Norwegian School of Economics
Bergen, Spring 2020

Reference Dependent Risk Preferences and Insurance Demand

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Master Thesis in Economic Analysis

NORWEGIAN SCHOOL OF ECONOMICS

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Abstract

This thesis explores insurance decisions with respect to modest risks. Bernoulli's expected utility theory is compared to a model where utility depends on both final wealth and changes in wealth relative to some reference point. Optimal insurance is derived within these frameworks. An important result in the expected utility theory is that full insurance is only optimal at actuarially fair premia. I show that when utility also depends on some reference point, full insurance may be optimal at unfair premia and no insurance may be optimal at fair premia. The aim of the study is to investigate which model is best suited to explain preferences over small-scale insurance contracts. The analysis is based on a survey experiment of 904 Norwegian citizens, representative of the general population, in the spring of 2020. The respondents were asked to choose between hypothetical income gambles and menus of small-scale insurance contracts. The results display strong indications that the reference dependent model is superior to expected utility theory when predicting insurance choices. The majority of the sample made insurance choices that can be explained by the reference dependent model, whereas only seven percent made choices that are in line with expected utility theory. There also appears to be high heterogeneity in both the degree of risk aversion and in people's reference points. Among those respondents whose choices are in line with the reference dependent model, approximately half seem to have full insurance as their reference point and prefer full insurance at unfair premia, whereas the other half seem to have no insurance as their reference point and prefer no insurance at fair premia.

Acknowledgements

I wish to acknowledge the help provided by my two supervisors, Professor Fred Schroyen and Associate Professor Mathias Ekström. I would like to express my great appreciation for the valuable guidance and insights you have provided this past semester. I would also like to thank Hallvard Natvik and Frende Forsikring for making this thesis possible. I gratefully appreciate the financial support you provided to gather data for this project. Finally, I would like to express my gratitude to Per Ståle Ekrol at YouGov for the flexibility and rapid replies when providing the dataset.

Contents

1 Introduction

The classic model for analysing decisions under risk is the expected utility theory (EUT) by Daniel Bernoulli (1738/1954). The central implication of this theory is that decreasing marginal utility of wealth leads to a risk preference known as risk aversion. Risk averse individuals dislike risk on their wealth, that is, they always prefer a safe outcome over a gamble with the same expected payoff. People who are risk averse are therefore willing to pay to eliminate risks. Hence, the theory may seem appropriate to explain the huge demand for insurance observed in the market.

Since Pratt (1964), it has been acknowledged that an important feature of EUT is that a concave utility function is almost linear with respect to small changes in wealth. Risk averse agents are therefore predicted to act as though they were risk neutral when considering very small risks. This has led insurance researchers like Mossin (1968) to predict that insuring against small risks is only optimal if the insurance premium is equal to the expected loss, or actuarially fair. However, most insurance policies available in the market usually contain a mark-up for profit and expenses known as loading. Data from Finance Norway (2019) show that insurance companies on average charge premia that are 40% higher than the expected loss.

While large scale insurance such as home insurance or automobile insurance may well be explained by EUT, the pervasiveness of small-scale insurance at heavily loaded premia remains a puzzle for this theory. There are many accounts of market setting where people appear to pay large insurance premia to insure against very modest risks (e.g. Cicchetti & Dubin, 1994; and Huysentruyt & Read, 2010). To illustrate, US consumer reports show that 40-80% of the profit on electronics comes from the sale of extended warranties.

Researchers like Rabin (2000) have shown that an extremly high degree of risk aversion is necessary to justify the observed purchace of small scale insurance contracts. Such abnormal levels of risk aversion is not consistent with the degree of risk aversion observed over larger stakes.

In other settings, people may choose not to insure when the premium is fair or even subsidized. This type of behaviour is also inconsistent with the predictions of EUT. Authors such as Anderson (1974) and Kunreuther & Slovic (1978) have found a strong reluctance to purchase heavily subsidised disaster insurance. Although this evidence is from large scale insurance, similar behaviour is likely to occur for small scale insurance. For instance, consumer protection agencies usually advice people not to purchase small scale insurance (i.e. The Consumer Council of Norway (2020)).

A growing body of research suggests that the observed anomalies among insurance customers may be explained by so-called reference dependent preferences. In this framework, utility is extracted directly from changes in wealth relative to some reference point, rather than just total wealth. This idea received increasing attention after it appeared in Kahneman & Tversky's prospect theory (1979). The framework has later been extended by many authors. Kőszegi and Rabin (2006; 2007) generalized the idea and proposed that overall utility depends upon both standard utility of wealth, as stressed in traditional EUT, and a gain/loss utility function that depends on how an outcome compares to some reference point. The crucial factor that distinguishes this framework from earlier models of reference dependence, such as prospect theory, is the specification of the appropriate reference point. Kőszegi & Rabin equate the reference point with recent expectations, thus allowing the reference point to be both endogenous and stochastic.

I apply Kőszegi & Rabin's reference dependent model, and an extension of this model proposed by De Giorgi & Post (2011), to analyse optimal insurance behaviour. I show that, depending on whether or not an agent expects to buy insurance, full insurance may be optimal at actuarially unfair prices, and no insurance may be optimal at fair and even subsidized premia.

The main aim of this thesis is to investigate whether insurance choices are in line with EUT or a reference dependent model with either "full insurance" or "no insurance" as the reference point. To explore this question, I use data from a survey experiment of 904 Norwegian citizens, representative of the general population, in the spring of 2020. The survey was funded by the Norwegian insurance company Frende Forsikring and carried out by the research institute YouGov.

The analysis is based on two different sets of questions from the survey. The first set of questions are income gambles, designed to elicit risk preferences over large stakes. These are necessary to find out if respondents are risk averse over large stakes, and to classify the degree of standard risk aversion for each respondent. In the second set of questions, respondents were asked to choose between insurance contracts over small stakes. Since optimal behaviour is different in EUT and the reference dependent framework, this set of questions can be used to divide respondents into different types: The EUT type, the full insurance type and the no insurance type, where the two latter types are respondents with reference dependent preferences.

If the reference dependent model can explain how insurance customers behave, understanding which reference point is more common in different parts of the population is important for insurance providers. I therefore provide a regression analysis to see which personal characteristics are associated with the full insurance type compared to the no insurance type. The degree of relative risk aversion is included in the regression to see if risk aversion affects the probability of being a full insurance type.

The degree of risk aversion over large stakes in the general population has been estimated in many studies, such as Barsky, Juster, Kimball, & Shapiro, (1997) and Schroyen & Aarbu (2018). Other studies have analysed optimal insurance choices in the reference dependent framework under various assumptions of the reference point (e.g. Eeckhoudt, Fiori, & Gianin (2018), Sydnor (2010) and Schmidt (2016)). Several of these studies show that a reference dependent model may be a substantially better predictor of insurance behaviour than EUT. This thesis is, to the best of my knowledge, the first study that attempts to indicate which reference point people have in an insurance context, and which characteristics are associated with the different reference points.

The thesis is organized as follows. Chapter 2 covers traditional expected utility theory and its implication for insurance decisions. Chapter 3 covers reference dependent preferences and gives a review of the relevant literature, while chapter 4 analyses optimal insurance decisions under various specifications of the reference point. In chapter 5, I explain and motivate the survey design and the empirical strategy, while the results are presented in chapter 6. Chapter 7 provides a summary and discussion of implications for insurance companies and chapter 8 concludes.

2 Expected Utility Theory

2.1 The Expected Utility Hypothesis

The expected utility hypothesis was first proposed by Daniel Bernoulli in his famous 1738 paper (1738/1954). The paper presented a new perspective on how individuals view choices with uncertain outcomes. Before Bernoulli, researchers assumed that risky prospects where evaluated exclusively by their mathematical expectation. Consequently, everyone facing the same risk, should value it equally.

Bernoulli, however, pointed out that if a very poor man somehow obtains a lottery ticket with an equal probability of winning either 20 000 ducats or nothing, he would probably be willing to sell this ticket for a price below the mathematical expectation of 10 000 ducats. On the other hand, a rich person would probably be willing to buy this ticket at the poor man's selling price. For the poor man, a sure gain below the expectation is safer than an uncertain gain with 10 000 in expectation. The rich man, however, can engage in many similar transactions and ultimately make a profit. This example shows that different people may have different valuations of identical risks.

To illustrate, Bernoulli uses the concept of *utility*: a person extracts subjective satisfaction or utility from the goods and services that he can acquire with his wealth. Thus, there exists a relationship between wealth and utility that can be characterized by a utility function u, such that for every wealth level w, there is a corresponding utility $u(w)$ attainable from this wealth. While wealth is an objective measure of how much goods and services that can be acquired, utility is a subjective measure of the satisfaction derived from those goods and services. Since the transformation from objective wealth to subjective utility will vary between people, the utility function is not observable. Nevertheless, we can make some general assumptions on how we expect the utility function to behave.

Suppose that $u(w)$ is a twice differentiable function. One natural assumption is that with higher wealth, one obtains more utility. Utility must therefore be an increasing function of wealth, that is, $u'(w) > 0$. Bernoulli further argues that a poor man obtains a higher increase in utility than a rich man would, for the same increase in wealth. This is equivalent to stating that marginal utility $u'(w)$ is decreasing in wealth, that is, $u''(w) < 0$, or that utility is a concave function of wealth.

The key feature of Bernoulli's paper is that people are expected to act as though they maximize expected utility. Denote a lottery L as a risky prospect where $x_s = \{x_1, x_2, \ldots, x_n\}$ are the n possible payoffs, depending on the state of the world s, and $p_s = \{p_1, p_2, \ldots, p_n\}$ are the probabilities with which the payoffs are received. The expected utility E(u) of the prospect L can be represented by the weighted average of the utilities u extracted from the outcomes x

$$E[u(L)] = p_1 u(x_1) + p_2 u(x_2) + \cdots + p_n u(x_n) = \sum_{s=1}^{n} p_s * u(x_s), \qquad (1)$$

where state s occurs with probability p_s and $p_1 + p_2 + \ldots + p_n = 1$.

Modern decision theory is usually based upon a formalized axiomatic characterisation of Bernoulli's theory, developed by von Neumann & Morgenstern (1944). The von Neumann-Morgenstern utility theorem states that an individual's preferences over lotteries can be represented by a function that takes the expected utility form (a utility function), if and only if four axioms hold. The axioms are presented below as preferences over different lotteries (Damodaran, 2007, p. 15; Levin, 2006).

The first axiom is known as *completeness*, requiring that lotteries are comparable and that agents can state a preference ordering, that is, either A is preferred to B, B is preferred to A or A and B are equally preferred. The second is known as *transitivity*, which requires that if an agent prefers A to B and B to C, he must prefer A to C. The third axiom is the *independence* axiom, stating that different lotteries are independent of each other, i.e. if lottery A is preferred to lottery B, the preference is unchanged when the two lotteries are mixed with a third lottery C. The fourth axiom, the axiom of *continuity*, states that if A is preferred to B, then any third lottery A' in the close neighbourhood of A is also preferred to B.

The four axioms are known with other names in some literature and the last two axioms also have more detailed specifications. For now, the above specifications should be enough to consider preferences that can be described by a twice differentiable utility function *u(w)*.

2.2 Risk Aversion

Suppose as discussed above, that utility is an increasing and concave function of wealth. The concavity of the utility function reflects the concept of *risk aversion.* An agent is defined to be risk averse if he at any wealth level dislikes a zero-mean risk, that is, any lottery with an expected payoff of zero (Eeckhoudt, Gollier, & Schlesinger, 2005, p. 7). The expected utility of a risky prospect is a point on a straight line between two points on the utility curve. By Jensen's inequality, any point on a secant line of a concave function must lie below the concave function (see Figure 1). The expected utility of a risky prospect must therefore always be lower than the utility of receiving the expectation with certainty. An agent with initial wealth w and a concave utility function u facing a zero mean risk z will prefer avoiding the risk, that is

$$u(w) \geq Eu(w+z), \tag{2}$$

for all w and z. For an arbitrary risk Z that is not restricted to zero mean, the risk averse agent will prefer the mathematical expectation with certainty to the risk, such that

$$u(w+EZ) \geq Eu(w+Z). \tag{3}$$

A concave utility function thus implies risk aversion, and an increase in the concavity of the utility function generally implies an increase in risk aversion. This link is intuitive if we look back to the example with the poor man obtaining a lottery ticket that gives 0 or 20 000 ducats with equal probability. If the man could choose 10 000 ducats with certainty instead of accepting the lottery, it would have a net positive impact on his expected utility; the negative effect on utility of having 0 instead of 10 000 is greater than the positive effect on utility of having 20 000 ducats instead of 10 000 ducats.

Although decreasing marginal utility is an appealing and intuitive assumption, it need not always be the case. Using exactly opposite arguments to those above, it can easily be shown that for an agent with a convex utility function, $u''(w)>0$, the above inequalities will be reversed, and the agent is said to be risk loving. Furthermore, for an agent with a linear utility function, $u''(w)=0$, inequalities (2) and (3) will hold with equality and the agent is referred to as risk neutral.

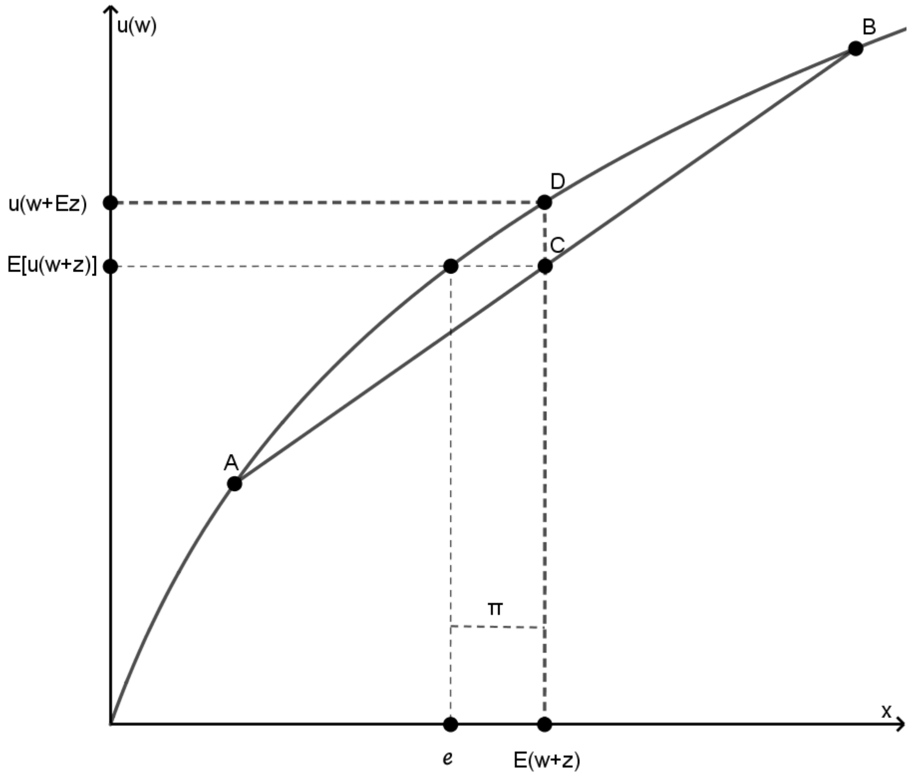

Figure 1. Point C is the mathematical expectation when A and B is realised with equal probability. As specified in Inequality (3), the utility of receiving the expectation with certainty, point D, is higher than the utility of the expectation, point C. (Drawn in GeoGebra)

2.3 Measures of Risk Aversion

As defined above, a risk averse agent is an agent who dislikes zero mean risks. It is important to note the "zero mean" qualifier. A risk averse agent does not dislike all risks; A risk with a sufficiently high expected payoff can be attractive to a risk averse agent.[1] How high this expected payoff must be for the risk to become attractive may vary between different risk averse individuals, because the degree of risk aversion may vary.

[1] It is not only the size of the expected payoff that matters. Variance, the second order moment, and even statistical moments of order higher than 2 will matter when comparing random variables.

2.3.1 Risk Premium and the Certainty Equivalent

Risk premium is a convenient measure of the degree of risk aversion that is often used in the literature. The risk premium is the maximal amount an individual will pay to get rid of a zero mean risk z (Eeckhoudt, Gollier, & Schlesinger, 2005, p. 10). The risk premium Π must satisfy

$$E[u(w+z)] = u(w-\Pi), \qquad (4)$$

where Π > 0 for risk averse agents, Π = 0 for risk neutral agents and Π <0 for risk loving agents. The higher the risk premium, the more risk averse an agent is. For an arbitrary risk Z, it is common to use the related concept of the certainty equivalent, which is the certain change in wealth that has the same effect on utility as bearing the risk Z (Myerson & Zambrano, 2005, p. 98). The certainty equivalent *e* must thus satisfy:

$$E[u(w+Z)] = u(w+e). \qquad (5)$$

The certainty equivalent is closely related to the risk premium; For zero mean risks z, e = -Π. Generally, the certainty equivalent equals the expected final wealth, minus the risk premium, *e* = $E[w$ + Z] – Π. Both Π and *e* are also marked in Figure 1.

2.3.2 The Arrow-Pratt Approximation

The risk premium Π, as specified by Equation (4), varies with the shape of the utility function *u*, the initial wealth level *w* and the distribution of the risk z. Di Finetti (1952), Arrow (1963) and Pratt (1964) independently developed a formula to approximate the risk premium for small risks (Gollier, 2001, p. 22). A description of their approximation[2] is presented below, followed by a discussion of how the approximated risk premium varies with *u*, *w, and z.*

Consider a zero mean risk z, such that E[z] = 0. Using a second order Taylor series expansion for the left-hand side of Equation (4) around the point z = 0, we obtain

$$E[u(w+z)] \approx E[u(w) + zu'(w) + \tfrac{1}{2}z^2u''(w)]$$

$$= u(w) + u'(w)E[z] + \tfrac{1}{2}u''(w)E[z^2].$$

[2] Known only as the Arrow-Pratt approximation

Since E[z] = 0 and E[z^2] = σ^2 we get

$$E[u(w+z)] \approx u(w) + \tfrac{1}{2}\sigma^2 u''(w).$$

Similarly, by using a first order Taylor series expansion for the right-hand side of Equation (4) around the point Π = 0, we obtain

$$u(w-\Pi) \approx u(w) - \Pi u'(w).$$

Replacing the two Taylor expansions in Equation (4) gives

$$u(w) + \tfrac{1}{2}\sigma^2 u''(w) \approx u(w) - \Pi u'(w)$$

And by solving for Π we get

$$\Pi u'(w) \approx -\tfrac{1}{2}\sigma^2 u''(w)$$

$$\Pi \approx -\frac{\tfrac{1}{2}\sigma^2 u''(w)}{u'(w)}.$$

Or equivalently

$$\Pi \approx \tfrac{1}{2}\sigma^2 A(w), \tag{6}$$

where *A*(*w*) is a function defined as

$$A(w) = -\frac{u''(w)}{u'(w)} \tag{7}$$

A(*w*) is referred to as the degree of absolute risk aversion (ARA), which is a measure of the rate at which marginal utility decreases when wealth is increased by one unit. From Equation (6) and (7), we see that the concavity of the utility function, measured as *u''(w),* is not sufficient to quantify the risk premium. Concavity is necessary and sufficient to indicate whether or not an agent is risk averse, but to quantify the risk premium, we also need the marginal utility of wealth *u'(w)*. This is because an individual may have a high *u''(w)* and be very risk averse, but he is not necessarily willing to pay a large risk premium if he is poor, since the marginal utility *u'(w)* is assumed to be high for low wealth levels (Penati & Pennacchi, n.d.).

The risk premium Π is a function of the degree of absolute risk aversion, which again is a function of wealth, i.e. the risk premium may vary with wealth. To see this, consider the rich and the poor man in Bernoulli's example, now facing a risk to lose or gain 100 ducats with equal probability. If the poor man has initial wealth $w = 101$, he would most certainly be willing to pay more than a rich man with wealth $w = 100\,000$ to get rid of this zero-mean risk. This may be true even if the rich and the poor man have the same utility function. A utility function that satisfies the example above exhibits a property known as decreasing absolute risk aversion (DARA). Two classical utility-functions that satisfy the DARA condition are $u(w) = \sqrt{w}$ and $v(w) = \ln(w)$. We can check and see that $A_u(w) = \frac{1}{2w}$ and $A_v(w) = \frac{1}{w}$, that is, both $A_u(w)$ and $A_v(w)$ are decreasing in w.[3] Notice that $A_u(w) \leq A_v(w)$ for all $w > 0$, which implies that a person with utility function $v(w)$ is more risk averse than a person with utility function $u(w)$ or equivalently that v is more concave than u. Utility functions where ARA is independent of w (such as $u(w) = \frac{1-e^{-aw}}{a}$) exhibit constant absolute risk aversion (CARA) and utility functions where absolute risk aversion is increasing in w (such as $u(w) = aw - \frac{1}{2}w^2$, for $w \leq a$) exhibit increasing absolute risk aversion.

We can see from Equation (6) that the risk premium is approximately equal to half the variance of z multiplied by the degree of absolute risk aversion. The risk premium is thus approximately proportional to the variance of the risk. The property that the risk premium only depends on the mean and variance of w, i.e., the first two statistical moments, is usually only true when considering small risks.[4] In the Arrow-Pratt approximation, the development of the Taylor series is limited to the second order, making the approximation only accurate in the neighbourhood of $z = 0$ and $\Pi = 0$. For larger risks, statistical moments of order higher than 2 may matter when determining the risk premium.[5]

[3] The product of the absolute risk aversion and wealth gives a unit free measure of risk aversion known as relative risk aversion. The relative risk aversion of the two utility functions in question is independent of w. Therefore, these two functions also belong in the set of utility functions with constant relative risk aversion (CRRA).

[4] It is true for large risks if an agent has so-called mean-variance preferences, such as in the special case when u is a quadratic function or when relative risk aversion is constant and the risk is normally distributed (Oxford Reference, 2020).

[5] The third and fourth moment, i.e. skewness and kurtosis, describe respectively whether the probability mass has its centre of gravity to the left or right and the proportion of the probability mass in the tail of the distribution.

2.3.3 Risk Aversion as a Second Order Phenomenon

In the domain of small risks, let $k > 0$ be a constant that represents the size of a risk z, such that $z = k\varepsilon$ with E[ε] = 0. Since the variance of z, var(z) = var(kε) = $E[k^2\varepsilon^2] = k^2E[\varepsilon^2] = k^2\sigma_\varepsilon^2$, because $E[\varepsilon^2] = \sigma^2$, we obtain from (6) that:

$$\Pi \approx \frac{1}{2}k^2\sigma_\varepsilon^2 A(w), \tag{8}$$

From this equation we can see that as k approaches zero, the risk premium Π approaches zero as k^2; Π is approximately proportional to the square of the size of the risk, and approaches zero faster than k. This property is particularly important as it predicts that expected utility maximisers should act as though they were risk neutral when considering sufficiently small risks. Segal & Spivak (1990) refer to this property as *second order risk aversion*, because for small risks, risk aversion yields a second-order effect on utility compared to the effect of the mean. They point out that the second order phenomenon relies on the assumption that the utility function is differentiable, such that a concave function is almost linear when considering small changes. In chapter three, I will discuss models where agents are risk averse also for small risks. These models consider preferences that exhibit *first order risk aversion*, that is, where the risk premium Π is proportional to k.

2.3.4 Relative Risk Aversion and the Power Utility Function

Recall that ARA measures the rate in which marginal utility decreases when wealth is increased by one unit. Thus, ARA is not a unit free measure of risk aversion. A more convenient measure would be the rate at which marginal utility decreases when wealth increases by one percent (Eeckhoudt, Gollier, & Schlesinger, 2005, p. 18). By multiplying initial wealth *w* with ARA, we obtain the coefficient of relative risk aversion (RRA):

$$R(w) = w\left\{-\frac{u''(w)}{u'(w)}\right\} = -\frac{wu''(w)}{u'(w)}$$

RRA, like ARA, may be a decreasing, constant or increasing function of wealth. With constant RRA (CRRA), the share of initial wealth an individual is willing to pay to get rid of a proportional risk is independent of initial wealth. CRRA, which also implies DARA, is one of the most common assumptions that are made on the shape of the utility functions when fitting data (Wakker, 2008). The following, widely used utility function, forms the basis for the analysis of standard risk aversion in this thesis:

$$u(w) = \begin{cases} \dfrac{w^{1-\rho}}{1-\rho} \; for\ \rho \neq 1 \\ \ln(w)\; for\ \rho = 1 \end{cases}$$

This utility function is very convenient, because

$$u'(w) = \frac{(1-\rho)w^{-p}}{1-\rho} = w^{-\rho}$$

$$u''(w) = -\rho w^{-\rho-1}$$

By plugging this into *R*(*w*), we obtain

$$R(w) = -\frac{wu''(w)}{u'(w)} = -\frac{w(-\rho w^{-\rho-1})}{w^{-\rho}} = -\frac{w(-\rho)w^{-\rho}w^{-1}}{w^{-\rho}} = \rho$$

That is, the constant $\rho \geq 0$ is equal to the coefficient of relative risk aversion.

2.4 Insurance Choice Under Expected Utility Theory

Insurance is an economic activity which occurs when one party agrees to pay an indemnity to another party in case of the occurrence of a prespecified random event generating a loss (Eeckhoudt, Gollier, & Schlesinger, 2005, p. 45). Generally, insurance is a special case of a risk-transfer or risk-minimizing strategy known as hedging. Karl Borch (1990, p. 1) points out that it is difficult to come with a complete definition of insurance because there are many types of financial insurance that do not fit a simple definition. For general purposes, Borch considers an insurance contract described by the following two elements: (1) The premium paid by the insured when the contract is concluded, and (2) the compensation which the insured receives if specific events occur when the contract is in force.

2.4.1 The Elements of Insurance

Following both Eeckhout et al, and Borch, this text considers insurance policies with the following two elements: An insurance premium P, paid by the policyholder, and a compensation, or *indemnity*, described by an indemnity schedule $I(x)$, which indicates the amount to be paid by the insurer to the policyholder for a random loss of size x. Full insurance occurs when $I(x) = x$. Partial insurance occurs when $I(x) < x$, which is commonly offered through a contract with coinsurance or a straight deductible.

The supply of insurance exists because insurance companies can pool the risks of many policyholders, thereby taking advantage of the Law of Large Numbers. Insurance companies who offer many contracts are assumed to be risk neutral because individual risks are very small compared to the size of the company. The demand for insurance exists because people are risk averse. A risk averse individual is willing to pay to eliminate risk on his wealth and this willingness to pay for insurance is linked to the risk premium. Whether or not an individual is willing to take up insurance therefore depends on the price of the insurance, i.e. the insurance premium P.

An insurance premium is said to be actuarially fair if it is equal to the expected indemnity, i.e. $P = EI(x)$. Under EUT, risk averse agents are predicted to purchase full insurance if the insurance premium is fair (Mossin, 1968). The consumer surplus of such a contract is equal to the risk premium. However, insurance policies in the market are usually not priced actuarially fair because insurance companies usually charge a mark-up for profit and expenses. This has an important implication for the optimal amount of insurance an individual demands.

2.4.2 Optimal Insurance Under Expected Utility Theory

If we assume that the mark-up is proportional to the indemnity, we can denote κ as the mark-up which is a percentage of $I(x)$, such that

$$P = (1 + \kappa)EI(x). \tag{9}$$

κ is often referred to as the loading factor. The contract is actuarially fair if κ = 0.

When κ = 0, full insurance is optimal for all risk averse agents because the insurance premium is equal to the expected loss. If κ > 0, full insurance is no longer optimal under EUT. If a risk averse agent facing a large risk can choose the indemnity schedule given the pricing rule in Equation (9), purchasing some insurance will usually increase the expected utility.[6] However, as I(x) approaches x, the coverage approaches full insurance and thus the uninsured risk approaches zero. As outlined in Equation (8), the cost of the uninsured risk approaches zero faster than the size of the risk. Consequently, when the uninsured risk is sufficiently small, the risk premium, and the willingness to pay for insurance, approaches zero faster than the size of the risk left uninsured. Thus, the marginal benefit of insurance decreases as the coverage increases. This is due to the property that risk aversion is a second order effect, implying that a risk averse agent becomes risk neutral for small risks. So, for a positive loading, $\kappa > 0$, utility is not a monotonic function of the indemnity, it is hump-shaped with a maximum such that the optimal $I(x) < x$. It is therefore always optimal for all risk averse agents to retain some of the risk when the loading is positive.

One way to retain some of the risk is through a so-called coinsurance policy. In the following, a coinsurance policy is used to show that it is always optimal to retain some of the risk when the loading is positive.

Let β denote the coinsurance rate, which is the fraction of the loss that is compensated by the insurer, such that $I(x) = \beta x$. The insurance premium of such a contract is equally reduced to βP. The state dependent final wealth w_1, for an individual with initial wealth w_0 choosing coinsurance rate β is thus:

$$w_1 = w_0 - \beta P - x + \beta x,$$

where the loss x is a random variable. In order to choose the coinsurance rate that maximizes expected utility, the policyholder faces the following optimization problem:

$$\max_{\beta} Eu(w_1)$$

$$= \max_{\beta} Eu(w_0 - \beta P - x + \beta x) \tag{10}$$

Let $M(\beta)$ be the objective function that is desired to be maximized such that

[6] If the loading is sufficiently high compared to the degree of risk aversion, we might find that the first order condition, Equation (11), Is not satisfied for any β. If the derivative of the expected utility of final wealth with respect to β, evaluated at β = 0 is negative, any amount of insurance will decrease the expected utility and we obtain a corner solution where no insurance is optimal.

$$M(\beta) = \ Eu(w_0 - \beta P - x + \beta x)$$

The corresponding first order condition is

$$M'(\beta) = E[u'(w_1)(x - P)] = 0$$

$$M'(\beta) = E[u'(w_0 - \beta P - x + \ \beta x)(x - P)] = 0 \qquad (11)$$

If we evaluate the first order condition in the special case when β = 1, we obtain

$$M'(1) = E[u'(w_0 - P)(x - P)] = 0. \qquad (12)$$

Since $P = (1 + \kappa)\mathrm{E}I(x)$ and $\mathrm{E}I(x) = \mathrm{E}(x)$ for β = 1, the factor (x – P) can be rewritten as

$$E(x - (1 + \kappa)x)$$

$$= E(x - x - \kappa x)$$

$$= -\kappa\, E(x)$$

Substituting back into (12) yields:

$$M'(1) = -\kappa u'(w_0 - P)E(x) = 0 \qquad (13)$$

It is now easy to see that the first order condition, evaluated at β = 1, is satisfied if and only if κ = 0. This proves that full insurance is optimal when the premium is actuarially fair. Note, however, that (13) is not satisfied for a positive loading, κ > 0. Hence, full insurance, β = 1, is not optimal when κ > 0. $M'(1)$ is in fact negative when κ > 0, indicating that expected utility is decreasing at β = 1. Notice further that $M''(\beta)$, the second derivative of the expected utility of final wealth with respect to β, is

$$E[u''(w_1)(x - P)^2],$$

which is always negative because the second factor is quadratic and thus always positive, and risk aversion ensures that the first factor is always negative. The expected utility is therefore a strictly concave function of the coinsurance rate. Together with the observation that expected utility is decreasing at β = 1, we can conclude that the optimal coinsurance rate is less than unity when κ > 0, i.e. partial insurance is optimal for a positive loading.

The above observations were formalized by economist Jan Mossin (1968). They can be summarized by the following proposition, known as Mossin's Theorem:

Proposition 1: *Full insurance ($\beta = 1$) is optimal at an actuarially fair price, $\kappa = 0$, while partial coverage ($\beta < 1$) is optimal if the premium includes a positive loading, $\kappa > 0$* (Eeckhoudt, Gollier, & Schlesinger, 2005, p. 51).

2.4.3 The Optimal Insurance Contract

Another way to retain some of the risk is through a contract with a straight deductible D, such that $I(x) = \max(0, x - D)$, for some $D \geq 0$ (Seog, 2010, p. 59). Arrow (1971) proved that a contract with a straight deductible is always the optimal contract when retaining some of the risk. For a non-binary loss, a straight deductible is always preferred to a coinsurance contract with the same premium because the deductible contract concentrates the indemnity on the larger losses. By changing from a deductible contract to a coinsurance contract, the policyholder reduces the indemnity when the loss exceeds the deductible and increases the indemnity when the loss is smaller than the indemnity. This change is equivalent to reducing the final wealth when the loss is small, in order to increase final wealth when the loss is large. This change in risk is an increase in risk known as a mean-preserving spread, which is disliked by all risk averse agents (Rothschild & Stiglitz, 1970). The coinsurance contract, or in fact any other contract, is a mean-preserving spread of the deductible contract (Seog, 2010, p. 58).

However, the optimality of the deductible contract relies on both the assumption that the loading factor κ is proportional to the expected indemnity, and that the policyholder is risk averse and the insurer is risk neutral. Furthermore, note that the optimality of the deductible contract is only strictly optimal for a non-binary loss. For a binary loss, a coinsurance contract and a deductible contract will give the same expected indemnity for equal premia, so the expected utility is equal for the two contracts.

Finally, it is important to note that the optimal retention rate, i.e. the choice of β or D, may vary with wealth. Under the common assumption of DARA , which was discussed in section 2.3.2, risk aversion and thus the demand for insurance is decreasing as initial wealth is increasing (Eeckhoudt, Gollier, & Schlesinger, 2005, p. 53). This implies that a rich man will choose a lower β (or a higher D) than a poor man, when insuring identical risks. However, wealthier individuals tend to purchase bigger houses and more expensive cars, thus taking on more risk and thereby increase their total demand for insurance.

2.4.4 The Insurance State-Space

One can obtain a graphical illustration of the optimal insurance for a binary loss by considering an insurance state space. Denote W_A and W_{NA} as the final wealth in the accident state and the no-accident state respectively. Let W_A and W_{NA} span a two-dimensional space as shown in Figure 2. Indifference curves indicate combinations of state-dependent final wealth that give the individual the same utility level. The 45-degree line represents the situation where the wealth is equal in the two states, i.e. a situation with full insurance and no risk. As opposed to the utility of wealth function, the indifference curves in the state space are convex for risk averse individuals, as they bend away from the risk-free state around the 45-degree line. The curvature of the indifference curves reflects the degree of risk aversion.

To derive the optimal amount of insurance, we must compare the indifference curves with the agent's budget line. Consider a risk where the two states W_A and W_{NA} are realized with probability p and $(1 - p)$. With an insurance premium as outlined in Equation (9), the state dependent final wealth becomes

$$W_{NA} = w_0 - (1+\kappa)pI$$

$$W_A = w_0 - (1+\kappa)pI - x + I$$

$$W_A = W_{NA} - x + I \tag{14}$$

By solving for I in W_{NA} we obtain

$$-(1+\kappa)pI = W_{NA} - w_0$$

$$I = -\frac{W_{NA} - w_0}{(1+\kappa)p}$$

Substituting I back into (14) and rearranging yields:

$$W_A = W_{NA} - x - \frac{W_{NA} - w_0}{(1+\kappa)p}$$

Finally, we solve for W_{NA}

$$W_{NA} = W_A + x + \frac{W_{NA} - w_0}{(1+\kappa)p}$$

$$W_{NA} = W_A + x + \frac{W_{NA}}{(1+\kappa)p} - \frac{w_0}{(1+\kappa)p}$$

$$W_{NA} - \frac{W_{NA}}{(1+\kappa)p} = W_A + x - \frac{w_0}{(1+\kappa)p}$$

$$\frac{W_{NA}[(1+\kappa)p - 1]}{(1+\kappa)p} = W_A + x - \frac{w_0}{(1+\kappa)p}$$

$$W_{NA} = \frac{(W_A + x)(1+\kappa)p}{(1+\kappa)p - 1} - \frac{w_0}{(1+\kappa)p - 1}$$

$$W_{NA} = \frac{x(1+\kappa)p - w_0}{(1+\kappa)p - 1} + \frac{(1+\kappa)p}{(1+\kappa)p - 1} W_A.$$

Thus, the budget line has a slope given by

$$\frac{(1+\kappa)p}{(1+\kappa)p - 1}$$

or equivalently[7]

$$-\frac{p(1+\kappa)}{1 - p(1+\kappa)}. \tag{15}$$

First, consider a situation where the loading is zero, $\kappa = 0$, and the probability of an accident is equal to one half, $p = 0.5$. The budget line will now have a slope of negative one, as stipulated in the left space of Figure 2. If the agent decides not to purchase insurance, he is at point A, where the wealth is high in the W_{NA}-state and low in the W_A-state. If the agent purchases full insurance, he is at point B, where the wealth is independent of the state. The agent's opportunity set consists of all points along the budget line between no insurance and full insurance, i.e. between points A and B. The points below the 45-degree line are not considered for insurance

[7] Note that this analysis is only valid for $0 < p < \frac{1}{1+\kappa}$. If $p > \frac{1}{1+\kappa}$, the insurance premium is higher than the value of the insured object.

problems, because more than full insurance is usually not offered in the insurance marked.[8] It is optimal to settle at the point where the budget line is tangent to the indifference curve with the highest level of utility. As illustrated in the left space of Figure 2, settling at point B with full insurance gives the highest utility level when $\kappa = 0$.

Consider now a situation where $\kappa > 0$, and the probability of an accident is unchanged. Now the price of a high wealth level in the accident state is higher, so the budget line is steeper, with a slope of $-(1+\kappa)/(1-\kappa)$. Because the slope of the budget line is steeper than the slope of the indifference curve at the 45-degree line, full insurance is no longer optimal. Now, settling at a point C with less than full insurance gives the highest level of utility, as is illustrated in the right space of Figure 2.

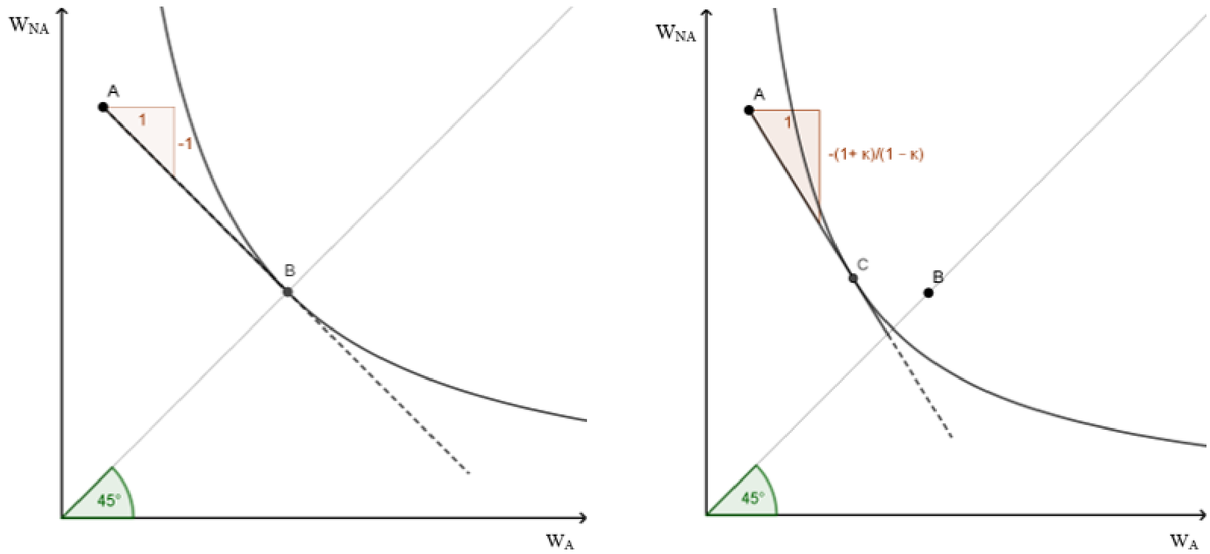

Figure 2. The insurance state space under EUT and second order risk aversion. The left space illustrates optimal insurance when κ = 0, whereas the right space illustrates optimal insurance when κ > 0. (The graphs are drawn in GeoGebra, inspired by Segal & Spivak, 1990)

Generally, the expected utility of an arbitrary point along the budget line can be expressed as

$$Eu(W_A, W_{NA}) = pu(W_A) + (1-p)u(W_{NA})$$

The slope of the indifference curve at this point is then given by

[8] Offering more than full insurance may cause problems with adverse selection: Only the high-risk customers buy more than full insurance, so insurance companies loses money and thus does not offer this contract (Culp, 2002, p. 325). Further, there will be problems moral hazard: the net payoff of an accident becomes positive, so there is an incentive to try to have an accident. The probability of an accident will therefore no longer reflect the expected indemnity.

$$-\frac{u'(W_A)}{u'(W_{NA})} = -\frac{pu'(W_A)}{(1-p)u'(W_{NA})}$$

For an arbitrary κ, it is optimal to move along the budget line towards full insurance if the slope of the indifference curve is steeper than the slope of the budget line, that is, if

$$-\frac{pu'(W_{A'})}{(1-p)u'(W_{NA'})} < -\frac{p(1+\kappa)}{1-p(1+\kappa)}.$$

If the inequality is reversed, it is optimal to move along the budget line towards no insurance. It is now easy to check that when $\kappa = 0$, full insurance is optimal if

$$\frac{u'(W_{A'})}{u'(W_{NA'})} > 1.$$

Which is true for all risk averse agents because u''(w) < 0

3 Reference-Dependent Preferences

In the EUT framework, individuals are predicted to act as if they maximize expected utility of final wealth. However, a large body of both empirical and theoretical research has suggested that EUT may be inappropriate as a descriptive model for decisions under uncertainty, especially when it comes to small risks. In this chapter I present some of the shortcomings of EUT and explore an extension of the EUT framework, where utility depends on both final wealth and how wealth changes from a "reference-wealth".

3.1 Shortcomings of the Expected Utility Theory

Kahneman & Tversky (1979) conducted a series of experiments and found that people may be both risk-averse and risk-loving, depending on weather a prospect is framed as a gain or as a loss. They also found that the utility function appears to be steeper for losses than for gains, resulting in surprisingly high risk aversion over small stakes. This is contrary to the important EUT result of risk neutrality when considering small risks.

Rabin (2000) points out that if plausible levels of risk aversion are observed for small and medium sized lotteries, EUT implies implausible high levels of risk aversion for large risks. To illustrate: If an agent turns down a modest stake gamble with a positive expectation, say a 50-50 chance to lose $100 or gain $110, then the marginal utility of money must diminish extremely quickly for small changes in wealth. In fact, turning down this wager imposes such curvature on the utility function that risk aversion becomes absurd for large gambles: The same individual is predicted to reject a 50-50 chance to lose $1000 or gain $∞, for any concave utility function.[9] From this, Rabin infers that risk aversion over modest risks has nothing to do with diminishing marginal utility of wealth.

As pointed out in the previous chapter, Mossin's Theorem predicts that full insurance is optimal only at an actuarially fair premium. This is, according to Borch (1974, p. 28), «against all observation». The existence of small-scale insurance in the market appears to be widespread.

For example, an empirical study by Sydnor (2010) on deductible-choices for home insurance provides evidence of surprisingly high levels of risk aversion over modest stakes. When faced with a menu of insurance contracts, customers chose surprisingly low deductibles. The decision to choose a low deductible indicates that the customer wants to insure against a high deductible, which is equivalent to insuring a very modest risk. However, those who held low deductibles paid far more than the expected value for that extra insurance. That is, the difference in the premium for a high and a low deductible was unproportionally large, and yet many preferred a low deductible contract. A similar study by Pashigian, Schkade, & Menefee (1966) also found strong preferences for expensive low deductible contracts in car insurance.

Huysentruyt & Read (2010) found that the willingness to pay for extended warranties when purchasing consumer durables was much higher than the actuarially fair price. According to US consumer reports, 40-80% of the profit on electronics comes from the sale of warranties. It is also suggested that it is only by selling extended warranties that commercial electronics stores can stay in business, indicating that the warranty-prices are heavily loaded.

The two studies presented above suggest that consumers demand *more* insurance than predicted by EUT. Though the opposite is also true: Kunreuther & Slovic (1978) found indications of risk loving preferences when they interviewed 3,000 uninsured homeowners in flood or earthquake prone areas. They found that 40 percent failed to purchase highly subsidized insurance even when their own estimates of premia, losses and probabilities indicated that the insurance was

[9] This result relies on the assumption that the agent turns down the -$100/+$110 bet for all initial wealth levels. If the bet is turned down only for initial wealth levels below some threshold, risk aversion is still extreme for larger risks, see table II, page 1284 in (Rabin, 2000)

priced below the actuarially fair premium. A similar study by Anderson (1974) found a strong reluctance to buy state-subsidized flood insurance.

Reference dependent utility theory may help explain some of the observed behaviour in the insurance market that violates the predictions of traditional EUT. As we shall see, reference points in insurance decisions may both allow for the optimality of full insurance when the loading is positive as well as no insurance when the loading is zero.

3.2 An Illustration of Reference Dependent Preferences.

The main assumption in reference dependent models is that there is a discontinuity of the marginal utility at a reference wealth *W*. Utility is thus not only a function of final wealth, but people extract direct utility from changes in wealth. For example, consider the following utility function where the reference wealth *W* is normalized to unity:

$$u(w) = \begin{cases} a\sqrt{w} & \text{if } w \leq W = 1 \\ a + b\left(\sqrt{w} - 1\right) & \text{if } w > W = 1 \end{cases} \quad where\ a \geq b \tag{16}$$

When *a* = *b*, the function takes the expected utility form as discussed in the previous chapter. EUT is thus a special case of reference dependent utility theory. When *a* > *b*, there is a kink in the utility function at the reference wealth, making the utility function non-differentiable at *W* (see Figure 3). Note that for these types of utility functions, the Arrow-Pratt approximation cannot be used for risks around *W*, because the approximation requires that the utility function is differentiable. Models of reference dependent utility with a kink in the utility function exhibit first order risk aversion at *W*, as coined by Segal & Spivak (1990). Around *W*, the utility function is no longer linear when considering small risks. Agents with this type of utility function may thus be risk averse also for small risks. Under first order risk aversion, agents are referred to as *loss averse*, a phenomenon that will be thoroughly discussed in the following section.

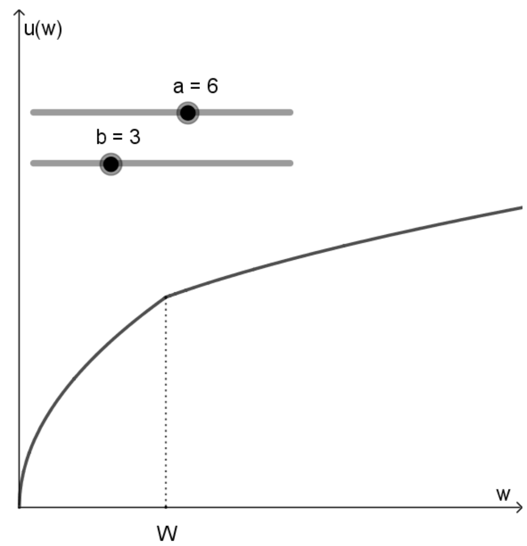

Figure 3. A non-differentiable utility function with a kink at the reference wealth W. (The utility function in Equation (16) Drawn in GeoGebra)

3.3 Literature on Reference Dependent Risk Attitudes

Harry Markowitz (1952) was the first to propose that utility is best defined on deviations from a reference point rather than on final wealth (Machina, 1987). Markowitz observed that a model of risk attitudes that captures the effect of gains and losses compared to current wealth is a better predictor of behaviour than a fixed utility function over final wealth. This observation has later been confirmed in many experimental studies.

One of the most influential theories of reference dependent preferences is prospect theory, which was developed by Kahneman & Tversky (1979). Building on Markowitz (1952), the authors propose a utility function (or "value function" in their terminology) that highlights the effect of gains and losses by placing the reference point in the origin of the coordinate system. An important aspect of their theory is the phenomenon of *loss aversion;* Their laboratory experiments have shown that the utility function appears to be much steeper for losses than for gains. They propose that the function has a point of non-differentiability at the origin – a reference point – that is represented by a kink. The kink separates positive values, gains, and negative values, losses, such that losses are weighted heavier than gains. In short, a loss averse individual is more averse to losses relative to a reference point than he is attracted by equally sized gains.

Denote $\lambda \geq 1$ as the coefficient of loss aversion. λ indicates how much steeper the utility function is for losses than for gains. If $\lambda = 1$, there is no loss aversion. If $\lambda > 1$, losses loom larger than gains. In a follow up- article, Kahneman & Tversky (1992) found that the median estimated λ among subjects in a series of choice experiments was 2.25, indicating that losses resonate approximately twice as much as equally sized gains.

Prospect theory also contains other extensions to EUT. The authors find indications of a nonlinear transformation of the probability scale; people tend to overweight small probabilities and underweight moderate and high probabilities. Prospect theory also suggests diminishing sensitivity in both gains and losses. This imposes a convex portion of the utility function and thus risk seeking behaviour in the loss domain. That is, for a continuous, strictly increasing value function $\mu(x)$, and reference point $r = 0$ such that x is the size of a gain, and -x is the size of a loss,

$$\mu''(x) < 0 \ \forall \ x > 0 \text{ and } \mu''(x) > 0 \ \forall \ x < 0. \tag{17}$$

And $\mu''(x)$ does not exist when $x = 0$ because of non-differentiability at $r \ \forall \ \lambda > 1$.

The following two-part power function was proposed to capture the effect of loss aversion and diminishing sensitivity (Kahneman & Tversky, 1992).

$$\mu(x) = \begin{cases} x^{\alpha} \ if \ x \ \geq 0 \\ -\lambda(-x)^{\beta} \ if \ x < 0 \end{cases} \tag{18}$$

where λ indicates the magnitude of loss aversion and $\alpha \in [0,1]$ and $\beta \in [0,1]$ indicate the rate at which marginal utility decreases (resp. increases) for gains (resp. losses).

Diminishing sensitivity in losses may explain the so-called disposition effect, which is a tendency to engage in risk loving behaviour in order to retain the reference point. However, prospect theory with risk lovingness in the domain of losses is inconsistent with the apparent strong risk aversion in losses found among consumers who purchase expensive insurance with low deductibles and very expensive extended warranties. Therefore, other factors than diminishing sensitivity in losses must be applied to explain this phenomenon.

Kőszegi & Rabin (2006) develop a general model of reference dependent preferences building on Kahneman & Tversky's prospect theory. They propose the following separable utility function:

$$U(w|r) = u(w) + \mu[u(w) - u(r)]. \tag{19}$$

where overall utility $U(w|r)$ depends upon both the standard outcome based utility of wealth $u(w)$, which we studied in the previous chapter, and a gain/ loss utility function μ[u(w) – u(r)] where r is the reference point. The gain/loss utility μ is a function of the difference in utility of the actual outcome and the reference outcome; That is, the gain/loss term increases or decreases overall utility depending on how an outcome compares to the reference point. In the special case where the actual outcome is equal to a deterministic reference point, there are no gains or losses so μ(0) = 0 and $U(w|w) = u(w)$, and the model reduces to traditional EUT. The authors point out that for large risks, u(w) is likely to dominate μ. That is, diminishing marginal utility of wealth u(w), as studied in traditional EUT, counteracts the psychological gain/loss utility μ for large risks. μ is likely to dominate only when considering small risks where u(w) is almost linear. Thus, when considering small risks, avoiding the sensation of loss is the agent's central concern.

For simplicity, Kőszegi & Rabin (2006) abstract from non-linear transformation of the probability scale. They suggest that in some situations the shape of μ corresponds to the value function in prospect theory with both loss aversion and diminishing sensitivity. This allows for risk loving preferences over small risks when framed as a loss. However, Kőszegi & Rabin (2006) also allow for a different assumption on the shape of μ, where one assumes only loss aversion, which is commonly taken to be the stronger of the two forces. With this assumption, they consider the following shape of the gain/loss function as an alternative to Equation (18):

$$\mu(x) = \begin{cases} \eta x \text{ for } x \geq 0 \\ \eta\lambda x \text{ for } x < 0 \end{cases} \tag{20}$$

where η ≥ 0 and λ ≥ 1. With this stronger version of the value function in prospect theory, the inequalities in (17) are replaced with:

$$\mu''(x) = 0 \;\forall\; x \neq 0 \tag{21}$$

That is, a piecewise linear function that is globally concave when λ is greater than 1. This approach is convenient to isolate the effect of loss aversion.

While, $u(w)$ is likely to dominate μ for large stakes, it is likely that μ is more heavily weighted for small stakes. However, the economic environment or the context in which a prospect is presented is also likely to influence how much weight is put on μ. η can be interpreted as the weight attached to the gain/loss component of overall utility. In the limit case of η = 0, no weight is attached to μ, and behaviour is predicted by standard EUT preferences. If η = ∞, all preferences are determined by gain/loss utility.

Although μ is not differentiable at $\mu(0)$, we can isolate η and λ by looking at the right and left derivative of μ at 0:

$$\mu'_{+}(0) = \eta \text{ and } \mu'_{-}(0) = \lambda\eta \tag{22}$$

Where $\mu'_{+}(0) = \lim_{x\to 0} u'(|x|)$ and $\mu'_{-}(0) = \lim_{x\to 0} u'(-|x|)$. Loss aversion for small risks around *r* = 0 can more formally be defined as the ratio between the left and right derivative of μ at 0:

$$\frac{\mu'_{-}(0)}{\mu'_{+}(0)} \equiv \lambda > 1 \tag{23}$$

Loss aversion and thus first order risk aversion is enabled if λ > 1 and the size of λ indicates the magnitude of the kink at the reference point. This definition was first formalized by Bowman, Minehart & Rabin, (1999, p. 157). Notice that in the case of no loss aversion, that is λ =1, the left and right derivatives in (22) are equal, and the function is differentiable for all w, thus implying second order risk aversion and the model is reduced to standard EUT.

3.4 Specifications of the Appropriate Reference Point

A common problem with reference dependent utility theories is the specification of the appropriate reference point *r*. When the reference point is unknown it is difficult to rigorously test reference dependent theories (Baillon, Bleichrodt, & Spinu, 2019). In order to explain why some consumers pay high premia to insure against small risks, while others show reluctance to purchase insurance at fair or even subsidized premia, we turn to the specification of the reference point.

In prospect theory, the authors suggest that the reference point is current wealth or the status quo.[10] Later research has confirmed that a preference for the current state of affairs, a status quo bias, is significant in many real decision-problems (Samuelson & Zeckhauser, 1988).

[10] Although the status quo is the key reference point in prospect theory, the authors suggest that there may be situations where the reference point is an individual's expectations. See Kahneman & Tversky (1979) page 286

Markowitz (1952), however, suggested in his early paper that under certain circumstances, the reference point may deviate from current wealth.

Implications of prospect theory have also been studied under several other specifications of the reference point such as the mean of the chosen lottery (Kahneman, 1992), and the lagged status quo (Thaler & Johnson, 1990). Further, models of disappointment aversion, such as those of Bell (1985), Loomes & Sugden (1986) and Gul (1991), specify the lottery's certainty equivalent as the reference point, and conclude that loss aversion implies strong aversion to all risks. Newer research, like that of Shalev (2000), suggests that the reference point is determined endogenously as a part of the decision problem. Sugden (2003) proposes a model that extends the validity of prospect theory by allowing the reference point to be stochastic.

A recent experimental study on the appropriate reference point by Baillon, Bleichrodt & Spinu (2019), suggests that two reference points stand out: The status quo and a security-based rule known as MaxMin, where the reference point is the maximum outcome that a subject can get with certainty. In an insurance context, the appropriate MaxMin reference point is full insurance. The study finds little evidence that people use the mean of a lottery as a reference point. Eeckhout, Fiori & Gianin (2018) consider the safe alternative of full insurance as the reference point within the framework developed by Kőszegi & Rabin (2006). They provide a theoretical framework to prove that full insurance may be optimal at an actuarially unfair premium. This reference point has also been considered in an insurance setting by Schmidt (2016).

In Kőszegi & Rabin's general model of reference dependent preferences (2006), they allow the reference point to be both endogenous and stochastic. A stochastic reference point may be a lottery's full distribution. They assume that the reference point is determined more generally by "probabilistic beliefs a person held in the recent past about outcomes", i.e. recent expectations. They stress that while existing evidence supports the status quo being an appropriate reference point, virtually all this evidence comes from contexts where people are likely to expect to maintain the status quo. They argue that when expectations and the status quo are different, a more general model with expectations as the reference point makes better predictions. For example, a person who does not get a pay-rise he expected may feel a loss, indicating that the expected pay rise is a more suitable reference point than the status quo.

Further, loss aversion with status quo as the reference point has commonly been used to explain the endowment effect, a phenomenon where owners value an object more than nonowners, since an owner's loss of the object looms larger than the nonowner's gain. However, the endowment effect should disappear if the owner expects to sell. For example, a merchant at the marketplace may feel a loss of money if he does not sell his merchandise. Also, here, setting expectations as the reference point may make better predictions when analysing loss aversion. In fact, by equating the reference point with recent expectations, Kőszegi & Rabin (2006) formalize the psychological idea proposed by Kahneman & Tversky (1984) that money given up in a planned transaction is not a loss.

3.5 Appropriate Comparisons with the Reference Point

When the reference point r is deterministic, the comparison $\mu[u(w) - u(r)]$ is straight forward. However, when the reference point itself is stochastic, there are different ways to compare outcomes to a distribution, because loss aversion may be induced by different psychological factors.

The analysis in Kőszegi & Rabin's (2006) general model of reference dependent preferences builds on disappointment aversion. The decision maker experiences a loss (or disappointment) when an outcome falls below the reference outcome in other states. That is, when the reference point is stochastic, they assume that the outcome is evaluated with "mixed feelings", defined as the average of the different utilities generated by the different reference points possible under that distribution. The decision maker thus compares an outcome with all possible outcomes of the reference point. For example, consider a binary loss of size L occurring with probability p. If the loss occurs, this outcome evokes a mixture of two feelings: a loss of L because the loss ($w - L$) is compared to the no-loss reference point (w) with probability (1 – p), and a gain of 0 because the loss ($w - L$) is compared to the loss reference point ($w - L$) with probability p. Since the loss ($w - L$) is compared to the no-loss reference point (w), the model considers "across-state" comparisons, were the loss is induced by a disappointment.

Another way in which one can compare outcomes to a distribution is by considering a state-dependent reference point were loss aversion only is induced by regret. The model with stochastic reference points by Sugden (2003) builds on regret theory (Loomes & Sugden, 1982) where the decision maker only experiences a loss (regret) if the outcome of a choice falls below the reference outcome in the same state of the world. Such a model only considers "within-state" comparisons. De Giorgi & Post (2011) analyse state-dependent reference points within the Kőszegi-Rabin framework. A state-dependent reference points may be appropriate when analysing how the outcome of a specific action compares to a stochastic reference point, such as an investor who compares his investment to a benchmark portfolio like a stock market index. Only allowing within state comparisons may also be useful in an insurance context because it is intuitive that people regret not buying insurance when the accident state is realized and regret buying insurance when there is no accident.

In the next chapter, I analyse optimal insurance decision under various specifications of the reference point, considering both across and within state-comparisons.

4 Analysis of Insurance Decisions with Reference Dependent Preferences

In a follow-up article, Kőszegi & Rabin (2007)(KR, hereafter) apply their reference dependent model to decisions with delayed consequences and study how expectations influence risk attitudes. They distinguish between three settings: The "Surprise" setting, as well as the two settings "UPE" and "CPE", both appropriate for anticipated risks. The "surprise" setting replicates the classical status quo prospect theory. Without any prior expectation of risk one expects no losses, and thus the status quo of not losing anything is the appropriate reference point; The decision maker must choose between the uncertain loss by facing the risk, or a certain loss by paying the insurance premium. Similar decision problems are studied in classical status quo prospect theory, where diminishing sensitivity in losses leads to a preference for taking the risk. However, the exposure to insurable risks does usually not come as a surprise. This thesis will therefore not focus on analysis in surprise situations. The focus in this chapter is on the specification of the reference point and the two equilibrium concepts, UPE and CPE, which are appropriate for analysing anticipated risks. The two concepts differ in terms of *when* the decision to insure against the anticipated risk is committed to.

In this chapter I explore the UPE and the CPE setting. I apply the reference points "full insurance" and "no insurance" and consider both within- and across-state comparisons. The aim of the analysis is to use the KR framework to explain why some agents purchase full insurance at loaded premia, while others purchase no insurance at fair or subsidized premia. The analysis in this chapter is restricted to binary losses, and to isolate the effect of loss aversion, μ is assumed to be the piecewise linear function in Equation (20).

4.1 UPE – Unacclimating Personal Equilibrium

The unacclimating personal equilibrium (UPE) is a solution concept that is appropriate when a risk is anticipated, but the decision to insure is only committed to shortly before the resolution of uncertainty occurs. When deciding whether to buy insurance in this setting, the decision maker compares the possible outcomes to a reference point that is fixed by past expectations. For example, consider an agent who contemplates whether to buy insurance. If, prior to this decision, he had expected to buy insurance, he will compare the possible outcomes without insurance to the outcomes with insurance. In this sense, the decision maker maximizes expected utility when taking the reference point as given.

Definition: *Let A be the set of actions available to the agent and let a be an element of this set. Let w_a be final wealth associated with action a. Action a ϵ A is an unacclimating personal equilibrium (UPE) if, for every action a' ϵ A,* $U(w_a|w_a) \geq U(w_{a'} \mid w_a)$.

That is, in a UPE, it is optimal to take the action one expected to take. There may, however, be multiple UPE. In this case, the decision maker will choose the UPE that gives the highest expected utility. This is referred to as the preferred personal equilibrium (PPE)

In order to explain the mentioned anomalies in insurance behaviour within the UPE setting, I provide an analysis of optimal insurance when the reference point is “full insurance” in Section 4.1.1, followed by an analysis when the reference point is “no insurance” in section 4.1.2. In section 4.1.3 I apply De Giorgi & Post’s (2011) approach to an insurance context and analyse optimal insurance when the reference point is state-dependent. The CPE setting, which is appropriate when the decision to insure is committed to long before the resolution of uncertainty, is considered in section 4.2.

In the following, I extend the illustrations from Figure 2, and provide a graphical illustration of the conditions for optimal behaviour with the two different reference points “full insurance” and “no insurance”.

4.1.1 Optimal Insurance when Expecting to Buy Full Insurance

If the risk had been anticipated and an agent had expected to pay the insurance premium as a routine transaction, paying the premium is the appropriate reference point. Can this reference point explain why some individuals prefer full insurance to partial insurance even at actuarially unfair premia?

Recall that reference dependent preferences may be represented by a kink in the utility function (se Figure 3). In the insurance state-space spanned by W_A and W_{NA}, reference dependent preferences may be represented by a kink in the indifference curves at the reference point. The magnitude of loss aversion λ indicates the size of the kink at *r*. If full insurance is the reference point, the kink in the indifference curve will be at the 45-degree line, i.e. point D in Figure 4. Full insurance is optimal if the slope of the indifference curve to the left of the kink is steeper than the slope of the budget line. If the kink is sufficiently large, full insurance may be optimal even at actuarially unfair premia.

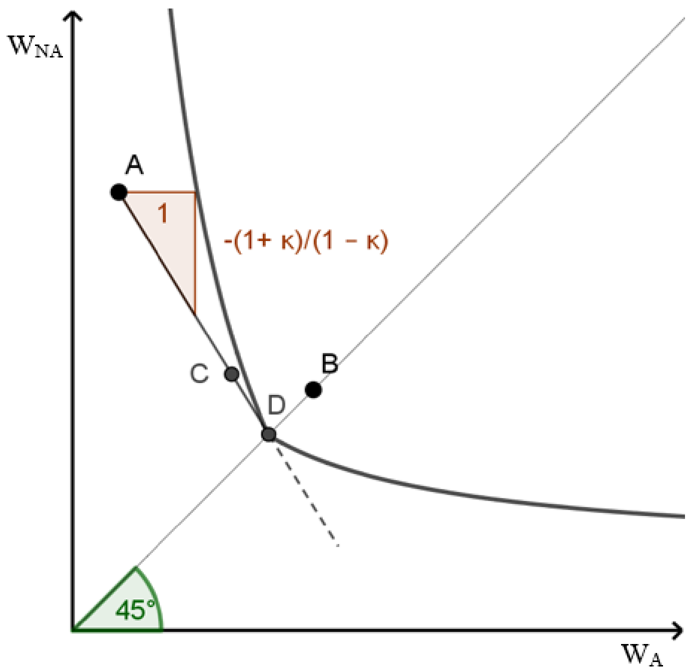

Figure 4. The state space illustrates the optimality of full insurance at an actuarially unfair premium when the reference point is full insurance. Points B and C are optimal insurance with respectively zero and positive loading under traditional EUT (Figure 2). (The graph is drawn in GeoGebra, inspired by Segal & Spivak, 1990)

To see this, denote W_{FI} as final wealth at the full insurance reference point (point D). With the reference dependent utility function specified by Equation (19) and (20), the expected overall utility U of an arbitrary point (W_A, W_{NA}) to the left of the kink, i.e. when $W_{NA} > W_{FI} > W_A$, can be expressed as:

$$p[u(W_A) + \lambda\eta\{u(W_A) - u(W_{FI})\}] + (1 - p)[u(W_{NA}) + \eta\{u(W_{NA}) - u(W_{FI})\}]$$

The slope of the indifference curve is given by

$$-\frac{U'(W_A)}{U'(W_{NA})} = -\frac{pu'(W_A) + p\lambda\eta u'(W_A)}{(1 - p)u'(W_{NA}) + (1 - p)\eta u'(W_{NA})}$$

$$= -\frac{p(1 + \lambda\eta)u'(W_A)}{(1 - p)(1 + \eta)u'(W_{NA})}.$$

The same argument can be used to show that for an arbitrary point $(W_{A'}, W_{NA'})$ to the right of the kink, i.e. when $W_{NA'} < W_{FI} < W_{A'}$, the slope of the indifference curve is equal to

$$= -\frac{p(1 + \eta)u'(W_{A'})}{(1 - p)(1 + \lambda\eta)u'(W_{NA'})}.$$

Recall that the slope of the agent's budget line is $-\frac{p(1+\kappa)}{1-p(1+\kappa)}$. If the slope of the indifference curve in the left neighbourhood of W_{FI} is steeper than the slope of the budget line, that is, if

$$-\frac{p(1 + \lambda\eta)u'(W_{FI})}{(1 - p)(1 + \eta)u'(W_{FI})} = -\frac{p(1 + \lambda\eta)}{(1 - p)(1 + \eta)} < -\frac{p(1 + \kappa)}{1 - p(1 + \kappa)},$$

then it is optimal to settle in the full insurance point, point D. By simplifying, we obtain

$$\frac{(1 + \lambda\eta)}{(1 + \eta)} > \frac{(1 - p)(1 + \kappa)}{1 - p(1 + \kappa)}$$

Subtracting 1 from both sides, gives

$$\frac{\eta(\lambda - 1)}{(\eta + 1)} > \frac{\kappa}{(1 - \mathrm{p} - \mathrm{p}\kappa)} \tag{24}$$

Proposition 2: *Consider an agent with reference dependent preferences expressed by Equation (19) and (20) who faces a small risk and has full insurance as his reference point. If Inequality (24) holds, full insurance is a UPE and is preferred to any insurance contract containing a deductible. If the inequality is reversed, no insurance, or an insurance contract containing a deductible is optimal and not a UPE.*

This is equivalent to Proposition 5 in Eeckhout, Fiori & Gianin (2018), who assume that the reference point is full insurance. Note that at an actuarially fair premium where $\kappa = 0$, it is optimal to buy insurance whenever $\lambda > 1$ and $\eta > 0$.[11] For loaded premia where $\kappa > 0$, it is optimal to buy full insurance if λ and η are sufficiently large.

4.1.2 Optimal Insurance when Expecting to Take the Risk

If the risk has been anticipated and a person expects not to buy insurance (i.e. he expects to take the risk), we have a situation with no insurance as a stochastic reference point. Can this reference point explain why some individuals prefer not to buy insurance when the premium is fair or even subsidized?

If no insurance is the reference point, the kink will be at point A in the right space of Figure 5. No insurance is optimal if the slope of the indifference curve to the right of the kink is flatter than the slope of the budget line. Recall that when the reference point is a distribution, KR follow the disappointment structure and assume that the outcome is evaluated with "mixed feelings", featuring across-state comparisons.

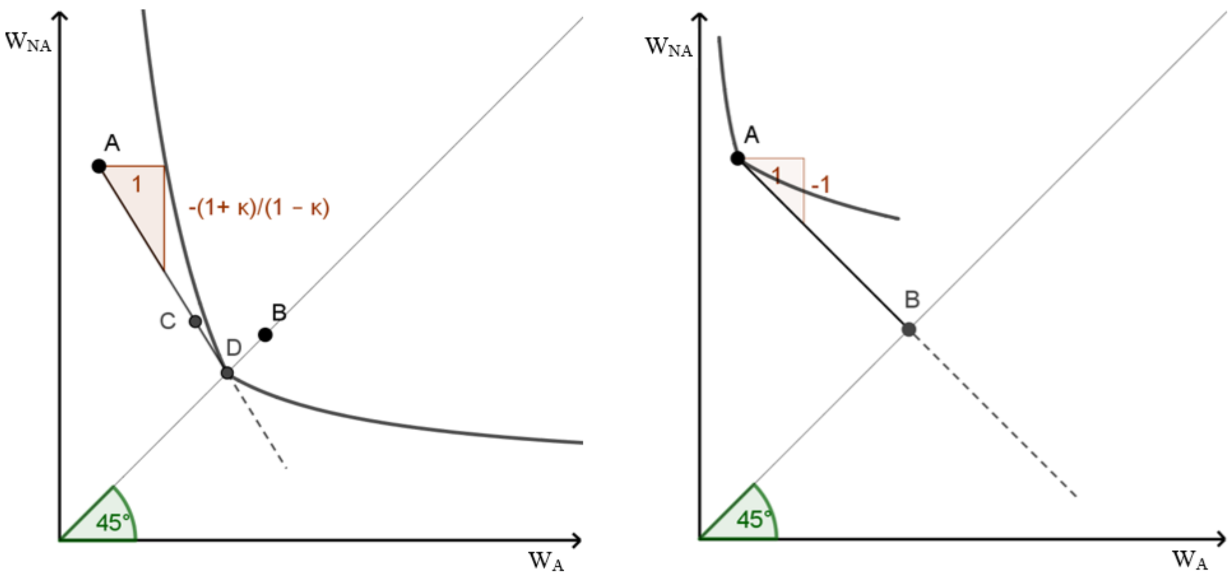

Figure 5. The right space illustrates the optimality of no insurance at an actuarially fair premium when the state-dependent reference point is no insurance. The left space is included for comparison. (The graphs are drawn in GeoGebra, inspired by Segal & Spivak, 1990)

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[11] If $\lambda = 1$ and $\eta = 0$ the model is reduced to EUT so the slope of the indifference curve is equal to the slope of the budget line. If also $\kappa = 0$, $u''(w) < 0$ ensures the optimality of full insurance (see Proposition 1)

Denote W_{ANI} and W_{NANI} as final wealth with no insurance in the accident and no accident state respectively. When the reference point is no insurance (W_{ANI}, W_{NANI}), point A in Figure 5, the expected overall utility U of an arbitrary point $(W_A\,, W_{NA})$ to the left of the kink, i.e. when $W_{NA} > W_{NANI} > W_{ANI}\ and\ W_A < W_{ANI} < W_{NANI}$, can be expressed as:[12]

$$p[u(W_A) + p\lambda\eta\{u(W_A) - u(W_{ANI})\} + (1-p)\lambda\eta\{u(W_A) - u(W_{NANI})\}] + (1 - p)[u(W_{NA}) + p\eta\{u(W_{NA}) - u(W_{ANI})\} + (1-p)\eta\{u(W_{NA}) - u(W_{NANI})\}].$$

The slope of the indifference is given by

$$-\frac{U'(W_A)}{U'(W_{NA})} = -\frac{pu'(W_A) + pp\lambda\eta u'(W_A) + p(1-p)\lambda\eta u'(W_A)}{(1-p)u'(W_{NA}) + (1-p)p\eta u'(W_{NA}) + (1-p)(1-p)\eta u'(W_{NA})}$$

$$= -\frac{p(1+\eta\lambda)u'(W_A)}{(1-p)(1+\eta)u'(W_{NA})}.$$

Similarly, the expected overall utility U of an arbitrary point $(W_{A'}\,, W_{NA'})$ to the right of the kink, where $W_{ANI} < W_{NA'} < W_{NANI}\ and\ W_{NANI} > W_{A'} > W_{ANI}$, is

$$\begin{aligned} p[u(W_{A'}) + p\eta\{u(W_{A'}) - u(W_{ANI})\} + (1-p)\lambda\eta\{u(W_{A'}) - u(W_{NANI})\}] \\ + (1-p)[u(W_{NA'}) + p\eta\{u(W_{NA'}) - u(W_{ANI})\} \\ + (1-p)\lambda\eta\{u(W_{NA'}) - u(W_{NANI})\}], \end{aligned}$$

and the slope of the indifference curve is

$$-\frac{U'(W_A)}{U'(W_{NA})} = -\frac{pu'(W_{A'}) + pp\eta u'(W_{A'}) + p(1-p)\lambda\eta u'(W_{A'})}{(1-p)u'(W_{NA'}) + (1-p)p\eta u'(W_{NA'}) + (1-p)(1-p)\eta\lambda u'(W_{NA'})}$$

$$= -\frac{p(1+p\eta+(1-p)\lambda\eta)u'(W_{A'})}{(1-p)(1+p\eta+(1-p)\eta\lambda)u'(W_{NA'})}.$$

[12] Note that the outcome in the no-accident state is compared to the outcome in the accident state and vice versa. This is due to KR's disappointment structure where outcomes are evaluated with "mixed feelings", which implies that outcomes are evaluated across states: actual outcomes are compared with all possible outcomes of the reference point. When outcomes are compared across states, losses occur even when the prospect is equal to the reference point. Within-state comparisons are considered in section 4.1.3.

$$= -\frac{pu'(W_{A'})}{(1-p)u'(W_{NA'})}.$$

When κ = 0, the slope of the indifference curve in the right neighbourhood of the kink is flatter than the budget line if

$$-\frac{pu'(W_{A'})}{(1-p)u'(W_{NA'})} > -\frac{p}{1-p}$$

$$\frac{u'(W_{A'})}{u'(W_{NA'})} < 1$$

Which is never true for any risk averse agent because u''(w) < 0. No insurance is therefore not optimal when κ = 0 in this model.

Notice that the slope of the indifference curve to the right of point A is independent of λ and η and is in fact the slope of the indifference curve with standard EUT preferences. This means that the kink at the reference point (W_{ANI}, W_{NANI}) only exists because the slope to the left of this point is steeper than the EUT slope. The kink at point A does therefore not affect the decision to move along the budget line compared to standard EUT preferences. Optimal insurance is thus determined by Mossin's theorem (Proposition 1), and full insurance is optimal only when κ = 0.

When the reference point is no insurance, the KR framework makes the same prediction about optimal insurance as standard EUT: When κ = 0, the slope of the indifference curve in point A is steeper than the slope of the budget line, so it is optimal to move along the budget line towards full insurance. Therefore, the KR model alone cannot explain why some individuals systematically prefer no insurance at fair or subsidized premia.

4.1.3 Optimal Insurance with a State Dependent Reference Point

Following the regret-based structure with a state-dependent reference point, outcomes are only compared with the outcome of the reference point in the same state. This may be more intuitive in the context of insurance choice. For example, it seems implausible that people experience a loss sensation because the outcome with insurance in the accident state $(\mathrm{w} - P_D - D)$ is compared to the outcome without insurance in the no-accident state (w). It seems more plausible that the outcome with insurance in the accident state $(\mathrm{w} - P_D - D)$ is compared to the outcome without insurance in the accident state $(\mathrm{w} - L)$, an thus evaluated as a gain. This section analyses optimal insurance when the reference point is state-dependent, and comparisons are only made within states.

When the reference point is state-dependent, the gain-loss term disappears when the choice and the reference point coincide because the stochastic outcome is equal to the stochastic reference point and there are no losses. In this regret-based structure, the decision maker does not experience a loss just because bad states yield worse outcomes than good states. The decision maker does, however, experience a loss when he takes an action that has an outcome which falls below the reference point in the same state.

When expecting full insurance, the reference point is deterministic and independent of the state of the world, so the expected overall utility when only allowing within-state comparisons are equal to those obtained when considering across-state comparisons. A state-dependent reference point does therefore not change the predictions in section 4.1.1 and Proposition 2. However, when expecting no insurance, the reference point is stochastic and now dependent on which state of the world that is realised. In this framework, loss aversion is induced by regret, rather than disappointment. Can no insurance as a state-dependent reference point explain why some individuals prefer not to buy insurance instead of buying (partial) insurance when the premium is fair or even subsidized?

To answer this question, we must again compare the slope of the budget line to the slope of the indifference curve to the right of the kink. If no insurance is the state dependent reference point, the kink will still be at point A (W_{ANI}, W_{NANI}) in the right space of Figure 5. No insurance is optimal if the slope of the indifference curve to the right of the kink is flatter than the slope of the budget line.

Because De Giorgi & Post (2011) first applied the state-dependent reference point to the Kőszegi-Rabin framework, their initials are used as subscript in the expected overall utility (U_{DGP}) in this case. When the state dependent reference point is no insurance, the expected overall utility U_{DGP} of an arbitrary point $(W_A\,, W_{NA})$ to the left of the kink, i.e. when $W_{NA} > W_{NANI} > W_{ANI} > W_A$ can be expressed as:

$$p[u(W_A) + \lambda\eta\{u(W_A) - u(W_{ANI})\}] + (1-p)[u(W_{NA}) + \eta\{u(W_{NA}) - u(W_{NANI})\}]$$

And the slope of the indifference is given by

$$-\frac{U_{DGP}{}'(W_A)}{U_{DGP}{}'(W_{NA})} = -\frac{pu'(W_A) + p\lambda\eta u'(W_A)}{(1-p)u'(W_{NA}) + (1-p)\eta u'(W_{NA})}$$

$$= -\frac{p(1+\eta\lambda)u'(W_A)}{(1-p)(1+\eta)u'(W_{NA})}.$$

Similarly, the expected overall utility U_{DGP} of an arbitrary point $(W_{A'}, W_{NA'})$ to the right of the kink, where $W_{NANI} > W_{NA'} > W_{A'} > W_{ANI}$ can be expressed as:

$$p[u(W_{A'}) + \eta\{u(W_{A'}) - u(W_{ANI})\}] + (1-p)[u(W_{NA'}) + \lambda\eta\{u(W_{NA'}) - u(W_{NANI})\}],$$

And the slope of the indifference curve is equal to

$$= -\frac{p(1+\eta)u'(W_{A'})}{(1-p)(1+\eta\lambda)u'(W_{NA'})}.$$

If the slope of the indifference curve in the right neighbourhood of the kink is flatter than the slope of the budget line, that is, if

$$-\frac{p(1+\kappa)}{1-p(1+\kappa)} < -\frac{p(1+\eta)u'(W_{ANI})}{(1-p)(1+\lambda\eta)u'(W_{NANI})}$$

$$\frac{1-p(1+\kappa)}{(1-p)(1+\kappa)} < \frac{(1+\lambda\eta)}{(1+\eta)} * \frac{u'(W_{NANI})}{u'(W_{ANI})} \qquad (25)$$

then it is optimal to settle in the no insurance point, point A. When the premium is fair, this can be reduced to

$$\frac{u'(W_{ANI})}{u'(W_{NANI})} < \frac{(1+\lambda\eta)}{(1+\eta)}$$

Because of risk aversion, the LHS is greater than one, but for small risks, the LHS is approximately equal to one, such that no insurance is optimal whenever

$$\frac{(1+\lambda\eta)}{(1+\eta)} > 1$$

Or equivalently, when

$$\frac{\eta(\lambda-1)}{(1+\eta)} > 0$$

That is, when the agent is loss averse. For an arbitrary κ, no insurance is optimal whenever

$$\frac{1-p(1+\kappa)}{(1-p)(1+\kappa)} < \frac{(1+\lambda\eta)}{(1+\eta)}$$

$$\frac{\eta(\lambda-1)}{(1+\eta)} > -\frac{\kappa}{(1-p)(1+\kappa)}$$

It is thus never optimal to buy insurance when $\kappa > 0$. For $\kappa < 0$, a critical combination of λ and η exists that makes no insurance optimal.

Having no insurance as a state dependent reference point may thus explain the optimality of buying no insurance at fair and even subsidized premia. This is summarized in the following proposition

Proposition 3: *Consider an agent with reference dependent preferences expressed by Equation (19) and (20) who faces a small risk and has no insurance as his state-dependent reference point. If Inequality (25) holds, no insurance is a UPE and is preferred to any insurance contract. If the inequality is reversed, some insurance or full insurance is optimal and not a UPE.*

4.2 CPE – Choice-Acclimating Personal Equilibrium

An alternative equilibrium concept proposed by KR is the Choice-acclimating personal equilibrium (CPE). The authors argue that this concept is appropriate when the decision maker can commit to the decision to insure long before the resolution of uncertainty. In the CPE setting, the decision maker has time to acclimatize to his decision, he will have become accustomed to his choice and hence expect the lottery that is induced by the choice. Therefore, the action and the reference point imply each other: the reference point is adjusted to match the decision. In a CPE, the reference point is fully endogenized, and the reference point can easily be identified, because it is equal to the choice.

Definition: *Let A be the set of actions available to the agent and let a be an element of this set. Let w_a be final wealth associated with action a. Action a ϵ A is a choice-acclimating personal equilibrium (CPE) if, for every action a' ϵ A,* $U(w_a|w_a) \geq U(w_{a'} \mid w_{a'})$.

When the choice is equal to the reference point in the regret-based framework with state dependent reference points, the loss/gain terms disappear, so choices are determined by standard EUT. The CPE concept is therefore only relevant in KR's disappointment-based framework, with across-state comparisons. When the reference point is equal to the choice in this framework, the expected overall utility U of any point (W_A, W_{NA}) can be expressed as:

$$p[u(W_A) + p\eta\{u(W_A) - u(W_A)\} + (1-p)\lambda\eta\{u(W_A) - u(W_{NA})\}] + (1 - p)[u(W_{NA}) + p\eta\{u(W_{NA}) - u(W_A)\} + (1-p)\eta\{u(W_{NA}) - u(W_{NA})\}]$$

$$= p[u(W_A) + (1-p)\lambda\eta\{u(W_A) - u(W_{NA})\}] + (1-p)[u(W_{NA}) + p\eta\{u(W_{NA}) - u(W_A)\}]$$

The slope of the indifference is given by

$$-\frac{U'(W_{ANI})}{U'(W_{NANI})} = -\frac{pu'(W_A) + p(1-p)\lambda\eta u'(W_A) - p(1-p)\eta u'(W_A)}{(1-p)u'(W_{NA}) + (1-p)p\eta u'(W_{NA}) - (1-p)p\eta\lambda u'(W_{NA})}$$

$$= -\frac{p[1 + (1-p)\eta(\lambda - 1)]u'(W_A)}{(1-p)(1 - p\eta(\lambda - 1))u'(W_{NA})}.$$

Note that when $\eta(\lambda - 1)$ approaches $\frac{1}{p}$, the slope of the indifference curve tends to -∞. For an arbitrary κ, it is optimal to move along the budget line and buy insurance if

$$= -\frac{p[1 + (1-p)\eta(\lambda - 1)]u'(W_{ANI})}{(1-p)\big(1 - p\eta(\lambda - 1)\big)u'(W_{NANI})} < -\frac{p(1+\kappa)}{1 - p(1+\kappa)}$$

For small risks, where $\frac{u'(W_{ANI})}{u'(W_{NANI})} \approx 1$, we obtain

$$= \frac{1 + (1-p)\eta(\lambda - 1)}{(1-p)\big(1 - p\eta(\lambda - 1)\big)} > \frac{(1+\kappa)}{1 - p(1+\kappa)}$$

Set $x = \eta(\lambda - 1)$

$$= \frac{1 + (1-p)x}{(1-p)(1-px)} > \frac{(1+\kappa)}{1 - p(1+\kappa)}$$

$$= \frac{1 + x - px}{1 - px} > \frac{(1 + \kappa)(1 - p)}{1 - p(1 + \kappa)}$$

$$= \frac{x}{1 - px} > \frac{\kappa}{1 - p - p\kappa}$$

$$= \frac{x}{\kappa} > \frac{1 - px}{1 - p - p\kappa}$$

$$= \frac{x(1 - p - p\kappa) + \kappa px}{\kappa(1 - p - p\kappa)} > \frac{1}{1 - p - p\kappa}$$

$$x(1 - p - p\kappa) + \kappa px > \kappa$$

$$x - px > \kappa$$

$$x > \frac{\kappa}{1 - p}$$

Substitute back $x = \eta(\lambda - 1)$ and consider only negative slopes of the indifference curve:

$$\frac{\kappa}{(1 - \mathrm{p})} < \eta(\lambda - 1) < \frac{1}{p}$$

Note here, that when the premium is fair, it is optimal and a CPE to buy insurance when the agent is loss averse ($\lambda > 1$ and $\eta > 0$). That is, a loss averse agent who knows that the premium is fair, plans to take the reference point "full insurance" and follows through with his plan because once the reference point is full insurance, full insurance is optimal. When $\kappa > 0$, full insurance is optimal and a CPE when $\eta(\lambda - 1)$ is sufficiently high. In contrast, when $\eta(\lambda - 1)$ is not sufficiently high for some $\kappa > 0$, no insurance is optimal but still a CPE.

However, in a CPE, individuals with the same degree of loss aversion are predicted to make the same choices, and, loss averse individuals are predicted to buy full insurance at fair premia. Therefore, the CPE setting cannot explain why some individuals systematically prefer no insurance at fair premia.

As the reference point is equal to the choice in the CPE setting, the reference point is easy to identify. The product $\eta(\lambda - 1)$ can be estimated based on the chosen lottery when κ and p are given. In a paper by Barseghyany, Molinari, OíDonoghue, & Teitelbaum (2013), this product has been estimated in a structural model with standard risk aversion, loss aversion and probability weighting.

4.3 Choice of Reference Points and Equilibrium Concept.

Recall that KR argue that CPE is an appropriate concept for situations when the decision is made long before the uncertainty is resolved. In contrast, the UPE concept is appropriate when the risk is anticipated, but the decision is committed to shortly before the uncertainty is resolved. In most insurance contexts, the loss can happen at any time, so the uncertainty is resolved at an unknown point in time. If policyholders pay a monthly premium and for each month evaluate whether to continue with the policy, the commitment is made at most one month before the resolution of uncertainty. Therefore, the UPE might be the appropriate setting, at least when considering small risks.

A drawback with the CPE setting, is that it implies that those who have similar values of λ and η, must also make identical insurance choices. The UPE setting allows people with the same values of λ and η to take completely different actions because they may have different reference points. Further, Aperjis & Balestrieri (2017) argue that CPE may result in suboptimal behaviour. This is because under CPE, an agent does not consider profitable deviations in which his action and expectation differ. Under UPE, however, expectations and actions are considered independently and may mismatch off-equilibrium. What's more, in the CPE setting, agents are assumed to understand that the choice made today will determine the reference point by the time the uncertainty is resolved. The fact that the agent understands today that the reference point in the future is dependent on today's choice is a very strong assumption.

In this thesis, I follow Aperjis & Balestrieri (2017) and assume the UPE setting in which agents consider profitable deviations where actions and expectations may differ. Further, I follow the extension of KR with state dependent reference points as proposed by De Giorgi & Post (2011). This allows for the optimality of no insurance at fair premia if the state-dependent reference point is no insurance, while also allowing for the optimality of full insurance at unfair premia when the reference point is full insurance.

The aim of this thesis is to explore which model, EUT or the reference dependent model, is more suited to explain small-scale insurance choices. Equipped with Propositions 1 through 3, we can say something about which of the two models insurance choices are in line with:

(1) If people prefer full insurance when the premium is actuarially fair but wish to retain some of the risk when the contract contains a positive loading, preferences are in line with EUT.

(2) If people prefer full insurance both when the premium is fair and when the premium contains some loading, preferences are in line with the reference dependent model where full insurance is the reference point.

(3) If people prefer no insurance both when the premium is fair and when the premium contains some loading, preferences are in line with the reference dependent model where no insurance is the (state dependent) reference point.

5 Methodology

To uncover which model is best suited to explain preferences over small-scale insurance contracts, I use data gathered through a survey of a representative sample of the Norwegian population. In this chapter I first motivate the choice of method. I then explain the survey design and describe the empirical strategy.

5.1 Natural Experiment, Controlled Experiment, or Survey?

One way to elicit risk preferences in an insurance context is through a natural experiment where one observes insurance choices in a real-world setting. For many insurance products, customers are presented with a menu of contracts where the deductible and the insurance premium vary. Authors such as Sydnor (2010), Cohen & Einav (2007) and Barseghyan et al. (2013) have used deductible choices in home and auto insurance to estimate risk preferences. However, modern insurance products are usually priced based on the customers risk profile. Therefore, each customer faces an individualized menu of contracts where the premium reflects the customer’s own probability of having an accident. It is therefore difficult to compare choices because different customers face different menus. By running a controlled experiment, each customer can consider the same menu of contracts.

Controlled experiments have been a cornerstone in the development of scientific fields such as physics, chemistry and medicine for centuries (Cappelen & Tungodden, 2012). However, controlled experiments were not used in the field of economics until it was introduced by Vernon Smith in the 1950s (i.e. Smith (1962; 1976)). The amount of control one obtains by studying an economic system in a laboratory setting inspired many economists to start conducting experiments.

Much research on insurance demand has been based on controlled experiments. In a recent review of the literature, Jaspersen (2016) reviewed 95 articles on insurance demand that are based on hypothetical surveys or experiments. 45 of the articles reviewed reported an experiment in at least one of their studies, while the remaining 50 were based on hypothetical surveys.

Smith (1982) emphasizes the importance of salient payments in economic experiments. By allowing the subjects to actually face the risk that is under consideration, they have an incentive to answer truthfully and the experimenter obtains so-called revealed preferences. When the stakes are real, respondents may also be more attentive, read the question twice or ask for help if they do not understand the question.

Nevertheless, much of the research on insurance decisions reviewed by Jaspersen (2016) have not included payments. A literature review of 74 experimental studies by Camerer & Hogarth (1999) investigate how the existence and magnitude of salient payments affect behaviour. Among the studies concerning risk attitudes, 8 studies reported higher risk aversion when gambles were real rather than hypothetical, whereas 3 studies reported no effect and 2 studies reported more risk-seeking behaviour when gambles were real. Thus, the conclusions are conflicting when it comes to differences in how people react to real versus hypothetical gambles.

When using hypothetical questionnaires, the experimenter obtains stated preferences rather than revealed preferences. Stated preferences may be more normative: respondents may choose the alternative that reflects how they wish to appear, rather than their true preferences. Generally, a questionnaire with hypothetical questions gives a higher likelihood of survey response-error because people may be inattentive or somehow give a response that does not reveal their true preferences.

On the other hand, there are some obvious advantages when using a hypothetical survey. For instance, the researcher does not have to pay out the prizes. It is thus possible to expose subjects to large hypothetical risks. Further, the downside risk that the subjects would face in a controlled experiment is bounded by the amount that could be confiscated from the subject, which usually amounts to the participation fee. This is not a problem in a hypothetical gamble, making questionnaires more suitable to measure attitudes towards large risks. Furthermore, a hypothetical survey allows the researcher to control both the stakes and the probabilities that respondents should consider. Finally, by using a questionnaire, it is relatively inexpensive to obtain a large sample for reliable data analysis.

5.2 Data Collection

The data for this study were gathered by the research institute YouGov. Throughout the period 20th to 27th of April 2020, 904 online interviews (Computer Assisted Web Interviews) were conducted with respondents in the age group 18-64. The sample is representative of the Norwegian population in terms of gender, geography, and age. Several other socioeconomic characteristics are also included, descriptive statistics for the sample are included in Table 9 in appendix B. The survey was funded by the Norwegian insurance company Frende Forsikring.

5.3 Survey Design

The questionnaire consisted of two sets of questions. The first set of questions are income lotteries designed to estimate risk aversion over large risks. These are necessary to find out if respondents are risk averse over large stakes. It is also useful to classify the degree of risk aversion for each respondent. In the second set of questions, respondents are faced with menus of small-scale insurance contracts to see which model that is best suited to explain preferences over such contracts.

5.3.1 The First Set of Questions - Income Lotteries

To elicit standard risk preferences over large stakes, respondents were asked to choose between hypothetical lifetime income gambles. This makes it possible to estimate intervals of relative risk aversion over large stakes. This set of questions was inspired by a study carried out by Barsky, Juster, Kimball & Shapiro (1997)(hereafter BJKS). They asked some 12 000 senior US citizens to choose between gambles over lifetime income. The answers were used to separate the sample into four distinct risk preference categories. Respondents in the BJKS-study were asked the following question:

Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50–50 chance it will double your (family) income and a 50–50 chance that it will cut your (family) income by a third. Would you take the new job? (Barsky, Juster, Kimball, & Shapiro, 1997, p. 540)

In this formulation, respondents were asked to choose between current income (y) and a risky income ($2y, \frac{1}{2}; 0{,}66y, \frac{1}{2}$). Those who answered "yes" were subsequently asked to choose between (y) and ($2y, \frac{1}{2}; 0{,}5y, \frac{1}{2}$), and those who answered "no" were asked to choose between (y) and ($2y, \frac{1}{2}; 0{,}8y, \frac{1}{2}$). This approach is convenient as it allows the authors to rank respondents by intervals of relative risk aversion without having to specify a particular functional form for the utility function.

In the BJKS study, respondents were asked to choose between their current job with a safe income and a new job with an uncertain income. The authors discuss the problem of a possible status quo bias as subjects might tend to prefer their current job. They therefore recommend a rewording of the question for future studies.

Hanna, Gutter, & Fan (2001) identify other problems with the BJKS-approach. For instance, they argue that the uncertain income is ambiguous with regards to gross income versus after tax income. Furthermore, they suggest having more than four intervals of relative risk aversion to distinguish between the most risk averse respondents.

Later studies, such as Kapteyn & Teppa (2011) and Schroyen & Aarbu (2018), used a rewording of the BJKS-formulation. To reduce a possible status quo bias, respondents were asked to choose between two new jobs. Kimball, Sahm & Shapiro (2008), as well as Kapteyn & Teppa (2011) have also used extended questionnaires that include six intervals for relative risk aversion rather than just four.

Following the advances from the original BJKS – formulation, I ask respondents to choose between two new jobs and distinguish between six different categories for relative risk aversion. I also use the term "available income" to avoid taxation issues. The question was formulated as follows:

Suppose that you are the only income earner in your household, and you have a good job guaranteed to give your household an income that is identical to your current income for all years henceforth. Reasons beyond your control force you to change your occupation. Suppose you can choose between two alternative jobs, ***job nr.1*** *and* ***job nr.2****. The jobs are identical (with respect to content, distance etc.)* **Job nr.1** *guarantees you the same available income as in your current job for all years henceforth.* ***Job nr.2*** *gives you a 50 percent chance of an available income twice as high as your current income, but on the other hand, a 50 percent chance that your available income will be reduced by one third (33,33%) for all years henceforth. What is your immediate reaction? Would you choose job nr.1 or job nr.2?*

As in the BJKS - study, respondents were asked to choose between current income (y) and a risky income ($2y, \frac{1}{2}$; $0{,}66y, \frac{1}{2}$). Those who answered "job nr.1" were subsequently asked to choose between (y) and ($2y, \frac{1}{2}$; $0{,}8y, \frac{1}{2}$), and those who answered "job nr.2" were asked to choose between (y) and ($2y, \frac{1}{2}$; $0{,}5y, \frac{1}{2}$). In order to split the most risk averse group, those who answered "job nr.1" in both the previous questions, were asked to choose between ($0{,}9y$) and ($2y, \frac{1}{2}$; $0{,}8y, \frac{1}{2}$). Furthermore, in order to split the least risk averse group and identify possible risk neutral or risk loving preferences, those who answered "job nr.2" in both the previous questions were asked to choose between (y) and ($1{,}5y, \frac{1}{2}$; $0{,}5y, \frac{1}{2}$)[13].

[13] In the last lottery, the upside is reduced to $1.5y$ to avoid offering the lottery ($0y, \frac{1}{2}$; $2y, \frac{1}{2}$). Since the outcomes of the lotteries are for all years henceforth, the outcome $0y$ is unrealistic because social help systems are usually in place in developed countries to ensure that households have a minimum income. The risk ($1{,}5y, \frac{1}{2}$; $0{,}5y, \frac{1}{2}$) is said to be a mean preserving reduction of the risk ($0y, \frac{1}{2}$; $2y, \frac{1}{2}$). Risk averse individuals like mean preserving reductions in risk (Rothschild & Stiglitz, 1970). However, respondents are not asked to compare the lotteries, but to compare a lottery to a safe alternative. Therefore, the mean preserving reduction in risk in the last question should not influence risk preferences.

5.3.2 The Second Set of Questions - Small Scale Insurance Contracts

In the second set of questions, subjects were faced with a hypothetical small binary risk, and asked to choose between insurance contracts with different deductibles. By varying the loading factors, we can find indications of whether preferences are in line with EUT or if a model with reference points and loss aversion is more appropriate to describe insurance behaviour.

In a first question, respondents were asked to choose between contracts of different deductibles when the loading was zero. The formulation of the question was as follows:

Suppose that you are about to purchase a hobby item worth 16 000 NOK. Assume that if the item is stolen or destroyed, the loss is not covered by any of the insurance policies you have today. You estimate that the probability that the item is stolen or destroyed is 5 percent each year. When buying the item, you receive an offer to insure the item against all type of damage and theft. The insurance is valid for one year at the time.

Insurance company Z offers you the following contracts. Which contract would you choose?

- *Full insurance (no deductible).* *Premium: 800 NOK/year*
- *Insurance with a deductible of 500 NOK* *Premium: 775 NOK/year*
- *Insurance with a deductible of 5000 NOK* *Premium: 550 NOK/year*
- *No insurance* *Premium: 0 NOK/year*

(The deductible is the part of the loss you must cover yourself. For example: If the deductible is 500, you will receive 15,500 to cover the loss. If the deductible is 5,000, you will receive 11,000 to cover the loss)

In a second question, respondents were asked to choose between similar contracts, but with a 10% loading factor (the premia were 10 % higher). In a third question, respondents were asked to choose between contracts where the loading factor was 40%. 10% was chosen to see how preferences change when there is a small loading compared to no loading. 40% was chosen because the average loading in the insurance industry over the past 15 years has been close to 40% (Finans Norge, 2019)

The order in which these three questions are presented to the subjects may influence their responses. Therefore, the sample was randomly divided into three subsamples, in which the subsamples received the three questions in different order.

After this set of questions, respondents were asked to indicate on a Likert scale from one to seven to which degree their answers were based on intuition (1) or calculation (7).

5.4 Empirical Strategy

In this section, I first describe how the first set of questions are used to elicit the degree of standard risk aversion. Thereafter, I describe how the second set of questions are used to see if preferences over insurance contracts are reference dependent.

5.4.1 Empirical Strategy to Elicit Standard Risk Aversion

I apply the same procedure as BJKS to group respondents into different categories of relative risk aversion. Depending on how respondents answer the income lotteries, we can find the fraction of current income an individual must retain in the bad state to be indifferent between the safe outcome and the lottery. Assuming constant relative risk aversion, there is a one to one relationship between this fraction and the coefficient of relative risk aversion ρ. Recall the CRRA utility function:

$$u(w) = \begin{cases} \frac{w^{1-\rho}}{1-\rho}\; for\ \rho \neq 1 \\ \ln(w)\; for\ \rho = 1 \end{cases}$$

where ρ is the coefficient of relative risk aversion. A respondent who prefers the safe outcome (y) to the first lottery (*2y*, $\frac{1}{2}$ *; 0,66y*, $\frac{1}{2}$), but prefers the second lottery (*2y*, $\frac{1}{2}$ *; 0,8y*, $\frac{1}{2}$) to the safe outcome (y), must have a ρ such that the following inequalities hold:

$$0.5\frac{(2y)^{1-\rho}}{1-\rho} + 0.5\frac{(\frac{4}{5}y)^{1-\rho}}{1-\rho} > \frac{y^{1-\rho}}{1-\rho} > 0.5\frac{(2y)^{1-\rho}}{1-\rho} + 0.5\frac{(\frac{2}{3}y)^{1-\rho}}{1-\rho}$$

Solving for ρ we obtain:

$$2 < \rho < 3.76$$

Thus, this respondent's coefficient of relative risk aversion is in the interval (2, 3.76]. By following the same procedure, we obtain the following six possible intervals of ρ: (-∞, 0], (0, 1], (1, 2], (2, 3.76], (3.76, 6.84], (6.84, ∞). We can thus identify which interval each respondent belongs to. An analysis of which personal characteristics are associated with different levels of risk aversion is included in appendix A.

5.4.2 Empirical Strategy to Explore Whether Insurance Preferences are Reference Dependent.

The three questions from the second set of questions can be used to distinguish respondents into four different types, depending on which model their preferences best correspond to. The four types are 1) the EUT type, 2) the full insurance type, 3) the no insurance type, and 4) others. The distinction is based on the UPE setting, following a regret-based structure with the state-dependent reference points "full insurance" and "no insurance". Note that the distinction relies on the assumption that preferences are *approximately* linear when considering the risk in question.

1) The EUT type: If risk averse respondents prefer full insurance when the loading is zero but wish to retain some of the risk when $\kappa > 0$, preferences are in line with Mossin's theorem and EUT (Proposition 1). Further, respondents whose answers in the income lotteries indicate that they are in the least risk averse group (with $\rho \leq 0$), may be risk neutral or risk loving. Respondents from this group who also choose no insurance in all three questions are also considered EUT types.[14]

2) The full insurance type: If risk averse respondents prefer full insurance when the loading is zero, and full insurance when $\kappa = 0.1$, we have an indication of first order risk aversion with full insurance as the reference point (Proposition 2). [15]

[14] Respondents with $\rho \in (-\infty, 0]$ are either risk loving or risk neutral. Those who are risk neutral are in the EUT framework predicted to be *indifferent* when $\kappa = 0$ and choose no insurance when $\kappa > 0$. However, a closer look at the data shows that only one respondent in this interval did not choose no insurance when $\kappa = 0$. For simplicity I therefore restrict this subgroup to those who demand no insurance in all three questions.

[15] It is theoretically possible for a risk loving agent to be a full insurance type. This is because the utility function of the risk loving agent also is approximately linear with respect to small risks and loss aversion with full insurance as the reference point will make full insurance more attractive. A no insurance type is not defined for risk loving respondents, because risk loving respondents who choose no insurance in all questions are EUT types. Since I later compare the full insurance type with the no insurance type in a regression model with risk aversion as an independent variable, these two types must be defined over the same risk aversion interval.

3) The no insurance type: If risk averse respondents prefer no insurance in all three questions, we have an indication of first order risk aversion with no insurance as the (state-dependent) reference point (Proposition 3).

4) Others: Respondents whose combination of answers does not fit any of the types above

Table 1 gives an overview of predicted response combination for the three first types.

Table 1: The first three types categorized by response combination.

Type	Choice with κ			ρ
	κ = 0	κ = 0.1	κ = 0.4	
1) EUT type (risk averse)	FI	<FI	<FI	(0, ∞)
1) EUT type (risk neutral/loving)	NI	NI	NI	(-∞, 0]
2) Full insurance type	FI	FI	≤FI	(0, ∞)
3) No insurance type	NI	NI	NI	(0, ∞)

FI = Full insurance, NI = No insurance

The classification of types presented in table 1 is based on how respondents are predicted to act based on EUT and the reference dependent model. There are, however, some caveats. First, recall that it is optimal for the risk averse EUT type to marginally reduce the insurance coverage when the loading marginally increases. It may be that a reduction in the insurance coverage of 500 NOK is too high, such that an extremely poor and very risk averse EUT type still prefers full insurance rather than a deductible contract when the loading is 0.1. Assuming the CRRA utility function, this is true whenever the following inequality is satisfied:

$$\frac{(w-880)^{1-\rho}}{1-\rho} > 0.95\frac{(w-853)^{1-\rho}}{1-\rho} + 0.05\frac{(w-853-500)^{1-\rho}}{1-\rho} \qquad (26)$$

The lowest income a single-person household can receive from the Norwegian Labour and Welfare Administration (NAV) is 229.588 NOK (NAV, 2020). Students, however, receive a combination of a grant and a loan equal to 121 220 a year (The State Educational Loan Fund, Norway, 2020). If we for simplicity's sake assume that students without extra work have the lowest income in Norway, and that the utility function is defined over yearly income, Inequality (26) is satisfied when the coefficient of relative risk aversion ρ > 38,6. A coefficient of relative risk aversion of 38,6 is extremely high. Most studies conclude that the heterogeneity in risk preferences is high, but the coefficient on average is in the single digit range (e.g. Schroyen & Aarbu (2018), Chetty (2006)). This is therefore considered a minor issue.

Second, following Proposition 2, those who prefer full insurance when the loading is zero, who also prefer full insurance when there is a 10% loading, are categorized as full insurance types. This relies on the assumption that the combination of η and λ are above some threshold: If we plug the values for κ and p into Inequality (24), we obtain:

$$\frac{\eta(\lambda-1)}{(\eta+1)} \geq \frac{0.1}{(1-0.05-[0.05*0.1])}$$

$$\frac{\eta(\lambda-1)}{(\eta+1)} \geq 0.106.$$

This implies that individuals with full insurance as the reference point and whose combination of η and λ satisfy the above inequality, will choose full insurance when κ = 0, and when κ = 0.1. Respondents who potentially have full insurance as the reference point, but who also have a combination of η and λ such that $\frac{\eta(\lambda-1)}{(\eta+1)}$ is in the interval $[0, 0.106)$ may choose full insurance when κ = 0 and less than full insurance when κ = 0.1. These respondents are thus loss averse to such a low degree that they are considered EUT types instead of full insurance types in this analysis.

A third important emphasis is that Propositions 2 and 3 are only valid for small risks where the utility function is approximately linear (u''(w) ≈ 0). However, as discussed in chapter 4 the main conclusions also hold for weakly risk averse attitudes. In the survey questions, respondents are faced with a risk of losing up to 16 000 NOK. Whether or not this is a sufficiently small risk depends on the size of initial wealth and the concavity of the utility function. In particular, Proposition 3 will only be valid for slightly higher values of η and λ if agents are so poor and risk averse that the utility function is no longer approximately linear when considering the risk in question. However, KR consider risks such as $100 or $1000 to be small and Aperjis & Balestrieri (2017) consider risks of $100 or $2000 to be small or modest. In both these papers, the authors assume that standard risk aversion is approximately linear when considering such risks and derive formal results under the assumption that $u(w) = w$. At the time of the survey, 16 000 NOK correspond to approximately $1600. Given the high wages and low levels of background risk in Norway, the risk presented in this survey is assumed to be considered small.

Recall that the three questions in the second set of questions were asked in different orders in case the ordering affects responses. To check for order effects, a proportion test is used to check if responses differ significantly between groups that receive the questions in different orders. The group that received a question as their first question is compared to the groups that received this question as their second or third question. If there are no order effects, the entire sample's responses can be used when classifying the different types.

After organizing respondents into four types, we may see how the proportion of EUT types compares to the proportion of full insurance types and no insurance types. A proportion test will be used to check for significant differences. If the proportion of full insurance types and no insurance types is significantly higher than the proportion of EUT types, we can conclude that the reference dependent model is a better predictor of preferences over small-scale insurance contracts than EUT.

For insurance companies, it is especially interesting to see which factors are associated with the full insurance type compared to the no insurance type. With this information, the companies know how to approach different market segments. To investigate such relationships, a regression model is used to see how different personal characteristics may influence the probability that someone is a full insurance type rather than a no insurance type. The socioeconomic characteristics gender, income (household income before tax), age, education, urbanization, and family life cycle are used as covariates. Income, age, education, and urbanization are interval coded data, so dummies are created for each interval and the lowest interval is the base level. For the income, education and urbanization questions, a dummy variable is also created for those who did not wish to answer. In addition, the six intervals of relative risk aversion are included in the regression model to see if those with higher levels of risk aversion are more likely to be full insurance types. Further, the Likert scale responses indicating to which degree answers were based on intuition or calculation are also included as a covariate in the model.

To avoid problems with multicollinearity, in which two or more covariates correlate with each other, a correlation test is performed. If two covariates are strongly correlated, only one of the two variables will be used in the regression model.

To see how the covariates may predict the probability that an individual is a full insurance type rather than a no insurance type, a dummy is created that takes the value 1 for the full insurance type and 0 for the no insurance type. Since the dependent variable is a dummy variable, the regression model that is estimated is the linear probability model (LPM). However, if the probabilities in question are close to 0 or close to 1, a logistic regression should be used because in a linear model the predicted probability may fall outside the 0-1 range (Von Hippel, 2015). For moderate probabilities, the LPM is preferred because results are often indistinguishable to a logistic model and the linear model is easier to interpret (Hellevik, 2009). To check the robustness of the result, both a LPM and a logistic regression is performed.

For the linear model, let Y_i denote the dummy indicating individual i's type. The probability that Y_i = 1 given a vector of covariates x_i, can be predicted by the vector x_i with coefficients β and a zero mean error term ε_i. α is the y-intercept, referred to as the constant term. The model that is estimated is then

$$Pr(Y_i = 1|x_i) = \alpha + x_i\beta^T + \varepsilon_i$$

where x_i is a row vector of covariates and β^T is the corresponding column vector of estimated coefficients. A coefficient from the β vector measures how a change in the corresponding covariate x_i changes the probability that $Y_i = 1$. The parameters of the model are estimated using ordinary least squares and weighted least squares.

In the logistic model, the probabilities must always be in the unit interval. This is achieved by putting the linear equation in exponential form, and dividing by a greater number:

$$Pr(Y_i = 1|x_i) = \frac{\exp(\alpha + x_i\beta^T + \varepsilon_i)}{1 + \exp(\alpha + x_i\beta^T + \varepsilon_i)}$$

If P is the probability that $Y_i = 1$, the probability that $Y_i = 0$ is 1 – P such that

$$Pr(Y_i = 0|x_i) = 1 - \frac{\exp(\alpha + x_i\beta^T + \varepsilon_i)}{1 + \exp(\alpha + x_i\beta^T + \varepsilon_i)}$$

The ratio of the two probabilities is thus

$$\frac{Pr(Y_i = 1|x_i)}{Pr(Y_i = 0|x_i)} = \frac{\frac{\exp(\alpha + x_i\beta^T + \varepsilon_i)}{1 + \exp(\alpha + x_i\beta^T + \varepsilon_i)}}{1 - \frac{\exp(\alpha + x_i\beta^T + \varepsilon_i)}{1 + \exp(\alpha + x_i\beta^T + \varepsilon_i)}} = \exp(\alpha + x_i\beta^T + \varepsilon_i)$$

By taking the natural logarithm on both sides we obtain

$$\ln \frac{Pr(Y_i = 1|x_i)}{Pr(Y_i = 0|x_i)} = \alpha + x_i\beta^T + \varepsilon_i$$

The parameters of the model are then estimated using maximum likelihood estimation. This regression reports odds ratios rather than the underlying coefficients. An estimate higher than 1 therefore means that the probability that $Y_i = 1$ increases and the probability that $Y_i = 0$ decreases. An estimate higher than 1 therefore corresponds to a positive estimate in the LPM. Similarly, an estimate below 1 corresponds to a negative estimate in the LPM.

Following most economic literature, the significance level throughout the analysis is set to five percent. This implies that if there is less than five percent probability that the null hypothesis is true (i.e. that the coefficient is equal to zero), we can reject the null hypothesis and conclude that the covariate has an effect on the probability that an individual is of a certain type. P-values show the probability of obtaining observations that are equal to, or more extreme than, those obtained in the survey, given that the null hypothesis is true. P-values below 0.05 will be referred to as significant, and p-values below 0.01 as strongly significant. To account for possible problems with heteroscedasticity, robust standard errors are estimated.

It is important to stress that any relationships found in this regression model must not immediately be given a causal interpretation. This may be due to problems like omitted variable bias, spurious relationships, and reverse causality. The aim of the regression models is not to say anything about causality, but rather to see which characteristics are associated with the different types.

6. Results

This chapter presents the results from the survey experiment. In order to find out which model is best suited to explain preferences over small-scale insurance choices, I start by presenting results from the income lotteries. The answers from the insurance questions is then used together with the answers from the income lotteries to classify respondents into different types, as described in the previous section.

6.1 Degree of Relative Risk Aversion Over Large Stakes.

In this section, I present the results from the first set of questions. These questions were income lotteries that were designed to obtain an interval of relative risk aversion (interval of ρ) for each respondent. The distribution of responses in percent is presented in table 2.

Table 2: Response distribution in percent by intervals of relative risk aversion ρ:

	(-∞, 0]	(0, 1]	(1, 2]	(2, 3.76]	(3.76, 6.84]	(6.84, ∞)
All	5.75	1.77	9.29	15.27	20.69	47.23

The numbers indicate the percentage of people in the different intervals, the row therefore sums to 100.

Generally, there seems to be considerable heterogeneity in the degree of risk aversion among the respondents. 47.23 percent reject all income gambles and thus fall into the most risk averse group, with a coefficient of relative risk aversion greater than 6.84. These individuals preferred the safe option (0,9*y)* to the risky outcome (*2y*, $\frac{1}{2}$ *; 0,8y*, $\frac{1}{2}$). 5.75 percent accepted all income gambles and are categorised as risk loving or risk neutral. Further, 67.92 percent are in one of the two most risk averse groups with ρ ϵ (3.76, ∞), and are thus unwilling to take the gamble (*2y*, $\frac{1}{2}$ *; 0,8y*, $\frac{1}{2}$). Schroyen & Aarbu (2018) generally found a lower degree of risk aversion in a very similar Norwegian sample that was surveyed in 2006. Their study found that 36.8 percent of the respondents were in the interval (3.76, ∞). This difference may be due to the economic outlook in Norway in 2006 compared to the Spring of 2020.

A closer look at the data shows that women and older respondents are significantly more risk averse than men and younger respondents. Responses for various subsamples and a regression analysis that indicates which characteristics are associated with higher levels of risk aversion is included in appendix A.2.

6.2 Insurance Choices and Classification of Types.

We now continue by analysing small-scale insurance choices, which combined with the estimates for relative of risk aversion will enable me to classify respondents into different types as described in section 5.4.2. As a first step in this analysis we need to understand whether the order in which the questions were asked affected responses. To this end, I carried out a proportion test were the responses for the group that received a question as their first question is compared to the responses for the groups that received this question as their second or third question. As is confirmed in Table 10 in appendix B, none of the tests came out significant. We can therefore conclude that the order in which the questions were asked did not affect responses. Since there are no ordering effects, the entire sample's responses to the three questions is used to distinguish respondents between the four different types. In Table 3, the distribution of the four types is presented in percent.

Table 3: Response distribution by type

	1) EUT type	2) Full insurance type	3) No insurance type	4) Other	Sum
Percent	6.64	31.75	32.74	28.87	100
Frequency	60	287	296	261	904

Surprisingly, only 6.64 percent of the respondents turned out to be EUT types, i.e. choose full insurance when the premium was actuarially fair and less than full insurance when the premium was loaded. This means that most people do not behave according to Mossin's theorem. EUT does not appear to be a good indicator of risk preferences over modest stakes. On the other hand, 31.75 percent of the respondents are full insurance types (choose full insurance for both $\kappa = 0$ and $\kappa = 0.1$) and 32.74 percent are no insurance types (choose no insurance in all three questions). That is, 64.49 percent of the respondents made insurance choices that can be explained by loss aversion and the two reference points "no insurance" and "full insurance".

Notice the relatively large group of uncategorized respondents (28.87 percent). However, I only consider full insurance types and no insurance types in the reference dependent framework. One could also allow for the reference point to be partial insurance with a low or a high deductible, such that a low (high) deductible type prefers the contract with a low (high) deductible for $\kappa = 0$ and $\kappa = 0.1$ (and possibly less insurance when $\kappa = 0.4$). 7.30 (4.09) percent of the respondents would then be categorized as a low (high) deductible type. By including these additional types, the proportion of reference dependent types is increased to 75.88 percent and the "Other" category is reduced to 17.48 percent. That is, only 17.48 percent of the respondents had a combination of responses that cannot be explained by EUT or reference dependent preferences.

In total, 6.64 percent of the respondents made insurance choices that are in line with EUT, and second order risk aversion. On the other hand, 65.49 (or 75.88) percent of the respondents made choices that are in line with a reference dependent model and first order risk aversion. The difference is large and statistically significant.

Recall that after the respondents had made their insurance choices, they were asked to indicate on a Likert scale from one to seven to which degree their answers were based on intuition (1) or calculation (7). The following table shows the mean answer and standard deviations for this variable.

Table 4: Mean intuition/calculation

Type	1) EUT type	2) Full insurance type	3) No insurance type	4) Other
Mean (std dev)	3.60 (1.699)	3.78 (1.628)	3.31 (1.785)	4.01 (1.559)
Frequency	60	287	296	261

T-tests show that the no insurance type has a significantly lower mean than the full insurance type and the others type. This indicates that the no insurance type used more intuition than the full insurance type and the others type. None of the other means are significantly different from each other.

Most respondents were either full insurance types or no insurance types. For an insurance company it is of interest to know which characteristics are associated with the full insurance type compared to the no insurance type. Table 5 shows the distribution of full insurance and no insurance types for the various subsamples. The categorical and interval coded variables are presented as conditional percentages, such that each row sums to 100. The continuous variables are presented as means with standard deviations in parenthesis.

Table 5: Distribution of full insurance and no insurance types

	(2) Full insurance type	(3) No insurance type
All	49.23	50.77
Gender		
Male	41.87	58.13
Female	56.46	43.54
Age		
18 – 34	60.82	39.18
35 – 49	42.93	57.07
50 – 64	45.89	54.11
Income		
<300k	69.84	30.16
300-600k	48.89	51.11
>600k	41.70	58.30
Education		
Primary	65.79	34.21
High	55.40	44.60
University < 3 years	43.18	56.82
University ≥ 4 years	42.18	57.82
Urbanization		
<5000	46.36	53.64
5000-49999	53.33	46.67
>50 000	47.78	52.22
Mean Likert scale value of Intuition (1) vs calculation (7)	3.78 (1.63)	3.31 (1.785)
Mean interval of relative risk aversion (2-6)	5.20 (1.08)	4.94 (1.35)

It appears that women and the youngest age group are more likely to be full insurance types than men and the older age groups. Moreover, it appears that low income and less education also is associated with being the full insurance type rather than the no insurance type. It additionally seems that those who base their answers on calculations rather than intuition are less likely to be full insurance types. To investigate whether these characteristics have a significant, partial effect on the probability of being a full insurance type rather than a no insurance type, we turn to the regression model. Table 6 shows the LPM and the logistic regression model.[16]

[16] The family life cycle variable was omitted due to problems with multicollinearity. The variable had a strong correlation with age.

Table 6: LPM and logistic regression

	LPM		Logistic	
	Estimate (std err)	p-value	Odds ratio (std err)	p-value
Female	0.109** (0.041)	0.008	1.607** (0.287)	0.008
Age 35 – 49	-0.148** (0.052)	0.005	0.517** (0.121)	0.005
Age 50 – 64	-0.153** (0.051)	0.003	0.501** (0.117)	0.003
Income 300k – 600k	-0.155* (0.072)	0.033	0.489* (0.166)	0.035
Income > 600k	-0.182** (0.068)	0.007	0.437** (0.140)	0.010
Income unknown	-0.134 (0.072)	0.063	0.536 (0.183)	0.068
Highschool education	-0.055 (0.076)	0.473	0.765 (0.270)	0.447
University < 3 years	-0.162* (0.079)	0.040	0.477* (0.173)	0.041
University ≥ 4 years	-0.159* (0.081)	0.050	0.486 (0.182)	0.053
Urbanization 5k – 49k	0.044 (0.058)	0.449	1.215 (0.305)	0.438
Urbanization ≥ 50 k[17]	0.005 (0.054)	0.926	1.021 (0.241)	0.931
Intuition/calculation	0.033** (0.011)	0.003	1.161** (0.059)	0.003
RRA	0.053** (0.019)	0.005	1.274** (0.109)	0.005
Constant	0.392* (0.152)	0.010	0.638 (0.434)	0.509
R^2	0.10		0.08	
N	583		583	

Robust standard errors in parenthesis

* p<0.05; ** p<0.01

First, note that the conclusions from the LPM and the logistic model are almost indistinguishable. The female dummy and both age dummies are significant at the one percent level. The female dummy has a positive coefficient in the LPM and an estimate greater than 1 in the logistic model, indicating that women are more likely to be full insurance types. For the

[17] As reported in the descriptive statistics in appendix B, the urbanization unknown category is very small (1.11 percent). This group is therefore aggregated with the >50 000 category. Similarly, the education unknown category is aggregated with the primary school category.

age variables, the estimates are negative and below 1 respectively, so people older than 34 are less likely to be full insurance types. It is also clear that wealthier people, and people with a university degree are significantly[18] less likely to be full insurance types. The urbanization dummies do not seem to influence the probability of being a full insurance type. The intuition/calculation variable is significant at the one percent level, this is in line with the observation earlier in this section, were we saw that the full insurance type indicated a higher degree of calculation than the no insurance type. The relative risk aversion variable (RRA) is also significant at the 1 percent level, indicating that more risk averse individuals are more likely to be full insurance types.

6.3 Limitations

Ideally, we want to predict both the reference point and the exact values of η and λ, such that we can predict at which loading factors people are ready to purchase insurance. However, as we saw in chapter 4, different reference points yield different behaviour, and it is difficult to separately identify λ and η. My analysis therefore only gives an indication of who is likely to have full insurance as the reference point, and thus more likely to buy insurance.

There are many factors that influence economic behaviour. The regression models in Table 6 aims to explain some of the response variability. Many of the variables are significant, but the model's explanatory power is relatively low. This indicates that the covariates can explain some of the response variability, but much of the variability is not accounted for. Important variables might have been omitted. For instance, someone's type might be related to earlier experience with insurance companies, the degree of trust in the insurance system and many other factors. Such factors are unobserved in the model and may correlate with variables such as age. It is therefore possible that explanatory variables correlate with the error term ε. Thus, the model may suffer from omitted variable bias and we may have a situation where the relationship between age and type is spurious.

Further, we do not know the direction of the relationships found in the regression analysis. For example, we do not know if a high income increases the probability of being a no insurance

[18] For the education dummy "university ≥ 4 years", the two regression models give conflicting conclusions. However, the p-values are almost identical, but in the logistic model, the value is slightly above the 0.05 threshold

type, or whether being a no insurance type increases the likelihood of obtaining a higher income.

7 Summary and Implications

This thesis applies the expected utility theory and a reference dependent model to analyse preferences over small-scale insurance contracts. A survey of 904 Norwegian respondents was conducted to investigate which of the two models that best describe stated preferences over insurance contracts. The main finding of the study is that a reference dependent model seems much more fit to predict preference towards small scale insurance than traditional EUT. Only 6.64 percent of the respondents made choices that are in line with EUT, whereas 75.88 percent made choices that are in line with the reference dependent model. Among the latter group, 31.75 percent indicate that they have “full insurance” as their reference point, as they prefer full insurance at unfair premia. 32.74 percent indicate that they have “no insurance” as their reference point, as they prefer no insurance at both unfair and fair premia. The results generally show high heterogeneity in both standard risk aversion and in preferences over small-scale insurance contracts.

7.1 Implications for Insurance Companies

The pervasiveness of the demand for small-scale insurance at heavily loaded premia has been widely applied by insurance companies. In this sense, the observation that preferences over small-scale insurance contracts are not in line with traditional EUT is not new. However, the observation that insurance choices may be explained by reference dependent preferences may be an important tool for insurance companies. The question of interest is which characteristics are associated with different reference points, such that insurance providers know which market segment to approach.

My analysis shows that women and the youngest age group (18-34) are significantly more likely to be full insurance types than men and the older age groups. Insurance companies may thus profit by targeting younger people and women when conveying small-scale insurance. A recent survey by Finance Norway (Finans Norge, 2020) indicates that men are the dominant decision makers in Norwegian households. As women are both more risk averse (see appendix A.2) and more likely to be full insurance types, promoting the idea that women should be in charge of insurance decisions in the household may be a winning strategy for insurance companies. Further, I found that the groups with a yearly income above 300 000 NOK, as well as people with a university degree, are less likely to be full insurance types. This information may be useful for targeted marketing campaigns.

The degree of standard risk aversion also affected the probability being a full insurance type; More risk averse individuals are more likely to be full insurance types. This is hardly surprising, but nonetheless important, because if one knows the degree of risk aversion over large stakes, this can be used as an indicator of insurance preferences over small stakes.

7.2 Implications for Further Research

My analysis estimates the degree of relative risk aversion and gives indications of which reference points people with reference dependent preferences have. A natural extension of this would be to estimate the parameters λ and η, or at least the product $\eta(\lambda\text{-}1)$. For the CPE setting, where the reference point is equal to the choice, this product has been estimated in a paper by Barseghyany, Molinari, OíDonoghue, & Teitelbaum (2013). With a status quo specification of the reference point, Kahneman & Tversky (1992) estimate λ within their model. However, for many of the possible specifications of the reference point under the UPE setting, we know little about the loss aversion parameters.

Although my analysis shows that preferences may be reference dependent in an insurance context, we cannot infer that risk preferences are reference dependent in general. The setting and the economic environment may influence the loss aversion parameters. For instance, in a study by Schoemaker & Kunreuther (1979), subjects were presented with insurance contracts similar to those in the present study. However, after choosing among different insurance contracts, these subjects were presented with the same risky prospect again, but in a pure gambling context rather than an insurance context. When presented with the same numbers in a more mathematical fashion, the subjects were much less risk averse. This phenomenon is often referred to as a context effect and indicates that reference points appear to be more important for decision making in an insurance context relative to a pure gambling context.

On the other hand, Cicchetti & Dubin (1994) found that the decision to insure against telephone line trouble is more consistent with traditional EUT than with status quo prospect theory. It is thus clear that more research is needed in this field. Specifically, there is a need to find out which contexts that induce reference dependent risk attitudes, which reference points people have, as well as the size of the loss aversion parameters λ and η. Understanding how reference points are formed and maintained is also a major issue. KR’s distinction between surprise, UPE and CPE situations is a major contributor to such insights, but further research is still needed.

8 Conclusion

In this thesis I evaluate choices of small-scale insurance contracts using two of the most prominent economic theories for decision making under risk. After surveying a representative sample of the Norwegian population, I found that an overwhelming majority makes choices that are in line with the reference dependent model. Only a negligible fraction makes choices that are consistent with the expected utility theory. Most modern models of decision making in the field of economics are compared with the expected utility theory because this classic theory still serves as a benchmark for such models. Many alternative models, including the reference dependent model, are simply extensions of Bernoulli’s expected utility theory. It is doubtful that any theory of economic decision making will be able to explain all economic behaviour. The goal is to find a model that can explain as much of the observed behaviour as possible. This thesis has shown that a model of reference dependent preferences may be more suited than the expected utility theory to explain preferences over small-scale insurance contracts. I also report great heterogeneity in both standard risk aversion and in preferences over small-scale insurance contracts. An understanding of how reference points may affect insurance decisions can therefore be a useful tool to predict consumer preferences for insurance. However, much of the behaviour in the insurance market is still not properly understood. How psychological factors influence risk preferences and insurance choice is still a major topic for further research.

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Appendix A

In this appendix, I revisit the intervals of relative risk aversion in order to investigate which factors are associated with a higher degree of relative risk aversion.

A.1 Empirical Strategy

Since the six intervals of ρ follow a natural order from risk loving/risk neutral to very risk averse, an ordinal regression model can be fitted to the data to see how different covariates may predict the degree of relative risk aversion. Since we cannot observe the exact value of the coefficient of relative risk aversion, ρ can be regarded a latent variable, depending on a vector of covariates x_i with corresponding coefficients β. An ordered probit regression can be performed on the six risk groups to see which covariates are associated with higher levels of ρ. Let τ_k denote the thresholds between the k intervals. The probability that an individual's ρ belongs to risk group k is given by the difference between the probability that the individual has a ρ less than τ_k and the probability of having a ρ less than τ_{k-1}. The model that is estimated is then

$$Pr(\tau_{k-1} \leq \rho_i \leq \tau_k | x_i) = Pr(\tau_{k-1} < x_i \beta^T + \varepsilon \leq \tau_k),$$

and maximum likelihood estimation is used to estimate the parameters of the model. The error term ε is assumed to be normally distributed with a zero mean. The model has 5 cut-offs because there are six categories of relative risk aversion.

A similar approach that can be used when the thresholds are known in advance is an interval regression. Since we know the thresholds τ_i, an interval regression will be included in the analysis to check the robustness of the result.

As in the regression analysis presented in the main text, the socioeconomic characteristics gender, income, age, education, and urbanization are used as covariates. To account for possible problems with heteroscedasticity, robust standard errors are estimated.

A.2 Results

The distribution of responses is presented in Table 7. The first row shows responses for the entire sample, consecutive rows show responses for various subsamples. The response distribution is given in percent, so all rows sum to 100.

Table 7: Response distribution in percent by intervals of relative risk aversion ρ:

	(-∞, 0]	(0, 1]	(1, 2]	(2, 3.76]	(3.76, 6.84]	(6.84, ∞)
All	5.75	1.77	9.29	15.27	20.69	47.23
Gender						
Male	6.51	2.17	10.41	16.49	19.74	44.69
Female	4.97	1.35	8.13	14.00	21.67	49.89
Age						
18 – 34	7.03	2.88	11.82	17.57	24.60	36.10
35 – 49	5.25	1.31	10.16	15.08	22.95	45.25
50 – 64	4.90	1.05	5.59	12.94	13.99	61.54
Income						
<300k	10.32	0.00	10.32	15.08	20.63	43.65
300-600k	7.24	1.81	4.52	15.38	17.65	53.39
>600k	3.86	2.20	11.29	16.80	23.14	42.70
Education						
Primary	5.17	3.45	12.07	8.62	13.79	56.90
High	6.45	1.47	8.50	13.78	16.42	53.37
Uni < 3 years	5.78	1.81	8.30	16.61	23.47	44.04
Uni ≥ 4 years	4.65	1.86	11.63	18.60	26.05	37.21
Urbanization						
<5000	9.09	0.65	4.55	14.29	16.88	54.55
5000-49999	5.00	1.67	8.00	16.67	22.00	46.67
>50 000	5.22	2.27	11.82	15.00	20.09	44.78

It appears that women are more risk averse than men, since the proportion of older women is larger in the two most risk averse groups. Similarly, older respondents and wealthier respondents appear to have higher proportions in the more risk averse groups. We can also observe that respondents with higher education and respondents living in densely populated areas appear less risk averse.

To investigate whether these characteristics have a significant effect on risk aversion, we turn to the regression analysis. Table 8 shows the result from the ordinal regression (column 1) and the interval regression (column 2).

Table 8: Ordinal and interval regression

	(2) Ordinal regression		(1) Interval regression	
	Estimate (std err)	p-value	Estimate (std err)	p-value
Female	0.174* (0.076)	0.021	0.727* (0.319)	0.023
Age 35 – 49	0.243** (0.086)	0.005	1.040** (0.364)	0.004
Age 50 – 64	0.546** (0.095)	0.000	2.346** (0.399)	0.000
Income 300k – 600k	0.222 (0.133)	0.094	0.944 (0.560)	0.092
Income > 600k	0.036 (0.119)	0.766	0.131 (0.505)	0.794
Income unknown	0.164 (0.133)	0.219	0.705 (0.564)	0.211
Highschool education	-0.170 (0.166)	0.305	-0.780 (0.699)	0.265
University < 3 years	-0.328* (0.166)	0.049	-1.487* (0.700)	0.034
University ≥ 4 years	-0.388* (0.170)	0.022	-1.753* (0.712)	0.014
Urbanization 5k – 49k	-0.040 (0.118)	0.735	-0.194 (0.501)	0.699
Urbanization ≥ 50 k	-0.045 (0.113)	0.693	-0.179 (0.479)	0.709
cut1	-1.471 (0.230)			
cut2	-1.333 (0.227)			
cut3	-0.851 (0.223)			
cut4	-0.342 (0.220)			
cut5	0.216 (0.218)			
Constant			5.858 (0.915)	
LnSigma			1.440 (0.038)	
N	904		904	

Robust standard errors in parenthesis

* p<0.05; ** p<0.01

From the table, we can see that the same variables are significant in the two different regression models. Women are significantly more risk averse than men, and the two older age groups are significantly more risk averse than the reference age group (18-34). Age and gender effects are also found in Schroyen & Aarbu (2018) and BJKS (1997). Notice also that both dummies for university education is significant, with a negative coefficient, indicating that those with a university degree are significantly less risk averse than those who have only completed primary school.

Appendix B

B.1 Descriptive Statistics

Table 9: Distribution of characteristics in percent.

Variable						Sum
Gender	**Male**	**Female**				
	50.99	49.01				100
Age	**18 – 34**	**35 – 49**	**50 – 64**			
	34.62	33.74	31.64			100
Household Income (NIBT)	**<300k**	**300-600k**	**>600k**	**Unknown**		
	13.93	24.45	40.15	21.46		100
Education	**Primary**	**High**	**Uni < 3 years**	**Uni ≥ 4 years**	**Unknown**	
	6.42	37.72	30.64	23.78	1.44	100
Urbanization	**<5000**	**5000-49999**	**>50 000**	**Unknown**		
	17.04	33.19	48.67	1.11		100

B.2 Order Effects

Table 10 shows the proportion of respondents choosing various contracts. The proportion choosing a specific contract when they receive the question as their 1st question is compared to the proportion choosing the same contract when the question is their 2nd or 3rd question. A proportion test is used to check for differences in proportions and the result of the test is presented as p-values. A p-value lower than 0.05 indicates that the proportions are significantly different and that the question order matters.

Table 10: Distribution of responses and result of proportion test.

$\kappa = 0$	Full insurance	D = 500 NOK	D = 5000 NOK	No insurance	Sum
1st	37.2	17.3	6.6	38.9	100
Not 1st	40.8	12.8	9.5	37.0	100
P-value	0.519	0.478	0.692	0.731	
$\kappa = 0.1$					
1st	36.8	17.2	9.3	36.8	100
Not 1st	39.7	13.3	8.5	38.6	100
P-value	0.604	0.538	0.904	0.748	
$\kappa = 0.4$					
1st	29.9	16.9	11.6	41.5	100
Not 1st	24.9	15.1	11.4	48.6	100
P-value	0.397	0.77	0.976	0.183	