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Factors influencing the willingness to pay for insurance in Norway

An empirical study of the willingness to pay for small insurance contracts

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Abstract

The purpose of this study is to investigate how the choice of deductible, degree of risk aversion and the level of income influence the willingness to pay for small insurance contracts in Norway.

We use data from a survey where individuals were asked to answer on a lifetime income lottery, as well as to answer on how much they were willing to pay for an insurance contract on a mobile phone. An interval regression for panel data is used to handle the survey data.

Our results suggest that the willingness to pay for small insurance contracts decreases with both a higher income and a higher deductible. However, we can not draw a reliable conclusion about risk aversion based on our results.

Keywords – Small insurance contracts, willingness to pay, expected utility theory

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1 Introduction

1.1 Background

Insurance has the purpose of replacing economic losses that are caused by random and unforeseen events. It is based on the signing of an insurance contract between an insurance company and a policyholder, who will pay a premium to the insurance company. If an accident occurs, the insurance company will provide the policyholder with a prespecified amount of compensation (Døving and Loen, 2021).

The principle of insurance is that there is a large group of people that are exposed to the same type of risk of economic loss. A certain percentage of these people will statistically experience economic loss, but it is impossible to predict exactly who will be affected. By purchasing insurance, individuals can spread the risk of potential losses across a community of policyholders. This allows for the losses to be distributed among multiple people, thereby reducing the burden for a single individual by levelling out the risk each individual faces. Through insurance, losses are transferred from one individual to the community as a whole (Døving and Loen, 2021).

Lastly, insurances differ in regard to the *insurance object* and the *value* at risk. Where the former is the item that is subject to the insurance contract and the latter is the estimated cost of a potential loss that the insurance is obliged to cover.

The premium paid by the insured must cover the following three costs:

1. The probable sum of compensation
2. Administration costs
3. Necessary fund allocations

As previously explained, insurance companies spread risk across several entities, collect premiums from the insurance buyers and pool these together in a fund. The fund's main purpose is to pay out claims but the capital in the fund is also actively invested in bonds and stocks with the purpose of generating an additional return. Insurance premiums are determined by assessing the likelihood and severity of economic loss. The likelihood, also known as frequency, is the probability for an unexpected event to occur. This enables the insurers to calculate the probable compensation they will have to pay. To minimize risk, insurance companies aim to have a large pool of policyholders to ensure that the variation in frequency and compensation will decrease and fall within a narrower range. Any significant deviation from this range would increase the volatility of the compensation paid by the insurers, potentially leading to insolvency.

1.1.1 Insurance contracts

The optimal choice of insurance contract is directly related to the individual's risk aversion. If we consider a risk-averse individual with a given level of initial wealth it has been shown that an individual with a higher loss probability, a higher degree of risk aversion, or a lower level of initial wealth will opt for more insurance (Schlesinger, 1981). An insurance contract outlines the terms and conditions of an insurance including the premium. This premium is based on the concept of actuarially fair premium, which is derived from historical data and risk assessment. An actuarially fair premium is a premium that is set equal to the value of the claims that are expected to be paid out by the insurance company (Pennacchi, 2006).

Naturally, the premium is a crucial component of the insurance contract, as it ensures that the insurer has sufficient funds to pay out claims when they emerge. Importantly, the premium must be large enough so that the insurer can avoid insolvency when claims are made and small enough that the consumer decides to purchase insurance. Furthermore, an insurance contract will typically specify the period of coverage, the amount of coverage and if there is any deductible. The policyholder agrees to pay the premium, while the insurer agrees to pay claims for losses or damages on the covered entities.

1.1.2 The Norwegian insurance market

The Norwegian insurance market is largely dominated by a handful of major players, and the market can be divided into five distinct entities. Specifically, Gjensidige, IF, Fremtind, and Tryg collectively hold a 76.7 percent share of the market, while the final entity is comprised of various other actors who represent the remaining 23.3 percent (Finans Norge, 2022). In addition to this market structure, the industry is further divided into four sectors, with motor vehicle insurance being the most prevalent, followed by housing-, personal-, and special insurance in descending order. This study focuses on the willingness to pay for special insurance, which falls outside of the other three categories and requires individuals to actively choose to insure a specific item such as their mobile phone.

Moreover, it is worth noting that an individual's possessions are often already covered by either her home insurance or personal insurance policy, and when purchasing a new product, a warranty from the manufacturer or retailer is typically included (Konsumenternas, 2023). In Norway, there is a policy called the *consumer purchases act* (forbrukerkjøpsloven) that allows the consumer to make a complaint if a defection happens within 2 to 5 years of the original date of purchase (Lovdata, 2019). Furthermore, as discussed above, insurance companies offer special insurance for individual items for an additional fee, with a few exceptions such as expensive jewelry. Despite these options, consumers are still asked by the retailer whether they want to purchase separate insurance for their product.

1.2 Problem formulation

In traditional economic literature, there are two important factors that explain an agent's demand for insurance namely her level of income and degree of risk aversion. Additionally, the choice of deductible is crucial because it provides the agent with the option to bear a part of the risk herself. In this paper we will further examine how these factors affect the willingness to pay for small insurance contracts. The novelty of this research lies in its scope, which is small insurance contracts on individual items in the Norwegian market. In particular, we will examine the theoretical willingness to pay for insurance of a mobile phone worth 7000 NOK. To that aim, we constructed the following research question:

How does the choice of deductible, degree of risk aversion, and level of income affect the willingness to pay for small insurance contracts in the Norwegian market?

Our results suggest that the size of a deductible and level of income are negatively correlated with willingness to pay for small insurance contracts, which is the expected relationship between these variables based on existing literature. However, our findings regarding the effect of risk aversion on willingness to pay are inconclusive. Consequently, this paper finds support for traditional literature when analyzing the deductible and income, while providing possible explanations for the inconclusive results of the risk aversion variable.

In this thesis we will first present relevant literature on utility theory, decisions under uncertainty, and behavioral economics that will help us answer our research question. This will be followed by a presentation of our data collection and construction of variables. In section 4 we describe the empirical methodology that was in consideration for our data. The chosen empirical methodology is used to run regressions, and the results are presented in section 5. In section 6 we discuss the implications and limitations of these results. Lastly, we answer the research question and provide a conclusion of our study.

2 Literature

In this section we will present some important concepts that are later applied in our analysis. We start by presenting the expected utility theory, risk aversion and risk premium. Followed by a presentation of the Arrow-Pratt approximation with related concepts. A subsequent examination of consumer behavior in regards to insurance and how to determine the optimal deductible for an insurance contract. At the end the reader is presented with alternative theories to the expected utility theory.

2.1 Expected utility theory

The Swiss mathematician Daniel Bernoulli first proposed the expected utility hypothesis in the essay *Exposition of a new theory on the measurement of risk* in 1738. Its main purpose was to show that two people may value a given lottery differently based on their psychological differences. Bernoulli's contribution was in contrast to the literature prior to him, which argued that the value of a lottery should be equal to its expected payoff, and therefore all participants should value a lottery accordingly. Bernoulli illustrated his belief through the following example[1]:

*Suppose an individual has 4000 ducats safely located at home in addition to 8000 ducats worth of foreign goods. The 8000 ducats in foreign goods needs to be transported home by ship, but there is a potential risk of sinking. If the ship has a 50 percent chance of sinking, the individual face an expected wealth of 0,5*4000 + 0,5*(4000+8000) = 8000. The individual can choose to send the foreign goods on two different ships, hence carrying 4000 worth of foreign goods each, and each ship still faces a 50 percent chance of sinking. The expected wealth will now be 0,25*4000+0,25*(4000+8000) +0,5*(4000 + 4000) = 8000. Interestingly, the diversification has made no difference to the individual's expected wealth.*

Bernoulli (1738) argued that most people would prefer the second option, and that this could be explained by using the concept of utility. He argued that most people do not extract utility from wealth directly but rather from the consumption enabled

[1] This is a simplified version of Bernoulli's example provided by Eeckhoudt et al.(2005, p.4). The original example used a 10 percent chance of the ship sinking.

by their current wealth. Since the utility that can be derived from consuming wealth varies depending on individual preferences, there exists a nonlinear relationship between wealth and utility. Furthermore, individuals each face their own utility function which is unobservable but is assumed to exhibit some basic properties of rational economic behavior. An increase in wealth w is assumed to lead to an increase in utility u, since it enables a larger consumption.

Bernoulli argued that dividing the transport of foreign goods on two different ships can be explained by having a utility function, *u(w)*, where the utility u is not only increasing but also concave with regards to wealth w. The utility function *u(w)* is assumed to be twice differentiable as it is concave if and only if its second derivative *u"(w)* is negative.

Consider a utility function *u(w)* $=\sqrt{w}$ which is an increasing and concave function of w (Eeckhoudt et al., 2005, p.6). When applied to Bernoulli's example, choosing to transport the goods with one ship only would yield an expected utility of $0.5 * \sqrt{4000} + 0.5 * \sqrt{12000} = 86.4$, while using two ships results in an expected utility of $0.25 * \sqrt{4000} + 0.5 * \sqrt{8000} + 0.25 * \sqrt{12000} = 87.9$. By using an increasing and concave utility function rather than expected payoffs, transporting the goods on two ships provides a higher expected utility than using only one ship. The assumption of concavity in the utility function is widely accepted in economic literature because it implies that the marginal utility of wealth decreases as wealth increases.

Neumann and Morgenstern (1944) argued that the expected utility model represents an individual's preferences when choosing between lotteries, if and only if four axioms[2] are satisfied. The first of these axioms is called *completeness*, which requires the alternative lotteries to be comparable so that individuals can specify their preferences. The second is *transitivity*, and requires that if an individual prefers lottery A to B and B to C, she must prefer A to C. The third is referred to as the *independence axiom*, and states that the lotteries must be independent of each other, meaning if lottery A is preferred over B that preference will remain when both lotteries are combined with a third lottery C. The fourth axiom is called *measurability* and requires that the probability of different outcomes in a given lottery can be measured (Damodaran, 2007, p.15). There are two additional axioms and the first is called *continuity*. It states that if lottery A is preferred to B, then

[2]Merriam-Webster online dictionary defines an axiom as a statement accepted as true as the basis for argument or inference.

a lottery close to A will also be preferred to B. To illustrate this, Levin (2006, p.5) used a lottery a short distance away in the direction of the second derivative A" as an example of a lottery close to A. Finally, there is the axiom of *reduction*, which is an assumption that "every function is equivalent, for all its values, to some predicative function of the same argument" (Russell, 1908, p.243).

2.1.1 Risk aversion

Individuals are considered risk-averse if they dislike all lotteries with an expected payoff of zero, also known as a zero-mean lottery, at any given level of wealth w (Eeckhoudt et al., 2005, p.7). It is worth noting that any lottery $\tilde{z}$ with an expected payoff other than zero can be broken down into an expected payoff, $E\tilde{z}$ and the zero-mean lottery $(\tilde{z} - E\tilde{z})$. A risk-averse agent will therefore prefer to receive the expected outcome with certainty and avoid the gamble. Hence, for a risk-averse and expected utility maximizing agent with initial wealth w, the expected utility of $w + \tilde{z}$ cannot exceed the utility provided by $w + E\tilde{z}$ for any initial wealth.

$$Eu(w + \tilde{z}) \leq u(w + E\tilde{z}) \tag{2.1}$$

For an intuitive interpretation of the above inequality see figure 2.1. Note that any linear line linking two points on the utility curve must exist below the curve itself. Points a and b are equally likely outcomes of lottery $\tilde{z}$. Importantly point d, which is the utility of receiving the expected value of the lottery with certainty, yields greater utility than point c, which is the expected utility of the sum of the initial wealth and the lottery.

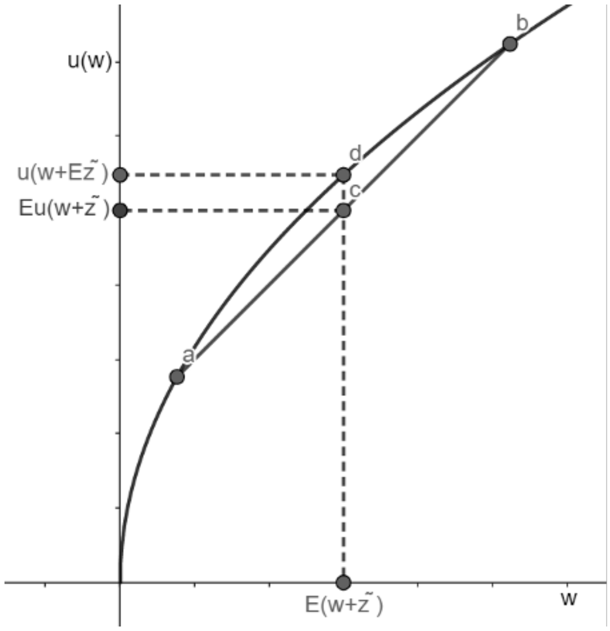

Figure 2.1: Utility from a lottery (Based on figure 1 from Toney (2020))

Thus, we can conclude that a concave utility function implies risk aversion. This can be understood by revisiting the simplified example presented by Eeckhoudt et al. (2005), which helps to provide an intuitive understanding of this concept. Consider the situation where only one ship is available: If the individual could choose to receive half of the value of the foreign goods with certainty, which would be 4000 ducats, the individual would accept. This is because a concave utility function implies that the utility of a change in wealth from initial wealth w to $w + 4000$ is greater than the utility of a change from $w + 4000$ to $w + 8000$. This situation is illustrated in figure 2.2 below. Hence, a risk-averse individual receives a higher utility from the safe option even though the expected payoff from both options are the same (4000 ducats). This is the trait of a concave utility function that implies decreasing marginal utility. To see this implication, note that in figure 2.2 any increase in w between points a and c provides a greater increase in utility the closer w is to a, which is the initial value. Thus, an increase in wealth has a greater effect on utility the closer wealth is to initial wealth, implying decreasing marginal utility.

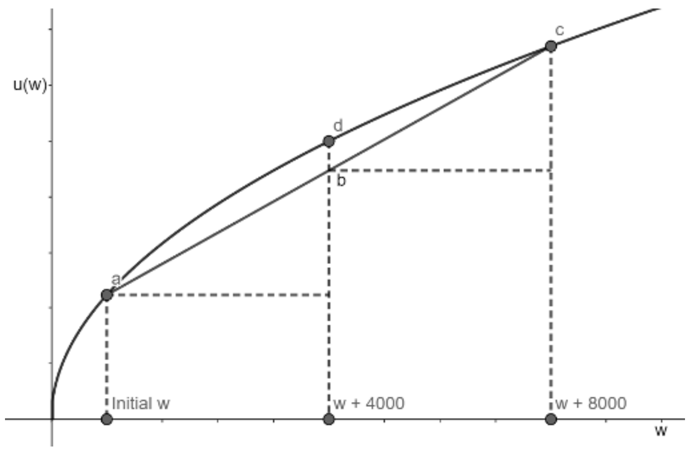

Figure 2.2: Utility from increasing wealth (Based on figure 1.1 from Eeckhoudt et al. (2005))

It is important to note that an agent does not necessarily have to be risk-averse. If an agent has a convex utility function, the convexity of the function implies that the agent extracts a higher utility from the change $w + 4000$ to $w + 8000$ rather than w to $w + 4000$. The agent is then considered to be risk-loving and her utility increases as the level of risk in the lottery increases. An agent could also be risk-neutral with a linear utility function. Then, the utility will be a function of $A + w$ where A is a constant. If A is zero, the utility will be exactly equal to the expected payoff of the lottery.

2.1.2 Risk premium and certainty equivalent

As explained in the previous section, a risk-averse agent dislikes lotteries with an expected payoff of zero. However, a risk-averse agent may like risky lotteries if the expected payoff is positive and sufficiently large. The required size of the expected payoff, also known as the risk premium, depends on the agent's degree of risk aversion. The risk premium associated with a given risk can be found by asking an agent how much she would be willing to pay to get rid of a zero-mean risk (Eeckhoudt et al., 2005, p.10). Letting π denote the risk premium and $\tilde{r}$ the zero-mean risk, then the risk premium must satisfy:

$$Eu(w + \tilde{r}) = u(w - \pi) \tag{2.2}$$

Intuitively, the risk premium must be set so that the agent is indifferent between paying the premium or accepting the zero-mean lottery. Equation 2.2 describes that a risk-averse agent dislikes zero-mean risk, $\pi > 0$, whereas a risk-neutral agent is indifferent towards zero-mean risk, thus $\pi = 0$, and finally a risk-loving agent likes zero-mean risk, and therefore $\pi < 0$.

Closely related to the risk premium is the concept of certainty equivalent e. The certainty equivalent is a measure of how large a certain gain has to be in order for the agent to be indifferent between receiving the gain or accepting a corresponding lottery. This value can be negative if the expected payoff of the lottery is negative. If we now let $\tilde{r}$ represent a risk with an expectation that differs from zero, then the certainty equivalent can be expressed as follows:

$$Eu(w + \tilde{r}) = u(w + e) \tag{2.3}$$

Equations (2.2) and (2.3) can be combined into $u(w - \pi) = u(w + e)$. From this, we can obtain $\pi = -e$. Thus, the amount an agent is willing to pay to get rid of a zero-mean risk is equal to the size of a certain loss that makes her indifferent between the loss and a lottery with negative expected value. Naturally, this amount, and consequently the expected value of the corresponding lottery, depends on her degree of risk aversion.

2.2 Arrow-Pratt approximation

Equation (2.2) shows that the risk premium π is a function of the utility u, initial wealth w, and the risk $\tilde{r}$. Arrow (1963) and Pratt (1964) independently developed a formula to approximate the risk premium for small risks (Gollier, 2001, p.22). This formula is known as the Arrow-Pratt approximation and can be derived as follows: Consider a zero-mean risk $\tilde{r}$, such that $E(\tilde{r}) = 0$. Using a second order Taylor series expansion for the left-hand side of equation (2.2) around the point $\tilde{r} = 0$, we obtain:

$$E[u(w+\tilde{r})] \approx E[u(w) + \tilde{r}u'(w) + 0.5\tilde{r}^2u''(w)] = u(w) + u'(w)E[\tilde{r}] + 0.5u''(w)E[\tilde{r}^2]$$

Since $E(\tilde{r}) = 0$ and $E(\tilde{r}^2) = \sigma^2$ it is possible to derive:

$$E[u(w+\tilde{r})] \approx u(w) + 0.5\sigma^2u''(w)$$

Similarly, by using a first order Taylor series expansion for the right-hand side of equation (2.2) around the point π=0, we obtain:

$$u(w-\pi) \approx u(w) - \pi u'(w)$$

Replacing the two Taylor expansions in equation (2.2) results in:

$$u(w) + 0.5\sigma^2u''(w) \approx u(w) - \pi u'(w)$$

And by solving for π we get:

$$\pi u'(w) \approx -0.5\sigma^2u''(w)$$

$$\pi \approx -\frac{0.5\sigma^2u''(w)}{u'(w)}$$

This can be rewritten as:

$$\pi \approx 0.5\sigma^2 A(w) \tag{2.4}$$

Where $A(w)$ is denoted as:

$$A(w) = -\frac{u''(w)}{u'(w)} \tag{2.5}$$

A risk-averse agent would exhibit a positive function $A(w)$, whereas a risk-loving agent would exhibit a negative function $A(w)$. For a risk-neutral agent the function $A(w)$ would be equal to zero. This function is known as the degree of absolute risk aversion (ARA) which measures the rate at which marginal utility decreases when wealth is increased by one unit.

From equations (2.4) and (2.5) we see that the risk premium π depends on the degree of absolute risk aversion A which is in turn a function of wealth w. Thus, the risk premium varies with wealth.

Consider equation (2.2) and two individuals with different levels of wealth. We can assume that an individual with initial wealth of 1000 ducats would likely be willing to pay more than an individual with initial wealth of 100 000 ducats to eliminate the zero-mean risk and receive the 4000 ducats with certainty. The core argument is that the individual with lower initial wealth to a larger degree relies on receiving the 4000 ducats. This intuition is known as decreasing absolute risk aversion (DARA). The concept of DARA will be discussed in the next section.

The Arrow-Pratt approximation, as denoted in equation (2.4), states that the risk premium for a given risk is approximately equal to half of the variance associated with the risk multiplied with the degree of ARA of an agent at a given level of wealth. Hence, the risk premium is approximately proportional to the variance of the risk. For small risks, a mean-variance model, which considers only the mean and variance of the underlying risks when determining individual risk attitudes, is likely to be valid (Eeckhoudt et al., 2005, p.12). For large risks however, the third and fourth statistical moments, degree of skewness and kurtosis[3] respectively, are likely to impact the risk premium.

[3]If skewness is different from 0, the distribution deviates from symmetry. If kurtosis is different from 0, the distribution deviates from normality in tail mass and shoulder (Cain et al., 2017).

2.2.1 Decreasing absolute risk aversion

Decreasing absolute risk aversion (DARA) is a specific type of ARA where the degree of risk aversion the individual exhibits decreases as her wealth increases. As previously discussed, we measure risk aversion with the help of Arrow-Pratt's ARA coefficient. As the individual's wealth increases her risk aversion decreases and she is willing to accept higher levels of risk. In other words, the amount of compensation required for the individual to take on risk decreases with wealth.

This intuition is supported in various previous studies such as Hamal and Anderson's (1982) study of rice-farmers in Nepal. The study showed that as farmers became wealthier, they were more likely to adopt riskier technology into their agricultural work. Furthermore, there is more recent evidence presented by Huber et al. (2023). In their study, they looked at the in-game currency of a mobile phone game, where the players could spend their wealth on new in-game content. The game was structured into rounds and after each successful round the players got to make a lottery choice, where the options were either a gamble with 50 percent chance of a high outcome and 50 percent chance of a low outcome, or a certain payout between the two outcomes. The lottery aspect of the game allowed Huber et al. (2023) to find the bounds of risk aversion for the players and thus, they could analyze the effects of wealth on risk aversion. Interestingly, their results were consistent with DARA as the probability of choosing the certain payout option after a successful round was negatively influenced by increases in wealth in the form of in-game currency.

There are two other theories about ARA, the first is constant absolute risk aversion (CARA), which assumes that risk aversion is independent of wealth. However, this assumption is unlikely to hold. Intuitively, a loss of 7000 NOK will have a larger financial impact on a person with a wealth of 100 000 NOK than on a person with a wealth of 1 000 000 NOK, which is the important observation that DARA captures. The second theory is increasing absolute risk aversion (IARA) which opposite to DARA suggests that as the individual's wealth increases their risk aversion does as well.

2.2.2 Relative risk aversion

Recall that ARA measures the rate at which marginal utility decreases when wealth increases by one unit. Hence, the value of ARA is dependent on the choice of unit to measure wealth, meaning ARA is not a unit-free measure of risk aversion. Unit-free measures of sensitivity are often preferred, such as the relative rate at which marginal utility decreases when wealth increases by one percent. This can be computed by multiplying ARA with initial wealth:

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

This formula yields the coefficient of relative risk aversion (RRA) (Eeckhoudt et al., 2005, p.18). There is no clear intuition to whether RRA is increasing, decreasing or constant.

There are two important effects pulling in opposite directions. The assumption of DARA suggests agents become less risk-averse as they become wealthier. At the same time, when agents get wealthier, they face an increased absolute risk. However, there is no way to tell which effect will be stronger and one common assumption is that these effects cancel each other out, resulting in constant relative risk aversion (CRRA).

2.2.3 Second order risk aversion

Second order risk aversion is commonly known as a second order phenomenon when limited to expected utility models. Because when risks are small enough, risk-averse agents who maximize expected utility behave similarly to risk-neutral agents (Eeckhoudt et al., 2005, p.13). They described this relationship with the following formula, where k is the size of the risk, π is the risk premium, σ_ϵ^2 is the standard deviation of a zero-mean lottery and $A(w)$ is the ARA:

$$\pi(k) \approx 0.5k^2\sigma_\epsilon^2 A(w)$$

Observe that $\pi(k)$ approaches zero when k approaches zero. Hence, at the margin, accepting a sufficiently small zero-mean risk has no effect on welfare for risk-averse agents.

However, this property is dependent on the assumption that the utility function is differentiable and close to linear when considering small changes (Segal and Spivak, 1990). They also compare second order risk aversion where the risk premium is approximately proportional to k^2, to first order risk aversion, where the risk premium instead is proportional to k. Consequently, models that exhibit first order risk aversion suggest that risk-averse agents behave in a risk-averse manner even when considering small risks. This relationship is illustrated in figure 2.3 below:

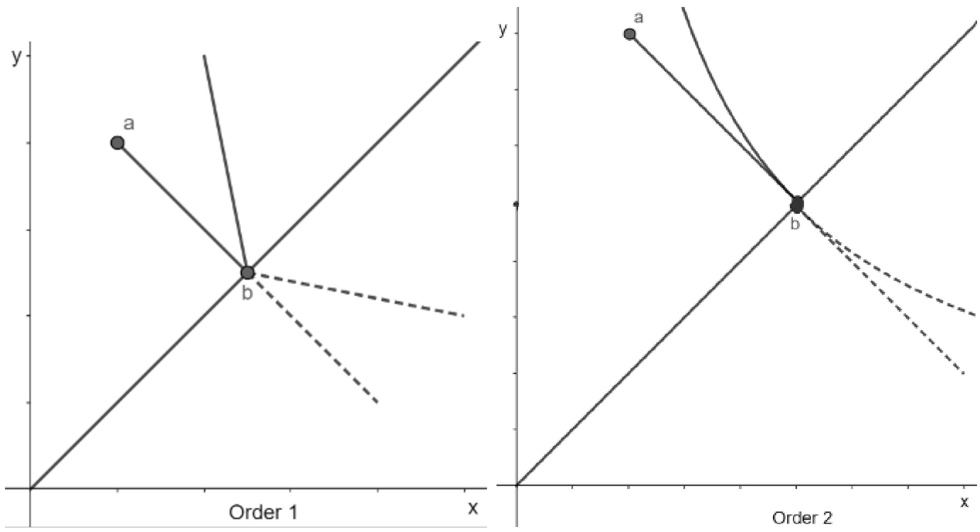

Figure 2.3: First order versus second order risk aversion (Based on figure 2 from Segal and Spivak (1990)

In these diagrams, any point *(x, y)* represents outcome x if an accident occurs, and y if it does not. Point a represents no insurance purchased, while b represents full insurance. Thus, the line between a and b represents the budget line available to a decision-maker. The indifference curves illustrate the key difference between first and second order risk aversion, which as mentioned is that first order risk aversion implies risk aversion even when considering small risks, whereas second order risk aversion implies risk-neutral behavior when facing sufficiently small risks. To see this, notice that as an agent moves from b towards a, meaning a change from full insurance to partial insurance, she will suffer more from a loss if she exhibits first order risk aversion rather than second order.

2.3 Consumer behavior in insurance

In this section we will present some commonly observed biases and behavioral patterns among individuals in the insurance market, which are opposing to the expected utility theory discussed in section 2.1. We explained in sections 2.1 and 2.2 the standard assumption of rational behavior, which implies that an agent will always prefer more money than less, exhibit diminishing marginal utility, and under uncertainty she always chooses the option that maximizes her expected utility. However, an individual can deviate from rational judgement if there are cognitive biases that influence her decisions (Haselton et al., 2006).

Then her decision-making will differ from utility maximizing behavior, since she will be influenced by her past experiences and by the manner information is presented (Kahneman et al., 2002). An example of this related to insurance is the concept of *framing*, which explains that a potential customer is affected by how the insurance contract is presented in terms of deductible, insurance premium and general insurance terms (Richter et al., 2019).

Another cognitive bias that affects an individual's decision-making when selecting insurance is called *anchoring*. People tend to underestimate the value of policies with a deductible. This can happen if the policy with full coverage serves as an anchor for individuals, as they do not have to do any advanced calculations. Therefore, when individuals look at different insurance options, it is convenient for them to look at the policies with a smaller deductible that yields a premium that is close to the full coverage insurance. Conversely, when they consider insurance policies with a large deductible their valuations tend to underestimate the value of the policy because of the added complexity of the calculations (Shapira and Venezia, 2008).

Additionally, people tend to overvalue objects that are in their possession, which is a concept called the *endowment effect*. The *endowment effect* can cause an individual to overinsure, and it can be explained in two parts. First, the individual overestimates the value of her possessions, and second, small damages get overweighted. Instead of paying for these small damages herself, relatively higher insurance premiums are paid, and this can be observed in insurance for electronics (Richter et al., 2019).

Previous literature has also shown differences in behavior between men and women. An example is in the educational testing literature where boys and girls have done multiple-choice tests, and the pay-off of risky guesses has been in focus (Hartog et al., 2002). These tests showed a greater tendency among boys than girls to guess on the questions. Furthermore, the results that girls are more risk-averse than boys are strong and consistent. Thus, this could be used to explain differences in choices between the two genders. Moreover, in the same study, evidence was also found that individuals' risk aversion rise as they age, and that risk aversion falls with education and income. The latter supports the concept of DARA explained in section 2.2.1.

2.4 Optimal level of deductibility

A full insurance contract with an actuarially fair premium is desirable to any risk-averse and expected utility maximizing agent (Razin, 1976). This is because of the relationship described in 2.1.1, which states that the concavity of the utility function implies that the agent prefers the certain utility provided by the insurance over the mathematical expectation. Furthermore, the maximum amount an agent is willing to pay for full coverage is equal to the actuarially fair premium plus the risk premium. Importantly, the utility from insuring at this price is equal to the utility of the mathematical expectation the actuarially fair premium is based upon. Figure 2.4 below illustrates this relationship:

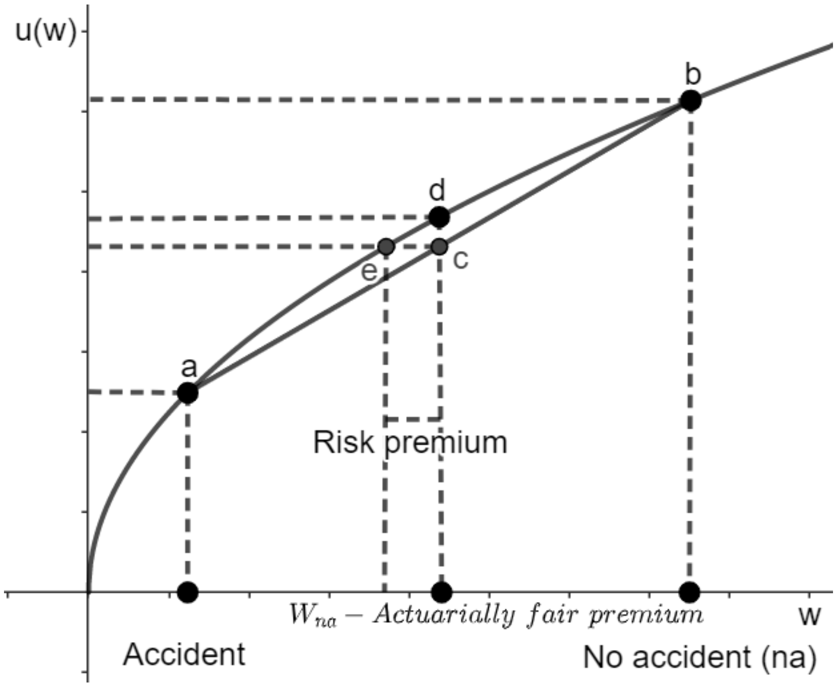

Figure 2.4: Utility from an insurance contract (Based on Figure 1 from Špirková and Král' (2010))

When deciding the optimal level of deductibility for an insurance contract, it is important to consider the concept of moral hazard, which is a situation where an agent can increase her exposure to risk as she does not bear the full consequences of taking the risk. It happens because of asymmetric information, where the insurer cannot observe the policyholder's actions to prevent a loss, which might be altered after signing an insurance contract (Shavell, 1979). A question insurance companies are likely to ask themselves is:

How can we incentivize consumers to purchase insurance while also preventing them from acting recklessly once they have acquired it?

Overall, insurance companies aim to reduce moral hazard by having the customer bear a certain amount of the risk in form of a deductible. Insurance is a crucial tool for risk distribution and plays a fundamental role in the theory of risk bearing (Moffet, 1977). Interestingly, the optimal level of deductible can be viewed as a strategic game between the insurance company and the individual, each attempting to minimize their own risk exposure and this can be repeated over multiple periods allowing the agent to adapt and change over time. On the other hand, the traditional approach to determining optimal insurance coverage is based on maximizing expected utility of the individual's wealth at the end of the specified period, also known as terminal wealth. However, this may overlook two essential aspects. First, an individual's savings may act as a substitute for insurance. Second, it fails to consider that an individual may allocate a portion of her current consumption as a form of risk-bearing.

Therefore, Moffet's (1977) model takes an individual's initial wealth into account and creates a risk-bearing budget based on the difference between the optimal consumption level under complete certainty and the optimal consumption level in a context of risk. The goal is to find a balance between purchasing insurance and building up a contingency fund, under the assumption that only one claim can be made during the period and is paid out at the end of the period. While finding a "one size fits all" solution is difficult, analyzing consumers' risk aversion and terminal wealth can help identify the optimal deductible level for each individual. The most important takeaway is that as an individual's wealth increases, she should be less willing to pay for insurance, which is supported by the assumption of DARA. Therefore, the deductible should vary in the same direction as her wealth.

2.4.1 Over-insuring

People tend to exhibit a surprisingly high level of risk aversion over modest stakes in the market, hence opting for the lowest deductible offered (Sydnor, 2010). This is despite the fact that the insurance premium is often far above the expected value and what would be considered an actuarially fair premium. Sydnor used a standard actuarial pricing scheme, which is a method that accounts for factors such as probability of a claim being made, size of the potential claim, and the administrative cost associated with the policy to estimate the risk of insuring a particular individual. This estimate is then used to determine the price the insurance company sets for each level of deductible. Thus, the model allows for different premia depending on deductible level, which is adjusted with the help of a multiplicative factor. This implies that a policyholder with a higher base premium, which is based on the underlying values insured, faces a higher marginal cost when opting for a lower deductible.

The results show that people often choose to hold a lower deductible even when the cost of holding it exceeds the expected value of the extra insurance. In Sydnor's (2010) study the initial deductible of the insurance was $1000 but the customers could choose to pay an extra premium to lower their deductible to $500, $250 or $100. Interestingly, close to 83 percent of the policyholders chose a deductible of $500 or $250. As a group they paid an average of $99.85 for the lower deductible and even more for the individuals that chose $250 deductible. However, the expected value of the lower deductible at $500 was $19.93, which implies that individuals on average almost paid five times the expected value to lower their deductible.

There are several explanations for these results, one of them is *risk misperception*. This implies that even if the individuals exhibit standard risk preferences, they might not have the correct subjective beliefs of the actual claim rates. Furthermore, the *role of the sales agent* is potentially something that influences an insurance buyer to accept a contract with a lower deductible and larger premium. Thus, customers might be convinced to pay more than their initial willingness to pay. Another effect is the *menu effect*, which describes that people are reluctant to pick extreme points from a menu, which could explain why people do not pick the lowest or the highest deductible (Sydnor, 2010). Other possible explanations mentioned are *consumption commitments*, *borrowing constraints* and *reference dependent preferences*. The latter will be discussed in section 2.5.2 and the others will not be further elaborated in this thesis.

2.5 Critique of expected utility theory

In the previous section we have presented empirical evidence against expected utility theory, particularly with regards to the choice of deductible in an insurance contract. In the following section we discuss two prominent models that take different approaches to explain situations in which expected utility theory does not hold, and briefly highlight how they impact the analysis conducted in this paper.

2.5.1 Disappointment aversion

In section 2.1 we discussed the four axioms proposed by Neumann and Morgenstern. The third axiom, labelled the *independence axiom*, has been subject to criticism. Gul (1991) argued that the expected utility theory is inconsistent with empirical studies that found violations of the *independence axiom* when new lotteries are mixed with existing ones. To illustrate this, Gul referred to Allais paradox from 1953, which presents the following two problems:

Problem 1: *Choose either 200 dollars with certainty (A) or 300 dollars with a probability of 0.8 and 0 dollars with a probability of 0.2 (B).*

Problem 2: *Choose either 200 dollars with a probability of 0.5 and 0 dollars with a probability of 0.5 (C) or 300 dollars with a probability of 0.4 and 0 dollars with a probability of 0.6 (D).*

Allais observed that most decision-makers chose A for **Problem 1** and D for **Problem 2**. The *independence axiom* states that given any three lotteries *p1*, *p2*, and q and a number $a\epsilon(0,1)$, *p1* being preferred to *p2* implies $ap1+(1-a)q$ is preferred to $ap2+(1-a)q$. Thus, assuming q denotes a lottery which yields zero dollars with certainty, and a equal 0.5, Allais paradox above constitutes a violation of the *independence axiom*, since introducing the new lottery q changed the most common preference. For simplicity, this is explained below:

For **Problem 1**, A was preferred to B, which implies the utility of 200 with certainty is more desirable than 300 with probability of 0.8.

$$u(200) > 0.8 * u(300) + 0.2 * u(0)$$

Whereas for **Problem 2**, C was preferred to D, implying:

$$0.5 * u(200) + 0.5 * u(0) < 0.4 * u(300) + 0.6 * u(0)$$

Given the assumption that $u(0) = 0$, the equation can be rewritten as:

$$u(200) < 0.8 * u(300)$$

As shown, **Problem 2** is simply the product of **Problem 1** and the new lottery q. According to Gul (1991), this contradiction could be explained if the lottery with the lower probability of disappointment was more strongly affected when combined with an inferior lottery. Note that for **Problem 1**, option A had no chance to yield a disappointing outcome, whereas B had a 20 percent chance to yield a disappointing outcome. Hence, Gul's argumentation suggested that A was affected sufficiently more than B by the inclusion of q, which caused the participants in Allais original observation to alter their preferences.

To explain this violation of the *independence axiom*, Gul proposed a modified version of the traditional expected utility model. He added a new parameter, the beta coefficient, to make the model consistent with Allais observations. Formally, the model was presented as follows, where $x \geq z$:

$$\frac{a}{1+(1-a)\beta}u(x) + \frac{(1-a)(1+\beta)}{1+(1-a)\beta}u(z) = u$$

Figure 2.5 shows an indifference curve for an individual with preferences that follow Gul's model when u is concave and the beta coefficient introduced in this model is greater than zero. Notice the kink in the utility curve at the 45-degree line. According to Gul's model, such a kink will occur whenever the beta coefficient is not equal to zero. However, when the beta coefficient is equal to zero, Gul's model reduces to the traditional expected utility model. The shape of the indifference curve in figure 2.5 brings one important implication to our discussion later in this paper, which is that risk-averse individuals will purchase full insurance above the actuarially fair premium.

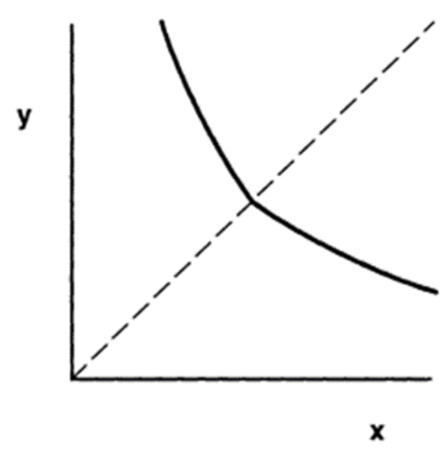

Figure 2.5: Gul's indifference curve (Figure 1 in Gul (1991))

For an intuitive explanation of this implication, we can say that individuals give an additional weight to disappointing outcomes, where disappointing outcomes are defined as outcomes with a lower utility than the lottery itself (Cerreia-Vioglio et al., 2020). Thus, when an individual considers buying insurance, she is willing to pay more than actuarially fair premium to avoid the overweighted disappointing outcome of needing the insurance (ex-ante). This is true for all positive values of the beta coefficient, whereas for negative values of the beta coefficient the opposite is true, and the individuals are considered elation seeking.

2.5.2 Prospect theory

Kahneman and Tversky (1979) conducted a series of experiments and found results that were inconsistent with expected utility theory. Through several theoretical choice problems constructed in a similar manner to Allais paradox, their findings consistently showed that the participants preferred certain outcomes with a given payoff over outcomes with a small risk of no gain and a small, but sufficiently large according to expected utility theory, increase in payoff. This finding was labelled the *certainty effect*.

Interestingly, when the probabilities shifted to small chances of positive outcomes, the participants preferred the riskier option when the payoff to probability ratio remained consistent. Kahneman and Tversky pointed out that this change in preference among participants is inconsistent with the *independence axiom*. As pointed out by Gul (1991) mixing in a lottery with payoff zero and a positive probability reduces the probabilities of the outcomes in the original lotteries without altering the payoff to probability ratio. If mixing in the new lottery causes a change in preferences among participants, then the *independence axiom* is violated.

Kahneman and Tversky also examined if the results differed when the questions were framed as losses rather than gains. They asked exactly the same questions, but with negative payoffs and discovered that the preferences were reversed for several questions. Because the preferences were mirrored around zero they named it the *reflection effect*. The first implication of this finding was that risk aversion for gains is accompanied by risk seeking behavior for losses. Most participants were willing to forego a higher expected payoff in favor of a certain gain, and conversely, they were willing to gamble with higher expected losses rather than taking a certain loss. The second implication was that the overweighting of certainty is persistent through a change in the sign of the payoff, and thus favors risk seeking behavior when the payoff is negative. The third and final implication was that since risk seeking behavior was observed for negative payoffs, a desire to minimize variance is eliminated as a potential explanation for the *certainty effect*.

Another interesting observation they made was that probabilistic insurance was generally unattractive when presented as a theoretical problem. In this case, an insurance policy where the customer would only pay half the regular price of an insurance, but if a situation that would normally receive a payout occurred, the customer would either receive the payout or simply be refunded the cost of the insurance with equal probabilities. This is arguably conflicting with real-life behavior since items like alarms and bike-locks can be viewed as a form of probabilistic insurance. Additionally, Kahneman and Tversky pointed out that all insurance can be viewed as probabilistic because even after purchasing insurance for a given type of risk, one would still be exposed to other types of risk.

Finally, the *isolation effect* describes the tendency among participants to ignore the components that are shared between lotteries. Consequently, the way information pertaining to a lottery is presented could have considerable impact on which option was preferred. To illustrate this, Kahneman and Tversky provided an example where the *certainty effect* caused a change in preferences when the probability of an outcome was presented sequentially. The original probabilities were 0.2 to win 4000 and 0.25 to win 3000 whereas the sequential probabilities were 0.75 to win 0 and 0.25 to then either win 4000 with probability 0.8 or 3000 with certainty. These probabilities are presented as decision trees in figure 2.6 below:

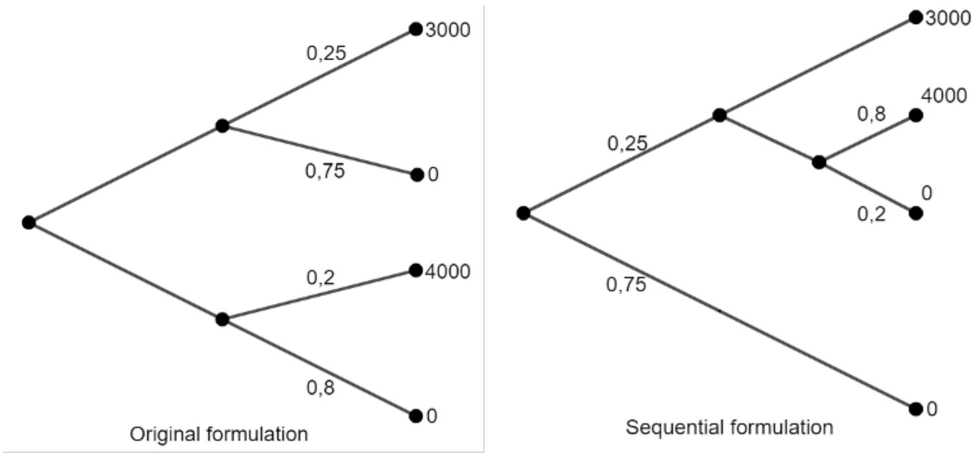

Figure 2.6: Original formulation versus sequential formulation of a decision (Based on figure 1 and 2 from Kahneman and Tversky (1979))

The choice had to be made before starting the lottery. The preferred choice changed from 4000 with 0.2 probability, to 3000 with certainty, which of course is really 3000 with $0.25 * 1 = 0.25$ probability. Thus, the *isolation effect* suggests the first step of the sequential formulation was ignored since it was shared for both choices.

To create a model that accounted for these effects, they introduced prospect theory, which is a purely descriptive theory, meaning the goal is to describe the actual decision-making process used by the participants. Notice how this differs from the theory of disappointment aversion, which proposed a model that altered as little as possible from traditional expected utility theory while explaining violations of the *independence axiom* (Gul, 1991). An important distinction between prospect theory and expected utility theory is that in prosect theory it is changes in wealth that determine the value of a lottery, not the final state of wealth (Kahneman and Tversky, 1979). This is derived from the *isolation effect* since initial wealth is a shared component when choosing between lotteries. Although this does not imply that initial wealth is irrelevant in prospect theory. The difference in value from receiving either 100 or 200 is assumed to be greater than the difference from receiving either 900 or 1000, and the same is assumed to be true for losses. Consequently, the model used is concave above the reference point, and convex below it. The reference point is determined by initial wealth. Therefore, the marginal value of both gains and losses decreases as the total gain or loss increases. Finally, the effect on value from a loss is assumed to be greater than from a gain. The justification for this assumption is that most people find bets with an equal chance of a given gain or loss unattractive. A function that satisfies these properties is presented in figure 2.7.

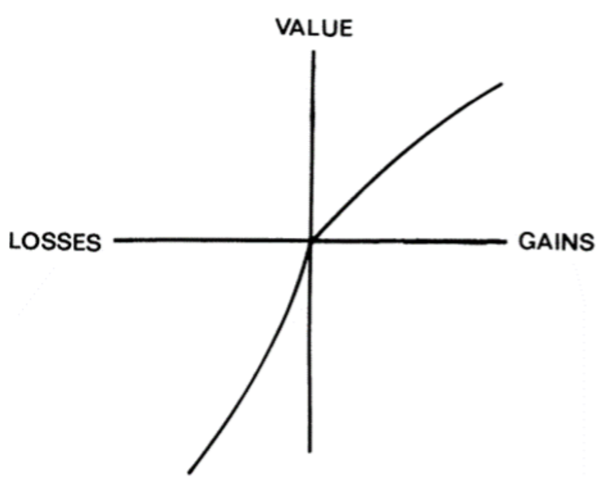

Figure 2.7: Value function from prospect theory (Figure 3 in Kahneman and Tversky (1979))

Further differentiating prospect theory from expected utility theory is the use of weights. In expected utility theory the weight associated with a given outcome is simply the probability, whereas in prospect theory decision weights are used instead. In this context, decision weights are a person's subjective interpretation of a probability. However, these decision weights were inferred from choices between theoretical prospects where the probability was explicitly stated. Thus, they are argued to be more than perceived probability, but rather a function of the real probabilities and the impact events may have on the desirability of prospects (Chen, 2014). Furthermore, there was a tendency among participants to overweight low probabilities.

Kahneman and Tversky argued that overweighting of low probabilities constituted an incentive to purchase insurance. Intuitively this seems reasonable, since insurance is commonly purchased to hedge against risks with low probabilities but highly impactful outcomes, such as an individual's house burning down. However, the shape of the value function in figure 2.7 is an argument against the purchase of insurance, since it is convex for negative values. Meaning the marginal effect of a loss on value is greater for small values, such as the insurance premium, than for large values such as the event one would insure against. Interestingly, the analysis in this paper considers small insurance contracts, and the convex value function for losses suggests a considerable decrease in value from a loss, despite the small sums at risk.

3 Data

3.1 Data collection

In this section we discuss our data set, the construction of variables, and present descriptive statistics. The willingness to pay (WTP) variable is interpreted as the maximum amount of money the individual is willing to exchange for an insurance on her mobile phone.

3.1.1 The data set

The data featured in this study is survey data collected from the Norwegian public with help from the data company YouGov. The collection of the data was made possible through financing from Frende Forsikring. Lastly, the questionnaire was designed by Toney (2020). The survey consists of three sets of questions:

The first section asks the respondents about their risk-preferences, while the second section covers insurance on hobby equipment with a value of 16 000 NOK. Finally, the last section looks at how much the respondents are willing to pay for an insurance on a mobile phone with a value of 7000 NOK.

The survey is based upon the answers of 904 individuals, who are Norwegian citizens aged between 18-64, and should be representative of the population. It is not possible to identify any of the respondents. In addition to the survey questions, the data set also contains information on socioeconomic characteristics of each respondent, such as age, gender, education, household income, marital status, area of residence and occupation.

Our data set was originally used in another study which focused on the two first sections of the survey (Toney, 2020). However, in this study we focused on the third section of the survey while the first section was used to determine the risk tolerance of the respondents. These two sections will therefore be elaborated in the following study, while the second section was omitted as it is not relevant for our research. The survey design is inspired by a study done by Barsky et al. (1997) where they asked 12 000 senior US citizens about a gamble of lifetime income.

3.1.2 Survey design and variables

In the first section of the survey the respondents were faced with the following scenario:

Imagine you are the sole income of your household and today's income will be your income in the years to come.

Note that the statement implies that you are forced to take part of a life-time income gamble where you must switch job and choose between two different job offers, which are as follows:

Job 1: *You are offered the same disposable income as your current one in all the years to come.*

Job 2: *You have a 50 percent chance to double your disposable income for the years to come, however, you have a 50 percent chance to cut 1/3 of your disposable income for the years to come.*

These offers can be written as a choice between receiving a payoff of y or $(\frac{1}{2} \cdot 2y); (\frac{1}{2} \cdot \ \frac{2}{3}y)$ when choosing between **Job 1** and **Job 2**, respectively. Here, y represents the individuals lifetime income. In the survey the respondents were asked a follow up question depending on their answer on the described income gamble. If the respondent answered **Job 1** on the income gamble, they were next faced with the option of choosing between y again or $(\frac{1}{2} \cdot 2y); (\frac{1}{2} \cdot \ \frac{4}{5}y)$. On the other hand, those who chose **Job 2** in the first question were then faced with the following options: y or $(\frac{1}{2} \cdot 2y); (\frac{1}{2} \cdot \ \frac{1}{2}y)$. This was then repeated a third time to further observe the risk preferences of the respondents in the survey. Those who answered **Job 2** on both questions, were finally offered the option of choosing between y again or $(\frac{1}{2} \cdot \frac{3}{2}y); (\frac{1}{2} \cdot \ \frac{1}{2}y)$. Lastly, the respondents who had chosen **Job 1** on the two first questions were then asked to choose between *0.9y* or $(\frac{1}{2} \cdot 2y); (\frac{1}{2} \cdot \ \frac{4}{5}y)$.

The third section of the survey presented the following hypothetical scenario for the respondents:

Imagine you just bought a mobile phone for 7000 NOK and you estimate that the risk of it getting stolen or destroyed is one to five every year. Furthermore, assume that stolen or destroyed telephones are not covered by your home- or travel insurance.

The respondents were then asked to choose a premium that they would be willing to pay to insure a mobile phone. This was replicated three times with three different levels of deductible, namely 0 NOK, 500 NOK and 2000 NOK. This allowed us to compare the respondents' willingness to bear risk when purchasing an insurance contract. Hence, if the individuals were willing to bear some of the risk themselves, they should prefer an insurance policy with a higher deductible.

The survey data set consisted of 14 questions. The dependent variable is the willingness to pay *(WTP)* which is an ordered variable taking a value between 1 and 5, where each number represents a certain interval of *WTP*. The five intervals for the *WTP* are in the range of 0-250 NOK. Additionally, as explained in section 3.1.1, the subjects were asked several questions about their socioeconomical background. These variables are as follows: gender, age, region, urbanization, education, marital status, occupation, and income.

3.2 Constructed variables

We chose to format the data set as panel data, since it allowed us to apply a time-dimension to the survey data. This enabled us to observe the data in three specific periods in section three of the survey, where each answer represented one unit of time. Therefore, we could group the three questions into a single framework, which helped us to avoid faulty measurements in the residuals as these were likely to be correlated for all three questions. This was necessary in order to draw any reliable conclusions.

We constructed two dependent variables WTP_{lower} and WTP_{upper}, which represented the intervals from the survey when the respondents were asked what they were willing to pay for the insurance. These variables are programmed so that WTP_{lower} and WTP_{upper} changes with the specific answer of the respondent. That is to say, the lower interval is 0 and the upper is 49 at the first threshold. In the next interval the lower interval (WTP_{lower}) will take the value of 50, and the higher interval (WTP_{upper}) will be assigned the value 99 and so on. To make the interpretation of these variables easier we log transformed them, which allowed us to interpret the result as changes in percentage when compared to the baseline.

The variable *ID* was constructed to enable us to indicate the answer of each respondent to each question, it ranged from 1 to 904. The individuals' answers to each question were grouped by the variable *Deductible*. Hence, when *ID* was equal to one, there were three observations, one for each level of deductible. This framework gave us 904 individuals under the variable *ID* and a total of 2297 observations. The loss in observations was due to missing values caused by respondents answering that they 'do not know'. In other words, the panel data was constructed such that *ID* is the time invariant variable and *deductible* the time variable. As previously explained, there were three different questions which each contained a different level of deductible (0, 500 or 2000). For each question, the individual could choose one of five different levels of *WTP*.

As mentioned in section 3.1.1 we used section one of the survey to construct a variable that captured the respondents' risk aversion. This was important because it allowed us to see if people's relationship to risk affected their willingness to pay for small insurance contracts. This variable is called *Aversion_level* and it allowed us to separate responses into different categories of risk aversion, from the least risk-averse to the most risk-averse. This is possible because the question was structured as an income gamble where the preferences of the respondents can be used to calculate their relative risk aversion. There are six groups in total, and the risk aversion coefficient is derived with the assumption that constant relative risk aversion holds as discussed in section 2.2.2.

Given that the coefficient of relative risk aversion is *R(w)*, the CRRA utility function can be written as:

$$u(w) = \begin{cases} \left(\dfrac{(y)^{1-R(w)}}{1-R(w)}\right) \; if \;\; R(w) \neq 1 \\ ln(w) \; if \;\; R(w) = 1 \end{cases} .$$

From the respondents' answers in the income gamble, we can tell that an individual that preferred **Job 1** on the first question and chose **Job 2** on the follow up question must exhibit preferences such that:

$$0.5\frac{(2y)^{1-R(w)}}{1-R(w)} + 0.5\frac{(0.8y)^{1-R(w)}}{1-R(w)} > \frac{(y)^{1-R(w)}}{1-R(w)} > 0.5\frac{(2y)^{1-R(w)}}{1-R(w)} + 0.5\frac{(\frac{2}{3}y)^{\;1-R(w)}}{1-R(w)}$$

The left-hand side shows the expected utility of wealth for those who chose **Job 2** on the follow up question $(\frac{1}{2} \cdot 2y); (\frac{1}{2} \cdot \; \frac{4}{5}y)$. This must be greater than the expected utility of wealth with the current income y, which in turn must be greater than the expected utility of wealth for the first option **Job 1** $(\frac{1}{2} \cdot 2y); (\frac{1}{2} \cdot \; \frac{2}{3}y)$, illustrated by the right-hand side equation. Solving the expression above for *R(w)* yields:

$$2 < R(w) < 3.76$$

If we solve the expression for all the different answers in the income gamble, we obtain the following values of the relative risk aversion: $(-\infty, 0], (0, 1], (1, 2], (2, 3.76], (3.76, 6.84], (6.84, \infty)$.

3.3 Descriptive statistics

In the following table the key characteristic of the data set is presented, providing an overview of the *WTP* for the different levels of deductible. In table 3.1 the survey respondents' answers to the questions are shown. As seen in the table the respondents had the possibility to answer 'do not know' in the survey, which was treated as a missing value in our study and is therefore omitted from the regressions. This resulted in the data set having a total of 2297 observations.

Table 3.1: *WTP* of the survey respondents

	Deductible		
	0 NOK	500 NOK	2000 NOK
Willingness to pay			
- 0 to 49 NOK	40%	46%	53%
- 50 to 99 NOK	19%	17%	12%
- 100 to 149 NOK	14%	13%	9%
- 150 to 199 NOK	9%	7%	6%
- 200 to 250 NOK	4%	3%	3%
- Do not know	14%	14%	17%

Note: *Do not know = 415 answers*

Next, table 3.2 presents the distribution of the categories of risk aversion. Since the risk aversion is measured from an income gamble, separately from the willingness to pay, this data is not dependent on the deductible. Additionally, in this part of the survey the respondents did not have the possibility to answer 'do not know'. Consequently there are 904 observations.

Table 3.2: Risk aversion of the survey respondents

	Sample distribution	
Aversion Level		
-∞ *to* 0	52	5.75%
0 to 1	16	1.77%
1 to 2	84	9.29%
2 to 3.76	138	15.27%
3.76 to 6.84	187	20.69%
6.84 to ∞	427	47.23%
Total:	904	100%

In *Appendix A* the characteristics of the survey respondents can be seen.

4 Methodology

In this section we describe our reasoning for the choice of methodology used to answer our research question and the specification of the chosen regression model. The section is structured as follows: We present two different approaches that can handle categorical data and explain why we chose our preferred model. In the final part of the section, we present two alternative model specifications for the chosen regression model.

4.1 Choice of regression model

As previously explained, we have reshaped our survey data to take the form of panel data with the time variant variable being *Deductible*. The categorical nature of the dependent variable implies that there is a requirement for a model that can capture the different intervals. We considered two different approaches for our research, an interval regression model and an ordered probit model, where we chose to proceed with the former. This is a common method used when the dependent variable is continuous and bound to intervals. The ordered probit model would be more challenging to interpret than our log-transformed interval regression, which enables a convenient baseline comparison of the variables. Furthermore, another drawback of the ordered probit model is that it is problematic to implement thresholds that represent the willingness to pay for the insurance in the model, and without correct thresholds it is difficult to draw any reliable conclusions.

The interval regression takes the lower and upper bounds of the interval as input and our dependent variable WTP is bound within the intervals of 0 – 49, 50 – 99, . . . , 200 – 250 NOK. Furthermore, WTP changes over three "time periods", which are represented by the different questions regarding the deductible the individual is faced with. Lastly, an assumption is that the error terms follow a normal distribution (Cameron et al., 2010, p.522).

In order to fit the interval regression to our data we have adopted a random-effects regression model to the panel data using the *xtintreg* command in STATA. We accounted for random-effects because we assumed that there was some random variation among the individuals that was affecting the outcome. This was beneficial because it allowed us to account for heterogeneity between the respondents, which is variations within and between the objects in the panel data. The dependent variable WTP is as specified in section 3.2 divided into two separate bounds, $log(WTP_{lower})$ and $log(WTP_{upper})$, which represent the lower and upper bounds in the panel data. Furthermore, the dependent variable is only observed if it falls into the specific interval, meaning the true value of the dependent variable is not directly observed. Instead, the model checks if the dependent variable falls within a certain range.

4.2 Model specification

The aim of our interval regression was to capture the latent willingness to pay (WTP) for small insurance contracts within the Norwegian population. We have used the following model for our estimation:

$$\begin{aligned} WTP_{it} =& log(WTP_{lower})_{it} + log(WTP_{upper})_{it} + \beta_0 + \beta_1 Gender_i + \\ & \beta_2 Education_i + \beta_3 Age_i + \beta_4 Family\_Lifecycle_i + \\ & \beta_5 Income_i + \beta_6 Occupation_i + \beta_7 Urban_i + \beta_8 Region_i + \beta_9 Deductible_t \\ & \beta_{10} Aversion\_level_i + \eta_i + \epsilon_{it} \end{aligned}$$

The gender dummy was meant to pick up differences in willingness to pay for small insurance contracts between men and women. We have included the gender dummy mainly because previous research has found that there is to a larger extent an aversion towards risk from women relative to that of men. In the regression we also controlled for the respondents' age to account for the potential of different insurance preferences among different age groups, since people tend to become more risk-averse with age (Hartog et al., 2002). The variable *Income* was included to account for differences between households' income levels. As risk aversion is assumed to be decreasing with wealth, this suggests that the willingness to pay for small insurance contracts should decrease as the variable *Income* increases.

In the regression, we also controlled for various other socioeconomic factors. The role of these control variables was to account for differences that might occur due to place of residence, attained level of education, and so on. For instance, level of education has shown to negatively influence a person's risk aversion (Hartog et al., 2002). The variable

Family_Lifecycle might impact the decision to sign a small insurance contract. Intuitively, family specific factors such as having young children can encourage a person to purchase a small insurance contract. Furthermore, it is natural to assume that a person's occupation will influence her willingness to pay for an insurance contract. For example, a student will likely have a different willingness to pay compared to a white-collar worker since an accident will affect them differently financially. Finally, we controlled for the area of residence and urbanization.

The random effects are represented by η_i and ϵ_{it} is the unobserved effects. The random effects capture unobserved individual heterogeneity (Greene, 2003, p.416). Both these effects are assumed to be independently and identically distributed, i.i.d., which implies that from a population each object is equally likely to be drawn and the distribution is the same for each randomly drawn object in the panel (Stock and Watson, 2015, p.90).

As explained in section 3.2 the variable *Aversion_level* was meant to show how the risk preferences among the respondents altered their *WTP* for a small insurance contract. There are several reasons to include a variable for the respondents' risk aversion. Intuitively, it is assumed that a more risk-averse individual is more likely to be willing to pay a larger amount to avoid bearing risk themselves whereas a less risk-averse individual is willing to bear more risk and would therefore exhibit a lower *WTP* for insurance (Pratt, 1964). Moreover, *WTP* should be correlated with the time variable *Deductible* since the deductible allows the individual to bear a portion of the risk.

Furthermore, we also conducted a regression model with an instrumental variable in order to handle potential issues of endogeneity. Problems of endogeneity arise when the control variable is correlated with the residual, or when there is a two-way causal relationship between the control variable and the outcome variable (Stock and Watson, 2015, p.471). This makes it difficult to determine which variable is causing an effect. In our model, this endogeneity problem could possibly occur for the variable *Aversion_level*. For example, there might exist unobserved effects that are correlated with this variable. Intuitively, people who previously experienced a need for insurance might exhibit greater risk aversion than those who have never needed insurance. We therefore chose to use *Gender* as an instrument on *Aversion_level*. We first conducted an interval regression with *Aversion_level* as the dependent variable since it is structured with intervals from

$(-\infty, 0], .., (6.84, \infty)$ and with *Gender* as an independent variable alongside the other socioeconomic factors. After that we estimated a prediction from this regression that is captured in the variable $\widehat{RA}$, which is our instrumental variable (IV) estimator, with the help of the postestimation command *predict* in STATA. Next, we used $\widehat{RA}$ in our initial regression as a substitute for the potentially endogenous *Aversion_level*. Further, *Gender* was excluded from the final regression as it was assumed to effect willingness to pay through $\widehat{RA}$ only. The instrument is supposed to only impact the dependent variable through the treatment, not in any other way and should be uncorrelated with the residual. This assumption is called the exclusion restriction , and this must be satisfied for an instrumental variable strategy to produce unbiased estimates (Wooldridge, 2015, p.509). The described model is specified as follows:

$$
\begin{aligned}
WTP_{it} = & log(WTP_{lower})_{it} + log(WTP_{upper})_{it} + \beta_0 + \beta_1 \widehat{RA}_i + \\
& \beta_2 Education_i + \beta_3 Age_i + \beta_4 Family\_Lifecycle_i + \\
& \beta_5 Income_i + \beta_6 Occupation_i + \beta_7 Urban_i + \beta_8 Region_i + \beta_9 Deductible_t + \eta_i + \epsilon_{it}
\end{aligned}
$$

5 Results

In this section we present the results from our regression models. We start with the result from the first regression model, explain the significance of this result, and interpret the estimated coefficients. Then we declare the level of significance and estimated coefficients of the second regression with the added instrumental variable estimator.

5.1 Random-effects interval regression

In table 5.1, the results from our random-effects interval regression are shown and they are derived from the first model presented in section 4.2. The table presents coefficients with corresponding standard errors and p-values for every variable. The constant is equal to 4.23 and the estimated standard error (σ_ϵ) of ϵ_{it} is equal to 0.35. Since our model assumes ϵ_{it} to be independent and identically distributed, we can calculate the willingness to pay when all variables are equal to the baseline values, which are omitted in the regression table. This is computed as follows: $WTP = e^{(4.23+0.5*0.35^2)} = 73.058$ NOK. Thus, the expected interval for willingness to pay when all variables are equal to their baseline values is *50 to 99* NOK.

Table 5.1: Random-effects interval regression

	Dependent variable:			
	$log(WTP_{lower})$ *and* $log(WTP_{upper})$			
	Coefficient	Std. err	z	P>|z|
Income				
500 000 to 999 999	-0.27	0.09	-3.09	0.002**
$\geq$ 1 000 000	-0.36	0.11	-3.12	0.002**
Prefer not to answer	-0.17	0.10	-1.71	0.087
Deductible				
500	-0.17	0.03	-6.57	0.000***
2000	-0.37	0.03	-13.63	0.000***
Aversion_level				
0 to 1	0.38	0.27	1.37	0.171
1 to 2	0.38	0.18	2.17	0.030*
2 to 3.76	-0.05	0.16	-0.34	0.737
3.76 to 6.84	0.15	0.16	0.96	0.340
6.84 to ∞	0.21	0.15	1.39	0.165
Gender				
Man	0.05	0.07	0.80	0.422
Age				
35-49	-0.34	0.10	-3.34	0.001***
50-64	-0.48	0.15	-3.20	0.001***
Education	Yes			
Region	Yes			
Family_Lifecycle	Yes			
Urban	Yes			
Occupation	Yes			
Constant	4.23	0.23	18.06	0.000***
σ_u	0.82	0.03	24.48	0.000***
σ_ϵ	0.35	0.01	30.31	0.000***
ρ	0.84	0.01		

Note: *Level of significance:* $^{*}p \leq 0.05$ $^{**}p \leq 0.01$ $^{***}p \leq 0.001$

For the variable *Income* we observe that *500 000 to 999 999* NOK and greater than or equal to *1 000 000* NOK are significant at the one percent level. Furthermore, the former has a coefficient of negative 0.27 and the latter a negative 0.36. This is interpreted as follows: When the income of an individual is between *500 000 to 999 999* NOK the individual's *WTP* for the insurance is 27 percent lower than an individual earning less than *500 000* NOK. Moreover, an individual with an income greater than or equal to *1 000 000* NOK has a *WTP* that is 36 percent lower.

The results show that *Deductible* is significant at the one percent level for both the *500* NOK and the *2000* NOK deductible alternatives. The coefficient for the deductible of *500* NOK is negative 17 percent and the standard error is 0.03. This implies that the *WTP* for the middle deductible is 17 percent lower compared to when the deductible is zero. For the *2000* NOK deductible the coefficient is negative 0.37 with a standard error of 0.03. Thus, the *WTP* for insurance is 37 percent less when the deductible is equal to *2000* NOK compared to the baseline.

As we can see the variable $Aversion\_level$ does yield a significant result when the aversion level is between one and two, which is significant at the 5 percent level. However, all other degrees of risk aversion are not significant at any level. Since only one level of risk aversion is significant it will have limited value in our analysis. Nevertheless, the significant result shows a coefficient of 0.38 with a corresponding standard error of 0.18. This implies that an individual that has a risk aversion level between one and two would be 38 percent more willing to pay for the insurance than an individual that is close to risk-loving or risk-neutral.

Of the control variables added to our regression model, *Age 35-49* and *Age 50-64* are significant at the one percent level with a coefficient of negative 0.34 and negative 0.48 respectively. The interpretation is that the older respondents exhibited a lower *WTP* for insurance compared to the youngest age group in the survey.

5.2 Random-effects interval regression w/ IV estimator

In table 5.2 we present the results from our random-effects interval regression with the IV estimator $\widehat{RA}$, which was supposed to capture the effect of *Gender* on *WTP* through *Aversion_level* as explained in section 4.2. The interpretation of the constant and σ_ϵ is the same as previously. Hence, willingness to pay is in the interval of *100 to 149* NOK because $WTP = e^{(4.84+0.5*0.35^2)} = 134.458$ NOK.

Table 5.2: Random-effects interval regression w/ IV estimator

	Dependent variable: $log(WTP_{lower})$ *and* $log(WTP_{upper})$			
	Coefficient	Std. err	z	P>|z|
Income				
500 000 to 999 999	-0.23	0.09	-2.61	0.009**
$\geq$ 1 000 000	-0.38	0.13	-2.86	0.004**
Prefer not to answer	-0.13	0.10	-1.28	0.200
Deductible				
500	-0.17	0.03	-6.57	0.000***
2000	-0.37	0.03	-13.63	0.000***
Age				
35-49	-0.27	0.13	-2.13	0.033*
50-64	-0.32	0.24	-1.32	0.187
$\widehat{\mathbf{RA}}$	-0.07	0.09	-0.76	0.449
Education	Yes			
Region	Yes			
Family_Lifecycle	Yes			
Urban	Yes			
Occupation	Yes			
Constant	4.84	0.54	9.03	0.000***
σ_u	0.82	0.03	24.49	0.000***
σ_ϵ	0.35	0.01	30.31	0.000***
ρ	0.84	0.01		

Note: *Level of significance:* $^{*}p \leq 0.05$ $^{**}p \leq 0.01$ $^{***}p \leq 0.001$

For *Income* between *500 000 to 999 999* NOK, the *WTP* for insurance is 23 percent lower than for *Income* below *500 000* NOK and this is significant at the one percent level. Given *Income* greater than or equal to *1 000 000* NOK the *WTP* for insurance is 38 percent lower than the baseline. The corresponding standard errors are 0.09 for the former and 0.13 for the latter. Furthermore, the category *Prefer not to answer* is not statistically significant at any level.

The *500* NOK and *2000* NOK categories of the variable *Deductible* are statistically significant at the one percent level and both have a standard error of 0.03. With a deductible of *500* NOK the *WTP* is 17 percent less than for an insurance contract without a deductible. Alternatively, the option with a *2000* NOK deducible leads to a *WTP* that is 37 percent lower than the zero deductible insurance contract.

The intrumental variable (IV) estimator $\widehat{RA}$ is not significant at any level. Therefore, the discussion will focus on our inital regression in section 5.1. Furthermore, from the variables controlling for socioeconomic characteristics, the variable *Age* is significant at the five percent level in the category $35 - 49$ while the $50 - 64$ category is not statistically significant. As observed in the first regression the older age group had a lower *WTP*.

6 Discussion

6.1 Implications of the analysis

The analysis conducted in this paper did not yield significant results for risk aversion on willingness to pay, with the exception of when the aversion level was between one and two, as mentioned in section 5. Given that only one of the six categories of risk aversion proved significant we can not make claims about the relationship between risk aversion and willingness to pay observed in this analysis. Nevertheless, the result is worth discussing from the perspective of the economic literature presented in section 2.

Remember that the certainty equivalent measures how large a certain loss must be for an agent to be indifferent between suffering a loss or accepting a corresponding lottery with a negative payoff, as discussed in section 2.1.2. The size of the certainty equivalent depends on the agent's degree of risk aversion. Intuitively, a more risk-averse agent should be willing to pay more to eliminate a risk. However, our findings are not sufficient to support this intuition.

One possible explanation is the second order phenomenon that applies to risk aversion in expected utility theory. In section 2.2.3 we used the arguments of Eeckhoudt et al. (2005) to show that when considering small enough risks, risk-averse agents behave like risk-neutral agents. Thus, if the respondents of the survey deemed the risk sufficiently small, we would expect them to answer independently of their risk aversion. Importantly, the measure used for risk aversion was obtained separately from the willingness to pay. Therefore, if the second order phenomenon holds we would not expect the level of risk aversion to be statistically significant.

However, Segal and Spivak (1990) pointed out that the second order phenomenon is limited to expected utility models. Hence, the assumption that utility functions are concave must hold for it to be a reasonable explanation for the observed results of risk aversion. In this paper we have examined prospect theory, which is an example of a model where the utility function is not concave.

Moreover, the variable *Deductible* did provide significant results. Recall that in section 2.1.1 we used equation (2.1), based on Eeckhoudt et al. (2005), to argue that risk-averse expected utility maximizers would prefer to receive the mathematical expectation of a lottery with certainty over the lottery itself. Thus, we would expect to find a willingness to pay that equals, or exceeds, the actuarially fair premium. When there is no deductible the actuarially fair premium can be computed as follows: $\frac{7000 * 0.2}{12} = 166.6$ NOK, which is the probability of a loss times the value of the insurance object. This is divided by twelve to obtain the monthly actuarially fair premium. Furthermore, when the deductible is 500 NOK the fair premium is $\frac{(7000 - 500) * 0.2}{12} = 108.3$ NOK, and finally when the deductible is 2000 NOK the fair premium is $\frac{(7000 - 2000) * 0.2}{12} = 83.3$ NOK.

As mentioned in section 5, we can observe from table 5.1 that the willingness to pay was within the interval of *50 to 99* NOK when all variables equaled their baseline values. A deductible of 500 NOK reduced the willingness to pay by 17 percent, meaning the willingness to pay became $e^{(4.23-0.17+0.5*0.35^2)} = 61.636$ NOK, which naturally corresponds to the interval of *50 to 99* NOK. Further increasing the deductible to 2000 NOK instead reduced the willingness to pay by 37 percent, which still resulted in the interval of *50 to 99* NOK because $e^{(4.23-0.37+0.5*0.35^2)} = 50.463$ NOK. Hence, the willingness to pay was lower than the actuarially fair premium for each level of deductible.

Furthermore, we observed the expected relationship of decreasing willingness to pay when the deductible increased. Notably, Moffet (1977) found that the optimal level of deductibility should be connected to an individual's level of wealth. Specifically, the deductible should go in the same direction as wealth. This argument is supported by our findings since the willingness to pay is negatively correlated with income, and the effect is stronger for the highest level of income. As presented in section 2.4, the increased income could cause an individual to be more willing to bear a portion of the risk herself, shifting the risk exposure from the insurance company to the policyholder.

Moreover, considering that the respondents were presented with three different questions each with a new deductible, it is possible that the *framing* of the survey affected their answers as Richter et al. (2019) found in their research. *Framing* could have affected the survey respondents in several ways. Firstly, the *anchoring effect* might have been present since the first question presented was the one with full coverage and this is inherently when the highest willingness to pay should be observed. As explained in section 2.3 there is a possibility that the respondents found it challenging to come up with a fair premium, especially for the 2000 NOK deductible. Richter et al. (2019) argued that normally people prefer to do simple calculations, which might have led to faulty estimates with the high deductible. Secondly, the survey presented a hypothetical scenario where the individuals were asked to insure a mobile phone. However, they were not given one and thus, the *endowment effect* is not present. It can be argued that the individuals would have overvalued the mobile phone if it was in their possession.

Interestingly, comparing our results with those of Sydnor (2010) reveals that participants in our survey expressed a much lower willingness to pay. In fact, we found an expected willingness to pay below the actuarially fair premium. Importantly, our results are based on responses to a theoretical insurance contract, whereas Sydnor inferred his findings from observed real insurance contract purchases. Thus, it is not surprising that Sydnor found a larger willingness to pay, since insurance is usually sold with a premium above the actuarially fair premium to cover the cost of administrative work and fund allocation, as mentioned in section 1.1. Furthermore, the effect of *sales agents* does not apply to our result. *Risk misperception* should not apply either, because the likelihood of an accident was explicitly stated in the survey. On the other hand, the *menu effect* was likely present. However, as described in table 3.1, the lowest interval of willingness to pay was the most frequently selected option. Therefore, we can assume this effect was small.

Additionally, because our findings suggest the willingness to pay for the insurance contract is lower than the actuarially fair premium, expected utility theory does not hold for our observations. This follows from the preferences of risk-averse expected utility maximizing agents explained in sections 2.1.1 and 2.4, specifically that these agents prefer the certainty an insurance contract with an actuarially fair premium provides over the mathematical expectation the premium is based upon. In table 3.2 we can observe that 94.25 percent of the respondents to our survey exhibited characteristics of risk aversion. However, our observations can potentially be explained by Gul's (1991) disappointment aversion model. This model is normally used to explain why full insurance is purchased above the actuarially fair premium. Although, as discussed in section 2.5.1, the opposite is true when the beta coefficient in the model is negative. Thus, if the respondents overweighted the positive outcome of not needing the insurance, this could explain why the willingness to pay was below the actuarially fair premium. Then the respondents would be considered elation seeking.

Prospect theory offers an alternative explanation for the observed willingness to pay. Recall that in section 2.5.2 we discussed how the convex shape of the value function for losses is an argument against purchasing insurance, since the marginal value is greater for the insurance premium than the economic loss suffered in the event of an accident. Whereas the main argument in favor of purchasing insurance is the tendency for agents to overweight unlikely outcomes (Kahneman and Tversky, 1979). Consequently, prospect theory can explain our results if the price sensitivity caused by the convexity of the value function for losses had a stronger effect than the tendency to overweight unlikely outcomes. Overall, the participants in the survey exhibited preferences that are inconsistent with expected utility theory but can potentially be explained by prospect theory or disappointment aversion.

Lastly, we found that income had an impact on the willingness to pay for small insurance contracts in Norway. Moffet's (1977) model illustrates that as an individual's wealth increases, she should be less willing to pay for insurance. Furthermore, the studies of both Huber et al. (2023) and Hamal and Anderson (1982) found that wealth had negative impact on risk averison. Our findings are consistent with these studies, which all support the assumption of decreasing absolute risk aversion.

6.2 Empirical limitations

In this section we discuss the weaknesses of the methodology used in our analysis with the aim to increase the transparency of the research conducted.

We assumed that the data in our sample was representative of the Norwegian population because we controlled for a wide range of socioeconomic characteristics. However, there might have existed systematic differences between the respondents in the survey and the general population. Specifically, one common weakness of public survey data is that we can not control who responds, meaning people with an interest in the topic are more likely to fill out the survey. Thus, our sample might have been better informed and exhibited a different willingness to pay than the population as a whole. Naturally, this could impact the reliability of the study. The deficiency that occurs when a sample is not a perfect representation of the population is called a *sampling error*.

Another limitation is the potential problem of endogeneity in our model. As discussed in section 4.2, problems of endogeneity arise when a control variable is correlated with the residual, or when there is a two-way causal relationship between the control variable and the outcome variable. In our model it is possible that the variable $Aversion\_level$ suffered from the endogenity problem, something we attempted to correct for with an IV estimator in the second model. However, since the IV estimator did not yield statistically significant results we can not draw any reliable conclusions about the effect of risk aversion on willingness to pay. Consequently, our results might exhibit biased estimates. Therefore, we must be careful to give a causal interpretation to the coefficients.

7 Conclusion

The purpose of this thesis was to examine the effect of deductible, risk aversion and income on the willingness to pay for small insurance contracts in the Norwegian market. To answer our research question, we conducted a random-effects interval regression on panel data with willingness to pay as the dependent variable. Of the key explanatory variables used, *Deductible* and *Income* yielded statistically significant results in alignment with findings from previous literature. In expected utility theory, an increase in income is assumed to lead to a lower willingness to pay for a small insurance contract. This is explained by the concept of DARA, which is supported by our findings. Furthermore, as the deductible increased, the coverage of the insurance contract decreased which reduced the actuarially fair premium. Thus, our result of negative correlation between *Deductible* and *WTP* is indeed the expected outcome. The final key explanatory variable used is *Aversion_level*, which proved to not be statistically significant and it is therefore of limited use in the interpretation of our results.

We have presented several possible explanations for the result of the risk aversion variable. Traditional literature could explain the result using the arguments of second order risk aversion where risk-averse individuals who maximize expected utility behave in a risk-neutral manner when considering sufficiently small risks. On the other hand, recent literature can be used to argue that our observed result is caused by behavioral biases among the participants, such as the *anchoring effect*. This bias might have trumped the effect of risk aversion, especially when considering a small risk presented in a theoretical setting. Another consequence of the theoretical setting used to present the small insurance contract is that other behavioral effects, such as the *endowment effect*, *risk misperception* and the *role of sales agents*, were absent from our results but may impact results inferred from real-life decisions.

Further research could examine the willingness to pay for small insurance contracts on singular items in countries other than Norway, preferably countries with differently structured insurance markets. Moreover, it would be interesting to do an experiment in collaboration with a large department store or insurance company that sell small insurance contracts, allowing for a more detailed analysis on the behavioral effects.

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Appendix

A1 Appendix A

Table A1.1: Appendix A

	Statistics
Number of observations	904
Income	
0 to 499 999	28%
500 000 to 999 999	35%
Over 1 000 000	16%
Prefer not to answer	21%
Gender	
Male	51%
Female	49%
Age	
18-34	35%
35-49	34%
50-64	31%
Education	
Secondary education	6%
High school	38%
University 1-3 years	31%
University 4< years	24%
Prefer not to answer	1%

Region	
Oslo	15%
Innlandet & Viken	30%
Agder & Sør - Østlandet	12%
Vestlandet	26%
Trøndelag/Nord-Norge	17%
Family Lifecycle	
Pre-family	36%
Young family	14%
Adult family	24%
Active empty nesters	23%
Senior citizens/In-active empty nesters	3%
Urban	
Large City	18%
Town with more than 50.000	31%
Town 5000 to 49.999	33%
Rural area with less than 5000	17%
Do not know	1%
Occupation	
Unemployed	22%
Student	14%
White-collar 1-3 years	27%
Blue-collar 4< years	25%
Self-employed	4%
Other	8%