Aalto University
School of Business

A Literacy Review of The Prospect Theory: Why Has It Been Revolutionary and How It Has Changed the Way We Conceptualize Decision-Making Under Risk

Bachelor's Thesis
Joonas Ylönen
Aalto University School of Business
Economics
Fall 2019

Author Joonas Ylönen

Title of thesis A literacy review of the prospect theory: What does it have to offer and how it has changed the way we conceptualize economics

Degree Bachelor of Science in Economics and Business Administration

The degree programme in Economics

Thesis advisor(s) Mikko Mustonen and Pauli Murto

Year of approval 2019 **Number of pages** 31 **Language** English

Abstract

In this paper, I will discuss, in great detail, the revolutionary prospect theory, presented by Daniel Kahneman and Amos Tversky in 1979. This literacy review explains the evolution of the prospect theory. The background involving the expected utility theorem from which it was born, to the modern real-life applications that prospect theorem has yielded. Prospect theory is a descriptive model to analyze the decision process under risk by which decision makers make their decisions. This theory itself consists of two phases; editing and evaluation phase. Both of these phases will be explained thoroughly, revealing the criticism the prospect theory has received and also the changes made in line with this criticism. The challenges regarding the formulation of the reference point are also noted. Overall, these findings have been an inherent part of the formulation of the field we today call behavioral economics. These insights are, therefore, to a great extent exploited, e.g., in the fields of finance and insurance, both of which I will review in this paper.

Keywords prospect theory; endowment effect; status quo bias; behavioural economics; behavioural finance

Contents

1. Introduction

In this undergraduate thesis, I will be presenting a literacy review about the Prospect theory. A theory that forever changed the way economical decision-making under risk is evaluated and theorized. Prospect theory was first presented to the world in 1979 by Daniel Kahneman (Nobel price winner 2002) and Amos Tversky (who would have shared the Nobel price if he wouldn't have died in 1996) both of whom were primarily psychologist. At first, prospect theory was truly controversial, mainly because economists commonly shared the framework of expected utility theory – which is, even till this day, taught in economics 101 courses – in which the decision-making in situations under risk is regarded as a rational process. This rational process took individual preferences in risk-seeking into account. However, the prospect theory found irrationals (anomalies) in human behaviour and these findings questioned the underlying axioms presumed in the preceding theory, e.g., the expected utility theory.

Prospect theory challenged the previous theoretical framework by presenting a strong claim with empirical evidence, among other things, that the thought process by which individuals make decisions under risk is not rational, at least in the traditional sense. They presented empirical evidence in which by merely changing the way the problem was formulated, people made completely different choices. This finding shocked the academic world, which mainly tried to explain the anomalies by denying the results of this paper, by questioning the methods by which the findings were discovered. Many of the phenomena presented by the prospect theory actually do stem from the relevant psychological literature. To demonstrate this, e.g., the value function presented in the theory reflects "three basic facts: organisms habituate to steady states, the marginal response to changes is diminishing, and pain is more urgent than pleasure." (Tversky and Kahneman (1990:1057)) This multidimensionality was probably one of the most eminent reasons for why the theory received its fair share of criticism.

Even though the framework presented by Kahneman and Tversky was profound, some of its findings were commonly noted by the public long before this paper was published. In an evergreen classic novel, Notes from the underground (1864) by Fyodor Dostoyevsky, the main character "underground-man" famously noted: "Man only likes to count his troubles; he doesn't calculate his happiness." For what this is worth, it could be, therefore, argued that the underlying brilliance presented by the prospect theory has been long recognized in the public. This helps to explain why the theory seems to be intuitively somewhat easy to follow.

During this undergraduate thesis, we will first dive into the paper in which the prospect theory was published in 1979. Secondly, I attempt to shine a light into the critic's prospect theory has received throughout the years it has existed. Thirdly, I will try to evaluate how the critic' has changed the framework published in 1979. On top of that, I will showcase how Kahneman and Thaler completed the first version of Prospect theory in 1990 and how these changes have shaped the formulation of the theoretical inputs of the theorem. To

emphasize the adaptivity of the theory I will showcase real-life evidence about the decisions made under risk and how the prospect theory helps us to analyse the occurring phenomena. Lastly, I will try to contemplate the question of why the prospect theory was revolutionary and what might be the future implications and applications for the theory.

1.1. The fundamental axioms of Prospect theory:

First off, prospect theory is a theory which offers a framework to understand and explain individuals choice processes under situations involving risk. This framework is mainly descriptive and therefore its aim is not to give any accurate figures or multipliers but rather to understand and describe the underlying narrative regarding the decision maker's thought process under risk. Prospect theory showcased two revolutionary findings: the first one was that "people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty" [Kahneman and Tversky 1979]. Before the presentation of this theory, expected utility theory had assumed that individuals probability weighting was in line with the mathematical equivalent counterpart. Therefore, the assumption that people are in fact weighting probabilities with inconsistency, was controversial, to say the least.

The second finding of Kahneman's and Tversky's empirical evidence had to do with the fact that people tend to emphasize the monetary downsides (losses) greater than in comparison with similar monetary upsides (gains). The mechanism by which this difference takes place will be explained in more detail later on this thesis. This second finding was truly controversial as well. Before this infamous article, expected utility theory assumed that the valuation of both gains and losses were emphasized with the same amount of weight because rational decision maker would realize that the only difference between the two is the sign in front of the number.

In the initial publication, [1979] Kahneman and Tversky defined the choice process under risk into two different phases: the first one has to do with the initial scanning and sorting of the problem ahead, namely the **editing phase**. The second phase has to do with the data processing of the sorted data, namely the **evaluation phase.** Both of these phases do not occur simultaneously and therefore they are taking place at different times. Let's now examine and define these phases with more depth.

2. Editing phase:

The main purpose of the editing phase is to make a preliminary analysis of the prospects[1]. This way, in the editing phase, a decision maker simplifies alternatives or possible outcomes for the evaluation phase. In order to make a preferable actual choice. Kahneman and Tversky [1979] suggest that the editing phase can be diversified for several different processes, all of which takes place simultaneously. With the framework about these different processes, they try to explain many of the occurring anomalies in preference and this way broaden our understanding about the choice process under risk. The theory about these different processes is supported by empirical evidence. Based on this empirical evidence, they propose that the editing phase consists of six different types of editing processes, namely: **Coding**, **Combination**, **Segregation**, **Cancellation**, **Simplification** and **The detection of dominance**. Below, we shall examine all of these editing processes in more detail.

2.1 Coding:

Coding can be seen as the most influential part of the editing phase, in which, Kahneman and Tversky are describing an empirical finding, from their surveys, that people tend to reform the possible outcomes, e.g., monetary sums of money, to more easily approachable concepts: **gains** and **losses**. This notion can not be complited by itself. For gains and losses to existing, they must, obviously, be defined in relation to some neutral reference point. Kahneman and Tversky argue, that the reference point is usually in correspondence to the current assets position, in which the actual amounts are received or paid. In other words, for a millionaire, a raise of 500 euros does have a completely different meaning than it would have to an average wage earner. However, the level of the reference point is not this one-dimensional. The actual location of the reference point, and this way the coding to gains and losses, can be affected (manipulated) with the simple act of formulating the proposed prospects differently or by influencing the expectation of the decision maker.

To demonstrate this, imagine the following scenario. On a normal morning journey to the university, our imaginative person would find a 5€ bill lying in the ground. After picking up the bill, this finding would probably lighten up the mood of this person, he/she might even tell about this unexpected event to their friends, during lunch. Despite this, this wonderful feeling of finding extra cash would probably fade away rather promptly since 5 euros is just not that significant monetary sum, in comparison of average person possessions.

In the next scenario, imagine this same morning journey to the university. But this time, our imaginative person would, instead of finding, lose a 5€ bill in the morning rush. When this loss is actually

[1] Uncertain alternative choice options

realized, the feeling of sadness is strong. During lunch time, our imaginative person would probably tell about this inconvenient accident to his/her friends with a detailed analysis of how this might have occurred. Later in the evening, the feeling of a loss, would probably still haunt our imaginative person, even though the 5 euros lost, is yet again, an insignificant amount of money to our person. One might even argue, that any reasonable person would not take this insignificant loss onto one's heart this strongly. Somehow, we all can identify with the latter situation. This example demonstrates, how the monetary sum of 5 euros, can be coded into gains or losses and furthermore how this coding might de facto affect the decision maker's feelings more than could be seen reasonable.

2.2 Combination:

The empirical studies seem to outline a possibility for the decision maker to simplify prospects by combining the probabilities associated with identical outcomes. Kahneman and Tversky found the following anomaly during the numerous surveys they compiled. When faced with two prospects, for example, Choice A (100€ gain with the probability of 20 %) and then with Choice B (100€ gain with the probability of 20 %). Both of these choices are taking place in timely different phases. Because of this, people often seemed to reduce this decision by combining alternatives A and B to a choice C (100€ gain with the probability of 40%) and evaluated their decision in this form. This is, yet again, a violation of what the expected utility theory is presenting.

2.3 Segregation:

In some scenarios, prospects can be divided, in the editing phase, into risky and riskyless components. For example, a choice between choice D (200€ gain with a probability of 90%) and choice E (100€ gain with a probability of 10%) can be seen as a choice between a sure gain of 100€ and a 90% chance for extra 100€. This way of dividing the prospect is another form of simplifying.

Coding, combination and segregation are applied to each prospect separately. Where as a cancellation, simplification and the detection of dominance can be applied to prospects as a set two of more prospects.

2.4 Cancellation:

Kahneman and Tversky proposed that people can isolate different parts from multiple prospect choices. For example, if people are told that in the first phase they get 100€ on top of the wealth level already they have and after that, they will have to choose between prospects A (100€ with a probability of 50%) and B (50€). People would discard the first set of information because it's similar for both possible outcomes. Therefore, people would naturally imagine the situation as a choice between prospects A and B. In this situation, the majority chose option B, the sure 50€. At least, according to the findings of Kahneman and Tversky. If we now take a closer look, this decision is actually a choice between A (100€ with the probability of 50% and 200€ with the probability of 50%) and B (150€). In this way, the whole act of choice is biased. In essence, a cancellation can be defined as an act, in which, decision maker discards similar information common for both prospects.

This anomaly can produce truly contradictory results. Let's demonstrate how these truly controversial outcomes can be acquired. If we now imagine another set of prospects, where decision maker will surely get 200€ on top of the wealth level they already pose. After this, the decision makers will have to choose between prospects A (-100€ with a probability of 50%) and B (-50€). In this situation, decision makers are likely to discard the information common for both prospects. From there, the situation is simplified to a choice between A and B. According to Kahneman's empirical experiments, decision makers do, in this situation, opt to go for the prospect A. Now, if we take a closer look, this decision situation is actually identical with the previous one. If we would not discard the first phase, in which, we acquired 200€ on top of our current wealth level, the decision would be made between A (100€ with the probability of 50% and 200€ with the probability of 50%) and B (150€). With this example, we can clearly identify the biased behaviour axiom, in other words, cancellation.

2.5 Simplification:

Kahneman and Tversky [1979] showcase two different types of simplification. The first one is concerned with rounding up or down possibilities. They illustrate this phenomenon with an example. When a decision maker is faced with a prospect E (101€ with the probability of 49%) they are likely to regard this decision situation as an even chance to win 100€. Even though with a simple calculus we can derive that the option after this simplification process is surely not the same as the prospect E. This rounding up or down effect, could be interpreted as a rule of thumb[2], where decision makers do acknowledge that their way of editing the prospect is, in fact, wrong. But its close enough, not to cause any further action to solve this inconsistency. This was,

[2] A broadly accurate guide or principle, based on practice rather than theory.

one of the remarkable notions presented by Richard Thaler, who's ideas influenced the field of behavioural economics (finance) and especially the of prospect theory. During this thesis, we will take a closer look into the finding presented by Thaler.

The second form of simplification has to do with the fact that decision makers tend to discard extremely unlikely outcomes. To illustrate this, lets visit another example. In this example, a decision maker faces a prospect F (100€ with the probability of 0,01%). The decision maker is likely to round this extremely unlikely outcome to 0 (never going to happened). This was a finding from the surveys Kahneman and Tversky put forward. This rounding phenomenon can be seen in the case of extremely likely outcomes, as well, where the rounding up goes, logically, to 1 (fully certain). This bias called simplification has been noticed for a long time, and therefore, is widely exploited by many. For example, insurance business does take this into account, to name one. On top of this, it is important to notice that individuals do vastly differ in their preferences. For this reason, their reaction regarding biases can vary significantly. These experiments are, therefore, trying to figure out the biases occurring around the mean, rather than to specifically focus onto individuals.

.

2.6 Detection of dominance:

The final process of the evaluation phase revolves around the detection of dominance. Detection of dominance can basically be defined as a scanning process, in which, the prospects are scanned through. And if a decision maker detects a prospect that is dominated (absolutely worse than alternatives), then this prospect will be automatically discarded from the future evaluation.

3. Evaluation phase:

After the editing phase, the decision maker evaluates each of the edited prospects according to their assigned value[3] and then chooses the prospect of the highest value. The overall value of an edited prospect was presented (in mathematical calculus) as a denoted V. This denoted V, is expressed in terms of two scales, weighting function (π) and the value function (v). Both of which, had their own set of axioms and ground-breaking insights. Let's now concentrate on the meaning, mathematical formulation and interaction of the weighting function(π) and the value function (v), in other words, the evaluation phase.

[3] Assigned value will be determined during the evaluation phase.

3.1 The Value Function

The value function is an inherent part of prospect theory because it tries to take into account several rather controversial facts. Firstly, people seem to put a larger amount of value to losses than for equal amounts of gains. Secondly, people seem to evaluate the value of a prospect in terms of difference and change, rather than in the absolute numerical difference between the starting point and the final state. In addition, Kahneman argues, that the relative magnitude of change from the reference point does have a greater significance that the absolute change in the examined prospect. These assumptions are coherent and in fact greatly influenced by similar findings done in the field of psychology [Nelson 1964). Kahneman and Tversky do point out, that decision makers tend to react in response to a point, that the past and present context have defined, namely the reference point. For this reason, the magnitude of change from the reference point does matter in the evaluation of the prospect. To shine more light into these psychological findings, let's demonstrate this with examples.

Imagine placing a hand into a bucket (A), full of ice (reference point), for ten seconds. Then to switch this hand to another bucket (B), with 20 Celsius water in it. After this switch, the water in a bucket (B) feels warm and calming. Now, in the second scenario, the second basket (B) stays the same but the first basket (reference point) is changed to basket (C), that has 40 Celsius water in it. In this second scenario, when one's hand is moved from the basket (C) to the second basket (B), the water probably feels cold or at least mild, even though the water in the second basket (B) remains the same. This principle of reference point dependence behaviour affects human behaviour also with other attributes such as wealth and prestige, Kahneman and Tversky argue.

To illustrate the relevance of the magnitude of change, from the reference point, let's take a look into another situation with baskets. In this situation, the first basket remains the same basket A (with ice-cold water in it). Now, to spice things up, the temperature of the water, in the first basket, is changed from the temperature of 0 Celsius to 6 Celsius. This change in the water temperature can probably be noticed with ease. To demonstrate the relevance of the magnitude of change from the reference point. In another situation, we would change the water temperature in the basket B (20 Celsius), to 26 Celsius. This difference can surely by noted but the felt difference in regard to the reference point (20 Celsius), would not be felt as significantly, compared to the change in the first example, when the temperature was changed from 0 Celsius to 6 Celsius.

Thus, as we have demonstrated with these examples above, Kahneman argues, we can assume that the function for gains (losses) is concave (convex), since it faces diminishing value from a gain (loss) increase. This phenomenon has later been named as diminishing sensitivity (Barberis 2013).

3.1.1 Visual representation of the value function

Figure 3 represents the description of the potential form of the value function. However, the main emphasis is not to precisely map out the exact magnitudes of change but rather to offer a visual description of the function. However, as we can see from the figure, Kahneman and Tversky defined the reference point to be located in the origo. The function for the gains is defined to be concave and for losses, it's defined to be convex, the reason for which we established the explanation for earlier. The convexity for losses seems to be steeper, than the similar magnitude of concavity for the gains. To demonstrate this more clearly, let's go through another example.

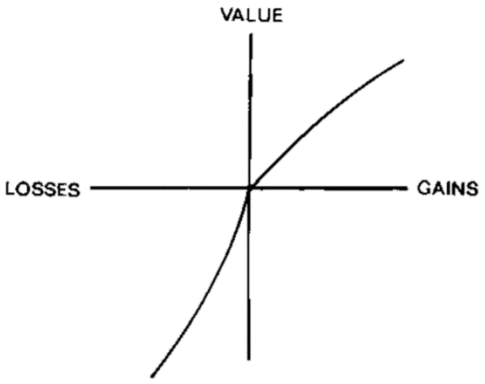


FIGURE 3.—A hypothetical value function.

In the original article, Kahneman [1979] proposed two problems for his students: Problem 1, Choose Options A [Gain of 6000 with the probability of 25%] or Option B [Gain of 4000 with the probability of 25% and Gain 2000 with the probability of 25%]. In this experiment, 82% chose the latter. Then Kahneman proposed another problem. Problem 2, choose between Option C [Loss 6000 with a probability of 25%] and Option D [Loss 4000 with a probability of 25% and Loss 2000 with a probability of 25%]. In problem 2, people chose option C with a majority of 70%. Even though the only difference between these two dilemmas is the sign in front of the proposed values, the difference in the answers is significantly different. One interesting behavioural element in this experiment, that Kahneman [1979] concluded, is that when the sign, in front of the sum of money, is positive. In other words, when decision makers face probabilistic chances to pursue gains they tend to be risk aversive[4]. On the other hand, when decision makers are faced with probabilistic chance to lose, e.g., money, they tend to be risk seekers[5]. This phenomenon, was the foundation behind the steeper convex function, later named loss aversion (Tversky 1991).

This finding was in contradiction with the utility theorem because in the expected utility theorem, the convexity (concavity) of the gain (loss) side, was recognized but they were, logically, both presented to be functions of the exactly same shape and size. Because of this contradiction, with the expected utility theorem, these findings were later on examined intensely. The results of these repeated experiments yielded, however, the same results that Kahneman and Tversky had already presented in their original paper in 1979.

[4] Is defined as a behaviour acted out by the decision makers, where, when exposed to uncertainty, decision makers attempt to lower this uncertainty. To put it differently, in these situations, decision makers are even willing to pay in order to reduce the uncertainty.

[5] Is defined as a behaviour, acted out by the decision makers, where, when exposed to uncertainty, decision makers are in fact, ready to pay for the increase of uncertainty.

3.2The Weighting Function:

The weighting function was also in contradiction with the expected utility theorems axioms since it supposed that if decision makers are shown the exact probability for an event to occur, they would evaluate their options in regard to this exact, mathematically sound, probability. In prospect theory, however, Kahneman argues, that decision makers do not actually evaluate these probabilities exactly in the same way, that would be mathematically correct. In fact, decision makers seem to weight these mathematical probabilities with an individual weight. In other words, Kahneman states, that decision makers do, on average, in fact, weight, e.g., truly small probabilities with significantly higher multipliers than would be mathematically correct. This contradiction is also true for truly high probabilities, the decision makers tend to evaluate these probabilities, with significantly smaller multipliers than would be mathematically reasonable. In essence, this is what Kahneman means with the weighting of probabilities.

In the weighting function, the mathematical probability for the event to occur and the value attached to it about each outcome is multiplied by a decision weight. These decision weights are not probabilities and they should not be interpreted as measures of degree or belief. Rather, "the decision weights represent the impact of events on the desirability of prospects and not merely the perceived likelihood of these events." In more technical terms, the weighting function follows the formulation of π (p) = x. The (p) here presents the probability for the event to occur. The weighting function is bounded by limitations π (0) = 0 and π (1) = 1. The assumption being, that impossible outcome is ignored, and certain events are belived to be certain. On top of this, it is assumed that π is an increasing function of p. If π (p) = p, then the expected likelihood principle[6] holds. In other scenarios, however, this is not the case. Kahneman points out, that the decision maker's decision weight can be altered by many distractions, e.g., by ambiguity. This feature of the weighting function will be discussed in more detail, later on in this thesis.

It is important to distinguish the weighting of certain probabilities from overestimation, which is usually the case with the estimation of rare events, such as plane crashes, in which, some decision makers do over-exagerate the probability for this tragical event to take place. This phenomenon can also occur by underestimating the probability for something to happen. E.g., when a decision maker is driving a car it might underestimate the probability for it to get into a car crash. In the prospect theory, it is explicitly assumed that people adopt the given probability (value of p). Kahneman states, that in-real-life both, overestimation and weighting are likely to take place.

[6] The probability weighting equals the actual mathematical probability.

3.2.1 The shape of the weighting function

In figure 4, is the early expression of the weighting function, the hypothetical weighting function can be found in the picture as a slightly curving line. The diagonal line, in figure 4, is the expected utility theorems "weighting" function. This demonstrates to us, what was the revolutionary element about the weighting function, in prospect theory, represented here. In the figure, "the slope of π in the interval, can be viewed as a measure of the sensitivity of preferences to changes in probability", Kahneman argues. He goes on stating, that since the simplifications in the editing phase may discard extremely likely or unlikely outcomes, the weighting function is not "well-behaved" near the end-points (0,1). With this, he means that the function would take a sudden turn towards 0 (never happening) and 1 (certain event), in the most extreme cases and this would make the function more confusing, and therefore this element is not illustrated in this figure 4. It is interesting to point out, that decision makers seem to have a truly limited understanding of probabilities.

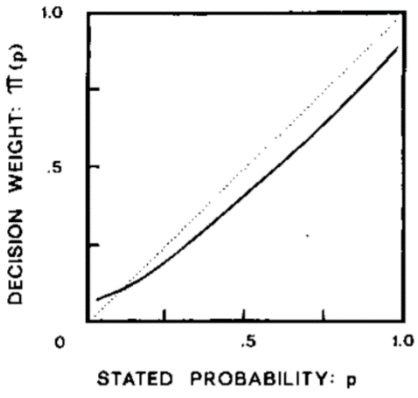


FIGURE 4.—A hypothetical weighting function.

During Robert Shiller's (Nobelist as well) lecture, about the prospect theory, he even comically argues, that it seems like decision makers brains have not yet adapted to this mathematically demanding form of reasoning, called probabilistic thinking. He goes even further, stating, that it seems like decision makers have a three-step-model for understanding probabilities. These are not possible, maybe and certain. This is, of course truly simplistic, and made with a good sense of humor, but does capture something truly relevant and magnificent about the prospect theory's way of contextualizing the probabilistic thinking process.

Let's now examine these both extreme ends of the weighting function. Kahneman simulated these situations, by asking the following guestions: Firstly, decision makers were asked to choose between the choice E (3000€ with the probability of 0,1%) or choice F (3€). The overwhelming majority (72%), in this experiment, chose the option E. In other words, they were willing to pay 3€ for a lottery ticket that had expected the value of 3€, which is rather odd, since usually this interaction involves transaction and waiting for costs. When the situation was turned on its head, and the decision makers had to choose between a choice G (-3000€ with the probability of 0,1%) and choice H (-3€) the even more significant majority (83%), chose the latter. Even though, yet again, the only difference between these decisions was the sign before the monetary sum of money.

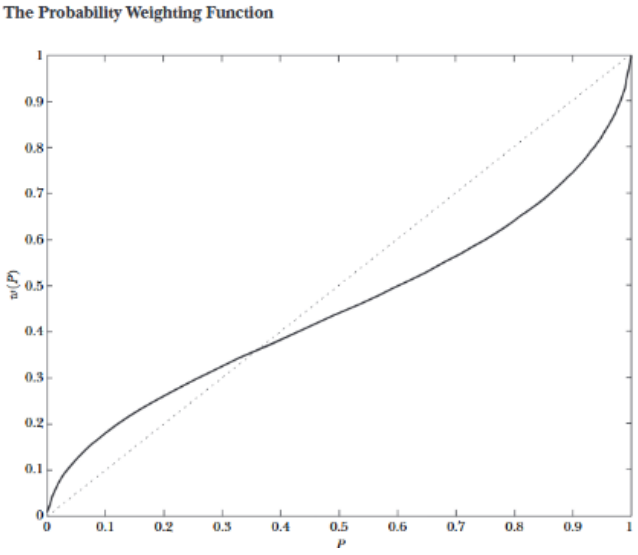
From this experiment, Kahneman concluded that decision makers are, on average, willing to pay for a lottery ticket (a possibility for huge gains) and for an insurance (avoidance of huge losses). Kahneman goes on stating, that even though, prospect theory predicts both of these phenomena (lottery and insurance), it falls short on fully explaining the mechanisms behind these truly complex phenomena. There is a lot more

happening here than merely the mechanisms behind the weighting function, but this analysis gives us a usable tool to understand and model, the process under which, decision makers may come about their decisions.

To demonstrate this process of the over- or underweighting phenomenon, Robert Schiller [2013] gives an example of flight cancelation insurances. He argues, that since there are huge individual differences in the attitude towards risk like we have established before. There are, therefore, huge differences in the attitude towards to necessity of, in this situation, insurances. This tendency, by a small minority of individuals, to highly, in this example, overweight the occurrence of the flight cancellation, is widely known and exploited by the flight and insurance companies, Schiller argues. Thus, the flight companies do offer a possibility to pay for insurance, to cover the damages, that could manifest themselves, if this specific flight would be cancelled. The price of this insurance, is of course, outrageous to any reasonable (rational) individual, and for this reason, only this small minority of individuals, who are overweighting the occurrence of the cancellation the most, are actually buying this insurance. Schiller jokes, that this is actually ingenious to use this bias into one's advantage. Despite the possible moral dilemmas, this exploitation might bring about, the flight companies are profiting hugely from offering this insurance.

3.2.2 The established shape of the weighting function

The initial form of the weighting function was a not fully developed one. Empirical experiments are done, later on, have slightly transformed the shape of the hypothetical weighting function presented in figure 4. Today the weighting function is presented in the form shown on the right.



The tendency to overweight the extremely high end of probabilities, as well as the extremely low end of the spectrum (in case of a lottery or insurance) is in the present day formulated like shown in figure 3. Therefore, the overweighting of small(er) probabilities can be found, surprisingly, from even small but still rather notable probabilities, like demonstrated in the illustration of this theory on this figure. It is truly surprising, that the underweighting of almost certain prospects does take place. This underweighting follows similar reasoning addressed in earlier figure 4.

An interesting side note is presented by Epper [2010], who argues that the decision maker's sociocultural and biological (male vs female) background seems to affect the distortion from the small- and

medium-sized probabilities, and can, therefore, influence the weighting function presented by Kahneman. Epper's empirical evidence furthermore provides strong evidence in favor of the phenomenon called the weighting function.

3.3 The Interaction: Value function x weighting function

The interaction between the value and weighting function is addressed here, with a description about the manner, in which, the π and v are connected and how they formulate the overall value for the prospect at hand.

Let's now examine the interaction between the weighting function (π) and the value function (v) through a mathematical lense.

For example, we have a prospect (x, p; y,q), where x and y represent for value and p,q represents the probability of the event. In this example, the mathematical formation of this problem would be transferred into the prospect theory like this,

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

To open up the mathematical presentation in this equation, prospects value is determined as the decision maker's weighting function (π), as a function of the probability (p,q) at hand and it would be multiplied by the decision maker's value (v), in a relation to the value (x,y). From this equation, we can derive the overall value of prospect (V), on to which the final evaluation, in other words, the act of a choice is based on.

The prospect theory also introduces another equation, in the lines with the theory, addressing on of the biases done in the editing phase. To understand why this is done, we have to examine earlier finding from the editing phase, namely the process of segregation. This process, in which, the destruction into a riskless part, and risky part for certain prospect, occurs. This should be inspected through a different mathematical lens.

Thus, the following equation,

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

In this equation, the first part v(y) describes the decision maker's value for the riskless option. On top of this, the latter part, (π (p) [v(x) – v(y)]), describes the risky part of the prospect. Let's now examine the

interaction of these through an example: V (500, 20%; 100, 80%) = v(100) + π (20%) [v(500) – v(100)]. This formulation follows the editing phases segregation section, for which we established the explanation earlier. The essential feature of this equation 2, is that the weighting function affects only the risky choice, in this example, the value difference between v(x)-v(y), and not the riskless part. This equation gives us an interesting framework from which we can evaluate more broad collection of different prospects.

4. The reference point

The reference point is defined as a base point, onto which further evaluation holds. Even though, the concept of the reference point is intuitively easy to follow and can be empirically found from different choices under risk. The most eminent critique or flaw of prospect theory revolves around the concept of reference point, which comically, acts as a cornerstone of this theory. The problem with the reference point is that it is not clear on how to exactly determine the reference point in each situation alone. It was even famously noted by Levy [1992]: "The prospect theory is reference-dependent theory without a theory of the reference point". For this reason, we are going to take a closer look into the literature around the concept of reference point and how it could be done more easily approachable. In the literature regarding the reference point, there have been found several personal biases affecting the decision maker's understanding of the reference.

3.1 Endowment effect

Richard Thaler, who consequently received his Nobel prize in 2017, worked closely with Kahneman and Tversky from 1979 onwards. Thaler was profoundly intrigued about the concept of the reference point, and since there was an eminent lack of proper studies about the reference point he heavily participated in this explanation process. In Thalers empirical studies [1980], he famously found out a pattern of behavior, what was later known as the endowment effect.

The endowment effect is loosely defined as a tendency of individuals to value items more, by the mere fact of owning them. To demonstrate this Thaler used one of this (economics) professor colleague as an example. Imagine a wine-loving professor, buying a bottle of wine for 10€. Time goes by and eventually, if auctioned, the value of this same vine bottle would be 200€. On special occasion as a way of celebration, this bottle is brought in, from the vine cellar to be served. Now, the professor is asked if he would be ready to sell the bottle for 200€. He says, most defenitely not. Then the professor is asked to buy an identical bottle of wine for 200€. He responses by saying, that only a fool would be ready to spend that much for a single bottle of vine. Now Thaler argues, we are witnessing an anomaly known as the endowment effect. The endowment

effect is, therefore, described as a phenomenon, in which, people often demand significantly more for giving up an object than they would be ready to pay in order to acquire it (the identical object).

4.2 The status quo bias

This story about vine-loving professor also brings into being another anomaly, presented by Zeckhauser [1988], called status quo bias. This bias refers to a phenomenon that people tend to value their current state of being more than could be seen as reasonable. Both the status quo and the endowment effect are tightly attached to the phenomenon presented by prospect theory like loss aversion. On the other hand, however, Tversky [1991] points out that there are several cost factors, including costs like the cost of thinking, transaction costs and psychological commitment to prior choices. For these reasons, Tversky argues, the status quo bias can take place even in the absence of loss aversion.

On top of this, Plott [2005] brings into the discussion, controversial but still relevant, the point about the exchange asymmetries that may also take place for the simple reason that the perceived objects, organically received, might be seen as more valuable. Valuable, because they might be seen as, e.g. a gift and therefore the exchange of these objects could be seen as impolite. In the famous test, modeling the status quo bias, done by Knetsch [1989], he gave a group of Cornell university students randomly either mugs, worth of 6€ or high-quality chocolate, worth of 6€. According to Coase's theorem[7], without transaction costs, half of the cups should be traded. For some reason, this did not occur. In fact, actually surprisingly 89% of those of whom were originally given the mug, wanted to keep it, rather than to change it for a chocolate bar. The same phenomenon did also occur for the other way, 90% of those, who first received a chocolate bar, wanted to keep the chocolate rather than to trade it for a mug. This was an astonishing result and was not taken for granted, for this reason, the test has been replicated multiple times, yielding the same kind of results time and time again.

The endowment effect, status quo bias, and the attempt to portray these accomodities as gifts are attempts to rationalize what goes in the mind of the decision maker. Getting a glimpse in to the mind of the decision maker, is one of vital importance, in order for the economic models to be transformed in a more human-friendly way. Models trying to theoretize and understand this "irrational" behavior is crucially important, but on the same token, they are truly difficult to be formed.

To go back to the question about the reference point. The challenges with the reference point do not end here. It should be also noted that decision makers do not posses predefined preferences, therefore, either do references points, for every situation beforehand. For this reason, Tverksy [1990] argues, it can be assumed

[7] Coases theorem: to put it simply is that when markets have no transaction costs, the participants will negotiate the most cost-effective way of distributing the perceived goods in a way that maximizes the value of the production. For this to be relevant, it is important to add that property rights must be clearly defined, for the theory to hold.

that decision makers decide their preferences in the process of making a choice or judgement. Thus, these preferences can be seen to be influenced by the context in which each choice takes place, and also by the procedure involved in the decision-making.

To stir things up, Knetsch [1989] brings to light an observation: "preference orderings are not defined independently of endowments: good A may be preferred to B when A is part of an original endowment, but the reverse may be true when initial reference positions are changed". This economically peculiar phenomenon could be described more mathematically: indifference curves are accustomed to having a kink at the reference point. In this way, the question about reference point dependence arises again.

More recently Rabin [2006] introduced an attempt to address the challenge of defining the reference point, hence gains and losses. Rabin proposed a framework, in which, the reference point is profoundly influenced by the decision maker's expectations about the possible outcomes in this exact moment. Barberis [2013] concludes that, in Rabin's paper, decision makers derive utility from the difference between consumption and expected consumption. This is truly alternative to conceptualize the concept of utility. Since in this way of contextualizing utility, the utility would not be derived from the act of consumption itself. Even though, by itself, it may not be the most accurate or scientifically relevant indicator of one's derived utility. This way of contextualizing might still give us a new framework, by which we can enhance our existing models modeling the perception of the process, through which the decision maker's utility is actually formed.

In his analysis, Rabin recognizes this and states that the analysis about the formulation of the decision maker's utility should not only follow this model, in which, but decision makers also derive utility only from gains and losses because the more traditional models do offer useful insights. Therefore, Rabin recognizes, that diversity in the used models, in portraying the mystical world of the mind of the decision maker, might be the key to more enriched theorization success.

4.3 Learning

The most convincing evidence towards the prospect theory can be found in the situations where the problem set (prospects) are relatively new for the decision makers. In these novel situations, demonstrated by Kahneman [1979, 1990] Thaler [1980], the above-mentioned anomalies do occur. However, when decision makers are facing prospects that they are familiar with, the anomalies tend to weaken significantly, and in some cases even disappear. List (2003,2004) kindly suggested that the prospect theory may be less useful in describing the behavior of experienced decision makers. The list also points out that the data, used in their analysis, provides evidence consistent with the notion that throughout time (trial and error) decision makers learn to overcome the endowment effect, even in situations beyond the specific problem they have earlier on encountered already.

An interesting study about this phenomenon was presented by Knetch 1989, who noted that "if decision makers can learn to overcome these anomalies. Then, even if these anomalies would exist, it would not be hard to dampen their effect, we simply, just need to teach decision makers about their inadequates and this way they will lean to avoid them. However, during his experiments, the extent to which, these anomalies occurred, decreased. They, however, remained significant enough that it could not be argued that it would be possible just to teach the decision makers out of their biases.

In spite, according to List, in the case of the cold professionals, doing, for example, efficient business, the decision makers can be taught to avoid these anomalies to a large extent. List's experiments are consistent with the notion that agents can learn to contextualize their endowments as opportunity costs rather than simply as a loss. For this reason, even though, the psychological reasons e.g. listed above, might be accurate in explaining the anomalies, List's data here does suggest that the psychological effect can also help to explain the attenuation of the anomalies. This is, by itself, a truly different approach in the literature, trying to figure out ways, out of the psychologically based anomalies, we are clearly making.

5. Critique towards the prospect theory

5.1 Critique of the methodology

Every piece of relevant scientific literature receives it's a fair amount of critique, even though it would be revolutionary. This is also definitely the case with prospect theory. The most eminent critique or flaw of prospect theory revolves around the concept of reference point a critique of which we tried already to tackle.

The most common critique, that the prospect theory's methods have received, has to do with the conditions under which the empirical (laboratory) part of the initial theory was formed. Early on, it was noted that the monetary incentives were too small, to motivate decision maker's to properly analyze the situation and, therefore, the results would not be adequate. This notion was tackled by Shehate (1992), who examined and demonstrated the preferences of Chinese students with monetary incentives equaling up to their three month's salary. The same caliber monetary incentives were not possible to offer in the western world since the monetary incentives would have been out-of-budget for the science project. Regardless, the evidence clearly suggested that Chinese students kept overweighting small probabilities, despite receiving sizeable rewards. From this Shahatem concluded, that the overweighting phenomenon can be found from both small and large monetary incentive cases. In other words: monetary incentives do not play a significant role in the overweighting phenomenon.

Suspicions towards the laboratory test's legitimacy in the original paper [Kahneman 1979] was common. These suspicions were various. One common suspicion was presented by many, including Isaac [1987], who argued, that the participants of these original tests were not facing a real decision, but rather a hypothetical one. The concern being, that when decision makers were faced with this hypothetical decision, the subjects would not have adequate incentives to think these complex problems fully rationally through. For this reason, subjects would not act in a manner which they would, when faced with a real decision.

Plott [1979] took this as a challenge and started to examine these accusations in an article: "A series of experiments designed to discredit the psychologists". In which, he presented a series of experiments with proper monetary incentives and other motivators, to take into the account of the notion about real-life relevance. Despite their best efforts to tear the theory apart, the vital parts of prospect theory remained intact. Later on, Tversky [1992] concluded that "All major violations of expected utility theory were obtained both and without monetary incentives". In other words, Tversky is pointing out how these violations of expected utility theory can be interpreted as findings supporting the prospect theory. Despite this, Tversky does aknowledge that with sizeable monetary incentives, the degree of which, for example, probability weighting occurs, decreases. But the principle is still significant. In Plott's, an article they were trying their best to simulate real-life decision-making scenarios and these experiments were regarded as a reasonable defence in favour of the prospect theory.

The more inventive critique was presented by Reilly [1982] who was concerned that the studied subject might not be fully informed or fully understand the nature of the reasoning or logic behind these experiments. For this reason, he conducted experiments in small groups, where the subjects were explained the reasoning process behind expected utility and were constantly reminded of this line of reasoning. The subjects also had the opportunity to interact with the experimenter. And were in this way as, informed about the monetary reasoning behind the expected utility theory, as possible. Despite all of this, the probability weighting and other illogical, psychologically created, biases remained. The reactions were occurring on a decreased rate but, despite that, they were still significant.

Both Plott's and Reilly's papers are attempts to discredit the prospect's theorems notions, by going as far as, formulating the research question in a way that could bring the status-quo (expected utility theory) back to the table, as the most accurate explanation for decision-making under risk in real-life and this way discredit the notions presented by the prospect theory. Even though their best efforts, scientists have been falling short on this attempt. The empirical evidence is amazingly strong in favor of the prospect theory and this has been noted time and time again. The most eminent problem with prospect theory is the lack of sufficient theory about the reference point and the deficiency related to this lack of reliable theory to once and for all to disclose this discussion about the relevance of this topic. On top of this, there have been challenges, that have been encountered during attempts to create practical models to be utilized in real-life-situations to correctly model human-like behavior.

5.2 Problems in the practical implementations

To get back to the critique, thought. More recently, some scientists are, after all this time, trying their best to nullify the prospect theory's notions. For example, Nwogugu [2005] claimed that prospect theory "is in fact developed under questionable data", an interesting critique, but not original one nevertheless. Nwogugu goes on stating that the choice process under risk is exceptionally complex. Therefore, it would be impractical to propose a simplistic model for decision-making under risk. This example shows, how even after decades of scientific literature, the findings can still be argued against. Nowadays, these earlierly proposed objections won't accumulate much of an effect (citations), since the topic is fairly largely debated in the scientific literature beforehand. In spite of that, it is useful to bring this ever-going debate into the limelight, in order to be discussed for good.

Barberis [2013] points out that even though, the major insights from prospect theory would be widely accepted, the theory turns out to be truly difficult to be properly adapted in practice, like noted above. Primitive, in some ways successful, attempts have been made in the fields of finance and insurance. In other fields, however, even after 40 years, the practical models are still yet waiting to be formulated or to be more accurate, for themselves to be developed. This is the most prominent path for the prospect theory to develop in the future. For this reason, today, this lack of practical insights can be seen as a major downside in the prospect theory.

To conclude, the critics of prospect theory have mostly tried to find imperfections from the empirical experiments done by Kahneman and Tversky. Numerous critical attempts have been presented on the basis of the absence of financial incentives, lack of opportunities to learn, by transaction cost and other economic variables. A major part of the critique has been properly addressed and the concerns about the relevance in the real-life situations have been tackled with the support of strong empirical evidence. However, the strict defining of the reference point has not yet been resolved and the proper practical prospect theory models are still under their way. These are the Achilles heels of prospect theory, they can still be addressed properly in the future.

However, as mentioned in the introduction, prospect theory is mainly a descriptive model, and for this reason, the in-depth insights can be mostly done on the contextual level. In prospect theory these have been the notion about the weighting function, demonstrating the unmathematical ways by which decision makers do contextualize probabilities. The other one has been the shape of the value function, demonstrating how decision makers actually, illogically overweight the subjective value of the losses in contrast to the gains. In the next chapter, we will dive into the empirical evidence and practical attempts to utilize the prospect theory.

6. Empirical findings and applications

One of the reasons why the prospect theory has held its ground is because of the strong empirical evidence to support its claims. This way the prospect theory differs greatly from many of the other models trying to explain the decision-making under risk, which does sometimes struggle with the explination for the empirical findings. The empirical evidence is in favor of, for example, the endowment effect of the prospect theory, especially with everyday consumable goods. Goods, like in the case of earlier illustrated example with mugs and chocolate bars. In experiments like these, there is literally no room for the argument, that decision makers would not have sufficient information and, therefore, well-structured preferences for the goods used in these experiments. Thus, the critique towards the legitimitacy of the experiments does not hold its ground in these cases.

To experiment with more unique objects, List (2003) performed an experiment, in which, he examined trading with unusual objects. To obtain this, he conducted the experiment using unique pieces of memorabilia. This made it certain, that the decision makers would not have encountered these objects before. This laid a groundwork for a great experiment to observe the evolution of the market behavior through out time when the decision makers developed more knowledge about the objects traded in the experiment. In this experiment, List noticed, that decision makers with more knowledge and experience about the traded objects were taking a significantly larger role in the market place. In other words, they traded more than the lesser-experienced decision makers. Inspired by this, List started to analyze market behaviour in a larger scale. List's (2003, 2004) findings do suggest that prospect theory may be less useful in describing the behaviour of experienced economic actors at least in the market place.

6.1 Finance

6.1.1 Implications for financial markets

The central axioms of the prospect theory, namely the weighting function and the value function, have probably been taken into account most strongly in the field of finance, since the status quo, in the finance sector is the decision-making process under risk. Recently, the evaluation and the studies concentrated on the financial markets and have been affected strongly by the prospect theory. This progress, in the analytical models used to understand the marketplace, however, is still relatively recent. Thus, it is still heavily under debate and evaluation.

To shed more light onto the roots of the economical analysis, we should remember the analytical framework, from which, the scientist here is trying to find their way out of. Before the prospect theory, markets were studied under more narrow models based on Von Neumann-Morgenstern[8] expected utility theory, this theory is still widely used and the status quo theory, by which, scientists are presenting their models of the economical behaviour of the decision makers. In spite of this, the psychological findings, including systematic errors (biases) in the way we think, were introduced by Kahneman and Tversky [1979]. The slow acceptance process of this reality, have, in fact, been the driving force in creating a new discipline explaining the economical behaviour we exhibit, called behavioural finance. In behavioural finance, the inconsistencies about the decision makers decision proses are taken more seriously into account. The main idea behind this discipline's economic analysis is not to ignore the huge body of literature and knowledge about human behaviour in the field of psychology. But rather, to integrate its valuable lessons into economic analysis. This all is done, in an attempt to create more profound economic models to explain the decision makers behaviour.

Despite this, Ritter [2003] reminds us, that modern financial theory works under the assumption called Efficient Markets Hypothesis (EMH), in which, the assumption is that *investors* are not rational but due to the huge mass off investors, the *markets* are rational. In this theory (EMH), the competition between investors seeking abnormal profits should be driving the prices to their "real" value and for this reason, the abnormal profits do vanish. However, in the light of the prospect theory, it is assumed that during some periods of time, financial markets are not functioning fully efficiently, in regard to the information available. This axiom about the prospect theory and more broadly about the discipline of behavioural finance has been controversial, to say the least.

6.1.2 Inconsistencies in the performance of the stocks

Interestingly, Barberis [2008] examined the possibility for overweighting to occur in the financial markets. More specifically in this paper, Barberis was interested about the relation of the skewness in the distribution of IPO[9]s and the historical profits followed, if invested in the IPOed stocks compared to a reference group of stocks, consisting of mainly similar companies, the difference being that these reference group stocks would not have been IPOed. Shokingly, they noticed that just like the prospect theory predicts, the IPOed stocks did actually underperform compared to the reference group. This was in contradiction with the expected utility theorems predictions.

[8] Is a theory about decision making under risk, in which, decision maker's will behave as if they would be maximizing the expected value of a function defined as potential outcomes in a specified point in the future
[9] IPO = Initial Public Offering = The first sale of a company's shares to the public

Barberis explained these findings by noting that the skewness of the distribution in the IPOed companies is actually heavily right leaning. This skewness mainly occurs because the IPOs that do heavily succeed, as the IPO's of Microsoft and Google, bring in phenomenal returns, and, therefore the right tail of the distribution is extremely long. The probability (a portion of all the IPOs done), however, for this to happen, is extremely low. For this reason, Barberis argues, the investors are actually overweighting the probability of this, extreme success. This overweighting happens with the expense of the actual situation, and this helps us to explain the fact that the average returns of IPOed are over-valued. With this in mind, Barberis goes on stating, like noted in the overweighting of the extremely unlike outcomes, the psychological findings explain the over-valuation of the IPOed stocks because the situation when funding an IPO could be parallelized against a gamble-like-situation.

During the last ten years, the implication the prospect theory puts forward the overweighting, and therefore the over-valuation of the IPO'ed stocks, have received huge amounts of empirical support. The first piece of criticism that Barberis have received has been the questioning the implication put forward that the more positively skewed stocks would have lower average returns. This critique has been tackled by several independent studies, including, e.g., a paper by Vorkink [2010], who noticed that using, various techniques to measure skewness, the results stayed the same. More positively skewed the stocks have in average lower returns on investment.

An interesting finding was conducted by Hwang (2012), who noticed that when a company have IPO'ed, the higher it's predicted skewness have been, the lower the firms actual average returns have been. These findings do go hand in hand with the central axioms of the prospect theory, e.g., the weighting function predicts that when the probability of something to happen decreases, the actual over-weighting phenomenon, made by decision makers, increases. This is exactly what the empirical evidence suggests, for this reason, these relatively new findings, are probably lifting their presence into more lime light.

6.1.3 Experimenting with the boundaries of the limits regarding implications

While most of the times, the new light the prospect theory has brought to the market analysis, sometimes academics do go into rather condescending analysis about the markets. For example, Ritter [2003] gives an example of how behavioural financial analysis can prove to be rather useful in determining the "right" stock prices. He argues, that because of the failure of the accountants to mathematically sufficiently account the relation with own and foreign money, the stock markets are likely to be undervalued during high rates of inflation and vice versa.

Even though this example might seem out-of-context, it serves here as an example how on the other hand the insights the prospect theory can truly help us to understand the financial market movements (the

overweighting taking places in IPOs), it can, on the other hand, pave the way for truly wild interpretations of the financial market movements. For this reason, caution is, on the other hand, slowing the adaptation of the prospect theory's central axioms, but at the same time this caution, prevents the science makers to be able to form these wild interpretations done in the name of prospect theory or the behavioural economics.

6.2 Insurances

The most logical practical applications for the prospect theory do manifest themselves in the areas of finance, as we established already, and in the area of insurance. The decisions regarding insurances are performed in the presence of a risky component like they were in the area of finance as well. For this reason, the imperfections and biases about the decision process, the decision makers manifest, itself is likely to occur, in this instance, in the acquirance of insurances as well. Thus, the prospect theory might have something to offer for the research done in the field of insurances, as well.

In fact, the prospect theory has been found to be useful in the modern studies about the behaviour the decision makers manifest, regarding their insurance policies. For example, Sydnor [2010] conducted a throughout analysis about the decision behaviour of 50 000 decision makers, who were deciding about their insurances. From this data, Sydnor noticed a behaviour pattern, in which, the decision makers were likely to choose an insurance policy, including smaller deductibility rate, even much so, that when compared to similar insurance policies with higher rate of deductibility, the decision makers were willing to pay an extra 100$ for the reduction of their deductible rate. Therefore, Sydnor argues, in the framework of the expected utility theory, this manifested behaviour pattern, can only be rationalized by unreasonably high levels of risk aversion since the decision makers are not exposed to irrational behaviour.

To explain this irrational behaviour, however, Sydnor heavily leans towards the prospect theory, and more specifically, the weighting function in the prospect theory, because it offers an explicit explanation for the behaviour that Sydnor has exposed in his experiments. Like in the case about the skewness of the distribution regarding IPOs and revenues regarding them, the decision makers seem to overweight the possibility for extremely unlikely events to occur. Thus, in this instance, the decision makers are willing to pay compensation, for the decreased rate of probability, for them to be exposed to the actual damages caused by the occurrence of the unwanted event. To go even further into this example, the decision makers seem to place more emphasis on the unpleasant outcomes, and they are, for this reason, willing to pay a higher premium for the reduction of the deduction, than could be seen reasonable.

6.3 Other possible applications for the prospect theory

6.3.1 Case: Cab drives in New York City

The insights of the prospect theory have been utilized in various different practical applications. It has been rather difficult, to say the least, but despite that, there have been a few true in-life-cases, outside finance and insurance, in which, the axioms of the prospect theory have been truly useful. Thaler [1997] conducted an experiment, where he examined the laws of labour supply, in the case of the cab drivers in New York City. Before thaler, there had been done a few studies regarding the labour supply but they shared a common problem in regard to the problem of estimation. Luckily for Thaler, cab drives do have flexible self-determined working hours, with face wages that are highly correlated within days but only weakly correlated within days. Because of these underlying facts, the results found from this experiment could be seen as reasonable and credible.

The experiment yielded the following interpretations. Firstly, cab drivers (at least inexperienced ones) tend to make labour supply decisions (weather to work or not) with "one day at a time" principle, rather than deciding their working hours in comparison within the framework of multiple days. On top of that, Thaler argued, cab drivers seemed to set loose daily income targets for themselves, and once that goal has been achieved, they do stop working on that day. These interesting findings were widely noticed, and the explanation for this irrational behaviour was under great debate. This experiment about the laws of labour supply, done with the data of New York City's cab drivers is a phenomenal example of how widely the prospect theory can be utilized when used properly.

6.3.2 The possibilities for future applications

Even though prospect theory was published in 1979, it has not been utilized as thoroughly than could be seen possible, according to Barberis [2013]. He argues, that the prospect theory had a bumpy start since it took a fairly long time before it has even been seen worthy of any attention. Finally, when the prospect theory started to gain the publicity needed to push the practical applications forward, problems with defining the reference point and several other problems regarding the practical implementations. For these reasons, actually achlomplishing these models themselves proved to be truly hard to overcome. Only more easily accessible applications in the field of finance and insurance, established their position as a worthy addon, to complement the existing models. For this, we went through some examples already.

It has been only recently, in this millennium, when prospect theory has been able to offer promising models to support the existing ones in various fields. E.g., Finnish scientists Korhonen and Koivuranta noticed

a longshot bias in the horse race markets, to explain this they utilized the weighting function and its conclusion to help to explain this noticed irrational behaviour. The betting market as a broader field has the potential to use these models more broadly. To tackle more of the macro level issues, there could be done made if these findings would be used, e.g., in the context of downward rigidity of nominal wages. Here, the concept of loss aversion relative to a reference point could bring in some new insights about the dynamic between companies and employees, when fighting throughout horrendous times of economic depression. These finding could be used more generally in industries, where the business cycles do play more significant roles. Barbeis concludes, that to name a few areas where the prospect theory has not been applied extensively, even though, there could be seen a huge potential for it, are fields such as health economics and macroeconomics as a whole. All in all, it can surely be said, that there is still plenty of potential for the use of prospect theory.

7. Conclusions

To conclude, in this paper we discussed, in great detail, the revolutional axioms presented by Daniel Kahneman and Amos Tversky in 1979, namely the prospect theory. Prospect theory has forever changed the way we conseptualize the decision-making process under risk. The theory itself is divided into two separate phases; editing and evaluation phase. The most prominent part of the editing phase is coding, in which, decision makers change the meaning of, e.g., monetary sums of money, to more easily approachable form; gains and losses. This has been one of the biggest conceptual insights of this theory.

However, as we established before, to review events in the light of gains and losses, they need to be in reference to something. In prospect theory, this was named as a reference point. The problem with coding (gains and losses) and the reference point is that, in the real-life applications, it has been unclear what a gain or loss represents in any given situation. This challenge remains unsolved. Addressing it is a key-challenge for the future of the prospect theory and its real-life applications.

On top of this, prospect theorems strong suit has been the weighting function, which demonstrates the way in which decision makers over and undervalues mathematical probabilities. In figure 2, this is truly brilliantly demonstrated. This finding is to a great extent used in the field of, e.g., insurance since the uncertainty is an inherent part of the industry. The weighting function does also question the expected utility theorems axiom about a rational decision maker, because it shows how, even when decision makers are greatly exposed to the true mathematical probability, the anomalies of over and underweighting still occurs.

Anomalies emerging from the evaluation of a prospect were greatly also noted by the value function. In the value function, it was demonstrated through empirical evidence, how decision makers were constantly feeling more pain (pleasure), from losing (gaining) an exactly equivalent monetary sum of money. In more

conservative models, e.g., the expected utility theorem, this contradiction would be not possible. These emerged anomalies were truly hard to fathom within the economists and were, therefore, criticised extensively. The experiments were conducted multiple times, each time with more like real-life situations for the decisions made under risk. Even though the best efforts, these anomalies stayed. Because of this truly strong empirical evidence, the prospect theory is today widely recognized.

The applications of this the prospect theory have been the most vital in the areas of finance and insurance since they are, in essence, concerned with situations involving uncertainty. This is why in these fields the prospect theory have naturally had a stronger foothold and also the framework has been adapted to the academic reasoning as well. In fact, this theorem has been an inherent part of the formulation in the field we today call behavioural economics. One of the first foot steps were made in that direction by Kahneman and Tversky and soon after by Thaler.

In other fields, the theory itself has proven to be truly difficult to be modelled into a given situation at hand. There have been plenty of practical problems, one of which have to do in regard to the definition of the reference point. Despite this, during this millennium, successful attempts have been made and, therefore, the prospect theory has been more widely utilized. Thus, in the near future, we might be able to model the prospect theory to fit a larger range of applications.

To conclude, the failure to endogenize all of the relevant variables at this stage of the prospect theory is a limitation of the theory but not a fatal flaw. Therefore, “we should see it as an opportunity to improve the theory rather than as a reason to reject it” (Rat Choice 1997). On top of that, the expected utility theorem is based on a normatively pleasing set of axioms, where as the prospect theory is mainly descriptive model, which has yielded inexplicable solid empirical evidence supporting this descriptive way of reasoning. When all this is taken into account, prospect theory has been a revolutionary descriptive model and even though it faces challenges in the real life applications, the potential behind the prospect theory is enormous.

References

Book references;

Thaler, R. H. (2015), Väärin käyttäytyminen. Käyttäytymistaloustieteen synty, suom. Kimmo Pietiläinen, Terra Cognita.

Fyodor Dostoevsky (1864) Notes From Undergroud, Epoch

Literature

Daniel Kahneman; Amos Tversky: Prospect Theory: An Analysis of Decision under Risk. Econometrica, Volume 47-Issue 2-1979, pp. 263-292

Helson, H.: Adaptation-Level Theory. New York: Harper, 1964

Nicholas C. Barberis: Thirty Years of Prospect Theory in Economics: A Review and Assessment. Journal of Economic Perspectives-Volume 27, Number 1-Winter 2013-Pages 173-196

Amos Tversky and Daniel Kahneman: Loss aversion in riskiless choice: A reference-dependent model, The Quarterly Journal of Economics, 1991

Kahneman, D., Knetsch, J. L. ja Thaler, R. H. (1991), "The Endowment Effect, Loss Aversion, and Status Quo Bias", Journal of Economic Perspectives 5: 193–206.

Adrian Bruhin, Helga Fehr-Duda and Thomas Epper: Risk and Rationality: Uncovering Heterogeneity in Probability Distortion. Econometrica, Vol. 78, No. 4 (July 2010), 1375-1412

Botond Köszegi, Matthew Rabin: A Model of Reference-Dependent Preferences. The Quarterly Journal of Economics, Volume 121, Isuue 4, November 2006, Pages 1133-1165

Michael Nwogugu: Towards multi-factor models of decision making and risk. A critique of Prospect Theory and related approaches. The Journal of Risk Finance Vol. 6 No. 2, 2005. pp- 150-162.

Jack S. Levy: An Introduction to Prospect Theory. Political Psychology, Vol. 13, No. 2, Special Issue: Prospect Theory and Political Psychology (Jun., 1992), pp.171-186

James C. Cox and R. Mark Isaac: Mechanisms for incentive regulation: theory and experiment. The Rand Journal of Economics Vol. 18, No. 3 (Autumn 1987), pp- 348-359

David M. Grether and Charles R. Plott: Economic Theory of Choice and the Preference Reversal Phenomenon. The American Economic Review, Vol. 69, No. 4 (Sep., 1979), pp. 623-638

Amos Tversky and Daniel Kahneman: Advances in prospect theory: Cumulative representation of uncertainty. Journal of Risk and Uncertainty, October 1992, Vol. 5, Issue 4, pp. 297-232

Charles A. O'Reilly: Variations in Decision Maker's Use of Information Sources: The Impact of Quality and Accessibility of Information. Academy of Management Journal, Nov. 1982 Vol. 25, No. 4.

Daniel Kahneman, Jack L. Knetsch and Richard H. Thaler: Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias. Journal of Economic Perspectives, Vol. 5 N

o. 1, Winter 1991, pp. 193-206

William Samuelson, Richard Zeckhauser: Status quo bias in decision making. Journal of Risk and Uncertainty, Vol. 1, Issue 1, March 1988, pp-7-59

Charles R. Plott and Kathryn Zeiler: The Willingness to Pay-Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions and Experimental Procedures for Eliciting Valuations. American Economic Review, Vol. 95, No.3, June 2005, pp. 530-545

Jack L. Knetsch: The Endowment Effect and Evidence of Nonreversible Indifference Curves. The American Economic Review, Vol. 79, No. 5, Dec. 1989, pp. 1277-1284

Jay R Ritter: Behavioral finance. Pacific-Basin Finance Journal Vol. 11 No.4, Sep. 2003 pp. 429-437

Barberis, Nicholas, and Ming Huang. 2008. "Stocks as Lotteries: The Implications of Probability Weighting for Security Prices." *American Economic Review*, 98 (5): 2066-2100.

Todd Mitton and Keith Vorkink: Why Do Firms with Diversification Discounts Have Higher Expected Returns?, Journal of Financial and Quantitative Analysis, Vol. 45, Issue 6, December 2010, pp. 1367-1390

Justin Sydnor: (Over)insuring Modest Riks. American Economic Journal: Applied Economics. Vol. 2 No. 4, October 2010, pp. 177-199

Reference lectures

Robert Shiller, Speech during his lecture about the prospect theory, Yale, 2013.

http://www.youtube.com/watch?v=fyOA2nbjVVQ