecision score (at 90%)	Sample Group	0,91	0,30	1	0	1
	Anchor Group	0,92	0,27	1	0	1
	Control Group	0,88	0,33	1	0	1
Anchor	Anchor Group	37,46	28,05	36	0	95

Sample size N = 53 Anchor group size N = 26 Control group size N = 27

On the overestimation score the mean of the sample group (1.75) indicates that on average the participants tend to be overconfident in their estimation. Combined with the standard deviation of the sample group (1.71) it gives strong indication that in general the participants show an overestimation in their performances in the survey. This is consistent with the findings presented in the literature stating that people tend to be more overconfident for difficult tasks. Comparing the anchor group and a control group based on the descriptive statistics of both these data sets it is interesting to see that the mean overestimation score is higher for the control group (1.96) than for the anchor group (1.58). This shows that the two groups are not strongly different. It gives a weak indication that the anchor group tends to be less subjected to overestimation than the control group. The mean of the anchor value (37.46) with the value of the standard deviation (28.05) however indicate that, following theory, the mean of the anchor group should be biased towards the higher anchor value.

The mean overplacement score of the sample group (-9.30) gives a weak indication that participants tend to show underplacement in the estimation of their score in comparison to other participants. The high standard deviation (23.64) is partially caused by the leaps in the data. The actual percentile ranking groups the participants at a certain actual percentage score due to the low differences in actual score of the participants, causing the leaps in the data. The difference between the mean of the anchor group (-8.00) and the mean of the control group (-9.20) gives an indication that the participants exposed to an anchor value tend to show less underplacement than the participants in the control group. With a mean anchor value of (37.46) this is a weak indication that on average implementing an anchor did cause a bias towards the anchor value. Although it is a weak implication it is consistent with the literature presented in this thesis stating that people tend to show less overplacement for difficult tasks.

Due to the characteristics of the overprecision scores for both the 50%- and the 90%- confidence interval the mean of this variable, since the value is either 0 or 1, gives the ratio of the participants that where overprecise in their estimate. Thus the standard deviation of both the 50%- and the 90%- confidence interval over precision scores hold no further valuable information. The min and max values are a result of the variable being 0 or 1.

Comparing the mean 50%- confidence interval overprecision scores of the anchor group and the control group it shows that for the anchor group 92% of the participants show overprecision against 96% for the control group. This indicates that imposing an anchor to the participants causes them to be less overprecise. Interesting however that given the sample size of N=57, both these values are very high. For the 90%- confidence interval overprecision scores it shows that 88% of the participants in the control group are overprecise against 92% for the anchor group. For the 90%-confidence interval, based on the mean, we see a reversal of the effect found by the 50%-confidence interval. For the 90%- confidence interval the implementation of an anchor causes the participant to be more overprecise. People seem to be insensitive to the level of confidence interval when constructing their confidence interval.

The descriptive statistics of the data give a general indication of the implications of the data. However it is not enough to draw any conclusions regarding the hypotheses stated in this thesis. In order to make a statement on the validity of the hypotheses the data needs to be further analyzed.

5. Methods & Results

In order to test the hypothesis stated in this thesis the data collected from the survey will be analyzed to find the evidence to either support or reject the hypotheses. The data collected from the survey makes it possible to compare two groups. The group exposed to an anchor value, and the control group that is not exposed to an anchor value. In order to see whether the anchor effects the overconfidence shown by the participants, the two groups have to be compared with each other. Because the direction of the bias caused by the anchor is dependent of the value of the anchor, the values of the anchors generated by the participants have to be examined in order to determine whether the data must be controlled for the value of the anchor.

For the effect of an anchor on overestimation and overplacement a comparison has to be made between the mean scores of both groups. If there is a significant difference between these sets of scores for the two groups, there is evidence that the introduction of an anchor prior to the estimation assignment does influence the degree of overconfidence a participant shows. First it has to be determined whether the two groups are normally distributed around the mean for the two forms of overconfidence. A Jaque-bera test determines whether normal distribution around the mean can be assumed for the the variables. If this is the case a T-test will suffice to determine if there is a significant difference between the scores for the two groups. If there is no normal distribution present, the data must be analyzed to determine whether a clear solution is present to solve the problem of non-normality. If there is no clear solution (e.g. omitting a strong outlier) for the problem of non-normality, a non-parametric test will be used to test the two groups. On the basis of the test statistics it is then possible to either reject or not reject the hypotheses. For the third hypothesis on the measurement of overprecision a proportion test will be conducted, because the overprecision score is a binary variable. The actual value of the anchors can be neglected because the binary form of the data does not allow any measurement in degree of overprecision. For all of these tests a significance level of $p = 0.05$ will be used and is assumed to be sufficient to draw reliable conclusions.

5.1 Overestimation

To determine a significant difference in overestimation between the anchor group and the control group a test between the two groups will be conducted. First the both groups must be tested for a normal distribution using the Jarque-Bera test statistic. For both the anchor group ($p = .62$) and the control group ($p = .06$) the Jarque-Bera test statistic does not reject the null-hypothesis of a normal distribution[2]. The assumption of a normal distribution can be made for both groups.

With the assumption of normality the two groups can be compared with a T-test. However it is first interesting to look at the effect of the anchor value on the overestimation score of the participants. If the value of the anchor has an influence on the overestimation score of a participant this has to be controlled in the data set. Looking at the influence of the anchor value on the overestimation score

[2] Appendix 9.1.1

using both a correlation coefficient (0.3) and a least squares regression with the overestimation score as dependent variable and the anchor as independent variable (p = .14) it can be assumed that there is no significant influence of the value of the anchor on the overestimation score[3]. Thus there is no need to correct for the value of the anchor.

With the assumption of normal distribution made for both the control group and the anchor group, the two groups can be compared using a T-test. The test will determine if the two means of both group are significantly different from each other under H_0 that both means are equal. With the T-statistic of 0.8 with a p-value 0.43 the null-hypothesis cannot be rejected[4]. There is no statistical evidence that suggests that there is a significant difference between the mean overestimation score of the control group and the anchor group. Furthermore, using Eviews as an analytical tool allows to conduct multiple different tests on the same value[5]. These tests however give no indication that there is ground to doubt the result of the T-test conducted on the data as they produce similar results.

5.2 Overplacement

In order to test for a difference of the mean overplacement scores of the control group versus the anchor group a similar approach as for the overestimation can be used. The means of both sample groups must be compared but in order to use a T-test statistic first the assumption of a normal distribution for both groups must be made. The probability of the Jarque-Bera test statistics of the anchor group (.40) and the control group (.81) do not reject the null-hypothesis of a normal distribution[6]. Thus the assumption of a normal distribution can be made for both groups.

Because the difference between the control group and the anchor group is made based on the implementation of an anchor value, again it is needed to investigate whether the magnitude of the anchor has a significant relation with the degree of overplacement shown by participants. If there is a significant influence of the anchor value on the overplacement score of participants, a controlling variable needs to be included to correct for this. The correlation of 0.03 between the anchor value and the overplacement score gives an indication that there is little to no significant influence of the anchor value on the shown overplacement score[7]. Using a regression analyses to test for a factitive relation between the value of the anchor and the overplacement score gives statistical evidence that there is no significant relation between the anchor value and the overplacement score indicated by a P value of 0.90[8]. Thus there is no need to correct the overplacement score for the value of the anchor since there is no direct significant relation between the two variables.

Since it can be assumed that both sample groups follow a normal distribution for the overplacement score it is possible to conduct a T-test on the mean overplacement scores on the anchor group versus the control group. Under the null-hypothesis that both groups have an equal mean the T-test will determine whether there is a significant difference between the anchor group and the control group. The T-statistics of -0.18 with a probability of 0.85 give no grounds to reject the null-hypothesis of an

[3] Appendix 9.1.2
[4] Appendix 9.1.3
[5] Appendix 9.1.3
[6] Appendix 9.2.1
[7] Appendix 9.2.2
[8] Appendix 9.2.3

equal mean for both groups[9]. There is no evidence of a significant difference between the overplacement scores generated by the anchor group and the control group.

5.3 Overprecision

In order to determine whether there is a significant difference between the overprecision scores of the anchor group and the control group a different statistical test has to be conducted. Because the overprecision scores are measured with a binary system, where 0 indicates underprecision and 1 indicates overprecision, a proportion test is needed to test for a significant difference between the two sample groups. There is no use to investigate if the value of the anchor affects the degree of overprecision since the binary measurement of the overprecision only indicates if there is overprecision, it does not show the individual degree in which the overprecision occurs. It is however interesting to look if participants with a higher anchor value are more likely to be overprecise, indicating that the value of the anchor determines the likelihood of showing overprecision. A point-biserial correlation analyses gave no statistical evidence to support such a relation[10]. In order to test whether there is a difference in overprecision scores between the two groups, the groups are divided on the basis of being exposed to an anchor or not being exposed to an anchor. The actual value of the anchor is neglected. The difference between the groups is thus based on the variable anchor that can be 'yes' or 'no'. The two groups are tested based on the success rate derived from the mean. Because the results are binary the mean gives a proportion of 'success' which can be used to conduct a proportion test Both for the 50%-confidence interval ($p = 0.61$) as for the 90%-confidence interval ($p = 0.44$) there is no ground to reject the null-hypothesis that the distribution of the anchor group are equal to the distribution of the control group[11].

[9] Appendix 9.2.4
[10] Appendix 9.3.1
[11] Appendix 9.3.2

5.4 Survey question control

In order to strengthen the validity of this research it is useful to perform an additional investigation on the question difficulty as presented in the survey. If one of the questions is significantly more difficult than the other questions the survey needs to be controlled for this question.

table 5.1

Correct Response rate

this table contains the percentages of correctly given answers for each question

question number	1	2	3	4	5	6	7	8	9
percentage correct answers	11%	8%	15%	6%	11%	13%	9%	4%	11%

Sample size N = 53

As presented in table 3.2 the differences in correct response ratio are negligible. A difference of 11% for the two outlying questions presents a difference of only 6 correct responses on a total of 53 responses, which cannot be marked abnormal. Both questions are nearly evenly deviated from the mean correct response rate of 10%. A proportion test is conducted to determine whether there is statistical evidence in support of a significant difference between the two outlying questions. If they do not differ significantly, it can be assumed that all the questions are of the same difficulty. The proportion test cannot reject the null hypothesis that both proportions are equal ($p = .51$) [12], since the two outlying values are not significantly different it can be assumed that all the questions are of equal difficulty.

[12] Appendix 9.3.3

6. Discussion of results

The main purpose of this paper was to investigate and elaborate the relation of the phenomena of the overconfidence bias and the anchoring-and-adjustment hypothesis where the approach of this paper reasons from an existent relation between the two phenomena. Although limited research existed on the relation between these two anomalies a line of reasoning could be drawn from the existent literature on both Anchoring and overconfidence.

The literature on the anchoring-and-adjustment hypothesis implied that although the anchor provided to a person does not hold any information regarding the subject of estimation, a person uses this anchor in some extend in his reasoning to produce an estimate. This causes the estimated value to be biased towards the value of the anchor (Tversky & Kahneman, 1974). The empirical implication of this is that the anchor provided to the subject is used as a piece of information by the subject, even though the anchor holds no actual information regarding the subject of estimation.

Combining this implication for providing an anchor with the theoretical implications of the hard-easy effect for overconfidence (Lichtenstein & Fischhoff, 1977) gave a theoretical basis for the line of reasoning used to formulate the first hypothesis of this thesis. The hard-easy effect implicated that a person tends to be more overconfident on difficult estimation assignments and becomes less overconfident as the assignment becomes less difficult. Thus if an anchor is provided to a person prone to an estimation assignment, this person believes he has more information at his disposal to make the estimation and thus would (wrongfully) asses it as an relatively easier task. This would cause the implementation of an anchor to decrease his level of overconfidence. Based on this the first hypothesis was drafted.

Hypothesis 1: *'Giving an anchor before a subject makes an estimation on an unfamiliar object has no influence on the overestimation of a subject's estimation'.*

Although the theory suggested that there is an influence of imposing an anchor on a subject prior to an estimation, the data collected for this thesis did not give any evidence in support of the rational expectations based on the theory. There is no empirical implication of an anchor having influence on the degree of overconfidence shown by a person. Noted that the participants did show an overall tendency to be overconfident in their correctly given estimates. Imposing an anchor however did not cause a significant change in the degree of the overconfidence shown by the participants. The hypothesis cannot be rejected based on the sample used for this thesis.

Based on the descriptive statistics of the samples however an indication of an effect of an anchor on the degree of overconfidence being present is indicated by the difference in the two means. Taking this into account two empirical implications can be derived based on the results of this thesis. The first implication is that there is no evidence for an effect of an anchor on the degree of overconfidence in the sample, however the validity of this result can be questioned given the implications derived from the descriptive statistics. Due to the relatively low number of participants in the samples (N=26) It could be the case that there is an influence of the imposed anchor on the degree of overconfidence, only the magnitude of this effect is not significantly large enough to be discovered in a dataset of this proportion (N=53).

In the case of the overplacement, again the anchor value can be seen as a wrongfully implemented piece of information that participants use to make their estimate. However in the case of the overplacement effect there is an effect opposite of the hard-easy effect described for overestimation. For overplacement theory suggests that people tend to show less overplacement if the task is more difficult, and more overplacement for a relatively easy task (Larrick, Burson, & Soll, 2007). Based on the theory the second hypothesis was drafted in a similar way of reasoning as the first, only in this case theory predicted an increase in overplacement when implementing an anchor.

Hypothesis 2: '*Giving an anchor before a subject makes an estimation on an unfamiliar object has no influence on the overplacement of a subject's estimation"*

The analyses conducted on the data did not give any significant evidence in support of a significant relation between an imposed anchor before making an estimate and the degree of overplacement shown by the participants. The expected relation between the anchor and the degree of overplacement based on the theory did not get any empirical support from the data analysis. Thus the hypothesis cannot be rejected and it cannot be assumed that imposing an anchor will affect the degree of overplacement shown by the participants.

Although there was only a weak indication of an effect of the anchor on the degree of overplacement derived from the descriptive statistics of the data, it is still possible that this relation is indeed existent. As mentioned before the number of participants (N = 53) could not be sufficient enough to present the effect that is tested with the data. For the testing on overplacement another defect in the data is present as due to the limited amount of questions answered correctly in combination with the limited amount of participants in the survey the percentile ranking used as a basis to determine the degree of overplacement is a very limited variable due to the big leaps in the percentile ranking. Making it hard to compare the mutual actual performances of the participants.

For the effect of an anchor on overprecision Block and Harper (1991) found no empirical evidence for the relation between an imposed anchor and the degree of overprecision shown by participants. The research presented in this paper however was an extension on the research presented by Block and Harper as they did not separate the overconfidence effect into the three definitions that where defined later (Moore & Healy, 2008). The third hypothesis was drafted as a reproduction of the research Block and Harper presented in order to confirm that the same results are found.

Hypothesis 3: "*Giving an anchor before a subject makes an estimation on a unfamiliar object has no influence on the overprecision of a subjects estimation*"

The overprecision shown by the participants is clearly visible in the data generated with the survey. As shown in table 3.1[13] the actual value of correct answers was within the 50%- confidence interval roughly 90% of the time. This is in line with earlier research that gave empirical evidence that people tend to be overprecise in their estimates (Alpert & Raiffa, 1982; Klayman, Soll, Gonzalez-Vallejo, &

[13] Page 13

Barlas, 1999; Soll & Klayman, 2004). However for the 90%-confidence interval there was only a small degree of overprecision (roughly 2%) shown by the participants. Testing for the relation between imposing an anchor before making an estimation and the degree of overprecision provided no empirical evidence to reject the third hypothesis. There was no effect found of including an anchor on the degree of overprecision. This is in line with the results presented by Block and Harper (1991).

Although the result of the tests on the third hypothesis where expectable, the difference in degree of overprecision between the 50%- and the 90%-confidence interval is remarkable. Where a high degree of overprecision is shown for the 50%-confidence interval, this overprecision has almost completely disappeared when participants were asked to give a 90%-confidence interval. However this can be explained when a closer look is taken at the dataset. It shows that 46% of the participants gave an equal or smaller confidence interval when asked for the 90%-confidence interval, subsequent to the question to formulate a 50%-confidence interval. This anomaly contradicts the assumed basic reasoning capabilities of the participants. It is mathematically impossible to present a smaller confidence interval at a 50% level than at a 90 % level. This suggests that subjects were very insensitive to the level of confidence interval. The anomaly found in this study also casts doubt on the validity of the overprecision measure often elicited based on self-reported 90%-confidence interval.

7. Conclusion

The main goal of this thesis is to give an answer to its research question in the most definite manner. The research question:

'Is there a relationship between anchoring and three types of overconfidence?'

This thesis used the study of Block and Harper (1991) on the effect of an anchor on overconfidence as a starting point for the investigation into the relation between anchoring and overconfidence. Where Block and Harper only used overprecision as a measurement of overconfidence this thesis focusses on all the three types of overconfidence defined by Moore and Healy (2008). There was a distinction made between the following three types of overconfidence:

1. Overestimation
2. Overplacement
3. Overprecision

Tests were conducted to search for empirical evidence in support of an existing relation between overconfidence and anchoring, however no significant relations where found for either one of the types of overconfidence. In addition to the original findings of Block and Harper that indicated that there is no significant relation between anchoring and the degree of overprecision, there is also no empirical evidence that supports the existence of a relation of anchoring on either overestimation or overplacement. In the results section it is discussed that there could be a relation existing, but that the effect of an anchor on the degree of overconfidence in general is too small to be found with a dataset of this proportion. However a similar sample proportion was used in the earlier study of Block and Harper thus as an extension of their study the results in this paper cannot be disregarded based on the sample size.

Based on the findings presented in this thesis the following conclusion can be made: there is no significantly relationship between anchoring and the three types of overconfidence. Although these two behavioral biases are combined often in real situations, there is no indication that an anchor can be used to induce a change in overconfidence shown by individuals.

8. Considerations

The main consideration of this thesis is the validity of the survey conducted to generate the dataset on which the conclusion of this thesis are based. Some of the estimation questions in the survey presented highly illogical answers[14], indicating that the participants are either very ignorant or that the participants did not fill out the survey truly reflecting their real world behavior on the decisions made in the survey.

The survey was administered online via the use of social media. Although the use of social media is a very effective way to find participants for a survey, it also decreases the degree of insight on whether the participants really reflects his real life behavior on the survey. There is no personal control and thus a participant can just as easily give completely random answers in order to lose as little time as possible on making the survey. The great variety in the time needed to complete the survey indicated that indeed not all participants filled out the survey in the same extend. A more personal approach could result in more representative answers given in the survey.

Another problem that arises in the survey is the fact that there is no material incentive presented in the survey and that thus there is little incentive to give answers representing the behavior participants would show in real life[15]. Introducing a financial incentive to the participants in the survey could nudge participants to give the answers that present their actual behavior at a greater extend. Due to the lack of resources this however was not possible for this research.

Besides the conditions on which the survey is taken it is also arguable that the formulation of the survey influences the outcome presented in the data. For this survey the anchor was placed after the nine estimations questions were made, and before the four performance estimations which are used to test the hypothesis. However there is no existing research found that discusses to which degree an imposed anchor is still used as a (unjustified) reasoning tool over multiple questions. Changing the placement of the anchor value in the survey could change the effect it has on the estimates made, and thus could change the degree on which the anchor has effect on overconfidence.

Further and more elaborate investigation is required to adapt the research methods to these shortcomings in this thesis. However this thesis is still valid as it presents a reflection of the real world situation in the best possible extend based on the data.

[14] The survey was conducted on Erasmus university students only, indicating a relatively high level of intelligence under the participants. However some of the answers given on the estimations were so improbable it is safe to assume a university student would now that it is incorrect. For instance multiple participants answered that there are '0' people displayed on the 'nights watch', a painting that is incorporated in the Dutch history curriculum on high school indicating that the participants have the knowledge to know that there are people painted on the painting.

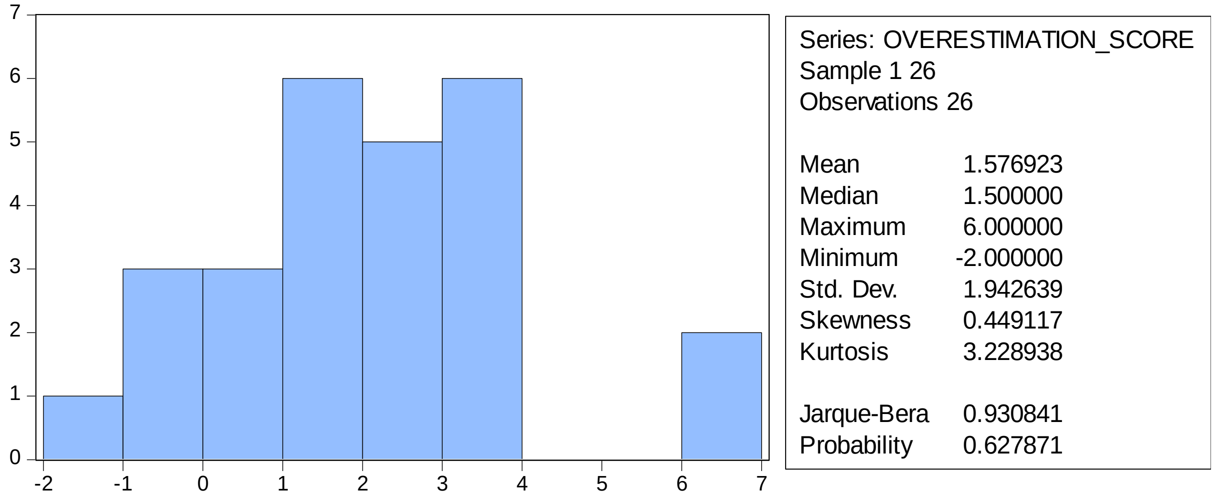
[15] The only incentive in this case is the goodwill towards the executor of the survey. However it is unlikely that this incentive is strong enough for all the participants.

9. Appendix

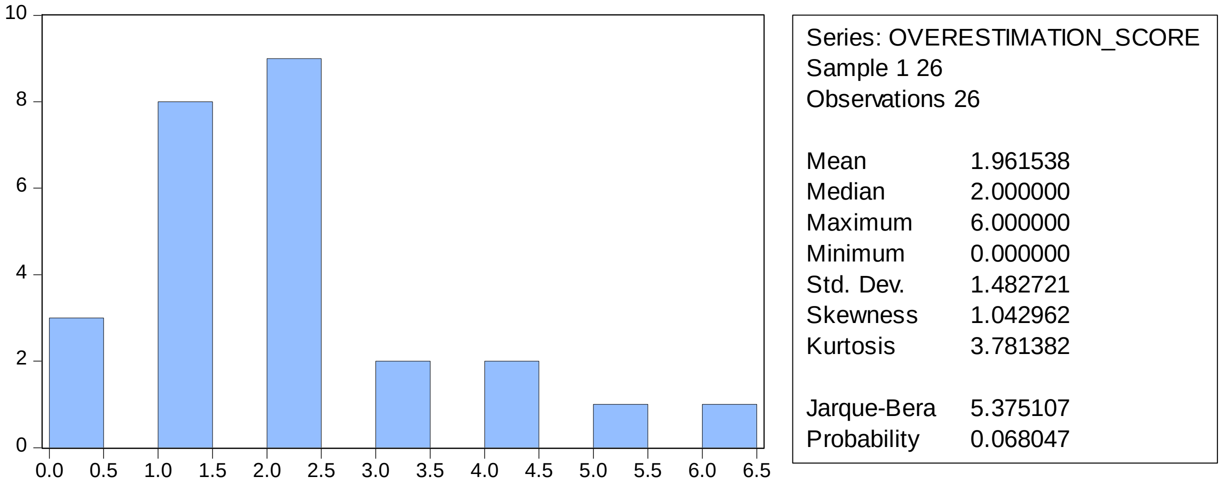
9.1.1 Normal distribution Test overestimation

-Jarque-bera test statistics for the variable: overestimation_score

Anchor Group



Control group



9.1.2 Test on significance of anchor value

-Correlation matrix including the variables anchor and overestimation_score

Correlation	ANCHOR	OVERESTIMATION_SCORE
ANCHOR	1.000000	0.297305
OVERESTIMATION_SCORE	0.297305	1.000000

-Regression analyses including variables: anchor and overestimation_score

Dependent Variable: OVERESTIMATION_SCORE
Method: Least Squares
Date: 06/14/16 Time: 23:12
Sample: 1 26
Included observations: 26

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ANCHOR	0.020587	0.013495	1.525468	0.1402
C	0.805707	0.627234	1.284539	0.2112

R-squared	0.088390	Mean dependent var	1.576923
Adjusted R-squared	0.050406	S.D. dependent var	1.942639
S.E. of regression	1.893045	Akaike info criterion	4.188054
Sum squared resid	86.00688	Schwarz criterion	4.284831
Log likelihood	-52.44470	Hannan-Quinn criter.	4.215922
F-statistic	2.327052	Durbin-Watson stat	1.480946
Prob(F-statistic)	0.140214		

9.1.3 T-test statistics on overestimation

-T-test statistics on the compared mean overestimation scores of both the control group and the anchor group

Date: 06/20/16 Time: 16:05
Sample: 1 26
Included observations: 26

Method	df	Value	Probability
t-test	50	0.802495	0.4261
Satterthwaite-Welch t-test*	46.74729	0.802495	0.4263
Anova F-test	(1, 50)	0.643998	0.4261
Welch F-test*	(1, 46.7473)	0.643998	0.4263

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	1.923077	1.923077
Within	50	149.3077	2.986154
Total	51	151.2308	2.965309

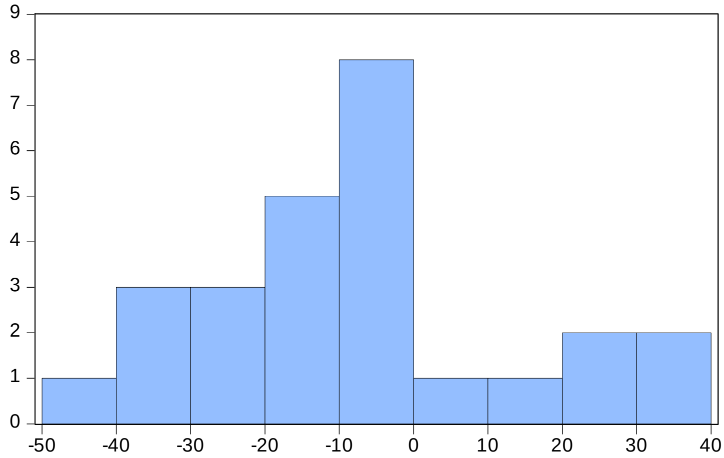
Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
OVERESTIMATION_SCORE	26	1.961538	1.482721	0.290786
OVERESTIMATION_SCORE_ANCHOR	26	1.576923	1.942639	0.380983
All	52	1.769231	1.722007	0.238799

9.2.1 Normal distribution test overplacement

-Jarque-bera test statistics for the variable: overplacement_score

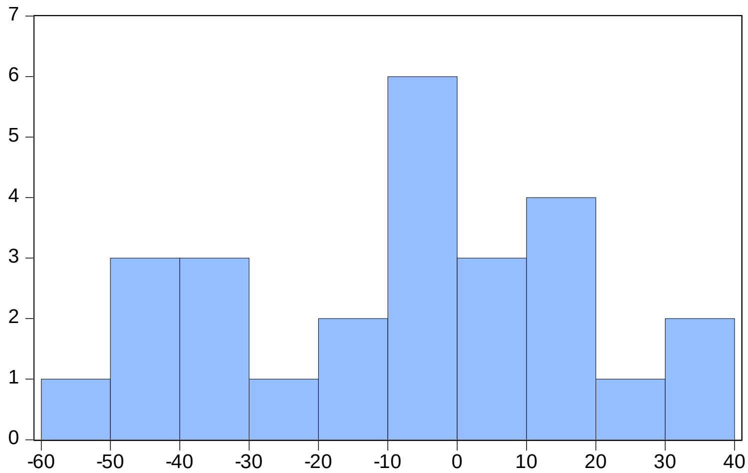
Anchor group



Series: OVER_PLACEMENT_SCORE_ANC
Sample 1 26
Observations 26

Mean	-7.999215
Median	-9.183673
Maximum	39.89796
Minimum	-40.10204
Std. Dev.	21.13890
Skewness	0.650000
Kurtosis	2.958641
Jarque-Bera	1.832687
Probability	0.399979

Control group



Series: OVER_PLACEMENT_SCORE__
Sample 1 26
Observations 26

Mean	-9.200157
Median	-8.571429
Maximum	37.89796
Minimum	-52.67347
Std. Dev.	25.68720
Skewness	-0.080470
Kurtosis	2.149613
Jarque-Bera	0.811482
Probability	0.666483

9.2.2 Test of significance of anchor value

-Correlation matrix including the variables anchor and overplacement_score

Correlation	OVER_PLACEMENT_SCORE	ANCHOR
OVER_PLACEMENT_SCORE	1.000000	0.026242
ANCHOR	0.026242	1.000000

-Regression analyses including variables: anchor and overplacement_score

Dependent Variable: OVER_PLACEMENT_SCORE
Method: Least Squares
Date: 06/20/16 Time: 16:53
Sample: 1 26
Included observations: 26

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ANCHOR	0.019773	0.153753	0.128606	0.8987
C	-8.739960	7.146048	-1.223048	0.2332

R-squared	0.000689	Mean dependent var	-7.999215
Adjusted R-squared	-0.040949	S.D. dependent var	21.13890
S.E. of regression	21.56736	Akaike info criterion	9.054043
Sum squared resid	11163.63	Schwarz criterion	9.150820
Log likelihood	-115.7026	Hannan-Quinn criter.	9.081911
F-statistic	0.016539	Durbin-Watson stat	1.537989
Prob(F-statistic)	0.898741		

9.2.3 T-test statistics on overplacement

-T-test statistics on the compared mean overplacement scores of both the control group and the anchor group

Test for Equality of Means Between Series
Date: 06/20/16 Time: 17:35
Sample: 1 26
Included observations: 26

Method	df	Value	Probability
t-test	50	-0.184076	0.8547
Satterthwaite-Welch t-test*	48.21432	-0.184076	0.8547
Anova F-test	(1, 50)	0.033884	0.8547
Welch F-test*	(1, 48.2143)	0.033884	0.8547

*Test allows for unequal cell variances

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	18.74940	18.74940
Within	50	27667.13	553.3426
Total	51	27685.88	542.8604

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err.of Mean
OVER_PLACEMENT_SCORE__	26	-9.200157	25.68720	5.037675
OVER_PLACEMENT_SCORE_ANCHOR	26	-7.999215	21.13890	4.145678
All	52	-8.599686	23.29937	3.231041

9.3.1 Point-biserial correlation analyses

-Correlation matrix of a point-biserial correlation analyses with the variables: anchor, 50%-confidence interval score and 90%- confidence interval score for the anchor sample group.

Correlation matrix

		50%- Confidence interval score	90%- Confidence interval score	anchor
50%- Confidence interval score	Pearson Correlation	1	,458	-,278
	Sig. (2-tailed)		,019	,168
	N	26	26	26
90%- Confidence interval score	Pearson Correlation	,458*	1	-,273
	Sig. (2-tailed)	,019		,177
	N	26	26	26
anchor	Pearson Correlation	-,278	-,273	1
	Sig. (2-tailed)	,168	,177	
	N	26	26	26

*. Correlation is significant at the 0.05 level (2-tailed).

9.3.2 Proportion Test on Overprecision

-The proportion test conducts a test on the two proportions given by the mean overprecision_score of both groups.

H_0 : P1 = P2
H_a : P1 ≠ P2

$$Z = \frac{P1 - P2}{SE} \qquad SE = \sqrt{P(1-p)(\frac{1}{n1} + \frac{1}{n2})} \qquad P = \frac{(P1.n1 + P2.n2)}{n1 + n2}$$

For the 50%-confidence interval score:

P1 = 0.94
P2= 0.92
N1 = 26
N2 = 27
* values used from table 3.1, descriptive statistic section (pg.

$$P = \frac{(0.94.26 + 0.92.27)}{26 + 27} = 0.93$$

$$SE = \sqrt{0.93(1 - 0.93)\left(\frac{1}{26} + \frac{1}{27}\right)} = 0.07$$

$$Z = \frac{0.94 - 0.92}{0.07} = 0.29 \quad (P = .61409)$$

For the 90%-confidence interval score

P1 = 0.91
P2= 0.92
N1 = 26
N2 = 27
* values used from table 3.1, descriptive statistic section (pg.

$$P = \frac{(0.91.26 + 0.92.27)}{26 + 27} = 0.92$$

$$SE = \sqrt{0.92(1 - 0.92)\left(\frac{1}{26} + \frac{1}{27}\right)} = 0.07$$

$Z = \frac{0.91-0.92}{0.07} =$ -0.14 (P = . 44)

9.3.3 Proportion test on question difficulty

-The proportion test conducts a test on the difference in the ratios of correctly given answers on the question with the highest and respectively lowest amount of correct responses used in the survey

P1 = 0.15
P2= 0.04
N1 = 53
N2 = 53
* values used from table 5.1, Methods & results section (page 17)

$$P = \frac{(0.15.53+0.04.53)}{106} = .095$$

$$SE = \sqrt{0.095(1-0.095)\left(\frac{1}{53}+\frac{1}{53}\right)} = 3.019$$

$$Z = \frac{0.15-0.04}{3.019} = 0.036 \text{ (P = . 51436)}$$

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