UiT THE ARCTIC UNIVERSITY OF NORWAY

School of Business and Economics

Anchoring & Auctions

Willingness to pay for public goods and anchoring in an auction

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Preface

It is with mixed feelings I submit my master thesis and thereby ending my life as a student. I have always argued that a student life is a exiting and confortable way of life. However, I am looking forward to the challenges that lie ahead.

The work on my master thesis has been interesting, but challenging. I did not realize the amount of work required conducting an experiment. There have been times of frustration and joy. The experience has been extremely valuable and I am left with a feeling of wanting more. I have scratching the surface of a huge field and hope it is not for the last time.

There are a few people that I wish to thank for helping me completing my master thesis. First I would like to thank my supervisor Eirik Eriksen Heen for helping med with everything from spell checking to theoretical input and analysis. He is probably one of the most engaging supervisors you can get, illustrated whit his own words; “my supervisor wants me to focus more on my own research and less on my students, but I can’t, this is so interesting”. I would like to thank my professors at the University of Tromsø for the knowledge they have given me. I would like to thank my parents and my brother for their love and support through my studies. A big thank to everyone who participated in my experiment and made all this possible. Lastly I want to thank Eir for being my research assistant and spell checker. For supporting me in the dark moments when I wanted to quit and for always encouraging me.

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Abstract

This thesis discusses the cognitive bias anchoring observed in economics, psychology and in general. Anchoring effect describes the common human tendency to rely too heavily on the first piece of information offered (the anchor) when making decisions. The thesis reports on an experiment examining anchoring effect on willingness to pay for a set of consumer goods. In this study I find that the actual willingness to pay for various consumer goods can be manipulated by an uninformative anchor, replicating Ariely et al. (2003). I furthermore demonstrate that the anchoring effect decrease and in some instances vanish under a Vickrey auction.

Keywords: Anchoring effect, Vickrey auction, Experimental Economics, Willingness to pay

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1. Introduction

I would like you to picture the street address of your best friend. Visualize it. Say the number out loud. I now would like you to answer the following question; how many practicing dentist are there in your community? Say the street address of your best friend is 2342. Would this number influence your answer to the question about the number of dentists? Would your estimate be higher than if your friend's address happened to be 33? If so, your decision may be biased by one of the most remarkable influences on human judgement, namely the anchoring effect. How does this effect influence your judgement? Why is it so remarkable? How can it be strikingly robust, pervasive and rigorously tested, while the mechanisms behind still remains an enigma? These are some of the questions I will explore in this thesis.

Many human decisions are made under condition of uncertainty. In such instances we use heuristics. A simple, efficient set of rules, which is used to determine what belief or action, has the highest chance of being correct in a given situation. They work well under many circumstances, yet they can lead to systematic deviation from logic, probability or rational choice theory. Economics use the concept of *homo economicus*. This is a rational agent that makes perfect decisions, acting as if they use game theory in social interaction and don't care for others welfare. Bounded rationally is a cornerstone in behavioural economics and challenge this concept. Bounded Rationality comes from humans' limited information processing capability and is backed up by humans' failure to maximize expected utility.

The purpose of this master thesis is to explore the nature of anchoring effects. Whit a better understanding if this cognitive bias, economists can make better predictions about subjects behaviour.

> (…) the rate of false positives depends not only on the observed significance level, but also on statistical power, research priors, and the numbers of scholars exploring the question. Importantly, a few independent replications dramatically increase the chance that the original finding is true.
>
> (Maniadis et al., 2014: 277)

The thesis also reports on an experiment examining anchoring effect on willingness to pay for a set of consumer goods. The purpose of this experiment was twofold. First, I checked whether the result of Ariely et al. (2003) replicate. Second, I investigated whether such anchoring, if it existed, was affected by an auction situation.

The master thesis is organized in the following way: chapter 2 explore the history of experimental economics. Chapter 3 presents different auctions types. Due to the relevance for the experiment it contains a more thorough review of the Vickrey auction. In chapter 4 and 5 both Expected Utility and Prospect theory is presented and the differences is discussed. Chapter 6 explores the anchor effect in depth. The remaining thesis is devoted to the experiment. In chapter 7 the experimental design is presented. Chapter 8 describes the procedure of the experiment and how it was conducted. Chapter 9 reports the results. Chapter 10 is an overall summery, with some discussion and conclusions based on the previous chapters.

2. Experimental Economics

Experimental economics has been the main character in one of the most amazing methodological revolutions in the history of science (Blume and Durlauf, 2008). In the curse of just a few decades, economics has been transformed from a field where the experimental method was considered ineffective, impractical and mostly irrelevant, to a field where the most exciting advancements are driven by laboratory data.

Experimental economics is a branch that focuses on individual behaviour in a controlled laboratory setting or out in the field. It applies experimental methods to study economic questions. Experimental economics helps to disprove or prove economic theories and develop insight and predictions about real-world behaviour.

A related field that can be called a modern extension of experimental economics is behavioural economics. Here the effects of cognitive, social, psychological and emotional factors on the economic decisions of institutions and individuals are studied. This field are mainly concerned with the bounds of the rationality of economic agents.

2.1 History

Experimental economics takes the form of several, partly intertwined and independent threads. To see a single coherent history can be difficult. Also pinpointing the first economic experiment can prove challenging at the least, and may often be less illuminating than thought to be. Roth and Sotomayor (1992: 170) illustrated this with the following analogy:

> Columbus is viewed as the discoverer of America, even though every school child knows that America were inhabited when he arrived, and that he was not even the first to have made a round trip, having been preceded by Vikings and perhaps by others. What is important about Columbus' discovery of America is not that it was the first, but that it was the last. After Columbus, America was never lost again.

Nevertheless, it is still possible to identify early experiments that have been of importance. To highlight key moments and achievements that has contributed to establish experimentation as a legitimate method in economics.

2.1.1 St Petersburg paradox

This classical example dates back 300 years and can be described as a willingness to pay game. The participants are asked how much they are willing to pay to play the following game. A fair coin is tossed, in the case of heads the participants receives 2 ducats and is allowed to throw again. For the next heads the participants receives 4 ducats, then 8 for the next heads, then 16 and so on. Hence at each stage the pot is doubled every time a head appears. The game ends when the toss results in a tail. The participant then receives the amount he has accumulated so far. The only way for the participants to go empty handed home is to throw a tail on the first throw.

In 1713 the mathematician Nicolas Bernoulli (de Montmort, 1713) asked this question to people in the streets of St Petersburg. No one would pay more than 10 ducats to participate in Bernoulli's game. This result contradicted an already established and accepted calculation of expected value, which gamblers had used for centuries. It states that you can find the expected value by multiplying the games payoff if you win, by the probability of winning and then summing up all the different outcomes. By using this rule on Bernoulli's game, what would the expected payoff be?

There are an infinite numbers "consequences" (tosses of heads followed by one tail) possible. The game ends the first time a tail appears and the participant wins whatever is in the pot. In short, the player wins 2^n ducats, where n is heads tossed before the first tail. The probability of a consequence of n flips $(P(n))$ is 1 divided by 2^n, and the expected payoff of each consequence is the price times its probability. Therefore, the expected value for n tosses would be:

$$E = \frac{1}{2} \times 2 + \frac{1}{4} \times 4 + \frac{1}{8} \times 8 + \frac{1}{16} \times 16 + \cdots$$

(1) $$E = 1 + 1 + 1 + 1 + \ldots$$

$$E \sum_{k=1}^{\infty} 1 = \infty$$

The expected value of the game is the sum of the expected payoffs of every possible outcome. Since the expected payoff of each possible outcome is 1, and there are an infinite number of them, this sum is infinite. If we use the expected value as the decision criterion, the player should be willing to pay ∞ ducats. Of course no one have infinite amount of money. People can only pay within their budget constraint. But since the possible payoff is quite big it is reasonable to assume one would pay more than 10 ducats to participate in Bernoulli's game. This early, but significant experiment is known as the St. Petersburg paradox.

It was considered a paradox because it contradicted with the leading assumption about rationality. An assumption that gave birth to the expression *l'homme clair* (human's at its best) and was seen as the norm for rational and optimal thinking. It was assumed that the "brightest minds" resonated according to the same laws that applied to mathematics and logics, the last being derived from the first. However, confronted with Bernoulli's question even the "brightest minds" deviated from the accepted normative rules. It challenged the classical assumption of rationality. This is the reason for the St. Petersburg Paradox great historical value. It also was the catalyst for later accepted distinction between normative and descriptive decision theory. It is a distinction between how decision ideally should be taken and how they actually are made.

2.1.2 Expected Utility

As a direct consequence of the St. Petersburg paradox, the concept of utility was born. Since then it has played a central role in decision theory. The concept of utility is used in Daniel Bernoulli's (Nicolas cousin) presentation of the paradox and his solution to it, published in 1738 in the Commentaries of the Imperial Academy of Science of Saint Petersburg (Bernoulli, 1738). Daniel's classical resolution to the St. Petersburg paradox involved the introduction of a utility function and a hypothesis of expected utility, predating Adam Smith by a generation and marginal utility theory by about a century. In Daniel's own words (1954: 24):

> The determination of the value of an item must not be based on the price, but rather on the utility it yields. The price of the item is dependent only on the thing itself and is equal for everyone; the utility, however, is dependent in the particular circumstances of the person making the estimate. Thus there is no doubt that a gain of one thousand ducats is more significant to the pauper than to a rich man though both gain the same amount.

Bernoulli argued that a rational or optimal choice is optimal relative to the decision maker. He also assumed that rationale decision makers choose the alternative that maximises the expected utility. With these two assumptions, Daniel Bernoulli can be seen as the founder of modern decision theory.

It still would take some time before someone picked up on Bernoulli's work. Nineteenth century economists rigorously outlined the traditional view of economics as a non-experimental science (Blume and Durlauf, 2008). John Stuart Mill (1963: 124) pointed out several practical obstacles in using experimental method. The problem of keeping (1) background conditions fixed, make it difficult to manipulate each cause in isolation. He also mentioned (2) the impossibility of controlling key economic variables. Instead he adopted a priori deductive method. This was a theoretical approach to decide what the "perfect" homo oeconomicus would do in a given situation. Even though the field of economics changed a lot after Mill, it took over a century before scepticism towards experimentation faded away.

It is generally agreed that the birth of experimental economics owes a lot to the mathematician John von Neumann and the economist Oscar Morgernstern. They moved on from Bernoulli's formulation of a utility function over wealth and formally developed the expected utility model over lotteries and gambles in their book *Theory of Games and Economic Behaviour* (1947). The assumption that economic actors behave rational had long been central in economic theory. But what does this mean? They gave a precise answer to this question and with a mathematical theory they specified what it would imply to make rational choices. Remarkably, they viewed the development of the expected utility model as something of a side note in the development of the theory of games (Levin, 2006).

Von Neumann and Morgenstern proved that, as long as decisions are maid according to the axioms, a utility function exists. It will be possible to assign a particular utility to every possible outcome of decisions in a way that one alternative is preferred to another. The preferred alternative has a higher expected utility than the other alternative.

The expected utility theory assumes that the probability of every outcome is objectively given. Later the theory was modified (Savage, 2012), enabling for a subjective estimation of outcome probability. Resulting in the Subjective Expected Utility Theory.

2.1.3 Bounded rationality

While some praised the SEU theory, some started asking questions. Does people make decisions according to the SEU-theory? In the 50s Herbert Simon was the most prominent critic of the Expected Utility Theory. He later received the Nobel price in economics for his pioneering research into the decision-making process within economic organizations.

The idea that SEU-theory gave a good description of human rationality was something he could not agree on. In the article *A behavioural model of rational choice (Simon, 1955),* he introduced the concept of “bounded rationality”. It is the idea that rationality of individuals is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make a decision. Simon argued (1955: 99):

> the task is to replace the global rationality of economic man with a kind of rational behaviour that is compatible with the access to information and the computational capacities that are actually possessed

Since the SEU model is based on the “economic man”, in Simon’s (1983: 13) analysis:

> the SEU model is a beautiful object deserving a prominent place in Plato’s heaven of ideas. But vast difficulties make it impossible to employ it in any literal way in making actual human decisions.

Simon used the analogy of a pair of scissors when describing his theory of bounded rationality. Rational human behaviour can be described as shaped by a scissor. The two blades are the cognitive limitations of humans and the structures of the environment. Meaning that pre-existing structure in the environment can be successfully exploited by minds with limited cognitive resources (Gigerenzer and Selten, 2002).

> However adaptive the behaviour of organisms in learning and choice situations, this adaptiveness falls far short of the ideal of ‘maximizing’ postulated in economic theory. Evidently, organisms adapt well enough to ‘satisfice’; they do not, in general, ‘optimize’.
>
> (Simon et al., 2008: 39)

Simon therefore rejects the classical assumption l’homme Clair as a norm of rationality. His bounded rationality perspective on decision-making sets the agenda for a lot of the later work in decision psychology, experimental and behavioural economics.

2.1.4 Prospect theory

The psychologists Daniel Kahneman and Amos Tversky followed in Simon’s footsteps. With the prospect theory they specified how decision makers systematically deviate from the

SEU-theory. When the theory was published in 1979 many of the individual elements was already known. The great contribution of Kahneman and Tversky was that they managed to formulate a precise mathematical theory on the same form as the SEU-theory. Entailing the theory to explain many of the systematic deviations of the SEU.

Nevertheless, economists largely neglected most of the research on decision-making. Simons bounded rationality had initially small or no effect on the basic assumption in economic theory (the assumption that each individual act rational). Behaviour that Simon described as an example of humans limited rationality, were often explained as a rational adaptation to the costs of searching for information. This changed with an experiment conducted by Kahneman and Tversky two years after the publication of the Prospect theory. The experiment is famously called the Asian disease study and illustrates a psychological bias called the framing effect. Tversky and Kahneman (1981) presented two problems (Figure 1):

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

<u>Problem 1</u>	**<u>Problem 2</u>**
Which of the two programs would you favor?	**Which of the two programs would you favor?**
*** If program A is adopted, 200 people will be saved [72%].**	*** If program C is adopted, 400 people will die [22%].**
*** If program B is adopted, there's a 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved [28%].**	*** If program D is adapted, there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die [78%].**

Figure 1: Framing effect[1]

They conducted the experiment with two different student groups. One group were confronted with program 1 and the other with program 2. The goal was to compare these two different problems, and how the students perceived them. By comparing the problems it is easy to see that option A and C are equal. The same applies for option B and D. The only difference is that problem 1 focuses on how many people will die, while problem 2 focuses on how many people will be saved. Out of 600 possible deaths, it is the same if 200 die (A) or 400 survive (C). In the same way D and B are two sides of the same story. It is then reasonable to expect that subjects would prefer either A and C or B and D. This was not the case. Tversky and Kahneman found that 72% preferred program A. It illustrated that the majority was risk averse. This means that the prospect of saving 200 lives with certainty was more promising than the probability of a 1/3 chance of saving 600 lives. In the second test group they found that 78% preferred program D. Contrary to the first test-group the majority in the second group were risk seeking. The 2/3 chance that 600 people will die is more acceptable than the certain death of 400 people.

The experiment illustrated that depending on the formulation of a question people would chose differently. This contradicted with a key aspect of the SEU-theory, which states that preferences should not be affected by irrelevant conditions as how identical options are formulated. This aspect was (still is) an essential aspect of the rationality concept used in economics theory. Tversky and Kahneman's experiment clearly illustrates that this assumption does not hold. Positive and negative formulation of a subject, dramatically influence decisions.

2.1.5 Vernon Smith

The last piece of the puzzle of experimental economics is at the same time one of the most important and distinctive. Vernon Smith started conducting experiments in the 50s. He described it himself:

> In the Autumn semester, 1955, I taught Principles of Economics, and found it a challenge to convey basic microeconomic theory to students. Why/how could any market approximate a competitive equilibrium? I resolved that on the first day of class the following semester, I would try running a market experiment that would give the students an opportunity to experience an actual market, and me the opportunity to observe one in which I knew, but they did not know what were the alleged driving conditions of supply and demand in that market.
>
> (Smith, 2002)

Similar experiments had been published before, but nobody at the time attributed particular scientific value to them. Smith was the expectation. Overcoming many obstacles, he finally managed to publish his experiment. Dr Smith has later authored or co-authored more than 250 articles and books in the field of economics. In the 60s he presented a set of rules for experimental design. For example, he highlighted the importance of monetary incentives. This was done to control subject's preferences. It is now a distinguishing feature of the economic way of experimenting.

Vernon Smith later shared the Nobel Prize in Economic Science with Daniel Kahneman for his ground-breaking work in experimental economics.

3. Auctions

An auction is the process of buying and selling goods or services by offering them up for bid, taking bids, and then selling the item to the highest bidder.

Auctions are of considerable importance both theoretical as well as practical. The number of goods that change hands each year by auction is big and the value is huge, illustrating the practical importance. In the absence of intermediate market makers, auctions represent one of the most familiar and simplest means of price determination, thus playing an important role in the theory of exchange.

For most of history, auctions have been a relatively uncommon way to negotiate the exchange of goods. Both set-price sales and haggling have been significantly more common. Nonetheless, auctions have a long history, being recorded as early as 500 B.C. (Krishna, 2009). I modern time auctions are very common. The development of the Internet has led to a significant rise in the use of auctions.

The model corresponding to the case where each bidder knows his valuation of the item with certainty and different bidders' valuations are independently drawn form each other is called the independent private values (IPV) model. Research on this has largely been restricted to the case where valuations, x, are drawn from a uniform distribution $[\underline{x}, \overline{x}]$ (Kagel and Roth, 1995).

Vickrey (1961) was the first to solve this model using a game theoretic formulation. He assumed risk neutral bidders, in a first-price sealed bid auction the unique risk neutral Nash equilibrium bid function given the uniform distribution above is:

$$(2) \qquad b(x) = x + \frac{(n-1)}{n}(x - \underline{x})$$

where n is the number of bidders in the auction.

3.1 Sealed first-price auction

Also known as a first-price sealed-bid auction. All bidders simultaneously submit sealed bids. This way no bidders know the bid of any other participant. The highest bidder pays the price they submitted (McAfee and McMillan, 1987). The bidders can only submit one bid each, and since they cannot see the bids of other participants they cannot adjust their bids accordingly. The first-price auction is theoretically isomorphic to the Dutch auction (Kagel and Roth, 1995).

3.2 Dutch auction

Also known as an open descending price auction (Krishna, 2009). In the traditional Dutch auction the auctioneer starts with a high asking price for some quantity of goods and then lowers the price until a participant accept the current price for some quantity of the goods or until the seller's reserve price is met (McAfee and McMillan, 1987). If the first bidder does not buy all of the goods, the auctioneer continues lowering the price until all of the items have been bid for or the reserve price is met. Goods are allocated based on bid order; the highest bidder selects items first followed by the second highest bidder, etc.

In theory the first-price and Dutch auctions' yield the same expected price. The situation facing the bidders is the same in both institutions (Kagel and Roth, 1995). Each bidder must decide how high to bid without knowing the others' decisions. The winning bidder pays the price equal to the bid he placed.

3.3 English auction

English auction is also known as an open ascending price auction and is arguably the most common form of auction in use today (Krishna, 2009). In an English auction the price is increased until only one-bidder remains. It is an essential feature of the English auction that the bidders always know the level of the current highest bid. The dominant strategy for a bidder is to bid up to their private valuation, x. Bidding less then x, you sacrifice opportunities' for winning the goods and making a positive profit. If you bid above x and wins, it will result in certain losses.

3.4 Vickrey auction

Vickrey auction is a type of sealed-bid auction. Bidders submit written bids without knowing the bids of the other participants in the auction. The highest bidder wins, but the price paid for the item is the second-highest bid. This type of auction is also famously called a second-price sealed bid auction. Stamp collectors have used this type of auction since 1893 (Lucking-Reiley, 2000), but Colombian University professor William Vickrey first described it academically in 1961 (Vickrey). In his original paper, Vickrey mainly considered auctions where a single, indivisible good is being sold. In this situation the names Vickrey- and second-price sealed-bid auction are equivalent and used interchangeably. In a single auction where a divisible good or multiple identical goods are sold however, these terms are used differently.

The bid function for this type of auction, following Vickrey's solution of the independent private-values model, is:

(3) $$b(x) = x.$$

In the same way as the English auction, this is also a dominant strategy. Bidding below x reduces the chance of winning the good with no increase in payoff since the second-highest price is paid. The other way around, bidding above x and winning as a result of the higher bid will result in losses. It is worth noticing that the dominant strategy does not depend on the number of bidders, the distribution form which private values are drawn, or risk attitudes (Kagel and Roth, 1995).

A Vickrey auction has the properties of incentive compatibility and self-revelation. In a Vickrey auction with private values each bidder maximizes their expected utility by bidding their valuation of the item for sale.

A Vickrey auction is only ex-post efficient if the seller is included as "player zero," whose transfer equals the negative of the sum of the other players' transfers.

3.4.1 Proof of dominance of truthful bidding

In a Vickrey auction with a single, indivisible item the dominant strategy is for each bidder to bid their true value of the good being auctioned (Lucking-Reiley, 2000).

Let v_i be bidder i's value for the good and let b_i be bidder i's bid for that good. We can then write the payoff for bidder i as follow

(4) $$\begin{cases} v_i - max_{j\neq i}b_j \;\; if \;\; b_j > max_{j\neq i}b_j \\ o \qquad\qquad otherwise \end{cases}$$

The strategy of overbidding ($b_i > v_i$) is dominated by bidding truthfully. Assume that bidder i overbids.

$$If \;\; \max_{j\neq i} b_j < v_i$$

Then the bidder would win the good with an overbid, but also with a truthful bid. The amount of the bid does not alter the payoff so the two strategies have equal payoffs.

$$If \quad \max_{j \neq i} b_j > b_i$$

Then the bidder would lose the good either way so the strategies have equal payoff also in this case.

$$If \quad v_i < \max_{j \neq i} b_j < b_i$$

In this case only the strategy of overbidding would win the auction. But then the payoff would be negative because they paid more than their value of the good. The payoff for a truthful bid would be zero. With this line of reasoning we can conclude that the strategy of truthfully bidding dominates the strategy of bidding higher than one's true valuation.

The strategy of underbidding ($b_i < v_i$) is dominated by bidding truthfully. Assume that the bidder i underbid.

$$If \quad \max_{j \neq i} b_j > v_i$$

Then the bidder would lose the good with an underbid as well as a truthful bid. The strategies have equal payoffs for this case.

$$If \quad \max_{j \neq i} b_j < b_i$$

Then the bidder would win the auction and the good either way. The strategies have equal payoffs in this case.

$$If \quad b_i < \max_{j \neq i} b_j < v_i$$

Then only a truthful bid would win the auction. The payoff for the strategy of truthful bidding would be positive as they paid less than their value of the item. The payoff for underbidding would be zero. With this line of reasoning we can conclude that the strategy of truthfully bidding dominates the strategy of bidding lower than one's true valuation.

Since the strategy of truthful bidding dominates both overbidding and underbidding we can conclude that this is an optimal strategy.

4. The economic man against the irrational brain

Theories of decision making under uncertainty assume expected utility (EU) maximization. However, EU is criticized on several grounds. Allais (1953, 1988, 1990) is probably the most known sceptic. He illustrated that preferences are non-linear. Tversky and Kahneman replicated the work of Allais and published an article later referred to as the seminal paper in behavioural economics (1979). They suggested a new model that competes with the EU paradigm. They created a new explanatory framework of people's behaviour, that they called Prospect Theory.

4.1 Expected Utility Theory

In a world without risk, economists believe that individuals have a utility function that can convert ordinal preferences into a real-valued function or utility function.

When risk enters the expected utility theory is used. It has the following functional form:

$$U = \sum_i p_i u(x_i) \tag{5}$$

Here there are i lotteries. In each lottery, i, the individual receive x_i dollars. The probability of receiving x_i is p_i. The lottery with the highest utility is preferred.

For example, assume there are two lotteries. In lottery A you receive $150 for sure. In lottery B you have a 60% chance of receiving $300 and a 40% chance of receiving nothing. The utility is each case is:

$$U_A = 1 * u(150)$$
$$U_B = .6 * u(300) + .4 * u(0)$$

You choose a lottery based on your expected utility. Risk neutral individuals have linear functions. Risk-loving individuals have convex utility functions (u''>0). And risk-averse individuals have concave utility functions (u''<0).

4.1.1 Axioms

In order for an individual to make decisions according to the expected utility theory, a set of four axioms must hold. They are called completeness, transitivity, continuity and independence. These are required before one can construct a utility function. Let A, B and C be defined as the following lotteries: $A = (x_1, p_1; x_2, p_2; \dots x_n, p_n)$, $B = (y_1, q_1; y_2, q_2; \dots y_n, q_n)$ and $C = (z_1, w_1; z_2, w_2; \dots z_n, w_n)$.

Completeness assumes that an individual has well defined preferences. For any two lotteries or gambles A and B, exactly one of the following holds.

(6) $$A \succcurlyeq B \text{ } or \text{ } B \succcurlyeq A$$

This means that people have preferences over all lotteries, and can rank them. For example, I prefer apples to oranges.

Transitivity assumes that preference is consistent across any three different options.

(7) $$if \text{ } A \succcurlyeq Band \text{ } B \succcurlyeq C \text{ } then \text{ } A \succcurlyeq C$$

If A is preferred (or indifferent) to B, and B is preferred (or indifferent) to C, then A is preferred to C. For example, I prefer apples to oranges, and oranges to bananas. Logically this implies that I prefer apples to bananas.

Continuity assumes that there exists a tipping point between being better than and worse than a given middle option. It states that if $A \succcurlyeq B \succcurlyeq C$, there exists a probability $\alpha \in [0, 1]$ such that:

(8) $$\alpha A + (1 - \alpha)C \sim B$$

An implication of the continuity axiom (sometime called the Archimedean property) is that if A is preferred to B, then a lottery close to A will still be preferred to B. In other words there exists some probability such that decision-makers is indifferent between the “best” and “worst” outcome. This however may seem irrational in some cases. Say the best outcome was \$2,000 with probability α and the worst outcome was being run over by a bus with probability $1 - \alpha$. Then again most rational people would probably be willing to walk across town to collect a \$2,000 price, and this might involve some probability, however small, of being run over by a bus.

With the assumption that preferences are complete, transitive and continuous, we can present them by a utility function U: P(lotteries) → ℝ, where $A \succcurlyeq B$ if and only if $U(A) \geq U(B)$. The last axiom, which also is the most controversial, will allow us to say a lot about the structure of U. It is the key to expected utility theory.

Independence assumes that a preference holds independently of the possibility of another outcome. In the space of lotteries P independence is satisfied if for all $A, B, C \in P \ and \ \alpha \in [0,1]$, we have

(9) $$A \succcurlyeq B \iff \alpha A + (1-\alpha)C \succcurlyeq \alpha B + (1-\alpha)C$$

In short independence says that if we mix two gambles with a third the resulting mixture does not depend on the third gamble. It is also called the substitution axiom. The logic being that if C is substituted for a fraction of A and a fraction of B, it should not change the ranking. This means that if I prefer apples to oranges, I will not change my preference between apples to oranges if I am offered a banana as well.

Normal utility theory assumes positive but diminishing return of money. A gain or a loss should be valued as a change in total wealth. For example, normal utility states that a gain of \$80 will give a smaller absolute change in utility than an equal loss of \$80. This can be expressed mathematically (eq 1):

(10) $$u(x) - u(x - \$80) > u(x + \$80) - u(x)$$

Assuming we have a value function that holds for all positive values of x. Individual should then have a function corresponding to figure 2. It is expressed by a smooth graph that is concave for all endowment values and without any breaking points.

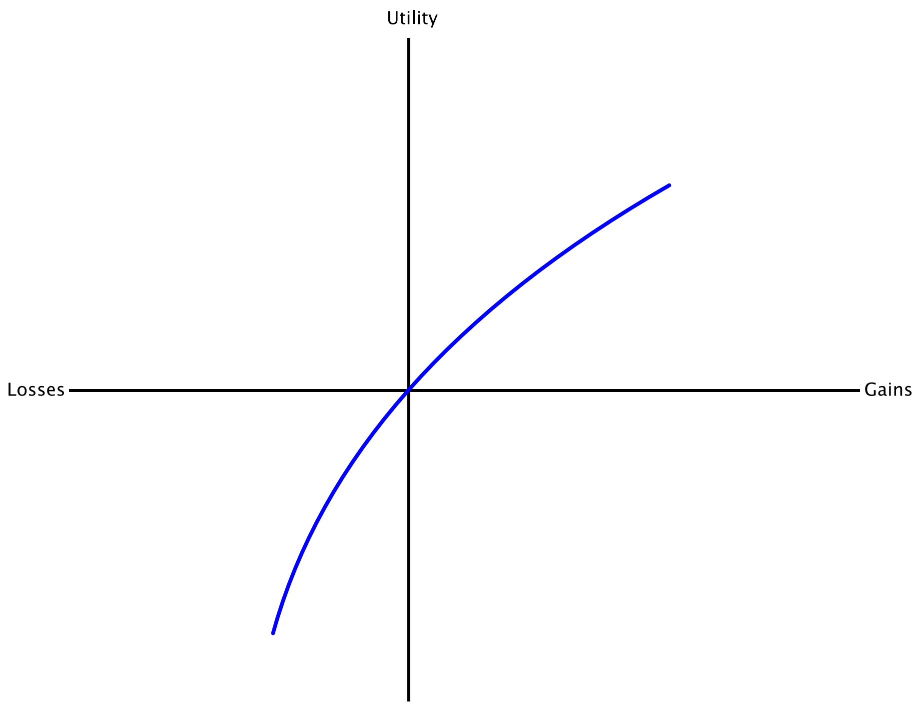

Figure 2: Valuation Gain/Loss in Normal Utility Theory[2]

Expected Utility theory emerged relatively unscathed from the first waves of tests. Independence of utility and probability was generally satisfied and expected utility predicted choices better than expected value did. However with time evidence of paradox started to mount.

4.2 The Allais Paradoxes

In the early 50s Marice Allais (1953) presented a survey with a hypothetical game. Subjects (with good knowledge of the theory of probability), routinely violated the expected utility axioms. It is now become known as the Allais Paradox. The most famous example illustrates a common consequence effect (Kagel and Roth, 1995). In the first game subjects choose between two gambles, A1 and A2.

The first game

Gamble A1

A 100% chance of receiving $1 million.

Gamble A2

A 10% chance of receiving $5 million.

89% chance of receiving $1 million.

And 1 % chance of receiving nothing.

Figure 3: The Allais Paradox, first game[2]

After the subjects have made a choice, they are presented with a second game and another two gambles (B1 and B2). They were asked to choose between them.

The second game

Gamble B1

An 11% chance of receiving $1 million.

And 89% chance of receiving nothing.

Gamble B2

A 10% chance of receiving $5 million.

And 90% chance of receiving nothing.

Figure 4: The Allais Paradox, second game[2]

The experiment shows that most rational individuals would prefer A1 to A2, and B2 to B1. But why is this a paradox? It is easy to show that if expected utility axioms where applied, the preference A1 > A2 should imply that B1 > B2. By preferring A1 (expected value is $1 million) to A2 (expected value is $1.39 million) the subjects are maximizing expected utility and not expected value. With this preference we have the following expected utility relationship:

$$u(1) > 0.1 * u(5) + 0.89 * u(1) + 0.01 * u(0) \qquad (11)$$

Which is the same as:

$$0.11 \ * u(1) > 0.1 \ * u(5) + 0.01 \ * u(0)$$

The by adding $0.89 \ * u(0)$ to each side, we get:

$$0.11 \ * u(1) + 0.89 \ * u(0) > \ 0.1 \ * u(5) + 0.90 \ * u(0) \tag{12}$$

This implies that a subject maximizing expected utility must prefer B1 (expected value is $110,000) to B2 (expected value is $500,000). But as mentioned over, this is not the case. The experiment illustrates that subjects are maximising expected utility in the first problem (A1 > A2) and maximising expected value in the second problem (B2 > B1). Their choice in the first stage is inconsistent with their choice in the second stage, and her lies the paradox. The probability of receiving $5 million is the same in both A2 and B2. Remembering the four axioms set forth by Von Neumann and Morgenstern (1947), we see that the independence axiom (substitution) is clearly violated.

Initially many felt that Allais's examples used so extreme sums that they did little damages to the regular, everyday application of the expected utility theory. But as the experiment where replicated and different sums where used, it grew in strength. Allais initially saw the results as a flaw in the conventional ideas of utility and did not se it as exposing a "flaw" in human psychology. Kahneman and Tversky on the other hand did. They replicated Allais's paradox and introduced many others. With sweeping evidence they introduced an alternative theory in 1979 witch they called "prospect theory".

5. Prospect Theory

Kahneman and Tverskys (1979) prospect theory specifies how decision makers systematically deviate from the Expected utility theory. Several of the theory's elements had been known for quite some time prior to the publication in 1979. However, the big contribution they made was formulating a precise mathematical theory on the same form as expected utility. They later described their strategy as follow:

> The theory that we constructed was as conservative as possible (…) We did not challenge the philosophical analysis of choices in terms of beliefs and desire that underlies utility theory, nor did we question the normative [status of] models of rational choice (…) The goal (…) was to assemble the minimal set of modifications of expected utility theory that would provide a descriptive account.
>
> (Kahneman and Tversky, 2000: x)

The economical audience was the main reason for this conservative approach. It was important that the field of economy could identify itself with the theory. This was not a bad idea. The article that introduced the prospect theory is the most sited article in economic literature (George Wu, 2004). Kahneman later received the Nobel Prize in economics manly from his work on the prospect theory.

5.1 Motivation

In 1979, Tversky and Kahneman conducted a series of replicating experiment testing the Allais paradox. They framed the problem in different ways, with prices involving money, course credits, vacations and so on. In every experiment the substitution axiom was violated in the same way. They called this pattern the certainty effect. Meaning that people overweight outcomes that are certain, relative to outcomes that are just probable. Tversky and Kahneman stated that where winning is possible but not probable, most people choose the prospect that offers the larger gain. The second stage of the Allais Paradox illustrates this.

5.1.1 The Reflection Effect

The two psychologists also found evidences of something they named the reflection effect. To illustrate imagine an Allais Paradox type problem, framed the following way (Figure 5).

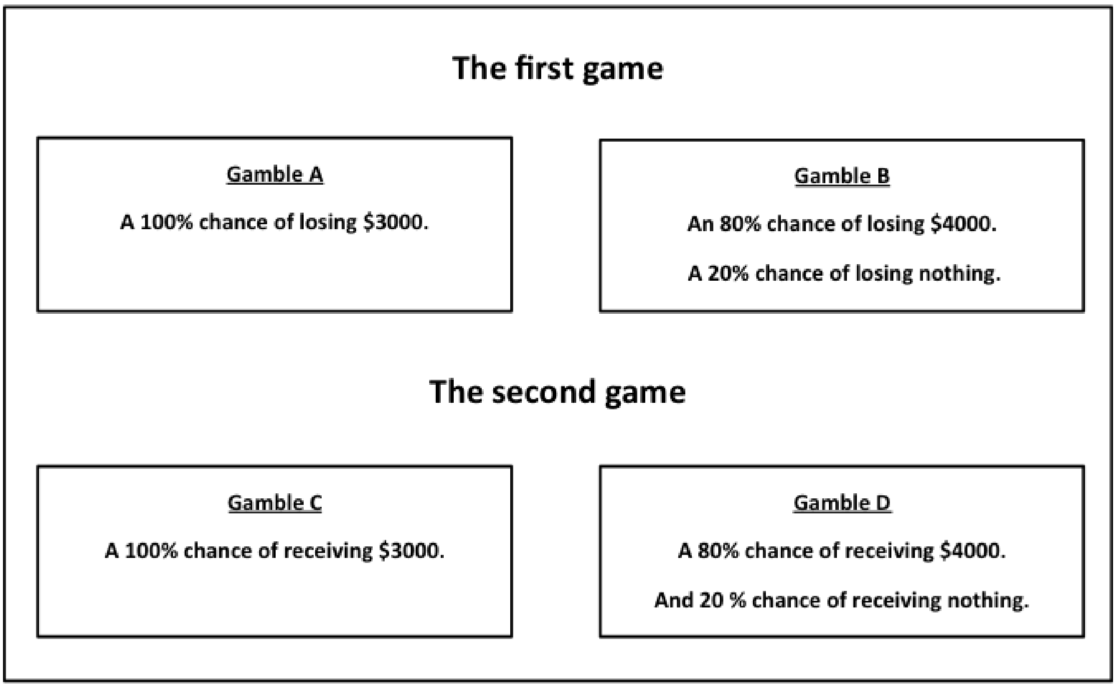

Figure 5: The Reflection Effect[2]

Kahneman and Tversky found that 92% chose B, while 20% chose D. A similar pattern was illustrated when varying negative and positive prizes and probabilities.

It explains that we have opposite risk preferences for uncertain choices, depending on whether the outcome is a possible loss or a gain. When we stand to lose something, people strongly prefer to take risks that might mitigate the loss. Conversely in cases where we can gain something, the effect shows that both the Ambiguity and Risk aversion biases are right. Simply put, while people are risk-loving over prospects involving losses, they become risk-averse over prospects involving gains.

Even though the framing effect was predicted by the reflection effect and the prospect theory it is important to make a distinction between the two effects. This distinction is not apparent in Prospect Theory but was something Fagley (1993) stressed the importance of. Framing effects are perceptual. In the same way as in terms of whether the glass is half-empty or half full. By phrasing the same outcomes, as they were losses versus gains resulting in different choices made by people are considered the framing effect. Reflection effects are not that complicated. It refers to having a preference for a gamble that is negative, phrased as losses, and having an opposite preference or a gamble that is positive, phrased as gains (Fagley, 1993). Nevertheless they both played an important role in the development and strength of the prospect theory.

The next stage of developing the Prospect Theory was to combine the reflection and certainty effects. If you have a prospect on the negative domain, people exhibit risk-loving behaviour for larger losses which are probable, rather than smaller certain ones. However, once prospects are in the positive domain, the certainty effect leads to a risk-averse behaviour for a sure gain, rather than one that may be larger but barely probable.

5.1.2 The Isolation effect

Tversky and Kahneman conducted yet another experiment and the findings were referred to as the isolation effect. It’s the phenomenon whereby people value a thing differently depending on whether it is placed alone (isolation) or next to an alternative. It follows from the fact that in order to simplify the choice between many alternatives, people disregard the common baseline, and focus only on the differences between the alternatives. In particular, a choice can be made to look better if it is placed next to an alternative relative to which it is distinctively better in some respect. Since different choice problems can be decomposed in different ways, this can lead to inconsistent preferences. This effect is related to the behavioural economics notion of anchoring, which will be discussed thoroughly later.

5.2 Theory

Tversky and Kahneman used the effects they had observed and designed a theory of decision-making under risk, which they called prospect theory. The theory distinguishes two phases in the choice process: an initial phase of editing and a subsequent phase of evaluation. The editing phase contains an initial analysis of the prospects. In the second stage, the edited prospects are evaluated and the one with highest value is chosen.

5.2.1 Editing phase

This phase consists of 6 major operations and contributes to reformulate and organize the options so as to simplify later evaluation and choice.

Coding. As illustrated above, Tversky and Kahneman showed that people usually perceive outcomes as losses and gains, rather than as final states of wealth. What is conceived as losses and gains are, of course, defined relative to some natural reference point. The expectation of the decision maker or the formulation of the offered prospects can effect the location of the reference point, and hence the understanding of outcomes as losses or gains.

Combination. By combining probabilities associated with identical outcomes, prospects can be simplified. For example, the prospect (200, .25; 200, . 25) can be reduced to (200, .50) and then evaluated.

Segregation. Some prospects consist of a riskless part that is segregated from the risky component in the editing phase. For example, the prospect (200, .80; 100, .20) can be decomposed into a sure gain of 100 and the risky prospect of (100, .80).

The above operations are applied to each prospect separately. The following is applied to a set of two or more.

Cancellation. The isolation effect, described above, is one form of cancellation. It can also involve discarding common outcome-probability pairs between choices. For example, the pair (200, .20; 100, .50; -30, .30) and (200, .20; 350, .40; -50, .40) are reduced to (100, .50; -30, .30) and (350, .40; -50, .40).

The two more operations that should be mentioned are **detection of dominance** and **simplification**. The first involves scanning outcomes that are strictly dominant and rejecting them without further evaluation. The second operation refers to the simplification of prospects by rounding of outcomes or probabilities. A prospect of (151, .49) is likely to be seen as an even chance to win 150. The discarding of extremely unlikely outcomes is a particularly important form of simplification.

It is assumed that the editing operations are performed whenever possible. Some of these operations prevent or permit others from being carried out. Therefore the final edited prospect could depend on the sequences of editing operations, which is likely to vary with the format of display and the structure of the offered set.

5.2.2 The Evaluation Phase

In this subsequent phase, people are assumed to examine all the edited prospects and choose the prospect of highest value. The overall value of a prospect, denoted by V, is expressed in terms of two scales, π and v. The first scale, π, associates a decision weight $\pi(p)$ with each probability p, which reflects the impact of p on the over all value of the prospect.

One important note is that π is not a probability measure. Tversky and Kahneman proved that $\pi(p) + \pi(1 - p)$ is typically less than unity (1). The function captures the idea that people tend to underreact to large probabilities and overreact to small. The second scale, v, assigns a number v(x) to each outcome x. This reflects the subjective value of that outcome. As mentioned above, outcomes are defined relative to a reference point. This point serves as the zero point of the value scale. In other words, v measures deviation from that point, i.e., losses and gains.

The formulation above is concerned with a simple prospect on the form (x, p; y, q). One receives x with the probability p, y with the probability q, and nothing with the probability 1-p-q, where $p + q \leq 1$. We can say that an offered prospect is strictly positive if its outcome are all-positive, i.e. x, y > 0 and p + q = 1. A prospect is strictly negative if all its outcomes are negative and it is regular if it is neither strictly negative nor positive.

Then if (x, p; y, q) is a regular prospect, i.e. either p + q < 1, or x ≥ 0 ≥ y, or x ≤ 0 ≤ 1, then

(13) $$V(x, p; y, q) = \pi(p)v(x) + \pi(q)v(y)$$

where v(0) = 0, π (0) = 0, and π (1) = 1. V is defined on prospects, while v is defined in outcomes.

A different rule is followed when evaluating strictly negative and positive prospects. A prospect like this is segregated into two components in the editing phase, a riskless component and a risky component. If p + q = 1 and either x > y > 0 or x < y < 0, then

(14) $$V(x, p; y, q) = v(y) + \pi(p)[v(x) - v(y)]$$

The value of a strictly negative or positive prospect equals the value of the riskless component plus the value difference between the outcomes, multiplied by the weights associated with the more extreme outcomes. It is important to note that a decision weight is applied only to the risky component.

The equations of the prospect theory set forth by Tversky and Kahneman resembles those of expected utility theory, but differs in that decision weights do not coincide with stated probability and values are attached to changes rather than to final states. This last point (difference) is an essential feature of the theory and is contributed to the value function. The assumption is compatible with basic principles of judgement and perception. People's perception is attuned to evaluation of differences or changes rather than the evaluation of absolute magnitudes.

After rigorously testing they found a trend regarding the shape and movement of the value function. Thaler et al. (1997) mathematically presented this as in equation (15). Here x represent the change in value. It is not a utility function but a value function. Hence it is normalized on the current level of endowments. The value of x is positive for gains and it is then set in the power of $\alpha \in (0,1)$. This makes the value of gains a concave function. The value of x is negative for losses. The function specifies that for negative values of x, the negative of the negative should be used, hence the absolute value of x. This is set in the power of $\beta \in (0,1)$. This will give us a convex utility function for losses. The value function also has a slope change at the origin presented by $\lambda > 1$.

(15) $$v(x) = \begin{cases} x^{\alpha}, & if x \geq 0 \\ -\lambda(-x)^{\beta}, & if x < 0 \end{cases}$$

In a experiment Tversky and Kahneman (1992) estimated the parameters of this value function. They found both α and β to be 0.88 and λ to be 2.25. They concluded that the rate of which a gain or loss decreases was equal $(\alpha = \beta)$. However an individual consider a loss to be over twice as bas as an equal gain.

In short they proposed that the value function is (1) defined in deviations form the reference point, (2) generally convex for losses and commonly concave for gains and (3) steeper for losses than gains. A value function that satisfies these properties is displayed in the figure below.

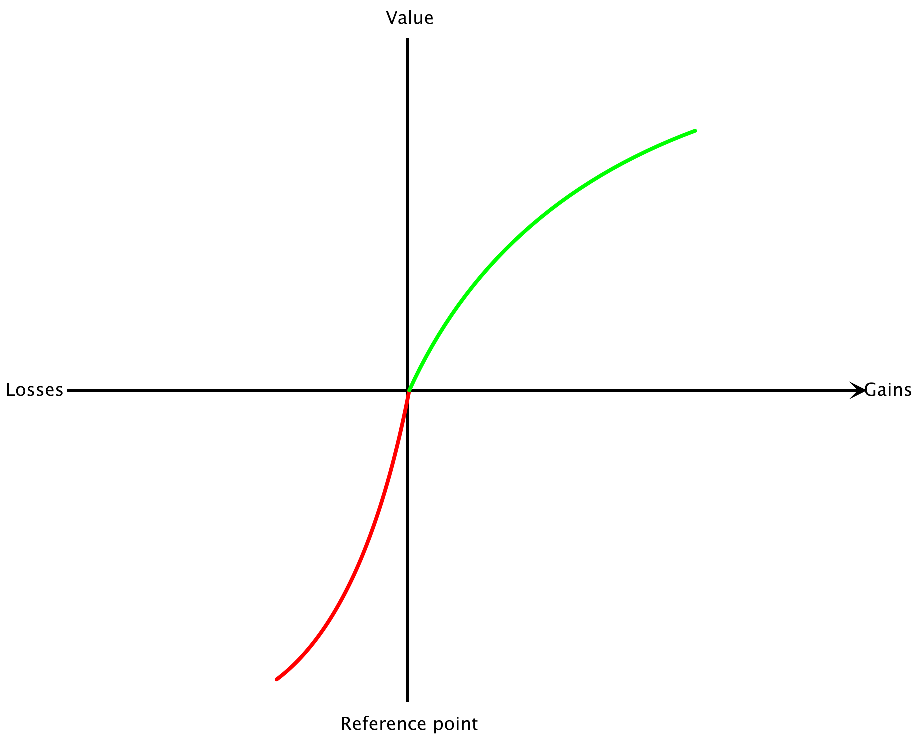

Figure 6: Value function (loss aversion). (Tversky and Kahneman, 1991)

As illustrated in figure 6 it is steeper on the loss side than on the gain side. This contradicts with normal utility theory. As we remember, utility theory assumes positive but diminishing returns of money. And that gains or losses should be valuated as changes in total wealth and not form a reference point. This is one of the main reasons Kahneman and Tversky (1979) article on prospect theory is called a "seminal paper in behavioural economics". It changed the field of economics. In how we see choices made by humans. How irrational a person can behave. If a model assume rational behaviour and don't take into account the irrationality of humans, it will have problems relating to the real world. One of the most robust and interesting irrational behaviours of humans is the anchoring effect. Introduced by Tversky and Kahneman and incorporated in the prospect theory through the isolation effect. The rest of this paper will explore this enigma.

6. Anchoring Effect

Suppose you own your own car dealership. Your business both sell new and used cars. It also provides the costumers with maintenance services. You have more than 10 years of experience in the business, both as a mechanic and a car dealer. One day a man arrives with his car. It's an old Opel Kadett. He needs an expert's opinion of what the actual value of the car is. You are happy to help. The man wants to know if a little bump is worth fixing given that the car is fairly old. His girlfriend had a minor collision and he is uncertain of what to do. He then provides you with facts about the car. It's mileage (160,000 kilometres), year (1986) and his personal estimate of the cars value, which is $2,800. You go through the numbers and do a quick inspection. Without a closer look, the state of the car cannot be established. You are uncertain of what to do, which price to set. When thinking over the facts once more, the man's own estimation echoes in your mind "I think the car should sell for about $2,800". Will the costumers own estimation influence your own?

If so, your estimation may be biased by one of the most remarkable influences on human judgment, namely the anchoring effect (Tversky and Kahneman, 1974). The man's goal is probably to get the highest value possible for his car. Being influenced by his estimates may be against your intentions. The good new is that you are in good company. Similar scenarios as the one above have been used by Mussweiler et al. (2000) to conduct an anchoring experiment. It indicated that car experts with over 5 years experience were influenced by value estimates done by the "customer". The magnitude of the influence proved to be dramatic. Estimates in the low and high anchor conditions deviated by more than 1,000 German Marks. This was equivalent to more than 25% of the actual value of the car.

6.1 The effect

Anchoring is a cognitive bias that describes the common human tendency to rely too heavily on the first piece of information offered when making decisions. It occurs when individuals use an initial piece of information to make subsequent judgement. Usually once the anchor is set, there is a bias towards that value. The ide of anchoring in decision-making was first introduced by Slovic (1967). He studied descriptions of preference reversal. However, the anchoring and adjustment heuristic was first introduced by Tversky and Kahneman (1974) in their pioneering work on judgement under uncertainty. It is one of the most remarkable influences on human judgement. There are at least two reasons for this according to Mussweiler et al. (2004). Firstly, the anchoring effect has proven to be strikingly pervasive and robust. Secondly, the mechanisms that produce anchoring have long remained an enigma.

6.1.1 Relevance

The effect has a wide reach and affects the outcome of many different judgement situations. Plous (1989) illustrated the effect when estimating the likelihood of nuclear war. In a resent study Bergman et al. (2010) found that people with higher cognitive abilities are less prone to the effect. The anchor effect has also influenced estimates of the mean temperature in Antarctica (Mussweiler and Strack, 1999a), estimates of self-efficacy (Cervone and Peake, 1986), negotiations (Galinsky and Mussweiler, 2001) and legal judgement (Chapman and Bornstein, 1996).

Ariely et al. (2003) Illustrated that anchors can have a direct impact on economic behaviour in an experiment involving real purchasing decisions. Participant were asked to write down the two last digits of their social security number (ID) and consider whether they would pay this number (in $) for a variety of consumption goods. The subjects were then asked to state their maximum willingness to pay (WTP) for each good. This irrelevant anchor strongly effected the subjects subsequent WTP for the goods. The high anchor groups WTP were 57% to 107% greater then the low anchor groups WTP. This experimental result challenges the traditional economic assumption. It is assumed that the price of a product in the market is determined by the balance between the desire of those with purchasing power (demand) and production at a certain cost (supply). The intersection determines the market price. WTP influences market price, but as Ariely et al. (2003) illustrate, WTP can easily be manipulated. Standard economic theory also assumes demand and supply forces are independent. It is possible to argue otherwise. Suggested retail prices, advertisement and promotions are example of real world anchors. These variables are connected to the supply side. This line of thought suggests a reversed situation where market price affects the willingness to pay, and not the other way around. Demand is not a completely separate force from supply (Ariely, 2008)

6.2 Designs

Anchoring effect are examined mainly trough four different experimental designs or paradigms. The experimenter provides anchor values either explicitly or implicitly, provided in an unrelated task or self-generated.

6.2.1 Explicitly provided

An explicitly provided anchor is the most common paradigm and was introduced by Tversky and Kahneman (1974). In this paradigm you evoke the participants to compare the target to the anchor value. This is usually achieved by asking the participants if something is larger or smaller than an anchor value. This was done in a classic study by Tversky and Kahneman (1974). Participants were asked to provide an estimate for the percentage of African countries in the United Nations. First the participants indicated whether this percentage was higher or lower than an arbitrary number (the anchor). This number was apparently chosen at random by spinning a wheel of fortune. In reality it was programed to stop at either 10 or 65, but the illusion of coincidence was important. In the subsequent question, participants then gave their best estimate of this percentage. The median estimation of the percentage of African counties in the United Nations was 25 and 45 for groups that received 10 and 65, respectively, as an anchor. Other examples of this paradigm involves throwing a dice (Mussweiler and Strack, 2000ab), using the two last digits of the social security number (Ariely et al., 2003) or emphasizing the random selection on the instructions (Strack and Mussweiler, 1997).

6.2.2 Implicitly provided

Implicitly providing an anchor to the participants is another alternative. The previous example with the car seller falls in this category. Northcraft and Neale (1987) used this design in an experiment. They illustrated that real estate pricing depend on the listing price. Relevant information about the property was presented to the real estate agents. The listing price of the property was used as an anchor. It was either below or above the actual appraisal. The experiment demonstrated that the anchor affected the value of the property.

6.2.3 Unrelated task

A third paradigm involves exposing the participants to an anchor in a preceding unrelated task. This was done by Wilson et al. (1996). The participants in their experiment was first asked to copy either five pages of words or five pages of numbers. Then they were asked how many students at the university would get cancer the next 40 years. Those who copied numbers estimated this to be much higher than those copying words.

6.2.4 Self-generated

Finally, anchors can be self-generated. This was also illustrated in the classical study of Tversky and Kahneman (1974). Two groups of students estimated, within 5 seconds, a numerical expression. One group estimated the product $(8 * 7 * \ldots * 1)$, while the other estimated $(1 * 2 * \ldots * 8)$. When rapidly answering such questions, the students just have time to actually calculate a few steps. The theory is that these first steps will act as an anchor. Results show that the median estimates for the descending sequence was 2,250 and for the ascending 512.

These are the four paradigms that have been used to demonstrate the anchoring effect. However, most of the research explicitly provides the anchor value. The standard paradigm introduced by Tversky and Kahneman (1974). This is probably the easiest to use in a laboratory setting.

6.3 Theoretical arguments

What is the explanation for anchoring effect and where does it result from? There are four theoretical accounts of anchoring effect trying to answer these questions (Mussweiler et al., 2004). They suggest that anchoring result from (1) conversational inferences, (2) numerical priming, (3) insufficient adjustment and (4) mechanisms of selective accessibility.

6.3.1 Conversational inferences

A conversational inference is a process of interpretation. It describes how people in an exchange assess others intentions, and how they base their response (Gumperz, 1982). Imagine you have two sources regarding results from a bicycle race. One report the winner's time to be 3h 52min, and the other report 3h 52mins and 3.5 s. A study has illustrated that the majority believes the second report to be about a close race. This has to do with how the result was presented and what is relevant. Grice's (1975) maxims of conversation entail that you should provide all the information that is relevant to a task, but not more or less.

Conversational inference attributes anchoring to participants who expect the experimenter to be maximally informative. They can then assume that the provided anchor is close to the actual value in question. This may lead them to consequently position their estimate in vicinity of the anchor. This may be the case when considering anchors that have clear relevance to the question at hand (Northcraft and Neale, 1987). This also implies that the anchor value is seen as informative for the participant. This is not always the case. It has ben demonstrated that anchor effects also occur if the anchor values are uninformative. Ariely et al. (2003) illustrated this with random selection, Wilson et al. (1996) with clearly unrelated anchors and Strack and Mussweiler (1997) with implausible extremes.

6.3.2 Numerical and magnitude priming

This account that anchoring effects are rather superficial and purely numeric in nature (Jacowitz and Kahneman, 1995). It assumes that anchor prime numbers or magnitudes are similar to the anchor value. Solving an anchoring task may simply render the anchor value itself more accessible. Subsequently influence the final judgement. For example, your ID number influences your estimation of the number of physicians in the phone book (Wilson et al., 1996). Suppose viewing the ID number increased the accessibility of similar numbers. These primed numbers were more likely to come to mind, thereby influencing your estimation. The sole determinant of anchoring effects is the anchor itself (Mussweiler et al., 2004).

In a resent study Smith and Windschitl (2011) produced results in line with numeric priming. They tested whether estimates based on calculation are influenced by comparison with irrelevant anchors. The study was set up with high and low anchors and short and long (4/15 sec) time limits. Participants where presented with math questions on the form $X_1 + X_2 + X_3 = Y$. Two studies where conducted, one where the anchors fall inside the boundary of distribution and one where it falls outside. The first study illustrated an anchoring effect when answering the math problem. The effect was larger when time pressure where a factor (Figure 7).

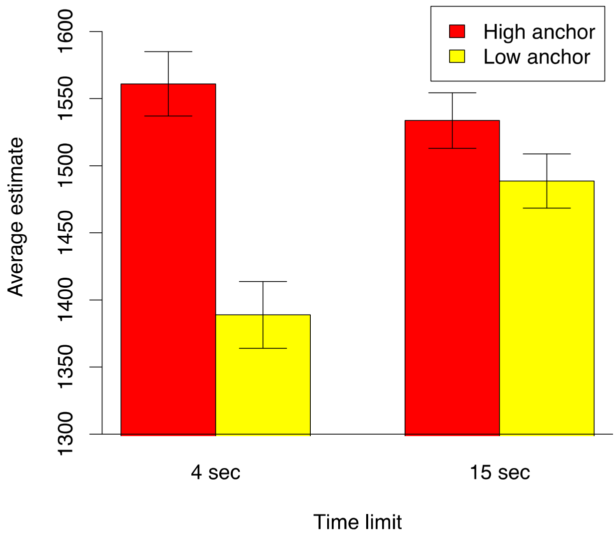

Figure 7: Numeric priming experiment results[3] (Smith and Windschitl, 2011)

The participants where exposed to extreme values in the second study. A robust anchoring effect was illustrated. They also got larger anchoring effect with more restrictive time pressure (figure 8).

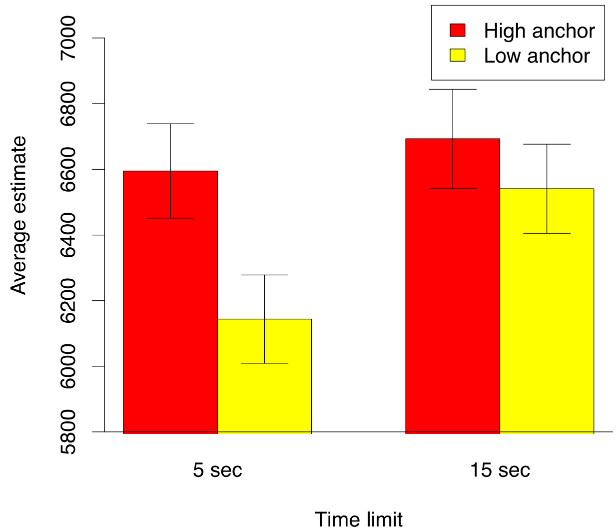

Figure 8: Numeric priming experiment results[3] (Smith and Windschitl, 2011)

Numeric and magnitude priming predict the result of this study. Smith and Windschitl (2011) point out that their study were not design to this purpose, but that it can qualify for speculations. One other account of numeric and magnitude priming goes so far as to claim only the anchors absolute value is represented in memory and experts influence (Wong and Kwong, 2000). For example an anchor of -50°C is perceived as 50.

The magnitude priming account is similar, but doesn't involve numbers. Big and small thoughts are cued by a physical action. It describes anchor priming according to magnitude concepts like "small", "big" and "long". These influence the estimate that people give. This was illustrated by Oppenheimer et al. (2008). In their study they had one group of people draw a long line while another group of people drew a short line. Both groups were then asked (among other questions) to estimate the length of the Mississippi River.

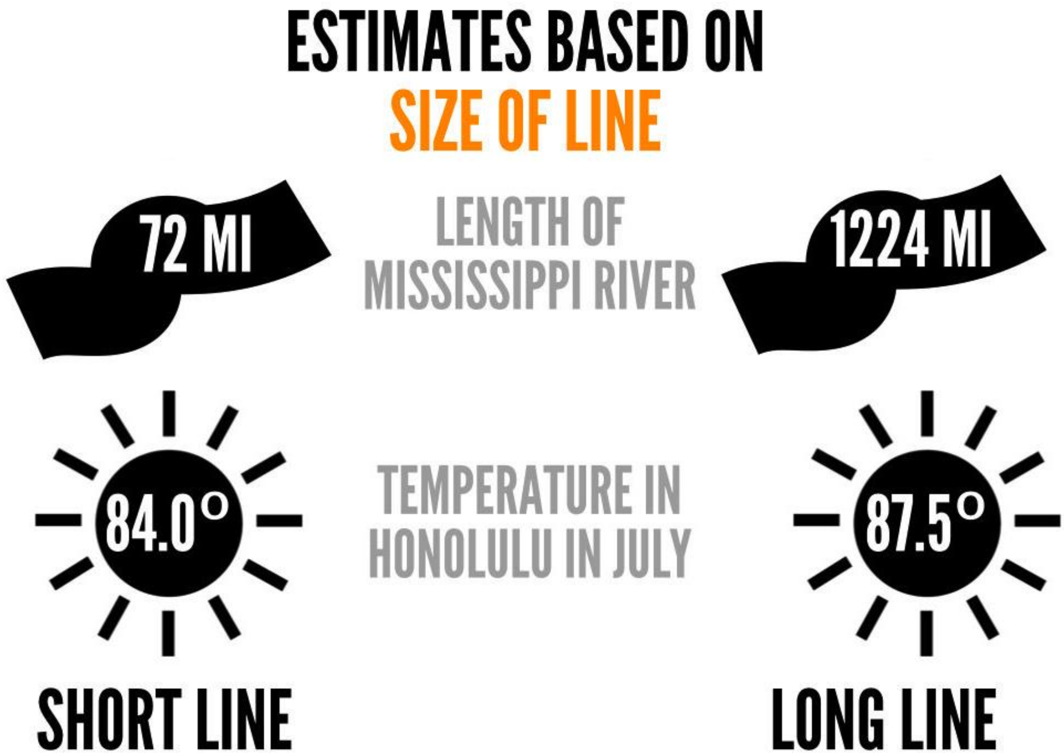

Figure 9: Magnitude priming experiment[4]

The actual length of the Mississippi River is 2,320 miles. The group that drew the short line estimated the length to be 72 miles while the group that drew the long line estimated the length to 1,224 miles (Figure 9). The study was replicated but this time asking the temperature in Honolulu in July. Both studies show a simple physical action that drastically effected behaviour.

Numeric and magnitude priming is a compelling argument. But it is insufficient for a complete understanding of the anchor effect (Mussweiler et al., 2004). This theoretical account does not, for example, explain the effect when the anchor question dimensions are altered (Mussweiler, 1997). If the anchor effect is induced by the anchor value itself, identical effects should result regardless of the context with which the anchor is associated. For example, you compare the height of the Brandenburg Gate to a given anchor value. Then you use the same anchor and compare the width of the gate. According to numeric and magnitude priming the effect should be identical. This is not the case. The anchoring effect is actually reduced if dimensions are altered in an subsequent question (Mussweiler, 1997)

Numeric priming also implies that anchors are short-lived because we are constantly exposed to numbers. The findings of Mussweiler and Strack (2001) is in conflict with this. They illustrated that anchoring effect can prevail for a week.

6.3.3 Insufficient adjustment

> In many situations, people make estimates by starting from an initial value that is adjusted to yield the final answer. The initial value, or starting point, may be suggested by the formulation of the problem, or it may be the result of a partial computation. In either case, adjustments are typically insufficient. That is, different starting points yield different estimates, which are biased towards the initial values. We call this phenomenon anchoring.
>
> (Tversky and Kahneman, 1974: 1128)

This was how Tversky and Kahneman first described anchoring effect. They contribute the effect to insufficient adjustment. For example, did Mahatma Gandhi die before or after the age of 140, or before or after age 9? This question was given to participants in an experiment conducted by Strack and Mussweiler (1997). Clearly neither of these anchors can be correct. But the two groups estimated significantly different. The low anchor group estimates averaging 50 and the high 67. According to Tversky and Kahneman people use the anchor as a starting point. Judging if this value is to high or low and then adjusting accordingly until an acceptable value is reached. Insufficient adjustment only works if the anchor value falls outside the boundary of possible distributions. Obviously Mahatma Gandhi did not die at age 140. People will adjust from there. If a reasonable number were given, though, there would be no adjustment. Therefore this theory can not explain the anchoring effect completely according to its critics (Mussweiler and Strack, 1999b). Epley and Gilovich (2001) demonstrated that insufficient adjustments contribute to the anchoring effect if the critical value is unacceptable generated by your self, rather than provided. It has also been illustrated that anchoring effect are not just obtainable for unacceptable anchor values (Mussweiler, 1997)

6.3.4 Mechanisms of selective accessibility

If a person is presented with names of violent leaders, they are more likely to subsequently perceive a person as friendly. On the other hand, presented with words of violence, they are more likely to perceive a person as unfriendly (Stapel et al., 1997). Which of these two effects is more likely to prevail? The selective accessibility model by Mussweiler (2001) present the most compelling accounts. Attention and memory of humans is in general biased towards evidence that confirm their hypotheses. They will tend to be directed towards an anchor.

> Absolute judgments are likely to be based on the knowledge that is accessible at the time the judgement is made, so that analysing the accessibility of target knowledge promises to provide a more complete understanding of anchoring enigma.
>
> (Mussweiler et al., 2004: 191)

According to the selective accessibility (SA) theory people make some judgement when presented with an anchor. They will evaluate the hypothesis that the anchor is an appropriate answer. If not, they will move on to another guess. But first the person will access all the relevant attributes of the anchor itself. When evaluating the new answer, the person looks for ways in which it is similar to the anchor. This is resulting in the anchoring effect. The SA model assumes that anchoring is in essence a knowledge accessibility effect. Comparing an anchor to a target will change the accessibility of knowledge about the target. For example, participants are asked if the Mississippi River is shorter or longer than 5000 miles. They will first test whether it is possible that this value actually is 5000 miles. Participants will selectively retrieve knowledge from memory that is consistent with this assumption. They engage in hypothesis consistent testing.

Mussweiler and Strack (1999a, 1999b) have conducted many tests to get support for their theory. One experiment asked the participants to estimate the price of a German car. They were first presented with either a low or high anchor. After testing the anchor effect, participants were asked a series of knowledge-based questions. These included target words that are associated with both inexpensive and expensive cars. Participants were faster in recognizing words associated with inexpensive cars after comparing with the low anchor (Figure 10). The same result was illustrated with high anchors and words associated with expensive cars (Mussweiler and Strack, 2000b)

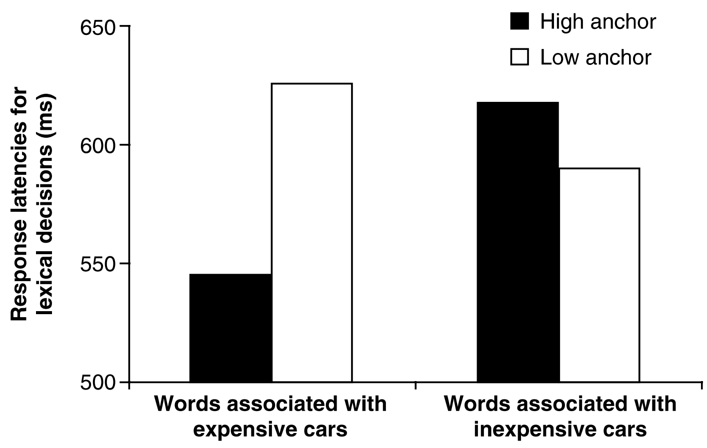

Figure 10: Selective accessibility[5] (Mussweiler and Strack, 2000b)

When comparing a target to an anchor it appears to increase access of anchor consistent knowledge about the target. This paradigm relies on people's semantic knowledge about a target and it is linked to social cognitive research (Mussweiler et al., 2004).

The selective accessibility model has received much praise for explaining the anchoring effect, but also its share of critic. Smith and Windschitl (2011) argue that the selective accessibility model relies on biased recruitment on information by memory. This suggests that anchoring will not influence estimates when people are performing a calculation based on available information. But as illustrated above, anchors can influence people's answers to math problems (Smith and Windschitl, 2011).

6.4 Still an enigma

The anchoring effect is one of the most unique, remarkable and robust influences on human judgement. It is also one of the most tested and researched biases. But still there dos not exist a complete understanding of the effect and its origin. Of the four leading theoretical accounts, it seems that each one describes something the others don't. And in the proses produces proof against each other. In a way it resembles the problem about light. Is it a particle or a wave? It certainly has some properties of both. The scope of anchoring effect is fascinating and should inspire further research.

7. Experimental design

The purpose of this experiment is twofold. First, I check whether the result of Ariely et al. (2003) replicate. Second, I investigate whether such anchoring, if it exists, is affected by an auction situation. Figure 11 describes the experiment step by step.

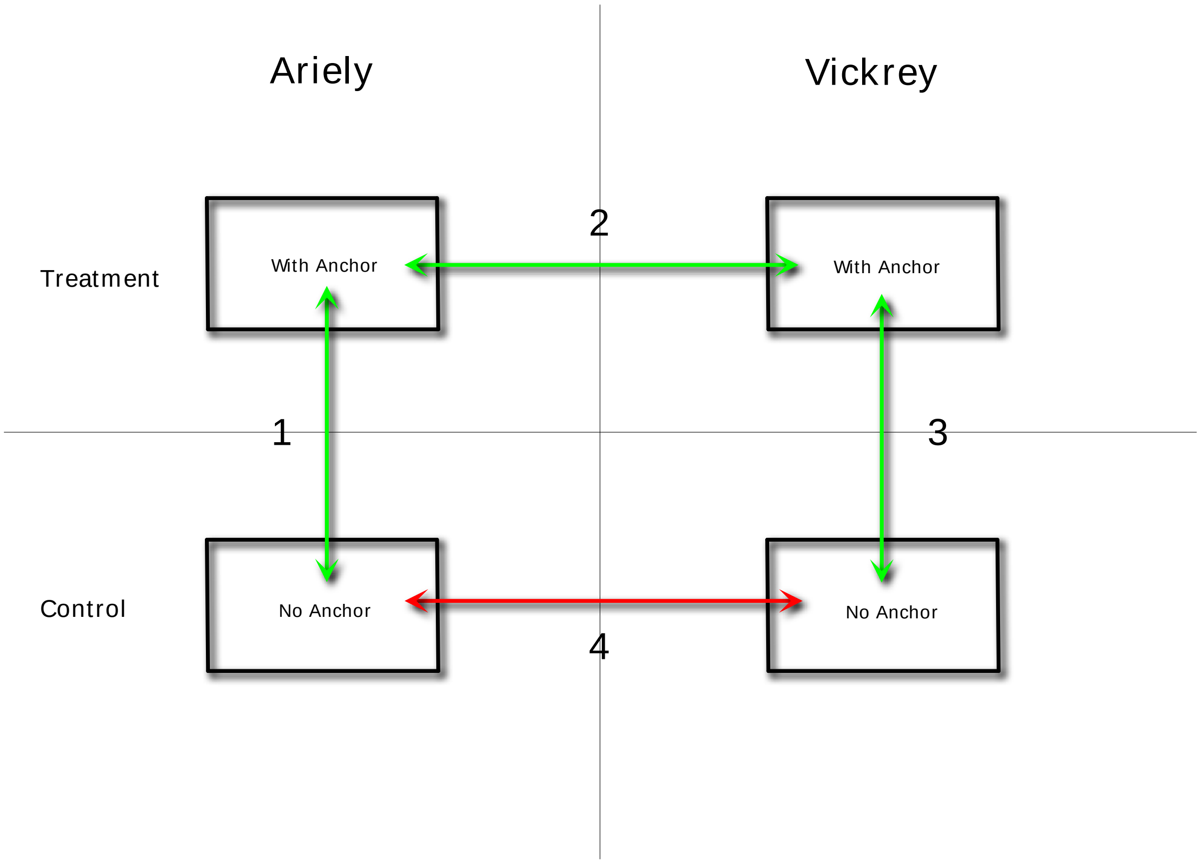

Figure 11: From The experiment: Experimental design[2]

In step (1) I try to avoid bizarre subsamples. I replicate earlier experiments (Ariely) and hope to demonstrate that an irrelevant anchor affects the subject's willingness to pay (WTP) for a variety of consumer goods. I compare the treatment group with the control group in the Ariely test. I also compare the anchor values (high, low and total) to the WTP data. In step (2), if an anchor effect exists in the first step, I try to remove the anchor. The Vickrey auction test is similar to the Ariely test. The same products and anchor method are used but it is framed as a Vickrey auction. I compare the two tests and hope to se a different effect from the anchor. In step (3) I compare the treatment group and the control group for the Vickrey test. Optimally the anchor will not matter. In step (4) the WTP between the to different treatments are tested, but this is not a part of this thesis.

7.1 Hypothesis

H. 1. When replicating Ariely et al. (2003), subjects are effected by an irrelevant anchor.

H.2. The anchor effect disappears (is smaller) when subjects are in an auction situation.

In short, I assume that the anchor effect is smaller in an auction. Subjects are more aware of the consequences in this situation. They know that bidding high can result in eventually buying the product. The hypothesis assumes that this will influence the anchor effect.

7.2 Design

As mentioned above the two tests are similar in many ways. The actual tests are identical but the instructions and possible consequences are different. In both tests there is a possibility that participants get offered to buy some of the consumer goods. In test 1 (Ariely Replication) you can only be offered to buy one item. Who receives this offer is randomly selected. The wording in test 1 indicates that you don’t have to buy if offered to. The chances are also small since only one person is selected per product (6). The reason for this is to ensure participants report their true WTP. The Becker-DeGroot-Marschak procedure is used to this effect. The context of this procedure will be described in a section below.

7.2.1 Becker-DeGroot-Marschak procedure

The subject formulates a max WTP for a consumer good. The stated WTP is compared to a price determined by a random number generator or procedure. If the subject’s stated WTP is greater than the price, he or she pays the price and receives the consumer good. If the subjects stated WTP is lower than the price, he or she pays nothing and receive nothing.

7.2.2 Vickrey auction

The instructions of test 2 (Vickrey Auction) are formulated as a Vickrey auction. It informs that the subject behind the highest bid for each product will be contacted and offered to buy that consumer good for the price of the second highest bid. The wording does not implicate any obligation to buy, but it does not explicitly explain that you don't have to purchase either. This is to ensure the best possible auction like situation.

Both designs are presented in the appendix.

7.3 Data collection

The experiment where conducted in two different forums. Half of the subjects where recruited via stands at the University of Tromsø. The second half were recruited via email and asked to participate in the experiment online trough SurveyMonkey.

7.3.1 Stand

The consumer goods were displayed and passers by were asked to participate in an experiment. The experiment where conducted on paper. Four different tests were distributed. A treatment and a control group for test 1 and a treatment and control group for test 2. Which tests the participants received was randomly decided. In advance each test were assigned one of the four suits from a standard 52-card deck. The deck was shuffled and the tests were sorted accordingly. This secured a random distribution. The control groups were smaller then the two corresponding treatment groups. When a sufficient number of control tests were distributed, the remanding treatments were randomly distributed using the two colours in the card deck instead of the four suits.

7.3.2 SurveyMonkey

The second half of the subjects where recruited via email (SurveyMonkey email service). They were asked to participate in the experiment and presented with a link to the test. The tests were randomly distributed using the same method as above. Each test was assign a suit and a card was drawn for each email address on the mailing list. Though time-consuming, it ensured a random distribution of the tests.

The digital tests were constructed using SurveyMonkey. It is a web survey service. It offers large-scale online web tools in both data analysis, brand management and consumer focused marketing. It has over 15 million users and offers it services to big companies as Samsung and Facebook among others. It is world leading in its field.

The online tests were identical to the ones on paper. The only different were the presentation of the consumer goods. They were presented with pictures instead if real life presentation.

7.4 Data analysis

I have used two different methods to analyse the data. To replicate Ariely et al. (2003) I use the Pearson correlation coefficient to estimate the correlation between the anchor and the maximum WTP. I have also used the Man-Whitney test since it is a possibility that values are not normally distributed. Figure 12 is a scatterplot form the experiment.

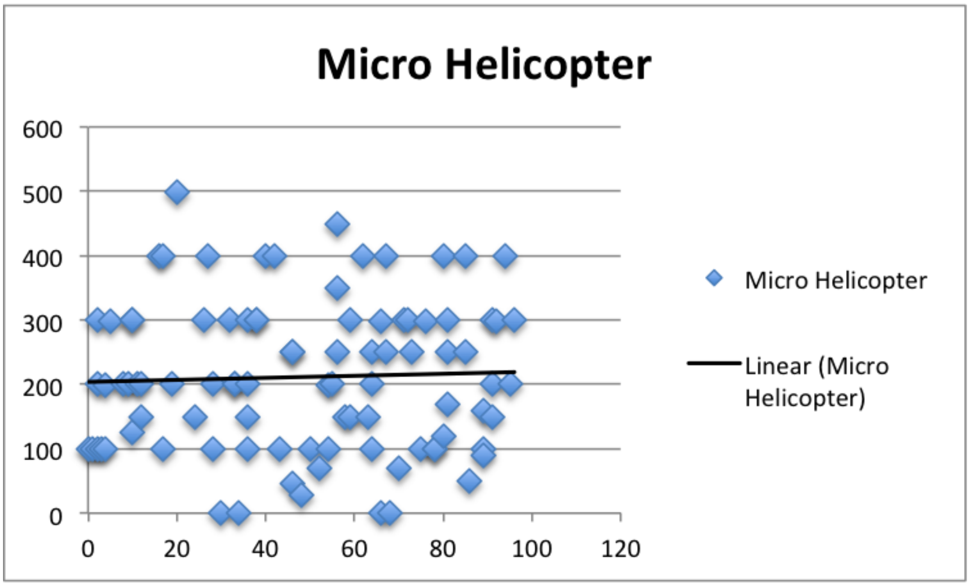

Figure 12: From the experiment: Scatterplots Micro Helicopter Ariely Replication[2]

It indicates that the values may not be normally distributed. The subject has an inclination to state round numbers as their WTP (50, 100, 150 etc.). This trend is observed for most of the consumer good in the experiment.

7.4.2 Pearson correlation

The Person product-moment correlation coefficient is a measure of the linear correlation (dependence or strength) between two variables X and Y. In this case an anchor (X) and a maximum WTP (Y). Person's r is a value between +1 and -1. Where 1 is total positive correlation, 0 is no correlation and -1 is total negative correlation. For example, you could use the test to find out whether peoples height and weight are correlated (they will be – the taller people are, the heavier they're likely to be).

There is a set of requirements that should be met. First, the scale of measurement should be interval or ratio. Second, variables should be approximately normally distributed. Third, the association should be linear. Finally, there should be no outlier in the data.

The coefficient is calculated according to this equation:

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2}\sqrt{\sum_i (y_i - \bar{y})^2}} \tag{16}$$

Since there is a possibility that some of these requirements can't be met, I have included the Mann-Whitney test as well.

7.4.3 Mann-Whitney test

The Man-Whitney test is a nonparametric test that allows two groups or conditions or treatments to be compared without making the assumption that values are normally distributed. The logic behind the test is to rank the data for each condition, and see how different the two rank totals are. If there is a systematic difference between the two conditions, the majority of the low ranks will belong to one condition and the majority of the high ranks will belong to the other condition. As a result, the rank totals will be different. If the two conditions are similar the low and high rank will be fairly equal. The Mann-Whitney test statistic "U" demonstrate the difference between the two rank totals. The smaller this is (depending in number of participants) the less likely it has occurred by chance.

Four requirements have to be met. First, there has to be two random, independent samples. Second, the data is continuous. This meaning it must, in principle, be possible to distinguish between values at the nth decimal place. Third, the scale of measurement should be ordinal, interval or ratio. Finally, for maximum accuracy, there should be no ties.

The null hypothesis asserts that the medians of the two samples are identical. The U value is calculated according to this equation.

$$U = NM + \frac{N(N+1)}{2} - \sum_{x_i} Rank(x_i) \tag{17}$$

8. Procedure

As mention the experimental design closely follows that of Ariely et al. (2003). However, I have altered it to be more like a Vickrey auction in test 2.

The participants are first given the opportunity to inspect six ordinary consumer goods (Toblerone Fruit & Nut chocolate, a micro helicopter, a Pantone card holder, the game Monopoly, chocolate truffles and a power strip), which were briefly described on request, without mentioning market price. The store prices range from NOK 49 to NOK 249 (figure 13 & 14), with an average retail price of NOK 131. The exchange rate at the time of the experiment was $\$1 \approx NOK\ 6$.

After reading the experiment instructions, the participants are asked to write down the two last digits (ID) of their social security number. The subjects are then asked whether they would bye each of the six consumer goods for a price equal to the last two digits of their ID. After this Accept/Reject (yes/no) response, they state their maximum willingness to pay.

In the Ariely Replication test (test 1), a random device will later determine whether the product would in fact be sold on the basis of the first, Accept/Reject response, or the second, WTP response (via the incentive-compatible Becker-DeGroot-Marschak procedure (1964)). The subjects understood that both their Accept/Reject response and their WTP response had some chance of being decisive for the purchase, and that one of them would be randomly drawn for each good. Each subject is eligible to purchase at most one product. In the corresponding control group, only the Becker-DeGroot-Marschak procedure is used. There is no anchor and no Accept/Reject response.

In the Vickrey auction test (test 2), the subjects are informed that the highest bidder for each consumer good will be contacted with an offered to buy. They will then pay the price corresponding to the second highest bid, according to the Vickrey auction procedure. The corresponding control group is no different, except the subjects are not exposed to an anchor.

The subjects in the experiment were undergraduate and graduate students at University of Tromsø. Three experimental sessions were conducted during the end of March 2014, and a total of 249 subjects participated. In the Ariely Replication test a total of 98 subjects participated in the treatment group and 26 in the control. The Vickrey Auction test had 99 participants in the treatment group and 26 in the control.

To replicate Ariely et al. (2003) I estimated the correlation between ID and WTP for both tests using the Pearson correlation. I also conducted a Man-Whitney test. The treatment groups (for both test 1 & 2) were divided into a low and high anchor group. These two were then tested against each other using the Man-Whitney. I also tested each control group against both high and low anchor groups. These procedures where conducted for each consumer good.

9. Results

A total of 13 test results were omitted form the experiment. The participants did not understand the experiment and conducted it incorrectly.

Table 1 displays how willingness to pay varies across quintiles of the ID distribution for the Ariely Replication test. The WTP typically increases for most of the consumer goods with ID, consistent with an anchor effect. The Pearson correlation coefficient is sizeable for 3 of the 6 goods (Toblerone, Pantone Card Holder and Truffles), ranging from 0.23 to 0.38. All three are significant at the 5% level. For the remaining three goods (Micro Helicopter, Monopoly and Power Strip) the Pearson correlation coefficient are not sizeable, ranging from 0.04 to 0.13, and they are not significant at the 5% or the 10% level. When looking at the average WTP for all goods the correlation is 0.21 and significant. The result for three of the products and the total WTP are similar to the result of Ariely et al. (2003) where correlation ranged between 0.32 and 0.52. The three consumer goods with the highest retail price (figure 13 & 14) did not have a significant anchor effect. It can indicate that the scope of the anchors were to low (or the price/quality to high). Resulting in all the anchors acting as low anchors.

Table 1: Result: Pearson Correlation for Ariely Replication

ARIELY REPLICATION
AVERAGE STATED WILLINGNESS-TO-PAY SORTED BY QUINTILE OF THE SAMPLE'S SOCIAL SECURITY NUMBER DISTRIBUTION

Quintile of the social security number distribution	Toblerone Fruit & Nut	Micro Helicopter	Pantone Card Holder	Monopoly (game)	Truffles (chocolate)	Power Strip	Average wtp for all products
1	kr 31.42	kr 209.05	kr 51.89	kr 215.79	kr 44.32	kr 98.84	kr 108.55
2	kr 32.39	kr 205.50	kr 51.78	kr 216.61	kr 56.89	kr 93.72	kr 109.48
3	kr 41.53	kr 215.42	kr 80.63	kr 216.95	kr 56.84	kr 121.58	kr 122.16
4	kr 47.06	kr 198.17	kr 84.56	kr 208.39	kr 77.67	kr 91.11	kr 117.82
5	kr 55.11	kr 229.89	kr 94.50	kr 260.94	kr 77.67	kr 133.83	kr 141.99
Person correlation	0.3843	0.0397	0.2336	0.1171	0.3280	0.1323	0.2109
p-value of correlation	0.0002	0.7071	0.0250	0.2663	0.0014	0.2087	0.0436

Table 2 displays how WTP varies across quintiles of the ID distribution for the Vickrey Auction test. The WTP does not increase with ID for 5 of the 6 consumer goods (the exception is Monopoly). This is not consistent with an anchoring effect. The Pearson correlation coefficients for the 5 goods are small, ranging from 0.01 to 0.09, and they are not remotely significant. Monopoly is the only good indicating an anchoring effect, with a Pearson correlation coefficient of 0.25, which is significant at the 5% level. When looking at the average WTP for all goods the correlation is 0.17 and barely significant at the 10% level. These results suggest that the anchor effect is lower under an auction situation. This is especially prominent if you compare the three consumer goods Toblerone, Pantone Chard Holder and the Truffles in both tests. In the Ariely Replication test they are correlated and strongly significant. In the Vickrey Auction test they are not correlated and strongly insignificant.

Table 2: Pearson Correlation for Vickrey Auction

VICKREY AUCTION

AVERAGE STATED WILLINGNESS-TO-PAY SORTED BY QUINTILE OF THE SAMPLE'S SOCIAL SECURITY NUMBER DISTRIBUTION

Quintile of the social security number distribution		Toblerone Fruit & Nut	Micro Helicopter	Pantone Card Holder	Monopoly (game)	Truffles (chocolate)	Power Strip	Average wtp for all products
	1	kr 40.37	kr 222.63	kr 48.32	kr 175.74	kr 78.05	kr 97.32	kr 110.40
	2	kr 39.72	kr 191.50	kr 60.17	kr 207.67	kr 59.06	kr 65.11	kr 103.87
	3	kr 31.68	kr 195.68	kr 49.95	kr 216.68	kr 57.47	kr 76.37	kr 104.64
	4	kr 34.61	kr 216.17	kr 87.56	kr 264.22	kr 66.56	kr 133.33	kr 133.74
	5	kr 47.44	kr 239.22	kr 57.67	kr 249.94	kr 85.50	kr 80.89	kr 126.78
Person correlation		0.0278	0.0912	0.0815	0.2542	0.0134	0.0909	0.1731
p-value of correlation		0.7925	0.3873	0.4399	0.0145	0.8991	0.3888	0.0989

Table 3 displays the Mann-Whitney test p-values for both the Ariely Replication and the Vickrey Auction test. The U-values are high for all products in both tests. This indicates that distribution is approximately normal and that Z-values can be used. Using these was not necessary since they were almost identical to the p-value calculated thorough the Mann-Whitney test. The small decimal deviation was not big enough to alter any results.

Table 3: Result: Mann-Whitney p-values

MANN-WHITNEY TEST P-VALUES								
	Ariely Replication	Vickray Auction	Ariely Replication Control VS			Vickrey Auction Control VS		
Anchor group	Low VS High	Low VS High	High	Low	High & Low	High	Low	High & Low
Toblerone Fruit & Nut	0.0069	0.3270	0.2670	0.0009		0.9283	0.3320	0.6031
	(711)	(928)	(515)	(307)		(552)	(549)	(1116)
Micro Helicopter	1.0000	0.1645	0.1141	0.1031	0.0751	0.0703	0.0063	
	(1057)	(875)	(474)	(448)	(922)	(413)	(392)	
Pantone Card Holder	0.0308	0.1389	0.1260	0.0008		0.3735	0.0293	0.0819
	(780)	(865)	(478)	(304)		(487)	(441)	(928)
Monopoly (game)	0.4777	0.0989	0.1585	0.0477	0.0601	0.4654	0.0414	0.1164
	(966)	(843)	(488)	(419)	(907)	(500)	(454)	(953)
Truffles (chocolate)	0.0083	0.0477	0.0053	0.0000		0.0340	0.0024	
	(720)	(801)	(367)	(220)		(387)	(365)	
Power Strip	0.1585	0.0549	0.1936	0.0226	0.0477	0.1802	0.0099	0.0271
	(876)	(808)	(498)	(394)	(891)	(450)	(405)	(855)

The null hypothesis asserts that the medians of the two samples are identical. U-values in parentheses.

For the Ariely Replication test Mann-Whitney p-values was significant at the 5% level for the same 3 consumer goods as when testing for Pearson correlation (Toblerone, Pantone Card Holder and Truffles). The null hypothesis of the Mann-Whitney test is thus rejected. The remaining three goods were not significant at the 5% level, also consistent whit the Pearson correlation test. This supports the suspicion of an anchor with insufficient scope (to low) or (and) to high valued consumer goods for this experiment. To test this I assumed that all data collected for these three goods were subjected to a low anchor. I then tested this against the control. As illustrated in table 3, the goods are now significantly different (two at 10% level and one at the 5% level) from the control group. Indicating that the whole set for these good behave as a low anchor.

In the Vickrey Auction test Mann-Whitney p-values for 5 of the 6 consumer goods was not significant at the 5% level. Truffles are the only consumer good that is significant (barely) at the 5% level. These results also support the indication of a smaller anchoring effect in an auction situation.

Figure 13 & 14 compares the average WTP for the low anchor groups, the high anchor groups and the control groups for each consumer good for both tests. Actual retail prices are also included. There are several things to read out of this. Both control groups has higher average WTP values than both the low and high anchor groups for every consumer good. This is again an indication of too low anchor values in general. The scope should probably have been bigger. Using the three last digits of the social security number could be a solution. Then again, the third last number is not randomly generated.

Another interesting comparison is the average WTP between the two tests. Figure 13 & 14 illustrate that almost every Average WTP value (14 of 18) is lower in the Vickrey Auction test than in the Ariely Replication. This also supports the initial hypothesis.

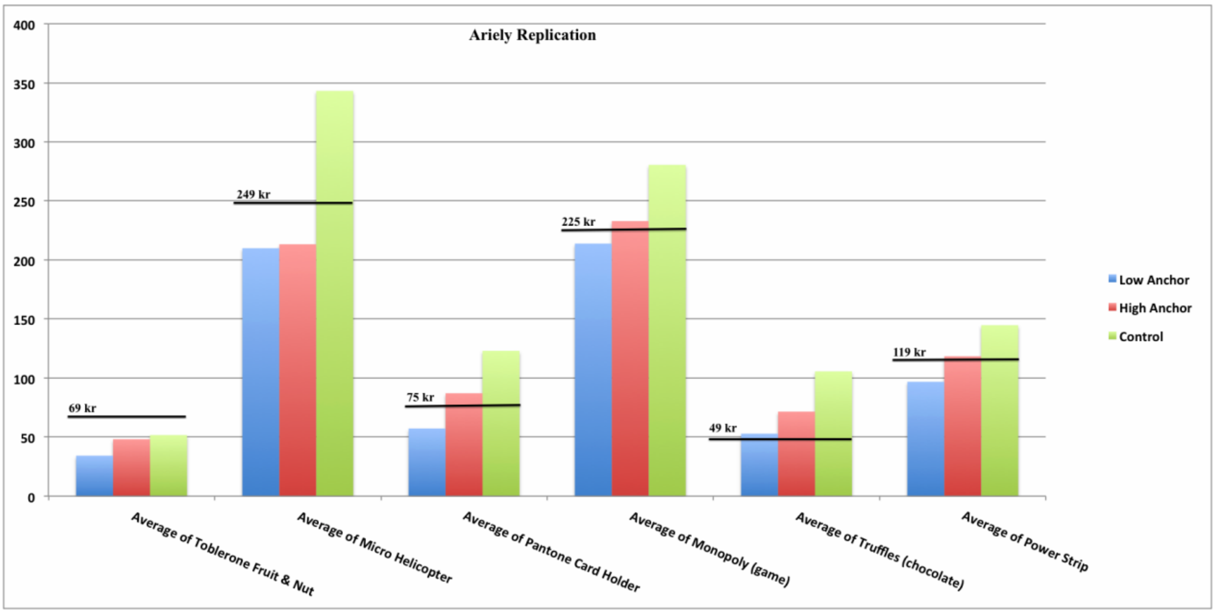

Figure 13: From the experiment: Ariely Replication average WTP chart[2]

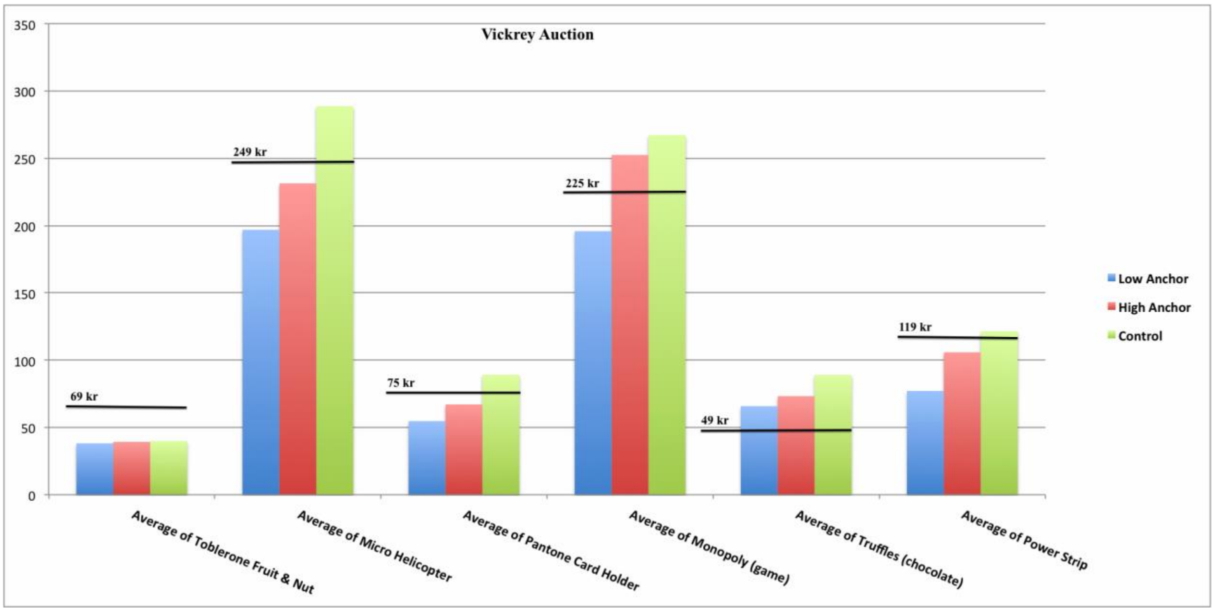

Figure 14: From the experiment: Vickrey Auction average WTP chart[2]

Figure 15 & 16 compares each WTP value for the consumer good Truffles for both tests as a scatterplot. For the Ariely Replication the WTP values are spread out and the trend line is increasing for higher anchors, indicating anchoring effect. For the Vickrey Auction the WTP values are more clustered and the trend line is linear. This trend is similar for the other consumer goods. The remaining scatterplots are printed in the appendix.

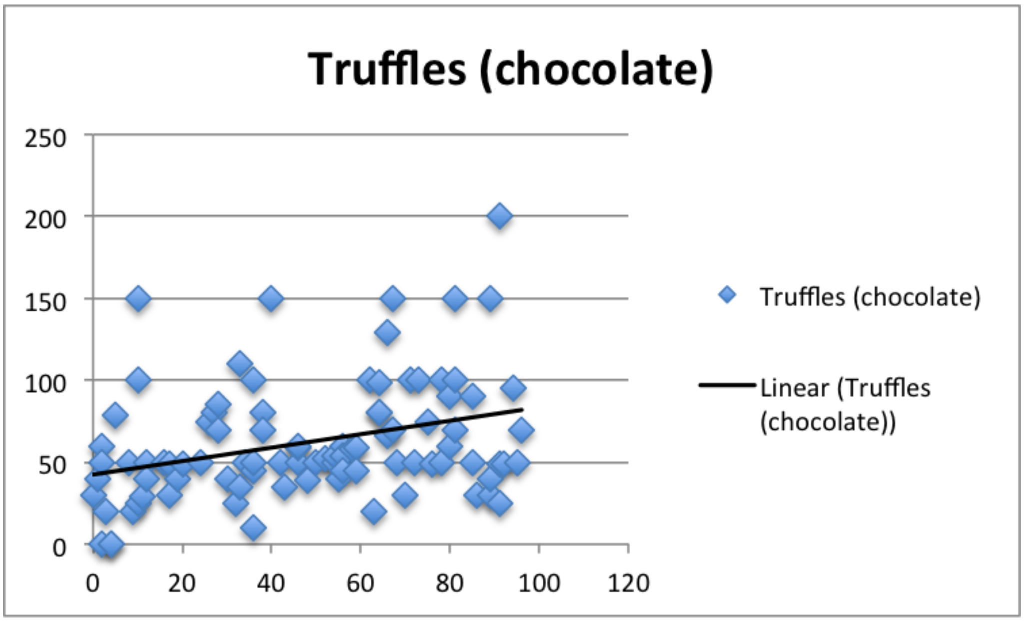

Figure 15: From the experiment: Scatterplots Truffles Ariely Replication[2]

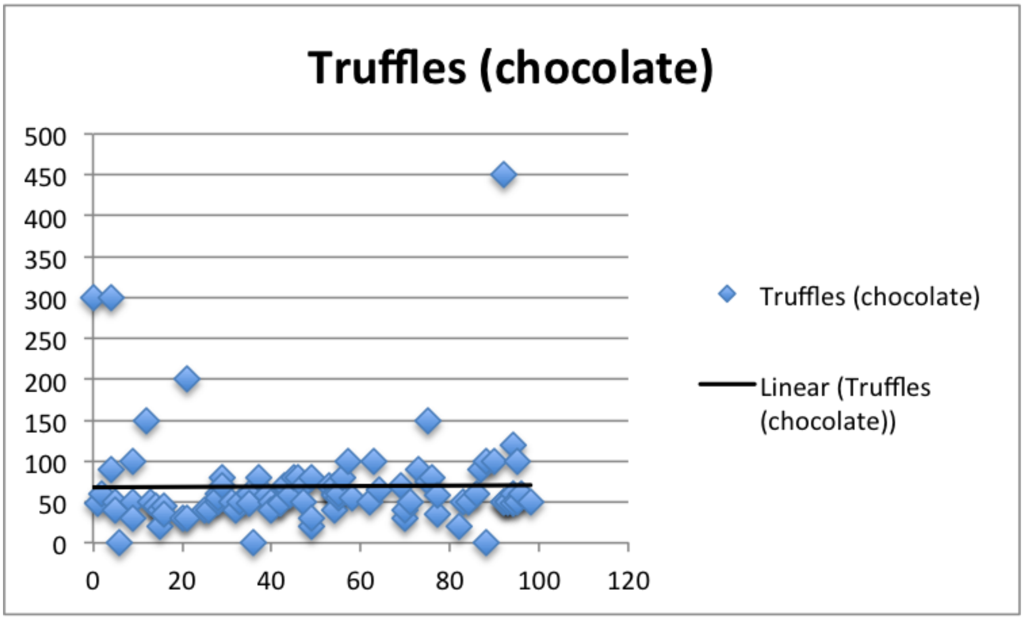

Figure 16: From the experiment: Scatterplots Truffles Vickrey Auction[2]

10. Discussion & Conclusion

With the analysis and comparison complete, I can now address the predictions and result of the experiment. In this thesis predictions have been addressed in relation to actual behaviour through this experiment. How did anchor values affect maximum WTP in the Ariely Replication test? Were the anchor effect removed in an Auction situation?

The results in Test 1 (Ariely Replication) were satisfying and mostly corresponding to the predictions. A strong anchoring effect was proven for 3 of the consumer goods. The three remaining goods were not significantly influenced by the anchoring effect. This, however, doesn't illustrate a failure of the anchoring effect. It is probably a consequence of the experimental design. The retail prices for the Micro Helicopter, the Monopoly game and the Power Strip was 249kr, 225kr and 119kr respectively. Whit an anchor range form 0 to 99 these consumer goods were to valuable. This probably resulted in all the ID numbers acting as low anchors. Since there doesn't exist a high anchor group it makes good statistical analysis difficult. I tested the whole data set for these three goods against the control and found them significantly different. I addition the Power Strip was introduced to the subjects as a Designer Power Strip. The wording can have affected the stated WTP as a high anchor (Mussweiler and Strack, 2000b). However, they were all proven to be uncorrelated and insignificant when testing for Pearson correlation. But all in all I have to be satisfied with replicating a strong anchoring effect for three of the consumer goods.

The results in Test 2 (Vickrey Auction) were also satisfying and mostly corresponded to predictions, but there were some surprising results. No anchor effect where proven for 5 of the 6 consumer goods when using the Pearson correlation test. Especially the three consumer goods that were affected by an anchor in Test 1 were not affected in Test 2 (low correlation and high p-values). This strongly indicates that my hypotheses were right. Also in the Mann-Whitney test 5 out of 6 consumer good did not illustrate an anchor effect (insignificant at the 5% level). In addition, 14 of 18 average WTP values were lower than the corresponding values in Test 1. Two consumer goods illustrated unexpected results. The Monopoly game demonstrated an anchor effect on WTP both in the Pearson correlation test and the Man-Whitney test (5% and 10% significant level). In Test 1 it was uncorrelated and insignificant in both tests. One explanation can be extreme outliers. These were not omitted from the data sets. The last consumer good with unusual behaviour were Truffles. In the Pearson correlation test it had the lowest correlation score (0.01) and the highest p-value (0.90), but it was significant in the Man-Whitney test. This is harder to explain. Extreme outlier can be a factor here to, but this is more uncertain. Regardless, the result demonstrates in general lower WTP values for the Vickrey Auction test.

Hypothesis 1: When replicating Ariely et al. (2003), subjects are effected by an irrelevant anchor. This was proven for 3 out of 6 consumer goods. The 3 remaining doesn't necessary illustrate a failure of the anchoring effect, but a problem with the experimental design. The results are satisfactory.

Hypothesis 2: The anchor effect disappears (is smaller) when subjects are in an auction situation. No anchor effect where proven for 5 of the 6 consumer goods and 14 of 18 average WTP values were lower than the corresponding values in Test 1.

Hypothesis 1 and 2 held whit a few exceptions. My findings indicate removal and lowering of the anchoring effect in an auction situation. When participating in an auction it would seem that the subjects are more aware of the consequences. In the Ariely Replication test there are also possible consequences. You can be selected to buy one of the consumer goods. Your own actions influence the consequences but they are also influenced by a random draw, which is out of your control. In the Vickrey Auction test the consequences are linked more directly to your own actions and are less random. Also, as illustrated before, the Vickrey auction has a dominant strategy of truthful bidding. This would seem to render the participants less prone to the anchoring effect.

The exceptions to the hypothesis are probably more a result of experimental design flaws than in the direction of rejecting the hypothesis. But this can obviously not be proven whiteout more research and is merely a statement of speculation from my part.

When assessing the results it is important to take into account the time limit and resources available when conducting this experiment. Optimally the experiment should have been executed in a lab with a controlled environment. This was not possible. The result should therefore be examined with a critical eye.

This thesis try to unravel a small part the mystery surrounding this cognitive bias. It provides a vivid illustration of the anchoring effect, one of the most unique, remarkable and robust influences on human judgement. Still there does not exist a complete understanding of the anchoring effect and its origin. Maniadis et al. (2014) state that a few independent replications dramatically increase the chance that the original finding is true. The scope of anchoring effect is fascinating and should inspire further research.

11. References

ALLAIS, M. 1953. Le comportement de l'homme rationnel devant le risque: critique des postulats et axiomes de l'école américaine. *Econometrica: Journal of the Econometric Society*, 503-546.

ALLAIS, M. 1988. *The General Theory of Random Choices in Relation to the Invariant Cardinal Utility Function and the Specific Probability Function. The (U, θ) Model A General Overview*, Springer.

ALLAIS, M. 1990. Allais paradox. *The New Palgrave, Utility and Probability*, 3-9.

ARIELY, D. 2008. *Predictably irrational : the hidden forces that shape our decisions,* New York, NY, Harper.

ARIELY, D., LOEWENSTEIN, G. & PRELEC, D. 2003. “Coherent arbitrariness”: Stable demand curves without stable preferences. *The Quarterly Journal of Economics,* 118, 73-106.

BECKER, G. M., DEGROOT, M. H. & MARSCHAK, J. 1964. Measuring utility by a single‐response sequential method. *Behavioral science,* 9, 226-232.

BERGMAN, O., ELLINGSEN, T., JOHANNESSON, M. & SVENSSON, C. 2010. Anchoring and cognitive ability. *Economics Letters,* 107, 66-68.

BERNOULLI, D. 1738. *Danielis Bernoulli... Hydrodynamica, sive De viribus et motibus fluidorum commentarii. Opus academicum ab auctore, dum Petropoli ageret, congestum*, Sumptibus Johannis Reinholdi Dulseckeri.

BERNOULLI, D. 1954. Exposition of a new theory on the measurement of risk. *Econometrica: Journal of the Econometric Society*, 23-36.

BLUME, L. & DURLAUF, S. 2008. *The new Palgrave dictionary of economics*, Palgrave Macmillan.

CERVONE, D. & PEAKE, P. K. 1986. Anchoring, efficacy, and action: The influence of judgmental heuristics on self-efficacy judgments and behavior. *Journal of Personality and Social Psychology,* 50, 492.

CHAPMAN, G. B. & BORNSTEIN, B. H. 1996. The more you ask for, the more you get: Anchoring in personal injury verdicts. *Applied Cognitive Psychology,* 10, 519-540.

DE MONTMORT, P. R. 1713. Essay d’analyse sur les jeux de hazard, Seconde Edition. *Revue & augmentée de plusieurs Lettres, Paris: Jacque Quillau,* 1713.

EPLEY, N. & GILOVICH, T. 2001. Putting adjustment back in the anchoring and adjustment heuristic: Differential processing of self-generated and experimenter-provided anchors. *Psychological Science,* 12, 391-396.

FAGLEY, N. S. 1993. A note concerning reflection effects versus framing effects.

GALINSKY, A. D. & MUSSWEILER, T. 2001. First offers as anchors: the role of perspective-taking and negotiator focus. *Journal of personality and social psychology,* 81, 657.

GEORGE WU, J. Z., RICHARD GONZALEZ 2004. Decision under Risk. *In:* DEREK J. KOEHLER, N. H. (ed.) *Blackwll Handbook of Judgement and Decision Making.* Malden MA: Blackwell.

GIGERENZER, G. & SELTEN, R. 2002. *Bounded rationality: The adaptive toolbox*, Mit Press.

GRICE, H. P. 1975. Logic and conversation. *1975*, 41-58.

GUMPERZ, J. J. 1982. *Discourse strategies*, Cambridge University Press.

JACOWITZ, K. E. & KAHNEMAN, D. 1995. Measures of anchoring in estimation tasks. *Personality and Social Psychology Bulletin,* 21, 1161-1166.

KAGEL, J. H. & ROTH, A. E. 1995. *The handbook of experimental economics,* Princeton, N.J., Princeton University Press.
KAHNEMAN, D. & TVERSKY, A. 1979. Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.
KAHNEMAN, D. & TVERSKY, A. 2000. *Choices, values, and frames,* New York
Cambridge, UK, Russell sage Foundation ;
Cambridge University Press.
KRISHNA, V. 2009. *Auction theory*, Academic press.
LAKSHMINARAYANAN, V. R., CHEN, M. K. & SANTOS, L. R. 2011. The evolution of decision-making under risk: Framing effects in monkey risk preferences. *Journal of Experimental Social Psychology,* 47, 689-693.
LEVIN, J. 2006. Choice under uncertainty.
LUCKING-REILEY, D. 2000. Vickrey auctions in practice: From nineteenth-century philately to twenty-first-century e-commerce. *The Journal of Economic Perspectives*, 183-192.
MANIADIS, Z., TUFANO, F. & LIST, J. A. 2014. One Swallow Doesn't Make a Summer: New Evidence on Anchoring Effects. *The American Economic Review,* 104, 277-290.
MCAFEE, R. P. & MCMILLAN, J. 1987. Auctions and bidding. *Journal of economic literature,* 25, 699-738.
MILL, J. S. & ROBSON, J. M. 1963. *Collected Works of John Stuart Mill: The earlier letters of John Stuart Mill, 1812-1848. Vol. 12-13*, University of Toronto Press.
MUSSWEILER, T. 1997. *A selective accessibility model of anchoring: Linking the anchoring heuristic to hypothesis-consistent testing and semantic priming*, Pabst Lengerich, Germany.
MUSSWEILER, T. 2001. 'Seek and ye shall find': antecedents of assimilation and contrast in social comparison. *European Journal of Social Psychology,* 31, 499-509.
MUSSWEILER, T., ENGLICH, B. & STRACK, F. 2004. 10 Anchoring effect. *Cognitive Illusions: A Handbook on Fallacies and Biases in Thinking, Judgement and Memory*, 183.
MUSSWEILER, T. & STRACK, F. 1999a. Comparing is believing: A selective accessibility model of judgmental anchoring. *European review of social psychology,* 10, 135-167.
MUSSWEILER, T. & STRACK, F. 1999b. Hypothesis-consistent testing and semantic priming in the anchoring paradigm: A selective accessibility model. *Journal of Experimental Social Psychology,* 35, 136-164.
MUSSWEILER, T. & STRACK, F. 2000a. Numeric judgments under uncertainty: The role of knowledge in anchoring. *Journal of Experimental Social Psychology,* 36, 495-518.
MUSSWEILER, T. & STRACK, F. 2000b. The use of category and exemplar knowledge in the solution of anchoring tasks. *Journal of Personality and Social Psychology,* 78, 1038.
MUSSWEILER, T. & STRACK, F. 2001. The semantics of anchoring. *Organizational Behavior and Human Decision Processes,* 86, 234-255.
MUSSWEILER, T., STRACK, F. & PFEIFFER, T. 2000. Overcoming the inevitable anchoring effect: Considering the opposite compensates for selective accessibility. *Personality and Social Psychology Bulletin,* 26, 1142-1150.
NEUMANN, L. J. & MORGENSTERN, O. 1947. *Theory of games and economic behavior*, Princeton university press Princeton, NJ.

NORTHCRAFT, G. B. & NEALE, M. A. 1987. Experts, amateurs, and real estate: An anchoring-and-adjustment perspective on property pricing decisions. *Organizational behavior and human decision processes,* 39, 84-97.
OPPENHEIMER, D. M., LEBOEUF, R. A. & BREWER, N. T. 2008. Anchors aweigh: A demonstration of cross-modality anchoring and magnitude priming. *Cognition,* 106, 13-26.
PLOUS, S. 1989. Thinking the Unthinkable: The Effects of Anchoring on Likelihood Estimates of Nuclear War1. *Journal of Applied Social Psychology,* 19, 67-91.
ROTH, A. E. & SOTOMAYOR, M. A. O. 1992. *Two-sided matching: A study in game-theoretic modeling and analysis*, Cambridge University Press.
SAVAGE, L. J. 2012. *The foundations of statistics*, Courier Dover Publications.
SIMON, H. A. 1955. A behavioral model of rational choice. *The quarterly journal of economics,* 69, 99-118.
SIMON, H. A. 1983. *Reason in human affairs*, Stanford University Press.
SIMON, H. A., EGIDI, M. & MARRIS, R. L. 2008. *Economics, bounded rationality and the cognitive revolution*, Edward Elgar Publishing.
SLOVIC, P. 1967. The relative influence of probabilities and payoffs upon perceived risk of a gamble. *Psychonomic Science,* 9, 223-224.
SMITH, A. R. & WINDSCHITL, P. D. 2011. Biased calculations: Numeric anchors influence answers to math equations. *Judgment and Decision Making,* 6, 139-146.
SMITH, V. L. 2002. *Vernon L. Smith - Biographical* [Online]. Nobelprize.org: Nobel Media AB 2013. Available: http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002/smith-bio.html [Accessed 29 May 2014].
STAPEL, D. A., KOOMEN, W. & VAN DER PLIGT, J. 1997. Categories of category accessibility: The impact of trait concept versus exemplar priming on person judgments. *Journal of Experimental Social Psychology,* 33, 47-76.
STRACK, F. & MUSSWEILER, T. 1997. Explaining the enigmatic anchoring effect: Mechanisms of selective accessibility. *Journal of Personality and Social Psychology,* 73, 437.
THALER, R. H., TVERSKY, A., KAHNEMAN, D. & SCHWARTZ, A. 1997. The effect of myopia and loss aversion on risk taking: An experimental test. *The Quarterly Journal of Economics,* 112, 647-661.
TVERSKY, A. & KAHNEMAN, D. 1974. Judgment under Uncertainty - Heuristics and Biases. *Science,* 185, 1124-1131.
TVERSKY, A. & KAHNEMAN, D. 1981. The framing of decisions. *Science,* 211, 453-458.
TVERSKY, A. & KAHNEMAN, D. 1991. Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics,* 106, 1039-1061.
TVERSKY, A. & KAHNEMAN, D. 1992. Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and uncertainty,* 5, 297-323.
VICKREY, W. 1961. Counterspeculation, auctions, and competitive sealed tenders. *The Journal of finance,* 16, 8-37.
WILSON, T. D., HOUSTON, C. E., ETLING, K. M. & BREKKE, N. 1996. A new look at anchoring effects: basic anchoring and its antecedents. *Journal of Experimental Psychology: General,* 125, 387.
WONG, K. F. E. & KWONG, J. Y. Y. 2000. Is 7300 m equal to 7.3 km? Same semantics but different anchoring effects. *Organizational Behavior and Human Decision Processes,* 82, 314-333.

12. End note

1. Taken from (Lakshminarayanan et al., 2011), presenting Tversky and Kahneman problem.
2. Figure created by myself.
3. Taken from (Smith and Windschitl, 2011).
4. Taken from http://christopherlee.com/anchoring-magnitude-mississippi-river/
5. Taken from (Mussweiler and Strack, 2000b)

13. Appendix

Experiment instruction.

Prissettingseksperiment

Gå gjennom og fyll ut eksperimentet kronologisk side for side. Deltakelse i dette eksperimentet er frivillig og all informasjonen du oppgir vil bli behandlet anonymt og konfidensielt. Vi vil senere be deg om å oppgi de to siste tallene i ditt personnummer. Disse vil ikke kunne brukes til å identifisere deg. Ved å delta i dette eksperimentet er du automatisk med i trekningen av en Apple TV.

Takk for at du tar del i dette prissettingseksperimentet. Vi er interessert i hvor mye du er villig til å betale for et utvalgt varer. Til å starte med kommer vi til å vise deg noen produkter og så stille to spørsmål om din verdisetting av hvert produkt:

- Det første spørsmålet spør om du er villig til å kjøpe produktet til en satt pris. Prisen vil bli bestemt tilfeldig ved å omgjøre de to siste tallene i ditt personnummer til en pris i NOK.
- Det andre spørsmålet spør deg om å oppgi den høyeste summen du er villig til å betale for produktet.

For hvert produkt vil vi tilfeldig velge en person som blir tilbudt å kjøpe produktet. Dette blir gjort ved å trekke et spørreskjema for hvert produkt etter at alle deltakerne har levert sitt skjema. Ingen deltakere vil bli tilbudt å kjøpe mer enn ett produkt.

Hvis du blir trukket ut vil svarene på spørsmålene avgjøre hvor mye du kan kjøpe produktet for. Siden det er to spørsmål, vil ett av dem bli brukt til dette formålet. Hvilket av disse to blir bestemt ved et myntkast.

Alternativer:

<u>Du blir tilfeldig valgt og det første spørsmålet brukes:</u>

Var svaret ditt JA, vil du bli tilbudt å kjøpe varen for den prisen.

Var svaret ditt NEI, vil det ikke forekomme noe transaksjon.

<u>Du blir tilfeldig valgt og det andre spørsmålet brukes:</u>

Vi har et ark med nedskrevne priser. Den høyeste prisen på arket er hva vi synes er den høyeste rimelige prisen for det aktuelle produktet. Fra denne listen trekker vi en pris.

Er denne prisen høyere enn det du svarte på det andre spørsmål, vil ingen transaksjon gjennomføres.

Er denne prisen lavere enn det du svarte på det andre spørsmål, vil du bli tilbudt å kjøpe produktet for denne lavere prisen.

Siden svaret ditt på det andre spørsmålet ikke påvirker hvor mye du eventuelt kjøper produktet for, men bare om du kjøper produktet eller ikke, er det til din fordel å oppgi den reelle maksimale summen du er villig og forberedt på å betale for produktet.

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Figure 17: Experimental instruction Ariely Replication

Prissettingseksperiment

Gå gjennom og fyll ut eksperimentet kronologisk side for side. Deltakelse i dette eksperimentet er frivillig og all informasjonen du oppgir vil bli behandlet anonymt og konfidensielt. Vi vil senere be deg om å oppgi de to siste tallene i ditt personnummer. Disse vil ikke kunne brukes til å identifisere deg. Ved å delta i dette eksperimentet er du automatisk med i trekningen av en Apple TV.

Takk for at du tar del i dette prissetting eksperimentet. Vi er interessert i hvor mye du er villig til å betale for et utvalgt varer. Til å starte med kommer vi til å vise deg noen produkter og så stille to spørsmål om din verdisetting av hvert produkt:

- Det første spørsmålet spør om du er villig til å kjøpe produktet til en satt pris. Prisen vil bli bestemt tilfeldig ved å omgjøre de to siste tallene i ditt personnummer til en pris i NOK.
- Det andre spørsmålet spør deg om å oppgi den høyeste summen du er villig til å betale for produktet

Når undersøkelsen er fullført vil vi for hvert produkt finne frem det høyeste budet. Er det du som har det høyeste budet vil vi kontakte deg og du vil få kjøpe det aktuelle produktet for prisen tilsvarende det nest høyeste budet. Altså det budet som er under ditt vinnerbud.

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Figure 18: Experimental instruction Vickrey Auction

Scatterplots for consumer goods in Ariely Replication

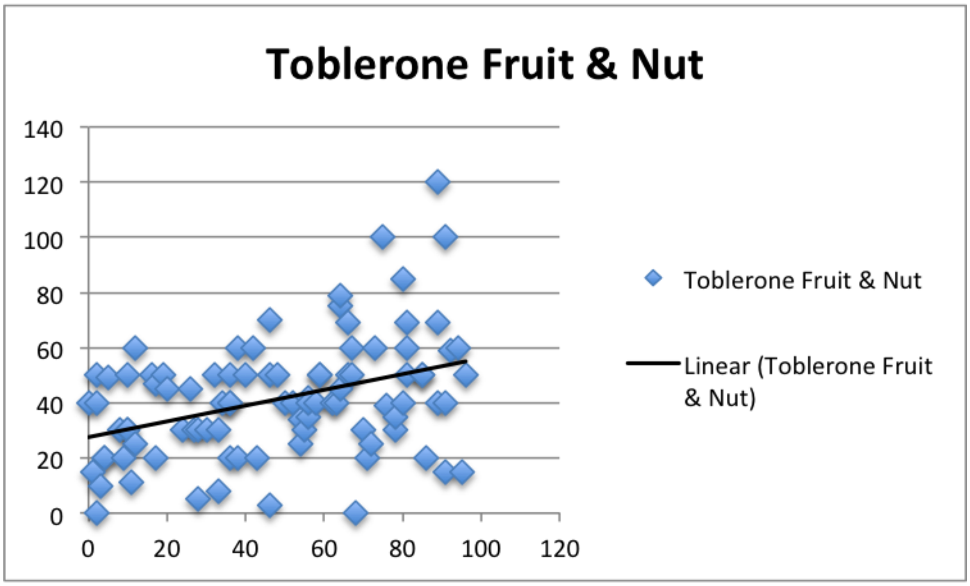

Figure 19: From the experiment: Scatterplots Toblerone Ariely Replication[2]

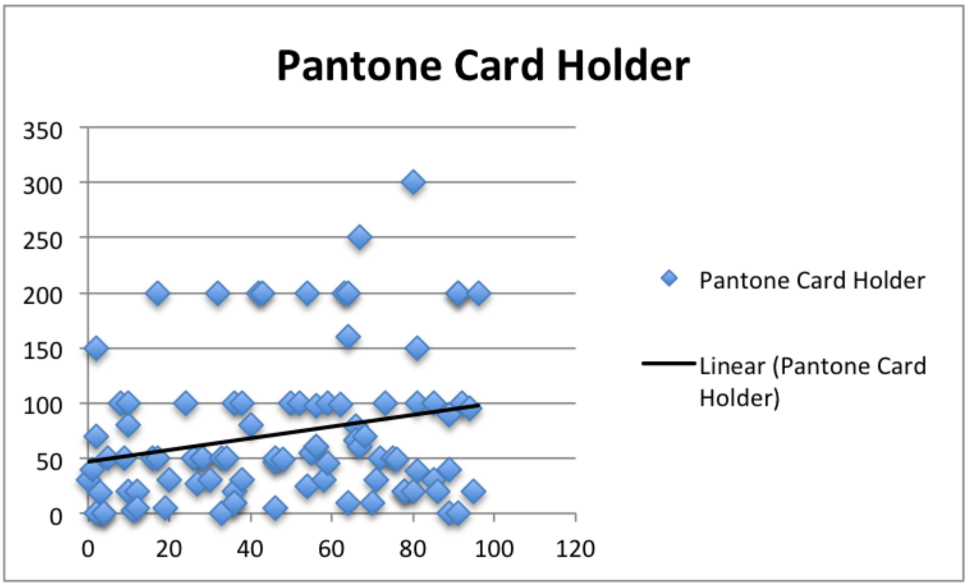

Figure 20: From the experiment: Scatterplots Pantone Card Holder Ariely Replication[2]

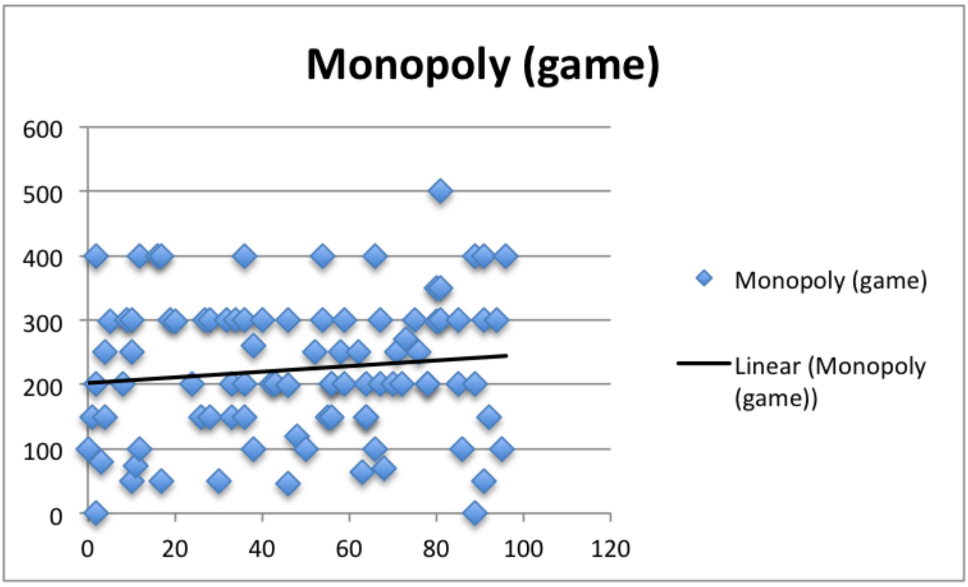

Figure 21: From the experiment: Scatterplots Monopoly Ariely Replication[2]

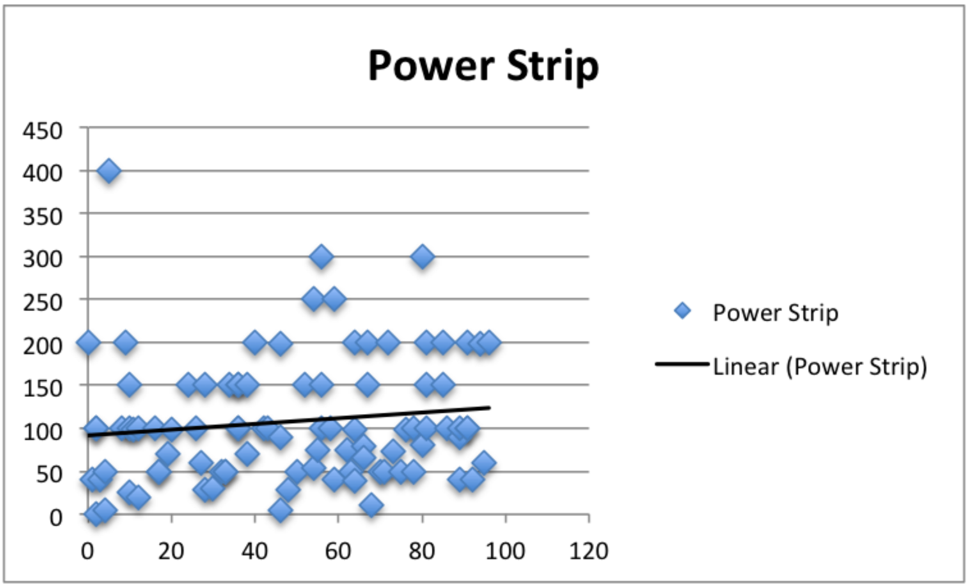

Figure 22: From the experiment: Scatterplots Power Strip Ariely Replication[2]

Scatterplots for consumer goods in Vickrey Auction test.

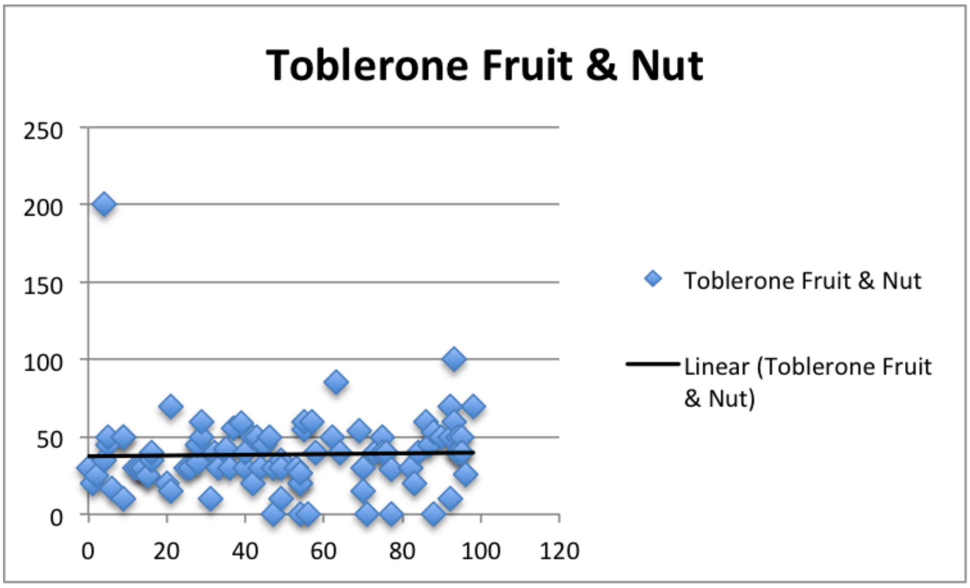

Figure 23: From the experiment: Scatterplots Toblerone Vickrey Auction[2]

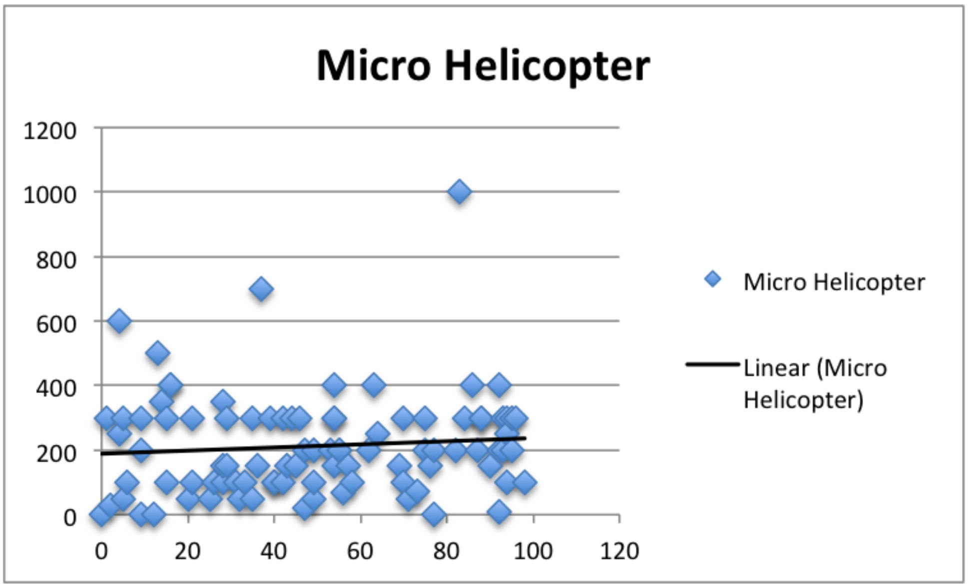

Figure 24: From the experiment: Scatterplots Micro Helicopter Vickrey Auction[2]

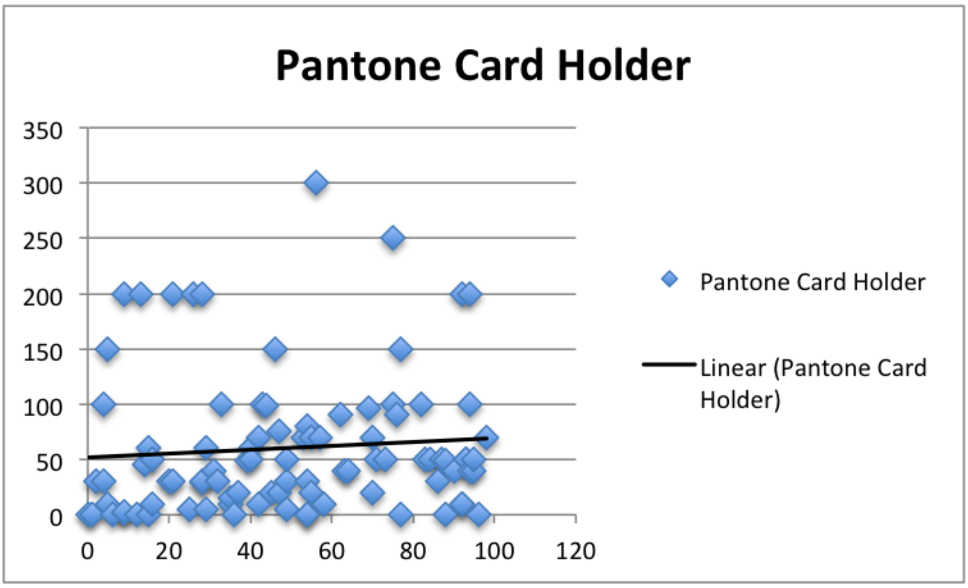

Figure 25: From the experiment: Scatterplots Pantone Vickrey Auction[2]

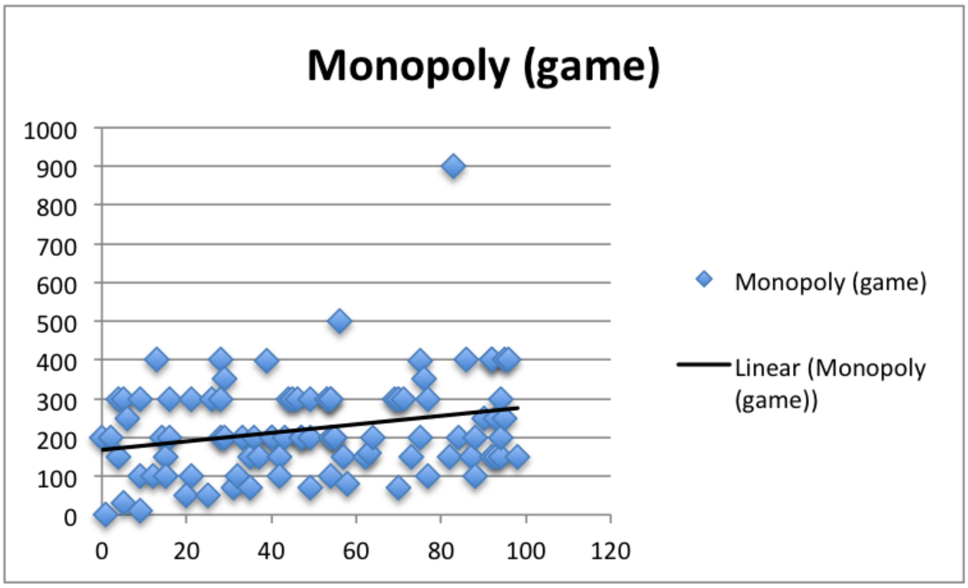

Figure 26: From the experiment: Scatterplots Monopoly Vickrey Auction[2]

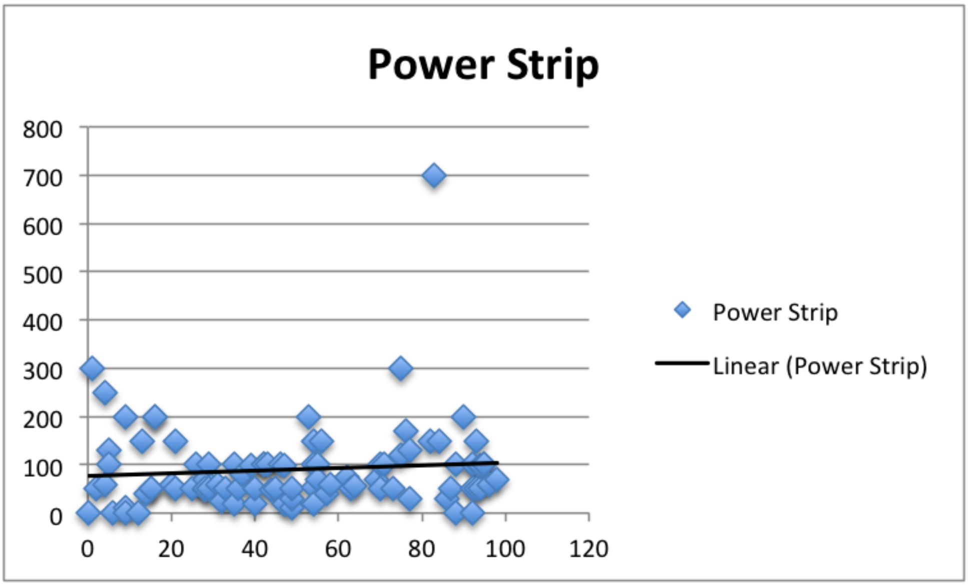

Figure 27: From the experiment: Scatterplots Power Strip Vickrey Auction[2]