UiT The Arctic University of Norway

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Behavioral sunk cost

Subsequent choices with prior investment

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Figure 1 - UiT students. Photograph by Marius Fiskum.......**Feil! Bokmerke er ikke definert.**

Foreword

As this master thesis marks the long years I’ve been Tromsø, at the arctic university. I would like to express my gratitude to friends and family for their patience. I would especially like to thank my supervisor, Andrea Mannberg, for giving me this task, and providing guidance along the way.

1 Introduction

As I’m writing this paper I manage to dig deep into some sections, as a result I care for the result of that piece being represented properly, the visual representation of seeing what has been achieved from so much time spent into that one section. That amount of notation, citation from different sites gathered, worked over and over to make up a small paragraph in the paper. why can’t I let it go? The tendency to invest resources such as, money, time, and effort into something that increases the means of utilizing that “something.” That “something” can be a car, relationship, thesis, or whatever creates a perception of an investment that can be cared for.

The phenomena described above is the sunk cost effect, a hypothesis established by Thaler (1980). The sunk effect is well documented in both economics and psychology, and research has provided support and rejection of the hypothesis in addition to evidence of a negative sunk cost. The sunk cost effect is more documented in hypothetical scenarios with monetary investments, and less so with behavioural investment. The existing literature have left small cracks and gaps to fill here and there, for which this thesis tries to address one of them.

As the current literature is well covered for monetary investments, and hypothetical scenarios, leaving participants with a lottery as a prize or premium for participation. For most incentivized experiments, the object of interest lies in the choice of pursuing a prize, subsequent decisions made after an endeavour, with outcome in terms of risk-free alternatives, or probabilistic alternatives. the crack lies in a combination of these, this paper investigates the sunk cost in an incentivized experiment of two parts, an endeavour in terms of behavioural investment, consequently faced with a decision with both a risk-free and a risky alternative.

From the experiment I analyse the sunk cost effect with two hypotheses: the first, answer if the size of the endeavour is affecting the probability of accepting a risky bet. The second, answers if the relevance of the sunk cost is affecting the probability of accepting a risky bet. These two hypotheses are tested with both bivariate using a contingency table, and multivariate analysis using a logit model. These two analytical tools are chosen because the outcome variable and the treatment condition variables are both dichotomous. We do not find significant results for the first hypothesis, however, the direction of association regardless of its significance is not as anticipated, the negative direction is consistent with the bivariate and multivariate. we do find consistent significant results for the Relevance of the sunk cost having a positive direction of association for accepting a risky bet.

The structure of the thesis is as follows, section two reviews economic theory explaining why the sunk cost should not occur, in addition to theories explaining how it might occur and perceived. The third section, highlights previous findings from the existing literature, and maps out the gap for the current research. The fourth section explains the current research. Followed by a review of the experiment, the introduction of the estimated sample, and explanation of the analytical procedures in section five. Section six explains the result, followed by discussion and conclusion in section 7.

2 Theoretical background

2.1 Consumer choice

As a characterization of rational behaviour, in neoclassic economics we describe the preference relation to an economic agent with three properties.

Completeness

Given that there are two alternatives, A and B. the first axiom says that the individual always has an opinion on the matter. That is, the individual can state "I prefer A to B," or "I prefer B to A," or "I think both alternatives are equally attractive," for which states indifference. If the individual does not exhibit completeness, then the individual will be paralyzed by indecisiveness.

Transitivity

This axiom explains consistency in the individual's decision making. If A is preferred to B, and B is preferred to C, consequently, A is preferred to C. If transitivity does not hold, then it would result in an endless loop of indecisions. Such as the case when, C is preferred to A.

Continuity

A technical assumption to analyse individual's response to relatively small changes in price and income. This axiom also carries an important feature about convex preferences.

If these three axioms are satisfied, then the individual whose preferences are being characterized is said to be a rational economic agent. Someone who pursues his subjectively defined preferences optimally. In order to optimize wealth optimally, two additional assumptions need to be introduced. First, agent exhibits non-satiation, the individual will always prefer more of a good than less. Second, utility functions are assumed to be quasi-concave, this assumption carries the property that such a function takes on a value greater than any specific constant is a convex set. That is, all combinations of x and y that are preferred or indifferent to a particular combination x^*, y^* form a convex set.

Given the three axioms are satisfied, we can measure the overall satisfaction received from consumption of a good, which is referred to as utility. by using a utility function, we can present how an individual rank the order of preference of the available goods. it is worth mentioning that the utility function is an ordinal utility function, for which displays, which good is preferred more and not how much more a good is preferred.

The individual will behave as he or she is maximizing utility subject to a budget constraint. To maximize utility the individual will spend all income on consumption, this is given by non-satiation assumption and is a condition for first order condition for a maximum. However, in order to maximize utility, the individual will not spend all income on simply one good, but allocate expenditures depending on the relationship between prices and the utility received from consumption. The prices are used as information about an opportunity cost, which is defined as the loss of utility given by the relative price differences between goods and the utility received from consumption. Thus, to maximize utility individuals will consume quantities of a good until the marginal utility received from a good is equal to the goods market price. this trade off is wat defines the marginal rate of substitution, the rate an individual is willing to trade a good to gain more of another good. The assumption of quasi-concave utility function is the equivalent to the assumption of a diminishing marginal rate of substitution.

OBS, the difference between the opportunity cost and the marginal rate of substitution:

The marginal rate of substitution describes the relationship between goods, in a two good model, the quantity of a good an individual is willing to give up for a quantity of another good.

The opportunity cost describes the relationship between goods in another way. The loss of utility, defined as the difference between prices and the utility received from consumption.

2.2 Choice under risk

The rational choice model and the model for choice under risk differs in the way that outcome is treated. The utility function in the rational choice model exhibits a ranking of preference order, since the outcome is known the outcome can be ranked dependent on the utility received from that outcome. In the model for choice under risk however, the outcome is probabilistic.

John von Neumann and Oskar Morgenstern laid out axioms of rational choice with the addition of independence of irrelevant alternatives that a rational individual will behave as they maximize the expected value of the utility function. that is, the expected utility function ranks lotteries based on how desirable they are and assigning them arbitrary value.

Independence of irrelevant alternatives
the axiom of independence of irrelevance, says that the decision maker is not affected by mixing both lotteries with the same third lottery in identical proportions

If an individual satisfies the axioms completeness, transitivity, continuity, and independence of irrelevant alternatives. The individual is said to choose the lottery that maximizes the expected value of their von Neumann-Morgenstern utility. We can illustrate a rational agent's behaviour in the event of a fair gamble with 50/50 chance of winning or losing. Let the utility function be represented by $U(W)$ where W is wealth. A lottery with equal probability of winning and losing k amount of dollars. Then we can mathematically represent the lottery:

$$E_x[U(W)] = \frac{1}{2}(W_0 + k) + \frac{1}{2}U(W_0 - k)$$

The assumption in the rational choice model of diminishing marginal utility gives the concave function for wealth, with Jensen's inequality we can derive to the result:

$$U(W_0) > E_x[U(W)]$$

This tells us that the individual's current level of wealth is higher than the certainty equivalent. That is, the concave function for wealth displays risk aversive preferences. This is illustrated graphically in figure 1.

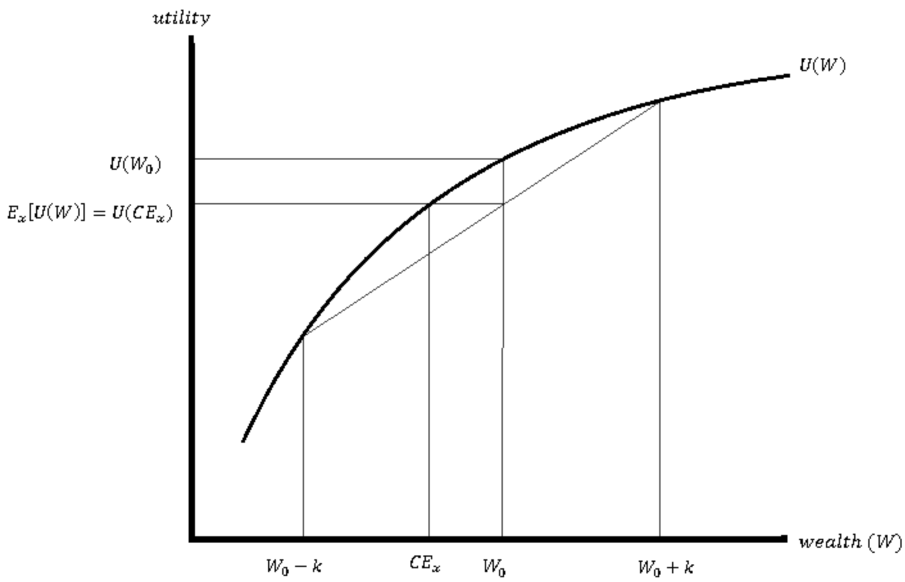

Figure 1 Risk aversion

For a risk-seeking individual, the shape of the utility function would be increasing convex function, to display risk-seeking preferences. Then by applying the Jensen's inequality we can show that the certainty equivalent will yield higher outcome than current wealth.

$$E_x[U(W)] > U(W_0)$$

Thus, a risk seeking individual will prefer to take the bet, because the utility received from taking the fair bet yields a more favourable outcome. This is illustrated graphically in figure 2.

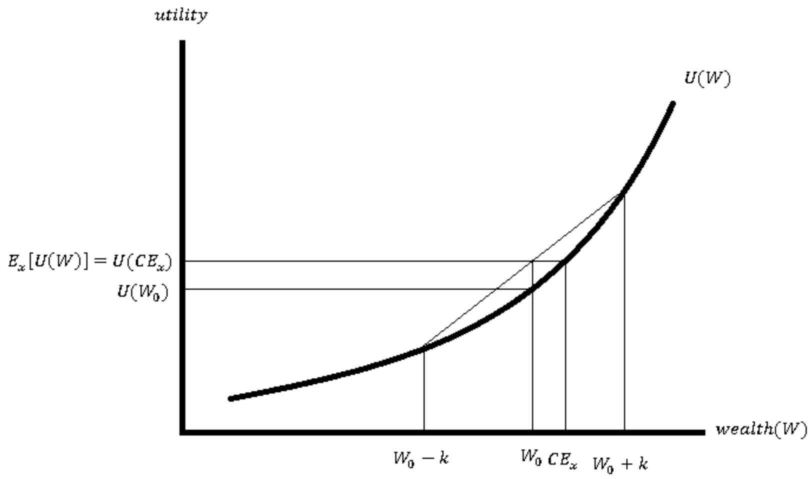

Figure 2 Risk seeking

The third individual who is indifferent will have neutral risk preference, for which the utility function in for this individual will be linear, and in this case, the certainty equivalent will be exactly the expected value of the outcome.

$$U(W_0) = E_x[U(W)]$$

That is, the individual is indifferent to taking the bet. This is graphically illustrated in figure 3.

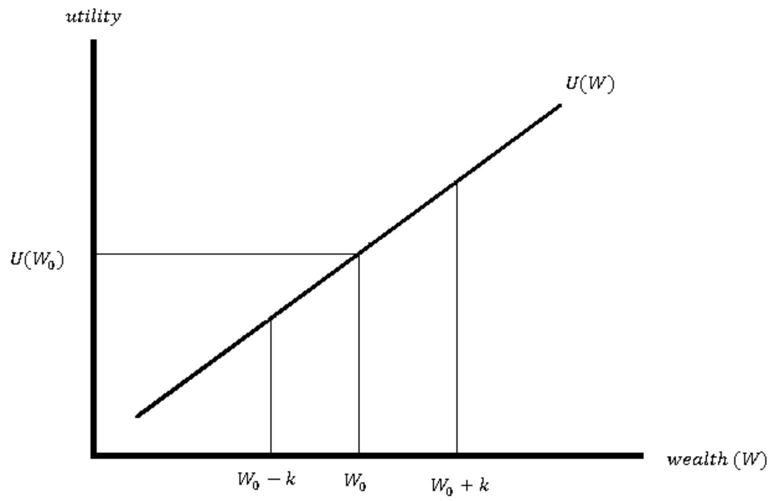

Figure 3 Risk neutral

2.3 Prospect theory

Prospect theory is choice model alternative to expected utility, for which it tries to describe and predict behaviour for individuals facing uncertain outcomes. The model relaxes the expectation principles, for which was observed to be frequently violated in expected utility theory. The theory is developed for simple prospect with monetary outcomes and stated probabilities

Expected utility theory use final states of wealth which makes the individuals exhibit risk aversive preferences, as explained by figure 1. However, this is not the case for most people, because people do not tend to operate with their entire wealth when considering prospects. Thus, the preceding models explains that individuals make decisions in a space for their current asset, rather their entire wealth. That is, people tend to think in terms of gains and losses. The use of a reference point allows psychology to play a role in the decision-making process, permitting framing effects to affect the representation of prospects, consequently, affecting the preference of the decision maker.

Three effects that are observed that lays the foundation for the model. Certainty effect, which describes the phenomenon where people overweight outcomes that are considered certain. By choosing a prospect yielding a lower certain value than a fair bet with probabilistic outcome, the individual violates the expected utility theory.

The reflection effect displays a shift of preference near the reference point, for which the domain below the reference point, the loss domain, the individual displays a reverse preference below the reference point. That is, the individual will display risk aversive preferences above the reference point, labelled the gain domain, for which the individual will choose a sure gain with a lower certain outcome over a probabilistic prospect yielding a higher gain with uncertain outcome. However, preferences reverse when in below the reference point, labelled the loss domain, displaying risk seeking preferences by choosing a probabilistic higher outcome over a smaller certain outcome.

The isolation effect shows the tendency for people to ignore the common features that prospects share and rather seek the differences between them.

The choice process in the preceding theory is comprised by two phases, editing and evaluation. The editing phase consists of the operations of coding, combination, segregation, and cancellation. And is done frequently to facilitate the task decision, because the individual subjectively frame and adjust the relevant prospects relative to the reference point. It is assumed that the individual will eliminate dominated or irrelevant prospects. That is, the editing phase is a simplification process of the relevant prospects.

the second phase in the choice process is the evaluation phase, consequently, the individual will choose the prospect yielding the highest value. the utility function in prospect theory is expressed in terms of two function, the weighting function, and the value function.

First, we introduce the value scale, referred to as the value function, which captures the subjective value of the outcome. the value function is defined by three properties, first, defined on deviations from the reference point, second, generally concave for gains and convex for losses, third, the value function is steeper for losses than for gains. Thus, it can be illustrated graphically, figure.4.

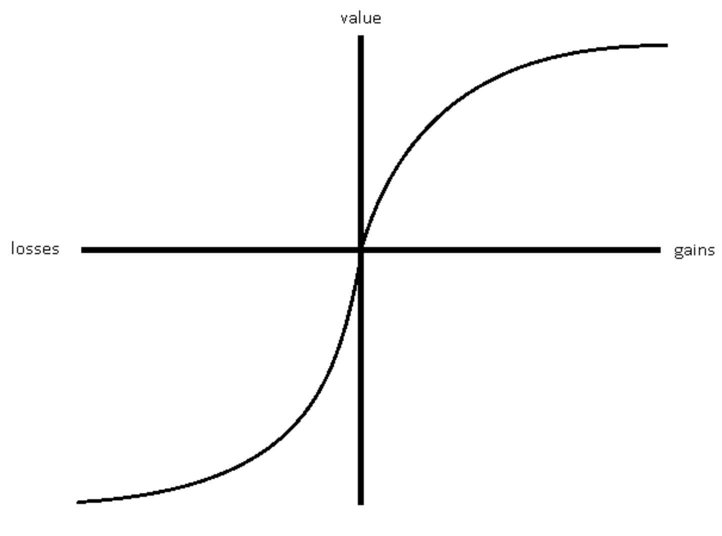

Figure 4 Value function

The value functions essential feature is that the carriers of wealth, reflects the current asset position rather than the absolute magnitude of wealth. That is, the value function captures the feature that people are more sensitive to change near the reference point. Consequently, referring to relative changes allows for the function to exhibit diminishing returns near the end points, which reflects the concavity in the gain domain and convexity in the loss domain. The loss domain being steeper than gain, reflects the fact that loss feels worse than a gain of the same amount feels good. though it should be noted that the value function presented in figure 4. Is based on responses to gains and losses in a riskless context.

The weighting function is a function that associates with the probability, although it is not treated as a probability, it works in similar manner, consequently, the weighting function interacts with the stated probability in the range [0,1]. By relating the decision weight to stated probabilities, the weighting function subjectively enhances the stated probability. The reasoning behind is that the certainty effect, which revolves from Allais paradox, makes the weighting function an increasing function of the probability. The salient property of the weighting function makes the obvious property of to the weighting function being zero in the event of an extremely low probability and being 1 when the outcome is considered certain.

Though, the weighting function mainly operates for high probabilities, there are sub assumptions for low probabilities, these subcategories capture some preferences from empirical findings. That is, for low probabilities the application of the weighting function becomes a sub additive function for probability, this implies that small probabilities are overweighted, consequently the certainty effect applies, for which under the assumption of subadditivity is referred to as sub certainty. This effect typically prevails for inconsistencies that arise from Allais type of preference. This feature characterizes the slop of the weighting function of uncertain events, the weighting function being regressive, making the preferences risk seeking for small probability gains and large probability losses, consequently, risk averse for small probability losses and large probability gains. The last assumption for small probability is labelled sub proportionality, which states, for a fixed ratio of probabilities, the ratio of the corresponding weights is closer to unity when the probabilities are low than when they are high.

The three sub assumptions entail that the weighting function is relatively shallow in the open interval and changes abruptly near the end points. The sharp drops or apparent discontinuities of the weighting function near the end points are consistent with the notion that there is a limit to how small a decision weight can be attached to an event. A similar quantum of doubt could impose an upper limit on any decision weight that is less than unity. This quantal effect may reflect the categorical distinction between certainty and uncertainty.

On the other hand, the simplification of prospects in the editing phase can lead the individual to discard events of extremely low probability and to treat extremely high probability as they were certain. Because people are limited in their ability to comprehend and evaluate extreme probabilities are either ignored or overweighted, and the difference between high probability and certainty is either neglected or exaggerated. Thus making the weighting function not well behaved near the end points.

2.4 Mental accounting

Mental accounting is a process of evaluation of the decision to execute a purchase, for which the behaviour is determined when the outcome is realized as either a gain or a loss.

In the consideration of a desired good to be purchase we open an account, for which a two-stage process takes place. First, the evaluation, comprised by acquisition utility and transaction utility. For which the acquisition utility considers three prices, the actual price charged for the good, the equivalent price, and the reference price of the good. Second, the purchase of the good is executed with a process of labelling specific good and expenditures are evaluated within their assigned categories. That is, the purchase is considered within a frame of temporal budget and grouped expenditures, for which the consideration is perceived as a paper gain the individual will execute the purchase.

The coding of outcomes is done through the value function that of Kahneman and Tversky (1979). The characteristics of the value function is described above, but in mental accounting the characteristics exhibit some important feature. The psychophysical principle is captured by the shape of loss and gain domain; it permits framing effects to affect choices. There are two ways to code joint outcomes, segregation, and integration. Coding of joint outcome was originally done hedonically, but as subsequent experiments resulted in a quasi-hedonic editing rule, for which was similar to hedonic editing with some exceptions. Multiple gains are segregated, multiple losses are segregated, smaller losses are integrated with large gains, smaller gains are segregated from large losses. In the case of prior events, prior gains, subsequent losses will be integrated, which displays risk seeking behaviour. Prior losses, subsequent losses will be segregated, for which displays risk aversion. However, when the opportunity to break even with a certain or risky prospect, risk seeking behaviour is displayed.

When the process above is performed, we can decide to close the account, for which the outcome of events will be realized. Whereas mental accounting favours closing accounts with perceived paper gain transferred to be realized gain.

3 Previous research on the sunk cost fallacy

The sunk cost hypothesis established by Thaler (1980) stating:

> "paying for the tight to use a good or service will increase the rate at which the good will be utilized"

Has been used as a benchmark for irrational decision making, to further investigate, where and how such behaviour exists. The documentation of the sunk cost is well reported in hypothetical scenarios, often with replication of the seminal paper, such as, Negrini et al., (2021) and Nash et al., (2019) report evidence consistent with Arkes and Blumer (1985). It is often a case in hypothetical scenarios for which the participants are coerced into choosing between two alternatives, which is usually to simplify the order of preferences, hence the completeness axiom. However, when incurred two sunk costs of different quantities for which the consumption of one good excludes the consumption of the other alternative, economic theory states that the individual should be indifferent between the two alternatives. Thus, when stating that one alternative yields a higher utility, the rational option favours the highest yielding alternative, regardless of the price.

Arkes and Blumer (1985) display a pattern of these hypothetical questions, for which rejects rational economic behaviour, they reason their findings with waste aversion. Readily translated into loss aversion, which might explain the popularity of prospect theory's value function. Roth et al., (2015) distinguishes between, utilization decision and progress decision. Which are often used in hypothetical scenarios. This type of two option decision scenarios occurs frequently in hypothetical scenario, which favours the use of prospects theory's value function because of its simple elegance in explaining preference between one or two prospects.

> A utilization decision focuses on a decision maker confronted with the choice between two equally attractive alternatives, such that preferences shift to the sunk cost alternative.
>
> In contrast, a progress decision is where the decision maker allocates additional resources to an initially chosen alternative, such that the sunk costs increase the likelihood of further fund allocation

Extensions have been introduced regarding incentivized experiments involving, certain and uncertain outcomes, temporal consumption, and behavioural investment. However, given the large literature on finding the sunk cost, explanations vary vastly, mainly because different experiments require salience and elimination of different variables. The following literature is to elicit the experiment presented in this paper.

3.1 resource sunk cost with certain outcome

Thaler (1999) implies from Arkes and Blumer's (1985) theatre experiment, for which displays behaviour consistent with the sunk cost effect in the first five plays out of ten, that people will eventually ignore the sunk cost. the reasoning behind this comes from Gourville and Soman (1998) where they show evidence indicating old money is more fungible than new money, in a study for payment depreciation and temporal consumption.

According to economics, time should be treated the same way as money, that is, equally fungible assets. However, there are studies reporting evidence of sunk cost effect, from incentivized experiments with behavioural investment.

Cunha and Caldieraro (2009;2010) found evidence of the sunk cost effect consistent with their prediction regarding their own model as an explanation for an underlying mechanism for behavioural sunk cost driver. Their BISC (behavioural investment sunk cost) model, which poses as an alternative to mental accounting. Their model is based on the theory of cognitive dissonance, where they introduce the effort justification mechanism. Their model operates with interaction between opportunity costs and the initial satisfaction for a given interval. As their model explains irrational decision making when the opportunity cost is low, their hypothesis was that when the initial satisfaction, defined as the BISC effect, of completing the initial endeavour would result in a lesser likelihood to switch to the dominating alternative. Thus, for when the opportunity cost presented as high "enough" the opportunity would offset the BISC value, resulting in the rational decision.

Sweis et al., (2018) conduct experiments of temporal consumption for mice, rats, and humans where they find evidence of the sunk cost in a foraging task. Their experiment involved a foraging task. The task for mice and rats revolved around a restaurant divided into four rooms, with rewards belonging to each respected room. The animals proceeded into the room entering the "offer zone" where they chose to either proceed to the next room or to enter a "waiting zone", consequently, entering the waiting zone and completing the time cost they earned their reward. The human task was of similar structure, a 30-minute analogous foraging paradigm, where the offer zone was replaced with four different galleries offering four different short videos of entertainment, and the waiting zone was replaced with a download bar. Flavours and genres were used as a function of cost for subjective preferences. With the option to quit when in the waiting zone, the time already spent waiting for the reward was measured as the sunk cost. Results from the experiment showed evidence of a robust sunk cost effects. Increasing prior investment amounts generated a continuously stronger sunk cost effect. That is, as the cost rose, the commitment to reward seeking behaviour with certain outcome increased.

Friedman et al., (2007) report evidence of stubbornness from their experiment involving hunting treasures from different islands on a given budget, participants could choose which islands they would like to stay longer to hunt treasures. Their experiment included a budget, for which the results indicated that participants would frequently stay longer on the islands reached with higher sunk costs. Although their result is inconsistent. The stubbornness is behaviour consistent with the commitment behaviour of Sweis et al., (2018).

3.2 monetary sunk cost with probabilistic outcome

Negrini et al., (2021) conducted an experiment regarding an incentivized investment task, involving two investment stages, with uncertain outcomes. Endowed with a currency of 10 the participants were divided into responsibility and no responsibility condition, for no responsibility condition. The conditions differed in a way that the computer did the initial investment decision for the participants in the no responsibility condition, whereas in the responsibility condition, they made the initial investment decision themselves. With a hypothesis stating, a higher likelihood of investing when the initial cost was more than zero than when initial cost was zero, the result indicated a reverse sunk cost bias, for which the likelihood of additional investment decreases with the size of the initial investment (the sunk cost).

3.3 resource sunk cost with probabilistic outcome

In an attempt to explain risk taking behaviour affected by prior costs and outcomes, Zeelenberg and Dijk (1997) report evidence ambiguous with respect to prospect theory, displaying risk averse behaviour in the loss domain, but in agreement and a stronger risk aversive behaviour in the gain domain.

Ronayne et al., (2021) conducted an experiment involving a cognitive demand task by counting Latin letters, whereas their finding is consistent with the sunk cost fallacy, in addition they include measurements of endowment effect which accounts for on third of the sunk cost effect. Their task revolved around counting Latin letters, by stating the correct number of letters 6 out of ten times yielded in a lottery. Once earning the lottery, they received an opportunity to accept a dominating lottery with twice the probability of winning chances. Their endowment group simply received the inferior lottery and then received the same lottery. To account for misunderstanding the task they added a control group, for which they simply stated which of the lotteries where more attractive.

Nash et al., (2019) had several studies in the pursuit of the sunk cost, but only their hypothetical scenario yielded the desired results. Study one which gave a reverse sunk cost effect, when asking the participant why they chose to continue the task, the majority of the answers replied that it was due to the probability. in their second study, which resulted in no sunk cost, the participants replied that they continued because the task itself was fun.

3.4 conclusion

Gourville and Soman (1998) proved that old money was more fungible than new money.

Cunha and Caldieraro (2009; 2010) proved that the higher the opportunity cost with interaction of initial satisfaction, the individual is more likely to switch to the rational choice.

Sweis et al., (2018) proved that the higher the cost for certain outcome the stronger the sunk cost becomes.

Negrini et al., (2021) showed results consistent with the quasi hedonic editing, with respect to Thaler, that the shape of the value function of prospect theory is perhaps even more steeper than originally predicted. Even though they find a reverse sunk cost in their incentivized experiment the same population sample indicated sunk cost behaviour in the replication of the hypothetical scenario that of Arkes and Blumer (1985). Similarly from Nash et al.,(2019) which also do not find evidence of sunk cost in the incentivized experiment but reports evidence consistent with the hypothetical scenario with Arkes and Blumer (1985)

Zeelenberg and Dijk (1997) display results consistent with the reverse sunk cost effect reported by Negrini et al., (2021) for which the individual in loss domain displays risk aversive preferences.

Ronayne et al., (2021) provide answers consistent with the sunk cost fallacy, and states that the endowment effect explains for roughly 1 third of the sunk cost effect. By including a endogenous task difficulty, for which contributes the participants a sense of achievement, similar to the result reported by Sweis et al., (2018), although these two differs from certain and uncertain outcomes, it can be reasoned with that the perception of utility perceived from the endeavour it self is enough outcome. this reasoning is given by a study on dopamine release from decision making in rats Saddoris et al., (2015) for which the results gave indication that cues predictive of available choices evoked dopamine release that scaled with the rat’s preferred choice dynamically shifted as delay to reinforcement for the large reward increased. Although this study is performed on rats, it generally applies to why endeavours give utility. such as the Lego task from the second study of Nash et al.,(2019).

From the small sample of literature represented here, it is mostly representative for the literature as whole. The documentation of the sunk cost effect is in large represented by hypothetical scenarios, and somewhat more ambiguous when presented in incentivized tasks, however, the results from the represented experiments remains more represented in the studies with certain monetary outcome, and less so in experiments with uncertain outcome.

4 Current research

Choice under risk was established by the von Neumann-Morgenstern utility theory, for which they proved by answering the St. Peterburg paradox, that an individual will always refuse a fair bet, the reasoning behind this is because that von Neumann-Morgenstern utility theory, codes probabilistic outcomes as final states of wealth.

Prospect theory explains by their use of the value function, that individuals codes event in terms of gains and losses relevant to a reference point, for which is the current asset position. Thus allowing framing of events to affect consequent decision making. And explaining that individuals will be risk seeking in the event of prior losses and loss aversive in the case of prior gains.

Mental accounting by Thaler (1980;1985;1990;1999) shows that individuals separate transaction to respective events of the incurred cost, for which the individual evaluate subsequent decisions, in relation to the accounted cost. I the extension of mental accounting, Thaler and Johnson (1990) shows that the value function, that of prospect theory, is even steeper than originally thought. Consequently deriving at the quasi-hedonic editing hypothesis, thus, indicating that the coding of subsequent losses with prior gains, result in risk seeking, and subsequent losses with prior losses will display risk aversive behaviour.

The quasi hedonic editing rule is supported by the findings of Negrini et al.,(2021) which find in their two stage investment task with prior loss or zero loss, that participants were risk aversive, consequently a reverse sunk cost effect.

Zeelenberg and Dijk (1997) conducted an experiment with hypothetical scenarios with uncertain outcomes, to further advance the prospect theory, their choices where in consistent to that tested to evaluate the prospect theory. in one of their conditions, their participants learned about the work before confronted with the choice, results displayed behaviour consistent with the quasi-hedonic editing rule, such that the participants were much more risk averse than participants in the behavioural sunk cost absent condition

The link between types of behaviour might lead to the uncertainty factor, “the devil you know versus the devil you don’t”, such elimination of uncertainty was proved to display a sunk cost effect in the event of temporal time investment with certain outcomes by Sweis et al.,(2018) for which they argue that given that mice, rats, and humans, are put in a reduced energy state which enhances the perception of the reward.

That is, the present research contributes the field by conducting experiment revolving behavioural investment in terms of time and effort, subsequently faced with a decision task with one certain and one uncertain outcome.

According to economic theory, individuals will equate marginal cost to marginal utility. the reasoning behind this is that the marginalism theory is based on the thinking of the last consumed good. for which the marginal utility consumed a good, will be equal to that goods price. that is, because of subjective preferences, the individual will place a subjective value on that good, such that the individual will consume different goods because the perceived cost is less than the utility received from the consumption of that good. Given the completeness, transitivity, and continuity axiom, which enables us to measure the individual’s utility received through a utility function, the utility function ranks the order of preferences for the available goods. the assumption in economic theory is that individuals will always seek to maximize this function, for which he will always pick the good which will result in the highest utility. That is, in the event of a historical cost, it should not affect decision making, because the rational agent will always chase the carrot in front, rather than the carrots left behind. Thus, for the case when it does happen, the individual will act irrational.

With this reasoning, in an incentivized task the irrational choice, applying ceteris paribus, for which, given that the preference is equally distributed among the different conditions, there should not be any sunk costs. In order to test this, the irrational choice will be the individuals not acting according to their preferences, thus, the reason behind the null hypothesis is, there is no difference between the different sunk costs conditions.

H0:
according to economic theory there is no difference between the sunk cost condition

Following the alternative hypothesis from Thaler (1980) the sunk cost effect, saying that a good will be more utilized after paying for the good.

> *H1.a: participants who experience high behavioural sunk costs are more likely to accept the risky bet than participants who experience low sunk costs.*
>
> *H1.b: participants who experience relevant sunk costs are more likely to accept a risky bet than participants who experience non-relevant sunk costs.*

5 Methodology

the purpose of the study was to test hypothesis H1a and H1b and was carried out as an online survey containing two parts. The first part is a game with a 2X2 design: High and Low sunk cost, Relevant and Irrelevant sunk cost. Participants was randomly assigned to different treatment conditions and rewarded with a premium, a head wear "buff" with a special design, for their participation. In addition, the participants could choose a design, of a t-shirt, for their second prize. After the participants were assigned, they played the game, where they put in time and effort, followed by a decision task with two alternatives. The risk-free alternative entailed keeping the earned premium. The risky alternative involved staking the earned premium in a game of chance to earn the chosen design for the prize. The second part containing a hypothetical scenario repeated five times with five different sunken resources.

The flow chart below illustrated in figure 1 describes the whole survey, I provide a detailed description if the different section of the survey below.

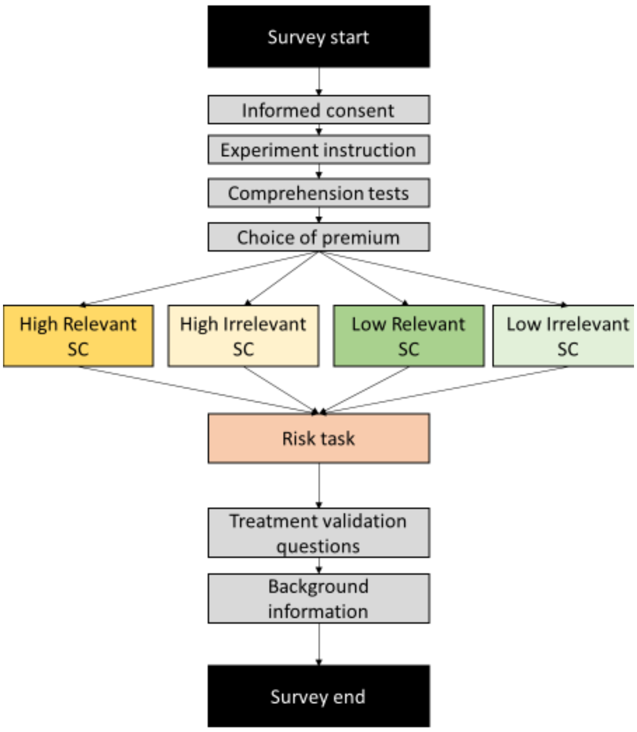

Figure 5. Flow chart illustrating sections of the survey

5.1.1 Participants

The participants where registered members of CARE (centre for avalanche research and education). The invitation to the survey was sent by email to those who was registered as backcountry / off poste skiers with address in Norway. The alternatives in the decision task were made to resemble alternatives when on backcountry touring, thus engaging the participants. The premium and prize are clothing used in backcountry environment, such that the participants can have value from the premium and prize. Members from Troms and Finnmark together with Møre and Romsdal were excluded from the invite for the purpose of inviting them to a follow up survey. The invitation went out to a total of 389 people, for which 193 of them accepted the invitation.

5.1.2 Experiment design

After accepting the invitation, the participants are met with a n instructional video combined with a text description, to ensure that the participants knew what each decision entailed. Consequently, tested on the subject, the risk-free alternative mean keeping the earned premium, the risky alternative involved staking the earned premium in a game of chance to win the price. The risky alternative could end in two outcomes different outcomes: unsuccessful outcome losing the earned premium, or successful outcome keeping the earned premium and receive the prize. After the comprehension tests the participants proceeded to choosing a design on the t-shirt of their choice, being the prize.

Then the participants were randomly assigned to one of four groups, and then played the incentivized game, Containing two tasks: the endeavour task, and the decision task. The endeavour task was a word puzzle and was about spelling words by clicking on letters that were moving inside a frame. To finish this task, the participants had to correctly click on the letter in the correct spelling sequence of the assigned word. Depending on the treatment condition, the game had different attributes. High and Low sunk cost differed in numbers of letters clicked to finish the game. High sunk cost had 150 letters, and Low sunk cost had 15 letters. Relevant and Irrelevant differed visually, Relevant sunk cost had a frame of a mountain where the letters moved with words associated with mountaineering, in addition they had an avatar moving for each letter correctly clicked. The difference between the Relevant and Irrelevant sunk cost condition is illustrated in figure 2.

Figure 6 visual difference between Relevant and Irrelevant sunk cost

In the Irrelevant sunk cost, participants clicked on words of no association to mountaineering and the letters of the words moved inside a black frame. The four treatment groups with their associated game attributes are:

1. High and Relevant sunk cost:
   150 letters; associated words; moving avatar; mountain frame.
2. High and irrelevant sunk cost:
   150 letters; no associated words; black frame.
3. Low and Relevant sunk cost:
   15 letters; associated words; moving avatar; mountain frame.
4. Low and Irrelevant sunk cost:
   15 letters; no associated words; black frame.

During this task the participants always had the option to abort the mission, in that case they proceed to the post experiment.

Following the endeavour, the participants proceed to the second part of the study, for which all the participants were presented with the same choice task. In the choice task, the participants were presented a scenery of an avatar facing a steep slope with two alternatives. This scenery is illustrated by figure 3.

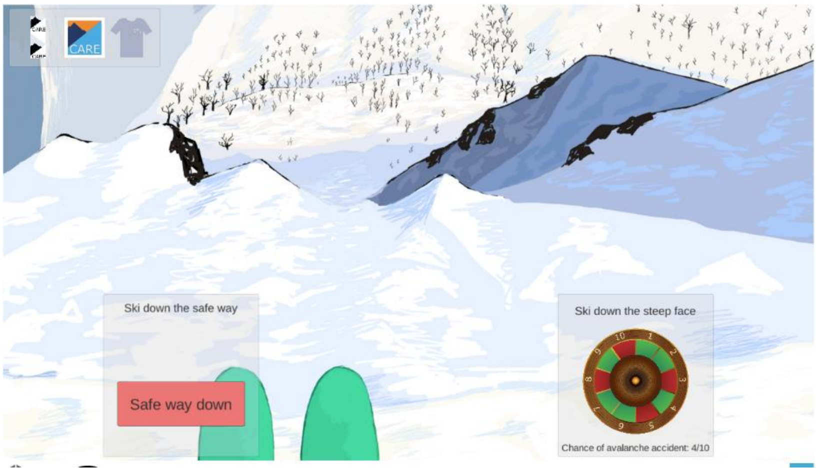

Figure 7 scenery of the choice task

The risk-free alternative results in skiing down safely from the mountain, no stakes were made, and the participants kept their earned premium. The risky alternative involved a probability of success displayed by a roulette wheel. The successful outcome had a 60% probability and results in a video displaying a skier skiing in good conditions down a steep face towards the company of the skier. The unsuccessful event had a 40% probability, and the result displayed a video of a skier being caught in an avalanche and ends up buried in snow. In the latter case, the participants were told that the skier is found only minutes after the incident, and that the skier was not harmed by the accident.

5.1.3 Control variables

The purpose of including control variable is that we predict that these variables have an affect on the participants choice. That is, I predict that risk preference, willingness to pay for the "buff" and the t-shirt, accidents related to avalanche terrain have an affect on participants choice. that is since the variables predicted to have an affect on the participants choice, I need to test the variables for difference between treatment groups, to single out any confounding factors that can affect the outcome of the estimation. Also I include variables where I want to see difference such as the NASA-TLX which is a measure of stated effort in: mental, physical, temporal, general, and frustration. These variables are measures from the game, and not included in the model.

After the game, the participants proceed to the post experiment, where they first answer treatment validation questions.

We use the NASA task load index (Hart and Staveland, 1988), the questions range in the interval from 0 to 20 and are stated effort from the endeavour involving: mental effort, physical effort, time related effort, effort in general, and frustration from the game. We use the NASA task load index (NASA-TLX), with purpose of measuring the perception of effort put in associated with risk taking decision.

The risk preference used in the study is Brief Sensation Seeking Scale (Hoyle et al, 2002). The questions range in the interval 1 to 7, regarding: exploring new places, restlessness when spending time at home, things that frightens them, wild parties, exciting friends, like new experiences even if it is illegal. The analyses presented in the paper revolve around a decision of risk, such that a variable for risk preference has the purpose of controlling for confounding factors.

5.2 Econometric approach

The purpose of the econometric approach is to establish causation between the treatment conditions and the dependent variable by testing hypotheses H1a and H1b. For the tests to be feasible, and results to be valid, the randomization has to work properly. The population in the data needs to be somewhat evenly distributed between treatment conditions. Consequently, the background variables and risk preference, needs to be within representative boundaries in each treatment condition to identify causation and minimize spurious association.

The dependent variable is a dichotomous variable taking the values 0 if the participants did not choose risk, and 1 if the participants chose risk, which is why a logit model is used in the multivariate analysis. I perform descriptive analysis to make sure that the participants are evenly represented in each treatment condition. The descriptive is not sufficient to ensure that the variables are not statistically different from zero, for which I perform a parametric test on the continuous variables, and a non-parametric test ordinal and Dichotomous variables. Continuous variables have the assumption of having a normal distribution, for which a student T-test is applied. I cannot assume a normal distribution for the ordinal and dichotomous variables as the scale is subjectively defined. A Kruskal Wallis test is applied, as it is more appropriate to test comparisons of medians rather than means (Kruskal and Wallis, 1962). The reason for these tests is to handle the difference in variables included in the multivariate analysis. If an overrepresentation of a variable is present, it can be removed, included, or held constant. This treated to make the interpretation of a sample representative for a whole population.

5.2.1 Bivariate analysis

Since the dependent variable and each of the treatment conditions are dichotomous variables, it makes it presentable in a 2X2 contingency table. From a contingency table we can calculate the probability, odds, and odds ratio, establishing both association and direction of association. Consider the alternatives r for risk and s for safe, chosen by participant n, in High sunk cost condition H, or Low sunk cost condition L. The probability for taking risk in the high sunk cost condition can be calculated as follows:

$$Prob(risk|high) = \frac{\sum n_{r,H}}{\sum n_{r,H} + \sum n_{s,H}} = P_{r,H}$$

$$Prob(risk|low) = \frac{\sum n_{r,L}}{\sum n_{r,L} + \sum n_{s,L}} = P_{r,L}$$

From the probability we can calculate the odds:

$$odds(risk|high) = \frac{P_{r,H}}{1 - P_{r,H}}$$

$$odds(risk|low) = \frac{P_{r,L}}{1 - P_{r,L}}$$

Then the odds ratio of choosing risk comparing high sunk cost condition to low sunk cost condition becomes:

$$odds\ ratio(OR) = \frac{odds(risk|high)}{odds(risk|low)}$$

From the odds ratio (OR) we can determine the direction of association. An OR greater than one indicates a positive direction of association between the dependent variable and the independent variable. An OR lower than one indicates a negative association between dependent and independent variable. And an OR of 1 indicates no direction of association. The significance of the association between the dependent and independent variable can be determined by Pearson’s chi-square test for given probabilities. Another type of chi-square test used is Yate’s continuity correction, however, this statistical test is recommended when the expected probabilities are lower than 5% for one or more cell, or less than 5 observations within a cell (missing REF).

5.2.2 Multivariate analysis

Although the bivariate analysis can achieve results of association and direction of association, it cannot control for background variables affecting the relationship between the outcome variable and the treatment variables. For example, the relative difference between willingness to pay for the “buff” and the t-shirt will affect the participants choice. A higher willingness to pay for the t-shirt compared to the “buff” indicate more outcome monetary incentives to take the risky alternative. A higher willingness to pay for the “buff” compared to the t-shirt indicates more monetary incentives to take the risk-free alternative. that is, a multivariate analysis is conducted to account for other variables affecting the relationship between the treatment variables and the outcome variable.

Since the outcome variable is a dichotomous, I use the logit model in the estimation of the multivariate analysis. The logit model presented here is derived from random utility models and aims at modelling the observed choice that an individual makes. Based on observed attributes of the decision maker and unobserved attributes which is treated as random. The summary of the logit model provided below is based on the description provided in (Train, 2009, s1-75), originates from (McFadden, 1973).

Consider a participant labelled n, this participants makes a choice denoted by the outcome variable Y, which takes two values, such as:

$$Y = \begin{cases} 1, if\ the\ participant\ choose\ risk \\ 0, if\ the\ participant\ did\ not\ choose\ risk \end{cases}$$

the outcome variable is determined on a behavioural function comprised of two factors, observed and unobserved. Consequently, the participants choose an alternative from the choice set $j = (r, s)$ where r is risk, and s is safe (safe = risk-free, but denoted as safe for not confusing subscripts). The participant receive utility from the chosen alternative, for which the models goal is to specify the utility received by the choice as accurately as possible. That is, in this situation the participant have two choice from which the participant will choose risk if and only if

$$Y = \begin{cases} 1 \; if \; and \; only \; if \; U_{n,r} > U_{n,s} \\ 0 \; if \; and \; only \; if \; U_{n,r} < U_{n,s} \end{cases}$$

Now, the received utility is perceived differently between the researcher and the participant, for which I cannot observed the true utility I specify a representative utility denoted V, the representative utility is combination of attributes over alternatives x_{nj}, and attributes of the participant z_{nj}, thus representative is presented as

$$V_{nj} = V\left(x_{nj}, z_{nj}\right)\forall j$$

Since the representative utility, specified as a prediction of the factors affecting the choice, and the true utility perceived by the participant from the alternative, is not the same. As there are some factors that the representative utility does not capture it has to be estimated by a random component. Thus true utility becomes:

$$U_{nj} = V_{nj} + \varepsilon_{nj}$$

The term ε_{nj} is the random component, capturing the factors that affect utility but is not included in the representative utility. the random component is defined as the difference between true utility and representative utility. We assume that each ε_{nj} is independently, identically distributed extreme value (iid). The density for each unobserved component of utility is:

$$f\left(\varepsilon_{nj}\right) = e^{\varepsilon_{nj}} e^{-e^{-\varepsilon_{nj}}}$$

With cumulative distribution

$$F\left(\varepsilon_{nj}\right) = e^{-e^{-\varepsilon_{nj}}}$$

We assume that the variance of this distribution is $\pi^2/6$, implicitly normalizing the scale of utility. the difference between two extreme value variables is distributed logistic, that is, if ε_{nj} and ε_{ns} are iid extreme then $\varepsilon^*_{nr} = \varepsilon_{nr} - \varepsilon_{ns}$ follows the logistic distribution.

$$F(\varepsilon^*_{nrs}) = \frac{e^{\varepsilon^*_{nrs}}}{1 + e^{\varepsilon_{nrs}}}$$

By assuming the errors are independent of each other, means that the unobserved portion of utility for one alternative is unrelated to the unobserved portion of utility for the other alternative.

The probability that participant n, chooses alternative r over s is:

$$P_{nr} = Prob(V_{nr} + \varepsilon_{nr} > V_{ns} + \varepsilon_{ns} \forall s \neq r)$$
$$P_{nr} = Prob(\varepsilon_{ns} < \varepsilon_{nr} + V_{nr} - V_{ns} \forall s \neq r)$$

The choice probability is the integral $P_{nr}|\varepsilon_{nr}$ overall values of ε_{nr} weighted by its density. Eventually arriving at the estimated model:

$$\ln\left(\frac{P_{nr}}{1 - P_{nr}}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7^2$$
$$= \beta_0 + \beta_1 X_1 + \cdots + \beta_8 X_8$$

The predictors are represented by X_k where each predictor is as follows

1. X_1 High SC (High)
2. X_2 Relevant SC (Snow)
3. X_3 (t-shirt-"buff")
4. X_4 risk preference
5. X_5 age
6. X_6 gender (Male)
7. X_7 (t-shirt-"buff")^2
8. X_8 accidents related to avalanche terrain (yes)

The categorical predicters mentioned have names in the parenthesis for which indicates the outcome is in respect to. This has additional purpose when interpreting the log odds, which will become clear the output from the logistic regression estimate is in terms of log odds, similarly to the bivariate analysis we can calculate the OR from the logistic regression by exponentiating the coefficients. The interpretation differs from different predictors, the categorical variables for example, as was done in the bivariate analysis. computes the OR comparing High to Low treatment group. As noted in the parenthesis of the categorical predictors, when we report the OR we are calculating them as the High to Low treatment group, Snow to Plain, Male to Female, and Yes to no for the accidents related to avalanche terrain. As well as the OR we are reporting the average marginal effect (AME), for which is the marginal effect of a change in predictor, holding other variables constant. We also have a nonlinear predictor, for the difference in willingness to pay, this is interpreted as having a positive and diminishing effect. Three of the models are based on the first regression equation for which only has 7 predictors. The last predictor, accidents related to avalanche terrain is included in an additional model

Data procedure

For the multivariate analysis I estimated four different models, three of the models are estimated using the same equation but with different samples. And a model including the predictor accidents related to avalanche terrain.

The first model is already treated for which this model excludes 19 participants in the estimation, 18 of these observations had zero willingness to pay for both premium and the prize, which is interpreted as having no monetary incentives to choose either alternative. the model specification presented in the multivariate analysis, have a specified the representative utility including willingness to pay as a variable affecting the relationship between the sunk cost conditions and the dependent variable. This means that when the representative utility specified fails to capture the motives behind the decision. Consequently the logit model will integrate the characteristics of the observations when estimating the output, thus leading to: strengthen the characteristics associative with their outcome, type 2 error. Or weakening the characteristics associative with their outcome, type 1 error. As such these are removed totally. The 1 observation of these participants have missing values for both willingness to pay.

For the second model I remove the observations with zero willingness to pay for the premium, this indicating that they have no monetary incentives to take the risk-free alternative. including these in the estimation would be rather obvious strength for the outcome in the positive direction. However, as they can be predicted accurately in terms of monetary incentives, if some of these participants would take the risk-free alternative, they would be contributors for a positive false (type 1 error).

the third model is based on the same sample as the second one, the participants have monetary incentives to take both the risk-free alternative and the risky alternative. the fourth model is re-estimation of the first model without participants highlighted by diagnostics plot of estimated values and cook’s distance.

6 Results

Table 1 shows the number of participants in each treatment group, for each adjustment in the data. Before any adjustments were made, the distribution of participants was acceptably even, however, as we see from the third adjustment in data frame 3, the difference escalates to a relatively big difference.

Table 1. Number of participants in each treatment condition

	High	*Low*	*Snow*	*Plain*
Data frame 1	99	94	103	90
Data frame 2	88	86	95	79
Data frame 3	81	74	89	66

Table 2 shows the descriptive and preliminary results of the NASA-TLX in addition to "play time," between High and Low sunk cost condition. The results show significant difference in perceived effort at the 5% significance level, with the exception of temporal effort which is significant at the 10% level. These results are from the second adjustment for which the total number of participants are 174.

Table 2. descriptive and preliminary of NASA-TLX between High and Low

	Mean High	*Min High*	*Max High*	*Mean Low*	*Min Low*	*Max Low*	*Difference Mean*	*statistic*	*P-value*
Play time	204.49	116	449	32.52	0	168	171.97	24.50	0.000
Frustration	2.58	0	16	1.66	0	13	0.92	5.80	0.016
Mental	3.10	0	13	1.87	0	11	1.23	9.04	0.003
Temporal	4.18	0	16	3.32	0	13	0.87	3.67	0.055
Physical	1.77	0	16	1.02	0	7	0.75	4.00	0.046

General	3.08	0	14	1.87	0	7	1.21	11.74	0.001
N	174								

Table 3 shows the descriptive and preliminary results of NASA-TLX in addition to “play time,” between Snow and Plain sunk cost condition. In contrast to the results from table 2, we have no significant difference in perceived effort in the Snow and Plain sunk cost condition. In addition, the difference in mean is relatively low comparing Snow and Plain SC condition to High and Low SC condition.

Table 3. Descriptive and Preliminary of NASA-TLX between Snow and Plain SC

	Mean Snow	*Min Snow*	*Max Snow*	*Mean Plain*	*Min Plain*	*Max Plain*	*Difference mean*	*Statistic*	*P-value*
Play time	115.56	0	449	124.23	14	403	-8.67	-0.58	0.564
Frustration	2.11	0	11	2.14	0	16	-0.04	0.11	0.742
Mental	2.60	0	13	2.37	0	11	0.23	0.02	0.902
Temporal	3.84	0	16	3.67	0	14	0.17	0.16	0.691
Physical	1.53	0	16	1.25	0	13	0.27	0.19	0.660
General	2.61	0	11	2.33	0	14	0.28	0.48	0.487
N	174								

Table 4 shows the descriptive and preliminary results of the variables included in the model between High and Low SC condition. In addition the variable accidents in avalanche terrain is included in this descriptive analysis, though it is not included in the first two estimated models. The results show no significant difference between High and Low SC condition. however, we see that the difference between means are all negative, that is, the Low treatment group is generally more representative in the right side of the mean, or the High treatment group is generally more representative in the left side of the mean. Male's are also and over represented in the data set, though the distribution of Females are evenly spread between High and Low SC condition.

Table 4. descriptive and preliminary of model variables between High and Low SC condition

	Mean High	*Median High*	*Mean Low*	*Median Low*	*Diff Mean*	*Statistic*	*P-value*
Took risk	0.59	1	0.66	1	-0.07	0.95	0.328
Relevant SC	0.53	1	0.56	1	-0.02	0.10	0.751
Age	34.18	32	36.16	32.5	-1.98	-1.25	0.212
"Buff"	59.40	50	62.30	50	-2.90	-0.41	0.680
T-shirt	196.32	200	201.50	200	-5.18	-0.39	0.701
wtp diff	136.92	149	139.20	150	-2.28	-0.20	0.838
Gender	0.84	1	0.85	1	-0.01	0.02	0.886
Accident	0.59	1	0.60	1	-0.01	0.01	0.920
(wtp diff)^2	23106.97	22201	25689.59	22500	-2582.63	-0.63	0.532
N	174						

Table 5 shows the descriptive and preliminary results of the variables included in the model between Snow and Plain SC condition. There is no significant difference to take into account when modelling the logit model. we do have a significant result of the outcome variable between Snow and Plain SC condition. Again Male's are over represented for the whole data set, but Female's are evenly distributed between the Snow and Plain SC condition. the difference in mean also show that Snow treatment group is represented more on the right side of the mean for willingness to pay for both the "buff" and the t-shirt.

Table 5. Descriptive and preliminary for model variables between Snow and Plain SC condition

	Mean Snow	*Median Snow*	*Mean Plain*	*Median Plain*	*Diff Mean*	*Statistic*	*P-value*
Took risk	0.70	1	0.54	1	0.15	4.15	0.042
High SC	0.50	0	0.52	1	-0.02	0.10	0.751
Age	35.18	32	35.14	33	0.04	0.02	0.980
"Buff"	65.02	50	55.80	50	9.22	1.30	0.195
T-shirt	202.79	200	194.18	200	8.61	0.64	0.521
wtp diff	137.77	150	138.38	150	-0.61	-0.06	0.956
Gender	0.83	1	0.86	1	-0.03	0.28	0.598
Accident	0.61	1	0.58	1	0.03	0.11	0.745
(wtp diff)^2	25247.77	22500	23344.05	22500	1903.72	0.48	0.631
N	174						

Table 6 and 7 shows the descriptive and preliminary analysis for risk preference, revealed risk preference, and the hypothetical question, for High SC condition and Relevant SC condition, respectively. From table 6 there is no significant difference between High and Low treatment groups. From table 7 we can see that the investment question there is significant difference between Snow and Plain treatment group. this indicates that the revealed preference is different in the Relevant SC condition, for which the Relevant treatment group is skewed towards the low end of the normal distribution and the Irrelevant treatment group is skewed towards the high end of the normal distribution.

Table 6. Descriptive and preliminary results for revealed and stated risk preference

	Mean High	Median High	Mean Low	Median Low	Diff Mean	Statistic	P-value
Risk Preference	3.14	3.21	3.21	3.286	-0.079	-0.87	0.386
Willingness to take risk	3.03	2	2.67	2	0.36	1.61	0.204
Investment question	22.50	20	20.23	20	2.267	0.67	0.506
N	174						

Table 7. Descriptive and preliminary results for revealed and stated risk preference

	Mean Snow	Median Snow	Mean Plain	Median Plain	Diff Mean	Statistic	P-value
Risk preference	3.16	3.14	3.20	3.29	-0.04	0.61	0.434
Willingness to take risk	2.93	2	2.77	2	0.15	0.28	0.599
Investment question	17.47	20	26.08	20	-8.60	6.36	0.012
N	174						

6.1 Bivariate analysis results

Table 8 and 9 display the number of participants taking the risky and the risk-free alternative, for both High SC and Relevant SC condition, respectively.

Table 8 Number of decisions for each group in High SC condition

Risk	Risk-free	Total

Low	57	29	86
High	52	36	88
Total	109	65	174

Table 9 Number of decisions for each group in Relevant SC condition

	Risk	*Risk-free*	*Total*
Plain	43	36	79
Snow	66	29	95
Total	109	65	174

Table 10 shows the probability, odds and odds ratio for each treatment group, for each treatment group. The OR in each SC condition is calculated comparing: High to Low, and Relevant to Irrelevant. As explained in the Methodology section, the OR can determine the direction of association. The OR comparing High to Low is less than 1, the direction of association is thus negative between the High SC condition and the Risky alternative. The OR comparing Snow to Plain is higher than 1, consequently the results show a positive direction of association between the Risky alternative and Relevant SC condition.

Table 10 Probabilities, Odds, and Odds Ratios for each treatment group in SC condition

	High	*Low*	*Snow*	*Plain*
Probability	0.591	0.663	0.695	0.544
Odds	1.444	1.966	2.276	1.194
Odds Ratio	0.735		1.905	

Table 11 shows the Chi-square statistics for given probabilities and Yate’s continuity correction with their P-values reported in Parenthesis, for High SC condition and Relevant SC condition. The result shows no significant association between High SC condition and the dependent variable. That is, the negative direction of association showing a $1 - 0.735 = 26.5\%$ lower odds of choosing risk in the High treatment compared to Low treatment is not significant. The result does however, show a significant association between the Relevant SC condition and the dependent variable, we can conclude that the positive direction of association showing a $1.905 - 1 = 90.5\%$ greater odds of choosing risk in the Snow treatment compared to Plain treatment is significant.

Table 11 Chi-square test with given probabilities and Yate's continuity correction, for High SC and Relevant SC condition

Pearson's Chi-square test	*High*	*Relevant*
Given probabilities	0.96 (0.327)	4.17 (0.041)
Yate's continuity	0.68 (0.410)	3.55 (0.059)

6.2 Multivariate analysis results

Table 12 shows the result from the models 1, 2, 3, 4, the coefficients are displayed with p-values in parenthesis. From Row 2 the High SC (High) we find no significant association between the outcome variable and a higher probability of choosing risk. Regardless of the insignificance, the direction of association is negative, which is not anticipated. Row 3 Relevant SC (Snow) shows a positive direction of association between experiencing relevant sunk cost, and this association is significant, the result is little robust at the 10% level of significance. From Row 4 the difference in willingness to pay is weakly significant with the exception of model 3 for which is not significant. Row 5, risk preference. This variable shows strong significant robust association with a positive effect on probability. Row 6, age, shows strong significant negative at the 1% level. Row 7, gender (Male), does not show significant, and the direction is hardly noticeable. Row 8, difference in willingness to pay squared, which shows weak significance across all models. though the direction is hardly interpretable.

Table 12 Regression coefficient with P-values in parenthesis for model 1, 2, 3, and 4.

	Model 1	*Model 2*	*Model 3*	*Model 4*
Intercept	0.879 (0.561)	1.235 (0.437)	1.766 (0.307)	1.827 (0.314)
High SC (High)	-0.312 (0.368)	-0.397 (0.285)	-0.599 (0.152)	-0.289 (0.439)
Relevant SC (Snow)	0.694 (0.045) *	0.812 (0.028) *	0.803 (0.052) .	0.934 (0.013) *
Wtp diff	-0.020 (0.054) .	-0.021 (0.071) .	-0.020 (0.111)	-0.032 (0.028) *
Risk preference	0.843 (0.007) **	0.804 (0.014) *	0.749 (0.045) *	1.005 (0.004) **
Age	-0.051 (0.003) **	-0.060 (0.001) **	-0.078 (0.000) ***	-0.059 (0.001) **
Gender (Male)	0.005 (0.992)	0.029 (0.953)	0.157 (0.792)	-0.260 (0.654)
(wtp diff)^2	0.000059 (0.082) .	0.000062 (0.088) .	0.000071 (0.091) .	0.000091 (0.064) .
Accident (Yes)			-0.026 (0.953)	
N	174	155	130	164

Table 13, shows the OR and corresponding confidence interval, and their p-values in parenthesis, in addition the average marginal effect. High SC (High) from Row 2, show negative direction and the association is not significant. Relevant SC (Snow) Row 3, show positive direction and the association is significant. The difference in willingness to pay Row 4, is negative, however, the direction of association is given by both the difference in willingness to pay and the squared difference in willingness to pay. Risk preference Row 5, shows strong significant affect with a positive direction of association as consistent with the previous results obtained. It is worth noting that the AME displays a big difference in having one unit higher risk preference with the associated probability of 16.5%. Age from Row 6 shows significant association in the negative direction. Gender from Row 7 shows insignificant results, with effect that is hardly noticeable.

Table 13 OR with associated confidence interval and P-value. And average marginal effect

	OR	*2.50%*	*97.50%*	*AME*
(Intercept)	2.41 (0.561)	0.13	49.25	
High SC (high)	0.73 (0.368)	0.37	1.44	-0.061
Relevant SC (snow)	2.00 (0.045)	1.02	3.98	0.139
Wtp difference	0.98 (0.054)	0.96	1.00	-0.004
Risk preference	2.32 (0.007)	1.29	4.37	0.165
Age	0.95 (0.003)	0.92	0.98	-0.010

Gender (male)	1.00 (0.992)	0.37	2.59	0.001
(wtp diff)^2	1.00 (0.082)	1.0000035	1.0001327	0.0000117
N	174			

7 Discussion and conclusion

We have now addressed the sunk cost experiment in terms of behavioural investment in an incentivized experiment. For which we answer the hypotheses H1.a and H1.b, using bivariate and multivariate analytical tools.

Considering hypothesis H1.a we find no evidence of being more likely of accepting a risky bet from experiencing High behavioural sunk cost compared to Low sunk cost. Despite not having a significant association between the High SC condition, both the bivariate and the multivariate indicated a negative direction, for which in terms of the logistic output indicates that experiencing high behavioural sunk cost reduces odds of accepting a risky bet compared to experiencing low sunk cost. Despite not having a significant association, the direction of association is consistent with that of Negrini et al., (2021) and Nash et al., (2019).

Considering hypothesis H1.b, our results show robust evidence on the 10% significance level from both the bivariate and multivariate analysis. The direction of association displays that experiencing relevant sunk cost makes you more likely to accept a risky bet, compared to experiencing irrelevant sunk cost.

Roth et al., (2015) insinuated that the reason for the documentation of the sunk cost both in incentivized experiments and hypothetical questionnaire. In this paper we present results displaying the sunk cost effect is present in a sample for which the average participant is 35. Consequently, contributing to documentation of the sunk cost effect in a sample representative for more than just students.

Age is persistently significant in a negative direction of choosing risk, thus implying that younger people are more susceptible of choosing risk, consequently more prone to the sunk cost effect. In contrast to the documentation of having a sample representing an older population, this evidence is consistent with Ronayne et al., (2021) report measures of cognitive reflection to be negatively correlated with sunk cost effect, as cognitive reflection increases with age. Our findings is consistent with this interpretation, as such complementing the insinuation from Roth et al., (2021)

The biggest limitation we faced in this paper was the sample size, for which there was a rather small sample than initially hoped for. This resulted in a battle of keeping the statistical power in tact and choosing the variables in the model.

Since the sample had observations with zero willingness to pay for the “buff” and the t-shirt, they displayed no monetary incentives to take risk, which is interesting. There could be many reasons as to why they had zero willingness to pay. whatever the reason, the interpretation of it stays the same, the utility they receive comes from other factors not specified by the model of my choosing.

Another limitation was the participants showing no incentives to choose the risk-free alternative, as they had zero willingness to pay for the “buff.” In an economic sense they show risk seeking preferences, as there is no monetary means of choosing the risk-free alternative.

The representation of different genders is highly skewed in the sample, for which males are overrepresented, we do not find significant association between likelihood of choosing risk. The results from gender is insignificant. Not only statistically, but the average marginal effect indicates that males and females are practically indifferent of choosing risk. Though this could be due to lack of females in the sample

The analysis conducted in this paper does not take into account that the significant result from experiencing relevant sunk cost could be due experiencing both high sunk cost and relevant sunk cost. Though the possibility for this is reduced by not finding an effect from High sunk cost group.

As the lack of female representatives for the estimated sample, a recommendation for further research is to include a more diversified sample in terms of gender. In addition it is interesting to note that age is such a strong factor on the susceptibility to the sunk cost, as such it would be interesting to see experiments on samples representative for older populations. It is also worth noting that the difference in observations between the Snow and Plain treatment group for Relevant SC condition, might have been contributing the difference in risk taking decisions, thus a bigger sample is needed to.

8 Reference

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