Myopic loss aversion, the endowment effect for risk and the limits of expectation-based reference-dependent preferences

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Abstract

I show that the Kőszegi and Rabin (2006, 2007) model of reference dependent preferences with loss aversion can rationalize myopic loss aversion (Benartzi & Thaler 1995, Gneezy & Potter 1997) : an agent's willingness to take risks is bigger (smaller) prior to (after) the realization of a background risk. Kőszegi and Rabin's model however also predicts an endowment effect for risk : an agent's willingness to take risks prior to the realization of a background risk increases in the level of background risk. In a tight experimental setup, I investigate these predictions both in the presence of a negative and a positive background risk. While I cannot reject a myopic loss averse behavior when the background risk is positive, I unambiguously reject it when the background risk is negative. I also overwhelmingly reject the endowment effect for risk predicted by the Kőszegi and Rabin model. These results cast doubt on the ability of the Kőszegi and Rabin model to neatly pin down the channels through which loss aversion strikes, and provide further evidence on the limits of expectation-based reference dependence.

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Key words: Endowment Effect, Expectations, Loss aversion, Myopia, Uncertainty

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1 Introduction

Myopic loss aversion (henceforth MLA) refers to the joint observation that individuals are loss averse (i.e. they dislike losses much more than they enjoy same sized gains), and that they tend to myopically (i.e. separately) evaluate each outcomes' realizations instead of solely considering the aggregate result. Consider an individual investing in a risky asset with positive return. Holding the asset exposes her to potentially many periods of ups and downs. A myopic individual will tend to separately focus on each "up" and "down" realized by the asset (e.g. every day). Loss aversion renders the asset unattractive given than the agent *frequently* experiences losses which weigh more than commensurate gains, although the asset's return is positive. Myopia therefore significantly decreases the extent to which an agent is willing to take risks. Identifying the underpinnings of such an exacerbation of risk aversion is crucial to further improve our understanding of decision making under uncertainty.

MLA has been put forward by Benartzi and Thaler (1995) as a plausible solution to the long lasting Equity Premium Puzzle[1] (Mehra and Prescott, 1985). They showed, by means of simulations, that the magnitude of the equity premium is consistent with investors evaluating their portfolios annually and weighing losses about twice as heavily as gains. Subsequently, numerous studies identified decision patterns coherent with MLA in controlled environments (among others Gneezy and Potters (1997); Thaler et al. (1997); Haigh and List (2005)). With the exception of Thaler et al. (1997), who use cumulative prospect theory to illustrate their thought, none of the existing tests of MLA rests on formal theoretical predictions. This renders their results particularly difficult to put in perspective, and makes it hard to precisely identify (and understand) the exact underpinnings of such a phenomenon.

The first objective of this paper is to reconcile MLA with modern formal economic modeling. We show that the increasingly popular model of reference-dependent preferences with loss aversion advocated by Kőszegi and Rabin (2006, 2007) [henceforth KR] is able to rationalize a myopic loss averse behavior. We consider situations in which individuals face a background risk (lottery 1) and have to decide on whether to invest in an avoidable risk (lottery 2). We derive the valuation for lottery 2 of participants at several points in time : before the realization of the background risk, and after it. In line with MLA, Kőszegi and Rabin predicts that the agent's willingness to pay for lottery 2 is higher prior to the realization of the background risk. Her willingness to take risks is thus bigger when risks are lumped together. The driving-force of this result is that the aggregation of risks mitigates the sensations of gains and losses, since it reduces the *distance* between the outcomes generating the aforesaid sensations of gains and losses. Besides rationalizing MLA, the model also clearly identifies its source. We show that, within the KR framework, MLA and the endowment effect for risk (Sprenger, 2010) are very

[1] The observation that standard general equilibrium models cannot rationalize the empirical fact that, over the last decades, stocks have outperformed bonds by a large margin without assuming unrealistically high levels of risk aversion.

closely related. The extent to which an agent is expected to display myopic loss aversion is determined by the amount of risk carried in the background risk : the riskier the background risk, the larger the effect of myopic loss aversion.

Our second objective is to tightly test the predictions of MLA and of endowment effect for risk. To that end, we designed a purposefully simple experiment replicating the risky environment described in the the theoretical section. In our experiment, participants face either a positive (GAIN treatment) or a negative (LOSS treatment) background risk. Their willingness to pay for the avoidable risk is elicited either prior to the realization of the background risk (EX-ANTE treatment), or after it (EX-POST treatment). The positive (negative) background risk is represented by 50-50 binary lottery yielding a gain (a loss) of CHF 8, and zero otherwise. The avoidable risk is represented by a 50-50 binary lottery yielding CHF 8, and zero otherwise, and is the same for every participants. The show-up fee in the LOSS conditions is CHF 8 higher than in the GAIN condition, such that participants' expected outcome is kept constant across these treatments. The LOSS treatment therefore simply is a negatively framed version of the GAIN treatment. The expected values of the lotteries, their risk and their associated distribution of outcomes are however identical. KR thus makes the prediction of a strictly identical behavior under the two conditions. MLA implies that the average reservation price for the avoidable risk is higher in the EX-ANTE than in the EX-POST treatment. Furthermore, MLA is predicted to be driven by the endowment effect for risk : the riskier the background risk, the bigger the myopic loss averse behavior. We investigate this relationship by varying the amount of risk carried by the background risk (i.e. the probability of gain/loss of the first lottery) in three additional conditions, both in the loss and the gain domain. In the LO treatment, the probability of realization of the background is set to 0.1 while it is set to 0.5 in the ME treatment, and to 0.9 in the HI treatment. KR make three strong predictions : 1. The reservation price for the avoidable risk is the highest in the ME condition, 2. The reservation prices in the LO and the HI conditions are equal, and 3. The domain of the first lottery is irrelevant to the reservation price for the second lottery : only the risk of the background risk is expected to affect willingness to take risks.

Overall, the results we present are rather disproving the KR-model : most of their theoretical predictions do not translate into actual behavior in our experiment. While we (barely) replicate MLA-behavior in the presence of a positive background risk, we find an inversed-MLA-behavior in the case of a negative background risk. This finding contradicts the model which predicts an identical behavior under both positive and negative background risk. Most importantly, we unambiguously reject most of the predictions related to the endowment effect for risk. We notably reject the equality between the reservation prices in the LO and the HI treatments, both in the gain and the loss domain. Moreover, while KR predicts a concave relationship between the reservation price for the second lottery and the probability of realization of the first lottery, we find a linearly decreasing relationship. Finally, we show, with a simple calibration exercise, that the magnitude of the treatment effects predicted by KR is unrealistically high. However, we also show that standard expected utility theory with and without risk aversion does not help rationalize the data.

Myopic loss aversion has been first experimentally investigated by Thaler et al. (1997) and Gneezy and Potters (1997). In Thaler et al. (1997), subjects were asked to invest their money between one fund mimicking the stock market, and another mimicking five-year bonds. Importantly, subjects did not know about the distribution of risk and return, but had to "learn trough experience". They show that investors who display myopic loss aversion are more willing to accept risks if they evaluate their investments less often, and are more willing to accept risk if all payoffs are increased enough to eliminate losses. They also show that investors who got the most frequent feedback (and thus the most information) took the least risk and earned the least money.

Our experiment is more closely related to Gneezy and Potters (1997), in which participants could invest a fraction of their endowment in a risky lottery yielding 2.5 times the amount invested with probability 1/3, and zero otherwise. In the HIGH treatment, participants had to make the investment decision at every period, for 12 periods. In the LOW treatment, participants' investment decisions were binding for 3 periods, and feedback on the realization of the lotteries was provided in a "clumped" way every 3 period. Participants in the LOW condition invested a significantly higher amount of their endowment in the risky lottery, indicating that the evaluation periods affect risk aversion in a way consistent with myopic loss aversion : the more frequently an investor evaluates an asset's returns, the more risk averse she will be. These results have been replicated with professional traders (Haigh and List, 2005)[2] and have been shown to be robust to market interactions (Gneezy et al., 2003).[3]

With the exception of Thaler et al. (1997), no experimental test of MLA rests on formal theoretical predictions. This renders their results particularly difficult to put in perspective. We use Kőszegi and Rabin (2006, 2007) model of reference-dependent preferences with loss aversion to rationalize myopic loss averse behavior. Reference-dependent preferences have proven to be very successful at rationalizing decision making under uncertainty (Allais, 1953; Rabin, 2000; Rabin and Thaler, 2001), market anomalies such as the endowment effect (Knetsch and Sinden, 1984; Knetsch, 1989; Kahneman et al., 1990) or labor market decisions (Fehr and Goette, 2005; Camerer et al., 1997). Among other models of reference-dependent preferences, the strength of the KR-model rests in its ability to put structure on the formation

[2]In their experiment, traders exhibited a behavior consistent with MLA to a greater extent than students.

[3]Noticing that all the aforementioned papers jointly varied both the information feedback about the realization of the investment and the investment flexibility, Bellemare et al. (2005) set up an experiment to disentangle either effect. They show that varying the information feedback alone suffices to induce a behavior that is in line with MLA. This finding is at odds with Langer and Weber (2008) who identify investment flexibility as causing MLA. Finally, in contradiction with the two previous papers, Fellner and Sutter (2009) find that investment horizons and feedback frequency contribute almost equally to effects of MLA.

of the reference point. While previous models left the researcher basically free to chose the argument defining the agents' reference point[4], KR elegantly grouded the reference point in rational expectations, and provided an equilibrium concept (the personnel equilibrium) which insures mutual consistency between beliefs and actions.

While the experimental literature and field evidence provide support for expectation-based reference points (Abeler et al., 2011; Ericson and Fuster, 2011; Gill and Prowse, 2012; Pope and Schweitzer, 2011) only few papers tightly put the KR-model at test.[5] Goette et al. (2014) introduce a probability of forced exchange in a typical market exchange experiment (Kahneman et al., 1990). As the probability of forced exchange increases, KR predicts that individuals' willingness to exchange should incrase. This mechanism could theoretically eliminate (and even reverse) the endowment effect (Knetsch and Sinden, 1984; Knetsch, 1989; Kahneman et al., 1990). Their results however uniformly reject such predictions, providing evidence against expectation-based reference points. In a related paper, Sprenger (2010) tests the endowment effect for risk, a prediction made by KR but not by alternative specifications of expected-based reference dependent models (Bell, 1985; Loomes and Sugden, 1986): when risk is expected by the agents (i.e. when their reference point is stochastic) and they are offered a certain amount, near risk-neutrality is to be expected. He demonstrates that the evaluation of a gamble's expected value never necessitates evaluating it over a loss-averse kink-point. Therefore, "when the referent is a binary gamble and an individual considers a certainty equivalent inside the gamble's outcome support, a loss-averse individual will appear risk neutral, regardless of her level of loss aversion". However, when the agents' reference point is certain and they are offered a lottery, risk aversion is to be expected. Sprenger documents both between- and within-subject evidence of such an effect and hence provides support for KR's formulation. Our experiment puts the endowment effect for risk hypothesis at a stronger test than Sprenger (2010) since we center our attention on situations in which the reference point of the agent *remains* stochastic but varies in risk, whereas Sprenger considered situations in which the reference point is either stochastic or certain. Finally, Gneezy et al. (2014) conduct a real-effort experiment in which they manipulate expectations and examine consequences on effort provision. In contrast to KR which predicts monotone responses to changes in expectations, they document non-monotonicities in the effort response to changing expectations for both outcomes and probabilities, providing evidence against expectation-based reference dependence.

On top of being a theoretically motivated test of the MLA hypothesis, our paper should also be considered a complement to the existing papers investigating KR's expectation-based reference dependent preference model. Along with Goette et al. (2014) and Gneezy et al. (2014), our mixed results provide further evidence on the limits of the KR model to realistically formalize the way agents anticipate future sensations of gains and losses.

[4]Such a degree-of-freedom might well have been the source of the success of reference dependence models to rationalize the aforementioned wide range of economic anomalies.

[5]Note that there are a few exception. For example, Heffetz and List (2014) find no effect of expectations.

The paper is structured as follows. In section 2, we present an overview of Kőszegi and Rabin's (2006,2007) model. We demonstrate that 1. myopic loss aversion can be rationalized can be easily rationalized, and 2. myopic loss aversion and the endowment effect for risk are closely linked. In section 3, we detail our experimental design, the treatments and we discuss the behavioral predictions. The main results are reported in section 4. A discussion and a calibration exercise of the KR model are provided in section 5. Finally, section 6 concludes.

2 Theoretical considerations

2.1 Reference-dependent prefenrences à la Kőszegi-Rabin

KR propose a model of reference-dependent preferences with loss aversion. They formulate a reference-dependent utility function $U(F|G)$ which allows the agent to evaluate a distribution of outcomes F in comparison to a distribution of reference points G :

$$U(F|G) = \int \int u(c|r)dG(r)dF(c)$$

where

$$u(c|r) = m(c) + \mu(c|r)$$

The function $m(\cdot)$ represents standard consumption utility. Given the small amounts at stake in our experiment and following Rabin's calibration theorem (Rabin, 2000), we assume a linear utility function $m(x) = x$. The function $\mu(c|r)$ represents gain-loss utility of consuming c relative to the reference point r. Following the literature, we assume the piecewise linear gain-loss utility

$$\mu(y) = \begin{cases} \eta y & \text{if } y \geq 0 \\ \eta\lambda y & \text{if } y < 0 \end{cases}$$

where η corresponds to weight attached to the gain-loss utility and λ represents the agent's degree of loss aversion.

KR offer a solution concept which insures that the agent behaves consistently with her expectations, and that her expectations are indeed formed consistently with her expected behavior : the personal equilibrium. Formally, considering a choice set $\mathcal{D}$ composed of lotteries F over consumption outcomes, a choice $F \in \mathcal{D}$ is a personal equilibrium if

$$U(F|F) \geq U(F'|F) \quad \forall \quad F' \in \mathcal{D}.$$

If the agent holds beliefs about outcome F, she prefers to consume the distribution of outcomes F, than any other distribution F'. At personal equilibrium, the agent's reference point can only be formed by a distribution she is preferring, given that she expects it.

2.2 The agent's environment : a background risk and an avoidable risk

We consider a situation in which the agent faces two levels of uncorrelated risk : a background risk, and an avoidable risk. The background risk is represented by the binary lottery

$$\tilde{x}_1 = \{K, 0\} \quad \text{w.p. } (\pi_1, 1 - \pi_1)$$

and the avoidable risk (e.g. an investment) is represented by the binary lottery

$$\tilde{x}_2 = \{G, 0\} \quad \text{w.p. } (\pi, 1 - \pi)$$

where $K > 0$ and $G > 0$.

The background risk is assumed to always take place and realize before the avoidable risk. While the agent cannot avoid the background risk, she can decide on whether or not to buy the lottery $\tilde{x}_2$, and therefore get an additional exposure to risk. The price paid by the agent for $\tilde{x}_2$ is p.

We will successively consider two different situations : an *ex-ante* situation in which the agent has to decide on purchasing $\tilde{x}_2$ *before* the realization of the background risk, and an *ex-post* situation in which the agent has to decide on purchasing $\tilde{x}_2$ *after* the realization of the background risk.

Before the realization of the background risk, the *ex-ante* distribution of final outcomes of an agent who decided to buy $\tilde{x}_2$ is represented by the tree depicted in figure 1. She is exposed to a combination of the background risk and the lottery $\tilde{x}_2$, for which she pays p. If the agent decides not to buy $\tilde{x}_2$, she is only exposed to the background risk. In this case, her wealth is represented by the distribution generated by $\tilde{x}_1$.

If the agent decides to buy $\tilde{x}_2$ after the realization of the background risk, two different scenarios apply. In the first case, K realized (e.g. the agent won the first lottery). She therefore sits at node B and contemplates the chance of getting $K + G - p$ with probability π, or losing the second lottery and thus ending up with $K - p$ with probability $1 - \pi$. She can also decide not to take the second lottery and therefore leave with K with certainty. In the second case, the agent lost the first lottery. She therefore sits at node C and contemplates the chance of getting $G - p$ with probability π, or losing the second lottery and thus ending up with $-p$ with probability $1 - \pi$. Not playing would leave her with 0 with certainty.

2.3 Myopic loss aversion and the endowment effect for risk

Our goal is to recover the widely documented myopic loss averse behavior (Benartzi and Thaler, 1995; Gneezy and Potters, 1997) under the preferences and the risky environment presented above. To this end, we sequentially derive a) the reservation price for $\tilde{x}_2$ of an agent *prior* to

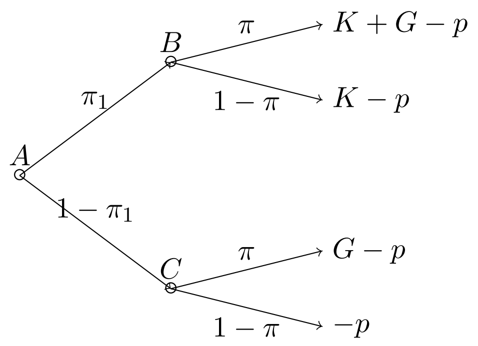


Figure 1: Lotteries. Distribution of outcomes F (decision to gamble on $\tilde{x}_2$)

the resolution of the background risk (i.e. the *ex-ante* reservation price for $\tilde{x}_2$), and b) her reservation price for the same lottery *after* the resolution of the background risk (i.e. the *ex-post* reservation price for $\tilde{x}_2$). In the ex-ante situation, the background risk and the avoidable risk are lumped together while in the ex-post situation, the avoidable risk "*stands alone*". A myopic loss averse agent is therefore expected to be more willing to take risk (i.e. have a higher reservation price for $\tilde{x}_2$) in the ex-ante than in the ex-post situation. We hereafter show that KR indeed rationalizes this behavior.

2.3.1 Ex-ante reservation price

In order to derive the *ex-ante* (node A) reservation price for $\tilde{x}_2$, one has to compare the agent's ex-ante utility of buying the lottery to her ex-ante utility of not buying the lottery and solely facing the background risk. In either case, personal equilibrium implies that the agent's reference point and her preferred distribution of outcomes coincide. That is, when calculating the agent's ex-ante utility of buying lottery 2, her reference point must consist of the distribution of outcomes she faces if she indeed expects to buy lottery 2. Similarly, the agent's ex-ante utility of not buying lottery 2 is calculated given that her reference point is "not buying lottery 2".

The utility of investing in $\tilde{x}_2$ prior to the realization of the background risk is

$$U(A|A) = \pi_1 K + \pi G - p - \eta(\lambda-1)\left[\pi_1(1-\pi_1)K + (1-\pi)\pi(\pi_1^2 + (1-\pi_1)^2)G\right]$$

It is equal to the expected value of lotteries $\tilde{x}_1$ and $\tilde{x}_2$, minus the price paid to buy the second lottery, the gain-loss utility terms associated to the background risk and the avoidable risk.

The ex-ante utility of not investing in $\tilde{x}_2$ is

$$U(A^s|A^s) = \pi_1 K - \eta(\lambda-1)\pi_1(1-\pi_1)K.$$

The first term is equal to the expected value of the background risk, and the second term corresponds to expected gain-loss utilities associated to the background risk.

The ex-ante reservation price for $\tilde{x}_2$ is then simply given by $U(A|A) \geq U(A^s|A^s)$. The solution to this inequality is :

$$p_A(\pi_1, \pi) = \pi G - \eta(\lambda - 1)\pi(1-\pi)[\pi_1^2 + (1-\pi_1)^2]G \tag{1}$$

The agent's ex-ante reservation price for $\tilde{x}_2$ is therefore equal to its expected value, minus anticipated gain-loss utilities arising from winning (losing) lottery 2 while expecting the complementary outcome to realize. Indeed, this price depends on π, the probability of realization of the avoidable risk. However, striking is that p_A is a concave function of π_1, the (independent) probability of realization of the background risk.

The endowment effect for risk The concave relationship between p_A and π_1 characterizes the endowment effect for risk that the KR preferences generate. Under such preferences, an increase in the the risk of the reference point increases the agent's willingness to take risk (i.e. the closer π_1 gets to 0.5, the highest the reservation price p_A). π_1 therefore mechanically affects the attractiveness of lottery 2 by changing the agent's reference point, without affecting lottery 2's expected value whatsoever.

The endowment effect for risk has first been identified by Sprenger (2010). In his paper, Sprenger shows that the KR model predicts an endowment effect for risk when the agents' reference points change from certain to stochastic (and vice versa).[6] Our paper differs from Sprenger as we restrict our attention to situations in which the reference point is stochastic. We show that the endowment effect for risk can also be identified within the stochastic domain, by simply manipulating the *amount* of risk present in the reference point.

2.3.2 Ex-post reservation price

If the agent is asked to value the lottery $\tilde{x}_2$ after the realization of the background risk, her *updated* expectations about future outcomes form her reference point. Hence, an agent whose $\tilde{x}_1$ positively realized is assumed to understand that she just received K, and that she therefore finds herself at node B. Her new reference point therefore solely consists of ending up with $K + G - p$ with probability π, or ending up with $K - p$ with probability $1 - \pi$. Simimlarly, an agent who lost the first lottery understands that she now sits at node C. The agent's reference point updates right after the realizeation of lottery 1. This simplifying assumption of a very fast (if not instantaneous) adjustment of the reference point has been originally made by KR and has found support in several experimental studies (Buffat and Senn, 2014; Gill and Prowse, 2012; Song, 2012).

[6] This intuition has been initially formalized in Kőszegi and Rabin (2007), proposition 1.

The utility of investing in $\tilde{x}_2$ after having won (respectively lost) the first lottery is given by

$$U(B|B) = K + \pi G - p + \eta(1-\pi_1)K - \eta(\lambda-1)(1-\pi)\pi G$$
$$U(C|C) = \pi G - p - \eta\lambda\pi_1 K - \eta(\lambda-1)(1-\pi)\pi G$$

while the utility of not investing in $\tilde{x}_2$ after having won (respectively lost) the first lottery is

$$U(B^s|B^s) = K + \eta(1-\pi_1)K$$
$$U(C^s|C^s) = -\eta\lambda\pi_1 K$$

where $\eta(1-\pi_1)K$ (respectively $\eta\lambda\pi_1 K$) correspond to the *experienced* elation (disappointment) of having won (lost) the first lottery.

Simple utility comparisons lead to the ex-post reservation price of first stage winners ($p_W(\pi)$) and first stage losers ($p_L(\pi)$)

$$p_W(\pi) = p_L(\pi) = \bar{p} \leq \pi G - \eta(\lambda-1)(1-\pi)\pi G \tag{2}$$

Striking is that KR predict a unique reservation price $\bar{p}$ for both first stage winners and first stage losers. This result stems from the simplifying assumption of linearity in the consumption utility $m(\cdot)$: Due to risk neutrality, no effects of revenue strike in our problem. $\bar{p}$ is therefore equal to the expected value of $\tilde{x}_2$, minus anticipated gain-loss utilities associated to losing (winning) the second lottery while expecting the complementary event to realize.

Myopic loss aversion A simple measure of the extent of the myopic-loss averse behavior predicted by the KR model can be obtained by subtracting the ex-post reservation price for $\tilde{x}_2$ (equation 2) to the ex-ante reservation price (equation 1) :

$$\Delta p \equiv p_A - \bar{p} = (\lambda-1)\left\{ 2\pi_1\pi(1-\pi_1)(1-\pi) \right\}\eta G \geq 0 \tag{3}$$

An agent is expected to be more willing to take risks whenever risks are lumped together. In our particular setting: when the agent has to decide to buy the second lottery $\tilde{x}_2$ in the presence of background risk, she is more willing to take risk (i.e. her reservation price is higher) than when she has to take *the same decision* in a world without background risk (or a world in which the background risk realized, no matter how). This translates into an ex-ante reservation price which is bigger than the ex-post reservation price. The driving-force of this result is that the aggregation of risks mitigates the sensations of gains and losses, since it reduces the *distance* between the outcomes generating the aforesaid sensations of gains and losses. Figure 2 illustrates the relationship between the ex-ante reservation price (p_A), the ex-post reservation price ($\bar{p}$), Δp and the probability of realization of the backgroud risk π_1.

Three additional observations are worth highlighting. First, in the KR model, the degree of myopic loss aversion is directly affected by the endowment effect for risk. Indeed, Δp is a concave function which is maximized at $\pi_1 = \pi = 0.5$. That is, myopic loss aversion is maximized when the level of both the background risk and the avoidable risk is maximized. Second, Δp is only concerned with the *risk* of the background risk (i.e. its variance), but not by its domain. Indeed, striking is that Δp depends on π_1, but not on K. It actually is straightforward to show that the ex-ante reservation prices p_A and the ex-post reservation price $\bar{p}$ derived in equations 1 and 2 hold true in the case of a negative background risk $K < 0$. This result is driven by the fact that, in the KR model, only relative comparisons between outcomes and expectations shape utilities. As a consequence, evaluating the conjunction of lottery 2 with a negative background risk of K essentially leads to the same *relative* comparisons than evaluating the conjunction of lottery 2 with a positive background risk of K. Third, the extent of myopic loss averse behavior is a monotonically increasing function of the coefficient of loss aversion λ.

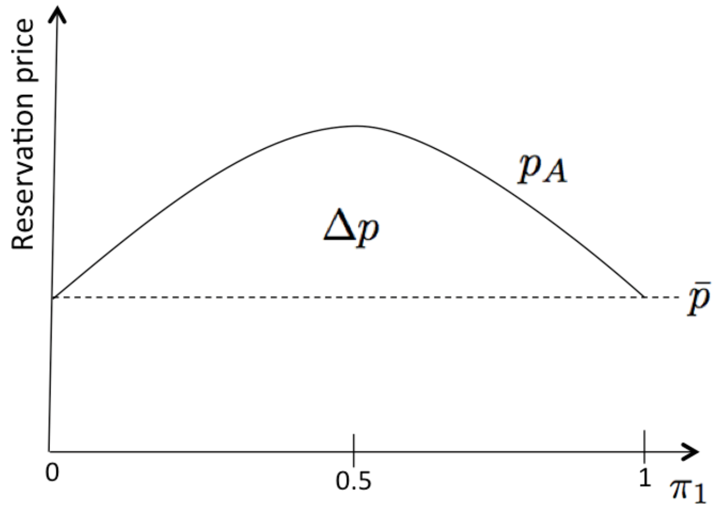


Figure 2: The solid line illustrates the ex-ante reservation price for the second lottery (p_A). The dotted line corresponds to the ex-post reservation price for the second lottery ($\bar{p}$). The area between the two lines correspond to our measure of myopic loss aversion (Δp). Note that MLA is maximized at $\pi_1 = 0.5$. Note that a increasing the degree of loss aversion (represented by a higher values of λ) would reduce p_A slower than $\bar{p}$, increasing therefore our measure of myopic loss aversion Δp.

3 Experimental Design

In this section we present our experimental design. A detailed description of the laboratory experiment is first provided. We then proceed with a description of the various treatments implemented and discuss their associated behavioral predictions.

3.1 Procedure

A total of 334 participants took part to this experiment. 26 sessions were conducted between the last week of October and the first week of November 2014. The experiment was fully computerized using Z-Tree (Fischbacher, 2007). After having been randomly assigned to a computer at the beginning of each session, participants received a set of instructions describing the entire experiment.[7]

The instructions disclosed the entire sequence of events to the participants, as well as the amounts at stake and the relevant probabilities. They explained to the participants that they were about to play at two different lotteries. The first lottery (i.e. the background risk) was a free lottery yielding K with probability π_1 and CHF 0.- otherwise. In order to mimic positive and negative background risk as well as different levels of risk, both K and π_1 were manipulated, as we will discuss in section 3.2. The second lottery was different from the first one in that (i) *it was not free*, (ii) it yielded $G = 8$ with probability $\pi = 0.5$ for all the participants, and zero otherwise. The second lottery was identical across all the conditions. In order to take part to it, participants had to pay for it by making use of (part of) their show up fee. They were asked to state their willingness to pay to play to the second lottery. The support of possible reservation prices ranged from CHF 0.- to CHF 6.- , in increments of CHF 0.2, and was incentivized using the Becker-DeGroot-Marschak price mechanism (Becker et al., 1964).[8]

Each lottery took the form of a wheel that participants had to spin (cf. Figure 3), without being able to influence its speed or the number of revolutions by pressing more/less on the spin button. The red and blue zones correspond to winning and losing areas, respectively. They are proportional to the probability of gain. At each draw, the pie rotated for approximately 5 seconds, after which the wheel eventually stopped on either the winning or the losing area.

Sociodemographics and related individual characteristics were collected at the end of the experiment. Participants were also asked to self report their "willingness to take risks in general", on a scale from 0 (not at all willing to take risks) to 10 (very willing to take risks). We then simply inverted this measure and used it as a proxy for risk aversion. This measure has been validated in large representative sample (Dohmen et al., 2011) and has been shown to be an accurate predictor of risk aversion. We also measured participants' numeracy with a six item questionnaire covering simple mathematical operations and compound interest calculations (Banks and Oldfield, 2007; Lusardi and Mitchelli, 2007; Gerardi et al., 2013). Finally, we measured participants' loss aversion in the spirit of Abeler et al. (2011). Participant were asked to make eleven *hypothetical* choices, each time between a fixed payment of zero and a small-stakes lottery. The

[7]The instructions of the experiment can be found in Appendix.

[8]Two unincentivized control questions made sure the participants understood the BDM procedure correctly. 97% of the sample answered correctly to at least one questions, and 83.83 % answered correctly to all the questions.

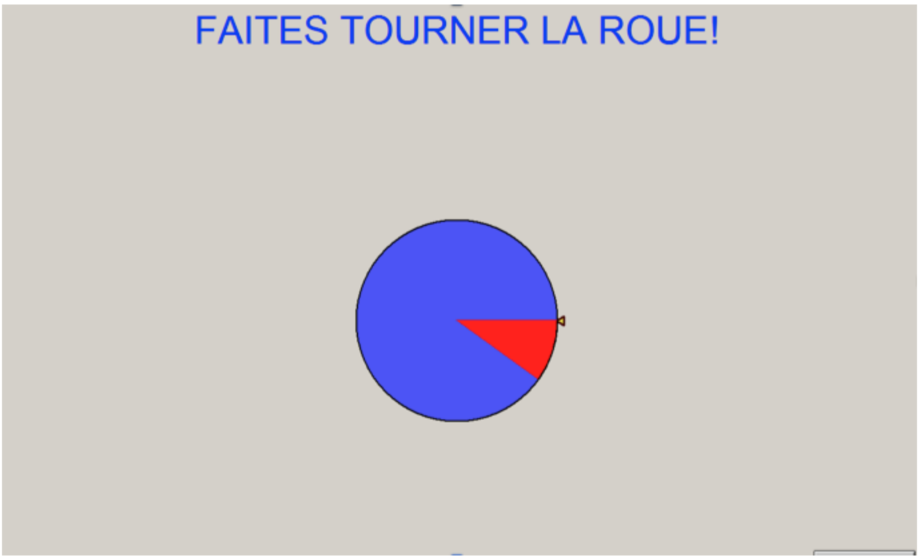


Figure 3: The computerized lottery (probability of gain 10%.)

lottery involved a 50/50 chance of winning CHF 6 or losing CHF Y, with $Y \in [-2, -7]$ in increments of CHF 0.5. As opposed to Abeler et al., we decided not to incentivize these choices. This decision was mostly driven by the fact that incentivized choices would have been likely polluted by the realizations of $\tilde{x}_1$ and $\tilde{x}_2$. For instance, participants might exhibit a *house money effect* (Thaler and Johnson, 1990) after having been lucky in the two lotteries, leading them to take more risk in the loss aversion task. Such an effect would lead us to falsely interpret that participants are less loss averse than they actually are. Another drawback of incentivizing this task is that a strict application of the KR model calls for incorporating all the potential gains and losses of the loss aversion task to the reference point. This would have uselessly complicated the theoretical predictions, without providing further benefits than under hypothetical elicitation of the agents' loss aversion. For similar reasons, incentivizing the loss aversion task *before* the main experimental task would not have helped either.

3.2 Treatments

This paper is jointly concerned by two questions : myopic loss aversion, and the endowment effect for risk. In order to identify each of these effects, 4 different treatments were implemented trough a *between-subjects* design. Each treatment was run under both positive and negative background risk. While under positive background risk (GAIN treatments), the first lottery yielded a gain of CHF 8 with probability π_1, it yielded a loss CHF 8 with probability π_1 under negative background risk (LOSS treatments). We therefore ran 8 different conditions in total. For their participation at the experiment, subjects in the GAIN treatments received a show-up fee of CHF 6.-, while participants in the LOSS treatments received a show-up fee of CHF 14.-. Participants in the GAIN and the LOSS conditions therefore had an identical expected revenue, for a given probability of realization of the background risk π_1.

3.2.1 Myopic Loss Aversion

In order to identify myopic loss averse behavior under both positive and negative background risk, 4 treatments have been implemented. In these treatments, the probability of realization of the background risk was set to $\pi_1 = 0.5$, which corresponds to the point at which myopic loss aversion is predicted to maximal. In the ex-ante conditions (EA), we elicited p_A, the ex-ante reservation price for $\tilde{x}_2$ (i.e. before the realization of the background risk), while in the ex-post conditions (EP) we elicited $\bar{p}$, the ex-post reservation price for $\tilde{x}_2$ (i.e. after the realization of the background risk). The only difference between the EA and the EP conditions is whether the background risk is realized, or not. Comparing the average reservation price under these conditions allows to identify myopic loss aversion in the presence of a positive (negative) background risk. A summary of these four conditions is depicted in table 1.

		Domain of the background risk K	
		GAIN ($K = 8$)	LOSS ($K = -8$)
Realization of background risk	Unrealized	EA-GAIN	EA-LOSS
	Realized	EP-GAIN	EP-LOSS

Table 1: Treatments implemented to investigate myopic loss aversion. The probability of realization of the background risk is $\pi_1 = 0.5$ in each condition. In the conditions in which the background risk is unrealized, participants' ex-ante (EA) reservation price is elicited (p_A). In the conditions in which the background risk is realized, participants' ex-post (EP) reservation prices ($\bar{p}$) are elicited.

3.2.2 Endowment Effect for Risk

While participants' ex-ante reservation price (p_A) for $\tilde{x}_2$ under $\pi_1 = 0.5$ were already elicited in the EA-GAIN and in the EA-LOSS conditions discussed in table 1, 4 additional treatments were run in order to identify an endowment effect for risk in the presence of both a positive or a negative background risk. To that end, the probability of realization of the positive (negative) background risk was set to $\pi_1 = 0.1$ in the LO-GAIN (LO-LOSS) condition and to $\pi_1 = 0.9$ in the HI-GAIN (HI-LOSS) condition. For the sake of readability, let us relabel the EA-GAIN (EA-LOSS) conditions into ME-GAIN (ME-LOSS), for *medium* probability. Note that the background risk is maximized in the ME conditions (i.e. when $\pi_1 = 0.5$). A summary of these six conditions is depicted in table 2.

		Domain of the background risk K	
		GAIN ($K = 8$)	LOSS ($K = -8$)
Probability background risk (π_1)	0.1	LO-GAIN	LO-LOSS
	0.5	ME-GAIN	ME-LOSS
	0.9	HI-GAIN	HI-LOSS

Table 2: Treatments implemented to investigate the endowment effect for risk. In each conditions, the participants' ex-ante reservation prices for $\tilde{x}_2$ (p_A) are elicited (i.e. the prices before the realization of the background risk $\tilde{x}_1$). Note that the observations in ME-GAIN (ME-LOSS) are the same as in the EA-GAIN (EA-LOSS) depicted in table 1.

3.3 Behavioral Predictions

Prediction 1 : Myopic Loss Aversion

Equation 3 formalizes myopic loss aversion. The reservation price for $\tilde{x}_2$ in the presence of *any kind* of uncorrelated background risk $\tilde{x}_1$ is expected to be higher than in a situation involving no background risk (or a realized background risk). Formally

$$\Delta p = p_A - \bar{p} \geq 0 \qquad \forall K, \pi_1 \tag{4}$$

The reservation price for the second lottery is therefore expected to be higher in the EA-GAIN (EA-LOSS) condition than in the EP-GAIN (EP-LOSS) condition.

Prediction 2 : Endowment Effect for Risk

From equation 1, the ex-ante reservation price for $\tilde{x}_2$ is predicted to be a concave, symmetric, function which is maximized at $\pi_1 = 0.5$. We therefore expect to identify the highest ex-ante reservation price for $\tilde{x}_2$ in the ME-GAIN and the ME-LOSS conditions. Symmetry implies that the price in the LO-GAIN (LO-LOSS) condition is expected to be the same than the price in the HI-GAIN (HI-LOSS) condition. Moreover, the ex-ante reservation price for $\tilde{x}_2$ is predicted to be independent of K, the stake in the first lottery. We therefore expect identical prices in the GAIN and the LOSS conditions, keeping constant the probability of gain in the first lottery.

These implications are clearly distinguished from expected utility theory which, under risk neutrality, predicts that both the ex-ante and the ex-post reservation price for the lottery $\tilde{x}_2$ is constant and equal to the lottery's expected value (πG). Risk neutral EUT maximizers should therefore remain unaffected by all our treatments. Introducing risk aversion slightly changes the picture. Assuming a standard CRRA[9] utility function $u(x) = x^{1-r}/(1-r)$, the agent's ex-ante reservation price is expected to monotonically increase in π_1 when the background risk is

[9] Recall that the higher the r, the more risk averse the individual.

positive.[10] The ex-post reservation price is predicted to be different between first stage winners and first losers (due to the first stage gain of K, and the concavity of $m(\cdot)$), but is however predicted to be independent of π_1. As one would expect, both prices are predicted to decrease in r, the degree of risk aversion of the agent. Qualitatively similar predictions hold in the presence of a negative background risk (i.e. when $K < 0$).

4 Results

Participants from the University of Lausanne (UNIL) and the Swiss Federal Institute of Technology in Lausanne (EPFL) were recruited using ORSEE (Greiner, 2004). The experiment took place in the experimental laboratory (LABEX) at the University of Lausanne. Subjects were allowed to participate in the experiment only once. A maximum of 16 participants took part in a particular session. On average, a session lasted 45 minutes and subjects earned CHF 10.775 (including their show-up fee). Summary statistics of the dependent variable (the willingness to pay for the second lottery) and the main observable individual characteristics are depicted in table 3.

63.3 % of our sample consists of male students. 53 % of the participants are enrolled at the University of Lausanne, and 13.5 % are regular smokers. On average, participants demonstrated sensible aversion to risk by picking up a price for $\tilde{x}_2$ of CHF 3.119 (recall that the expected value of the second lottery is CHF 4). The average self-reported degree of risk aversion is 4.117 (out of 10). This value maps into a coefficient of relative risk aversion of $r = 0.62$ (see Dohmen et al. (2011), footnote 40), a value which seems a bit conservative in light of Holt and Laury (2002) who classified only 13% of their sample as very risk averse (with estimated coefficient of risk aversion $r \in [0.68, 0.97]$).

Following Gerardi et al. (2013), we computed an index proxying participants' numerical abilities. Participants were allocated to four different groups, group 1 (4) gathering participants with the lowest (highest) numerical abilities. With a score of 3.422 out of 4, our average participant ends up with a higher numerical ability index than 86.7 % of the participants in the sample used by Gerardi et al.[11] This is not surprising given that our participants only consists of university students.

[10] the agent's ex-ante reservation price is determined by the inequality

$$\begin{aligned} &\pi_1 \left[\pi \frac{(S+K+G-p)^{1-r}}{1-r} + (1-\pi) \frac{(S+K-p)^{1-r}}{1-r} \right] \\ &+(1-\pi_1) \left[\pi \frac{(S+G-p)^{1-r}}{1-r} + (1-\pi) \frac{(S-p)^{1-r}}{1-r} \right] \\ &\geq \pi \frac{(S+K)^{1-r}}{1-r} + (1-\pi) \frac{S^{1-r}}{1-r} \end{aligned} \tag{5}$$

where S is the participant's show up fee.

[11] For details on the classification, see the online appendix of Gerardi et al (2013).

Making use of participant's answer to the hypothetical loss aversion questionnaire à la Abeler et al. (2011), our average estimated upper bound on the loss aversion parameter is $\lambda = 1.869$. It corresponds to the maximum value of λ under which the agent accepts to take a 50-50 lottery between $+6$ and $-Y$, where $Y \in [-2, -7]$. With such a coefficient, an agent rejects a 50-50 lottery between a $+6$ and $-Y$ for all $Y > 3.2$. This coefficient is sensibly smaller than what is usually estimated in the literature. We are likely to have underestimated this parameter given that it was elicited using hypothetical choices.

Finally, columns VI and XI of table 3 provide F-statistic (p-values in brackets) associated to the null hypothesis of identical means accross conditions. We can never reject the null hypothesis of identical means. Moreover, an omnibustest test from a multinomial logistic regression does not reject the null hypothesis of equal observable characteristics accross the conditions ($\chi^2(63) = 70.15$, p-value=0.25). The randomization process of the treatment allocation was thus a success.

4.1 Myopic Loss Aversion

In order to identify myopic loss averse behavior, we compare the average reservation price for the second lottery of participants in the EA and the EP conditions. We successively consider the case of a positive and a negative background risk. The probability of realization of the background risk (π_1) is equal to 0.5 in all conditions; It is the parameterization for which myopic loss aversion is predicted to be maximal.

As highlighted in prediction 1, the average reservation price of the participants in the EA-GAIN (EA-LOSS) condition is expected to be higher than in the EP-GAIN (EP-LOSS) condition. The KR-model generates a myopic loss averse behavior in the sense that the agent is expected to be more willing to take risks whenever the risks are lumped together (i.e. when the decision on participating to lottery 2 is presented along with lottery 1).

Figure 4a depicts the unconditional average reservation price for the participants in the ex-ante and the ex-post condition in the GAIN treatments (i.e. positive background risk). The reservation price is CHF 3.13 in the ex-ante condition, while it is CHF 2.66 in the ex-post treatment. Unconditionally, participants therefore are more willing to take risk in the ex-ante condition (i.e. when the background risk and the avoidable risk are lumped together). This difference in prices is significant at the 90% confidence interval ($p = 0.0667$). Moreover, we cannot reject the one-sided null hypothesis that $p_A > \bar{p}$ ($p = 0.966$). This first piece of evidence indeed speaks in favor of a myopic loss averse behavior in our sample.

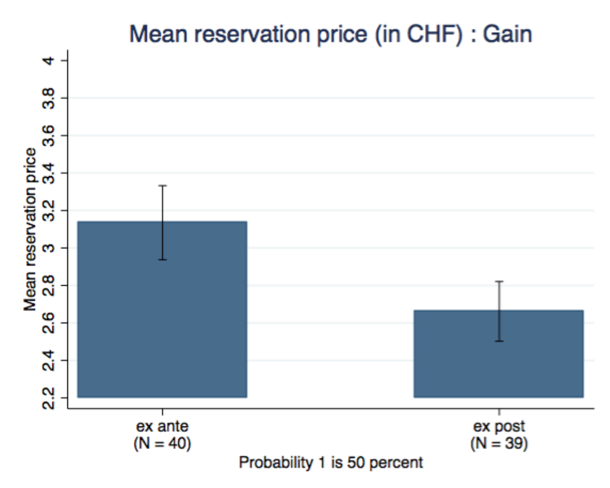
The picture is drastically different for the participants in the LOSS treatments (i.e. negative background risk). As depicted in figure 4b, the participants in the ex-ante condition value $\tilde{x}_2$ at CHF 3.03 (which is not significantly different from the reservation price of the EA-GAIN participants), whereas participants in the EP-LOSS condition have a reservation price for the

Table 3: Descriptive statistics and randomization tests

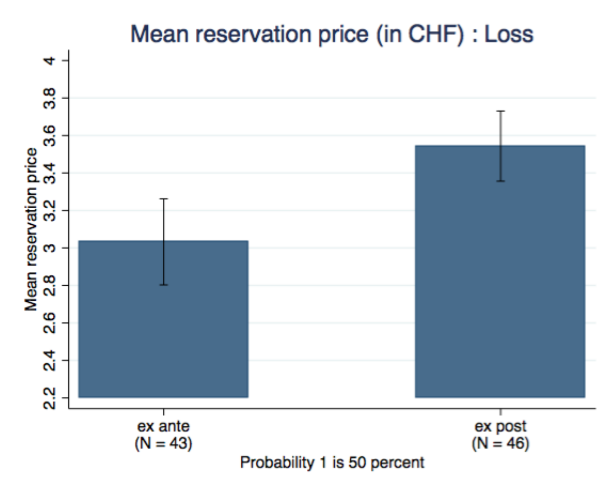
	Overall	Positive Background Risk ($K = 8$)					Negative Background Risk ($K = 8$)				
	Overall	EA(0.1)	EA(0.5)	EA(0.9)	EP	F-Test	EA(0.1)	EA(0.5)	EA(0.9)	EP	F-Test
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Reservation price for $\tilde{x}_2$	3.119										
	(1.297)										
Risk aversion (0 to 10)	4.117	4	3.725	4.455	4.154	1.071	3.628	4.209	4.550	4.196	1.939
	(1.935)	(2.176)	(2.000)	(1.797)	(1.927)	[0.363]	(1.619)	(1.934)	(2.050)	(1.939)	[0.125]
Numeracy index (1 to 4)	3.422	3.692	3.500	3.409	3.359	2.077	3.302	3.442	3.575	3.152	2.311
	(0.770)	(0.569)	(0.679)	(0.757)	(0.778)	[0.105]	(0.803)	(0.854)	(0.675)	(0.894)	[0.0781]
Male	0.623	0.641	0.700	0.477	0.564	1.641	0.628	0.698	0.725	0.565	0.976
	(0.485)	(0.486)	(0.464)	(0.505)	(0.502)	[0.182]	(0.489)	(0.465)	(0.452)	(0.501)	[0.406]
Age	20.77	21.41	21.12	21.16	0.82	0.330	20.05	20.16	20.55	20.91	1.592
	(2.921)	(2.826)	(3.139)	(5.176)	(2.437)	[0.803]	(1.588)	(2.214)	(1.753)	(2.475)	[0.193]
French (mother tongue)	0.802	0.795	0.675	0.727	0.744	0.497	0.884	0.884	0.825	0.870	0.234
	(0.399)	(0.409)	(0.474)	(0.451)	(0.442)	[0.685]	(0.324)	(0.324)	(0.385)	(0.341)	[0.873]
Regular smoker	0.135	0.231	0.150	0.0909	0.154	1.034	0.186	0.116	0.0500	0.109	1.410
	(0.342)	(0.427)	(0.362)	(0.291)	(0.366)	[0.379]	(0.394)	(0.324)	(0.221)	(0.315)	[0.242]
UNIL	0.536	0.667	0.525	0.636	0.564	0.695	0.605	0.465	0.375	0.457	1.566
	(0.499)	(0.478)	(0.506)	(0.487)	(0.502)	[0.557]	(0.495)	(0.505)	(0.490)	(0.504)	[0.200]
Hypothetical loss aversion	1.869	1.979	1.838	1.946	1.994	0.435	1.887	1.817	1.684	1.817	0.891
	(0.668)	(0.771)	(0.685)	(0.646)	(0.612)	[0.728]	(0.628)	(0.682)	(0.544)	(0.745)	[0.447]
Swiss citizen	0.515	0.538	0.450	0.568	0.487	0.453	0.512	0.558	0.425	0.565	0.690
	(0.501)	(0.505)	(0.504)	(0.501)	(0.506)	[0.716]	(0.506)	(0.502)	(0.501)	(0.501)	[0.559]
Observations	334	39	40	44	39		43	43	40	46	

Notes : Averages on overall sample in column I (standard deviation in parenthesis). Columns II-V (respectively VII-X) provide summary statistics for the participants in the positive (negative) background risk treatment displayed in the left-hand side (right-hand side). Columns VI (XI) display the F-statistic (p-values in brackets) associated to the null hypothesis of equality of means accross columns II-VI (VII-X).

second lottery of CHF 3.54. While we only barely reject the null hypothesis of equality between the two prices ($p = 0.086$), we confidently reject the one-sided hypothesis of myopic loss aversion ($p_A > \bar{p}$) at the 95% confidence interval ($p = 0.0432$). Under negative background risk, the participants in our sample behave contrary to the myopic loss averse hypothesis.



(a) Positive background risk ($K > 0$)



(b) Negative background risk ($K < 0$)

Figure 4: Myopic Loss Aversion Tests

4.1.1 Regression Analysis : Myopic Loss Aversion

In order to take into account the observable individual characteristics, we proceed with a regression analysis. We estimate the model

$$\text{price}_i = \beta_0 + \beta_1 \text{EX-ANTE}_i + \beta_2 \text{LOSS}_i + \Gamma' X_i + \epsilon_i \tag{6}$$

where price_i is individual i's reservation price for the second lottery. EX-ANTE is a dummy variable taking the value 1 if the agent's reservation price for lottery 2 was elicited *prior* to the realization of the background risk. LOSS is a dummy variable taking the value 1 if the agent is in the negative background risk treatment. X is a vector of control variables including participants observable characteristics (among others : gender, education, age, risk aversion, upper bound on loss aversion parameter λ, and score at numeracy test). It also contains the dummy K$\times$ex-post. For participants in the GAIN (LOSS) treatments whose *ex-post* reservation price were elicited, this dummy takes the value 1 if the participant won (lost) the K francs at stake in the first lottery. This coefficient therefore allows to control for potential revenue effects, house money effects, or break-even effects related to the realization of the background risk.

The first column of table 4 depicts the estimation of specification 6 without controls. The effect of the EX-ANTE treatment is slightly negative, but insignificant. This is not surprising since the EA treatment had an opposite effect on the participants in the GAIN and in the LOSS conditions (as we depicted in figure 4) and we did not add an interaction term.

Participants in the LOSS condition stated a willingness to pay CHF 0.394 higher than participants in the GAIN condition ($p < 0.05$). Adding control variables to the pooled regression (column 2) does not affect the results. From all the control variables, *only* our proxy for risk aversion and for the parameter of loss aversion λ are significant, and have the expected sign.

The coefficients of the pooled regression above are not fully informative as they do not take into account the variation in the data that can be captured by the interaction between the EX-ANTE treatment and the GAIN/LOSS conditions. We tackle this issue by running specification 6 separately on the GAIN and the LOSS subsamples. As depicted in column 3, we reject the null hypothesis that prices in the EA-GAIN and EP-GAIN are identical ($p = 0.066$) : the reservation ex-ante reservation price for lottery 2 is higher than the ex-post reservation price when the background risk is positive. Controlling for individual characteristics however renders this coefficient insignificant ($p = 0.428$, column 4). In the negative background risk conditions, however, participants in the EA-LOSS treatment report a willingness to pay for lottery 2 which is significantly lower by CHF 0.511 ($p = 0.086$) than participants in the EP-LOSS condition. This difference increases to CHF 0.790 in the estimation which controls for observable characteristics ($p = 0.005$).

In a nutshell, while – in line with myopic loss aversion hypothesis – participants took more risk before the realisation of the positive background risk condition than after it, the effect reversed in the presence of a negative background risk. This switch in sign is in plain contradiction with the myopic loss aversion hypothesis, and the prediction of the KR model. A cross specification mean test rejects the null hypothesis that the effect of the EA treatment is the same in the GAIN and the LOSS subsamples. In the specification without controls, the test-statistic is $\chi^2(1) = 6.48$ ($p = 0.0109$), while in the specifications including controls the test-statistic is $\chi^2(1) = 8.13$ ($p = 0.0043$).

A surprising results is that participants in the EA-LOSS treatment pay an average of CHF 0.103 less[12] for the second lottery than participants in the EA-GAIN, although they enjoy a higher show-up fee. Adding control variables to the estimation increases this difference even further to CHF 0.94! This result suggests that participants in the LOSS condition weight more heavily the anticipation of future losses (which are due to the background risk) than the positive house-money effect they might experience thanks to their higher show-up fee. Finally, notice the absence of house-money effect in the EP conditions in the gain domain, identified by the negative and unsignificant coefficient reported on the interaction variable K $\times$ ex-post (column 4). In the loss domain, we do not document a break-even effect : the reservation price for lottery 2 after a first stage loss is lower. This coefficient is however insignificant. In either domain, the realization of the first lottery is of no importance for participants' ex-post reservation price.

[12] The average price in the EA-GAIN condition is 2.662 + 0.473 = 3.135 while the average price in the EA-LOSS condition is 3.543 - 0.511 = 3.032.

Table 4: dependent variable : Reservation price

	Pooled	Pooled w.c.	Gain Domain	Gain w.c.	Loss Domain	Loss w.c.
Ex-ante	-0.048	-0.319	0.473*	0.205	-0.511*	-0.800***
	(0.200)	(0.194)	(0.254)	(0.257)	(0.296)	(0.280)
Loss domain	0.394**	0.463**				
	(0.198)	(0.185)				
K x ex-post		-0.331		-0.121		-0.554
		(0.249)		(0.307)		(0.400)
Risk aversion (0 to 10)		-0.156***		-0.149**		-0.093
		(0.047)		(0.057)		(0.078)
Hypothetical loss aversion (upper bound)		-0.551***		-0.680***		-0.408
		(0.168)		(0.165)		(0.267)
Numeracy index (1 to 4)		0.126		0.055		0.196
		(0.126)		(0.165)		(0.181)
Age		0.041		0.007		0.064
		(0.045)		(0.051)		(0.074)
Male		0.171		0.262		0.063
		(0.193)		(0.271)		(0.264)
French (mother tongue)		-0.144		-0.185		0.095
		(0.276)		(0.291)		(0.554)
Regular smoker		0.323		0.028		0.869*
		(0.259)		(0.214)		(0.501)
UNIL		0.203		0.444*		0.023
		(0.207)		(0.251)		(0.313)
Swiss citizen		0.038		0.036		-0.040
		(0.196)		(0.216)		(0.310)
Constant	2.925***	3.331***	2.662***	4.084***	3.543***	2.790
	(0.154)	(1.203)	(0.159)	(1.397)	(0.187)	(2.024)
R^2	0.023	0.261	0.043	0.439	0.033	0.214
Observations	168	168	79	79	89	89

OLS estimation. Robust standard errors in parentheses. In all conditions, probability of gain in lottery 1 and in lottery 2 is 50%. The dependent variable is the reservation price for the second lottery (0 to 6). Risk aversion ranges from 0 (very willing to take risks in general) to 10 (not at all willing to take risks in general). Lambda is an estimate of the loss aversion parameter λ. Levels of significance: $*p < 0.1, **p < 0.05, ***p < 0.01$.

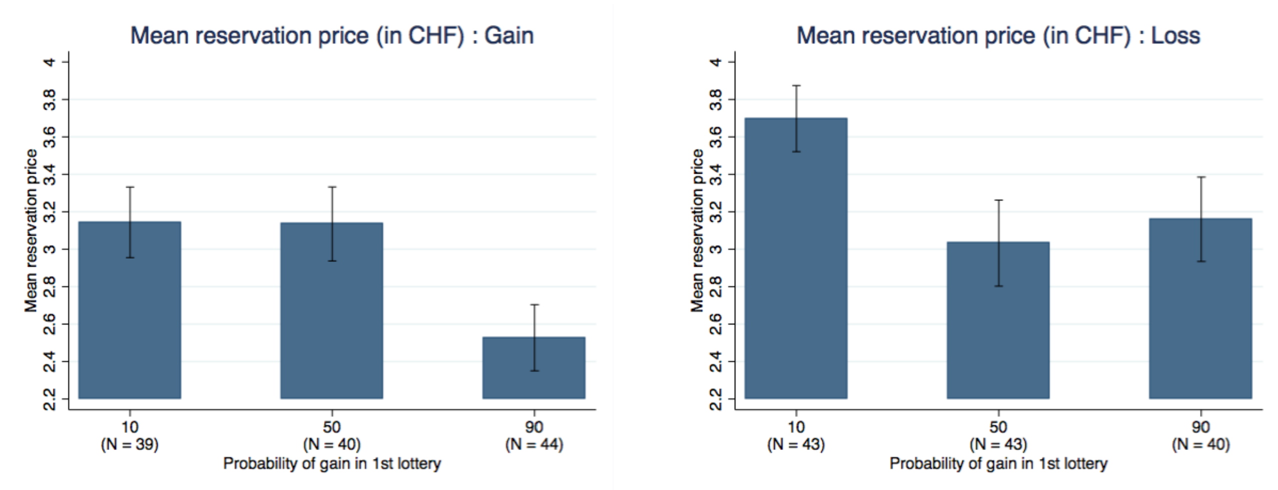
4.2 The Endowment Effect for Risk

The endowment effect for risk is tested by comparing the average *ex-ante* reservation price of the participants in the LO, the ME and the HI conditions. We successively consider the case of a positive and a negative background risk.

As underlined in prediction 2, the average reservation price of the participants in the EX-ANTE conditions is expected to be a concave function of the probability of realization of the background risk (π_1). The endowment effect for risk generated by KR-preferences translates into a reservation price for the avoidable risk which is predicted to be the highest in the ME conditions (i.e. when the background risk is maximized). Furthermore, symmetry implies that the reservation price in the LO and in the HI conditions is expected to be identical.

Figure 5a depicts the average unconditional ex-ante reservation price for $\tilde{x}_2$ of the participants in the GAIN condition. Striking is that we reject a symmetric, bell-shaped, relationship between the ex-ante reservation price and the probability of realization of the background risk. While a one sided t-test on means cannot reject the null hypothesis that the reservation price in the LO condition is smaller thant in the ME condition ($p = 0.5125$), a two sided t-test unambiguously rejects the null hypothesis that reservation price in the LO and in the HI conditions are equal ($p = 0.0193$).

Similarly, the data do not better fit the endowment effect for risk prediction in the case of a negative background risk, as depicted in figure 5b. First, we clearly reject the null hypothesis that the reservation price in the LO contition is lower than in the ME condition (the p-value of a one sided t-test on means is $p = 0.9879$). Moreover, we strongly reject the symmetry prediction of identical reservation price in the LO and in the HI conditions ($p = 0.0621$).



(a) Positive background risk ($K > 0$)

(b) Negative background risk ($K < 0$)

Figure 5: Testing the endowment effect for risk

4.2.1 Regression Analysis : Endowment Effect for Risk

In order to take into account the observable individual characteristics, we proceed with a regression analysis. We estimate the model

$$\text{price}_i = \beta_0 + \beta_1 \text{LOSS}_i + \beta_2 \text{MEDIUM}_i + \beta_3 \text{HIGH}_i + \Gamma' X_i + \epsilon_i \tag{7}$$

where price_i is individual i's ex-ante reservation price for the second lottery. LOSS is a dummy variable taking the value 1 if the agent is in the negative background risk treatment. MEDIUM and HIGH are dummy variables taking the value 1 if the agent faces a probability of realization of the background risk of $\pi_1 = 50\%$ or $\pi_1 = 90\%$, respectively. Finally, X is a vector of controls including the same variables as in specification 6.

We start by estimating specification 7 without the control variables. The results are depicted in the first column of table 5. The average ex-ante reservation price of participants in the LO-GAIN condition is given by the constant (CHF 3.245). In contradiction with the predictions, participants in the negative background risk condition display a reservation price which is about 11% higher ($p < 0.05$). Furthermore, we strongly reject the null hypothesis that participants in the LO and in the HI treatments have a similar reservation price. Indeed, participants in the HI condition report a reservation price almost 20% lower than participants in the LO condition ($p < 0.01$). Finally, we also reject the null hypothesis that the reservation price is the highest in the ME condition. The reservation price of the participants in the ME condition is almost undistinguishable from the reservation price of the participants in the LO condition ($p = 0.1$). Moreover, the sign of this coefficient is negative, whereas the model predicts it should be positive.

Adding control variables to the estimation increases the significance of the results substantially without modifying their interpretation (their sign), as depicted in column 2. All the control variables are insignificant *except* our proxy for risk aversion and for the parameter of loss aversion lambda, which both have the expected sign.

Columns 3-6 document the effect of the probability of realization of the background risk separately for the positive and the negative background risk samples. They therefore control for the interaction effect between the probability of the background risk, and its domain. Basically, the interpretation of the results remain identical as in columns 1 and 2. We strongly reject that the average reservation price of participants in the ME condition is higher than in the LO condition. Indeed, the reservation price in the ME condition is either undistinguishable from the reservation price in the LO condition (in the gain domain) or it is lower (in the loss domain). Furthermore, we overwhelmingly reject the null hypothesis that the reservation prices in the LO and the HI treatments are equal. In our sample, participants systematically report a much lower reservation price in the HI condition ($p < 0.05$) than in the LO condition. These results are in sharp contradiction with Sprenger (2010) who does find support for an endowment effect for risk when the subjects reference point switches from stochastic to certain.

Table 5: dependent variable : Reservation price

	Pooled	Pooled w.c.	Gain Domain	Gain w.c.	Loss Domain	Loss w.c.
Loss domain	0.362**	0.330**				
	(0.164)	(0.152)				
Medium	-0.350*	-0.449**	-0.009	-0.140	-0.665**	-0.732***
	(0.201)	(0.174)	(0.273)	(0.232)	(0.290)	(0.261)
High	-0.588***	-0.613***	-0.616**	-0.491**	-0.538*	-0.733**
	(0.192)	(0.176)	(0.258)	(0.230)	(0.286)	(0.289)
Risk aversion (0 to 10)		-0.112***		-0.107**		-0.100
		(0.040)		(0.052)		(0.063)
Hypothetical loss aversion (upper bound)		-0.734***		-0.683***		-0.773***
		(0.111)		(0.156)		(0.172)
Numeracy index (1 to 4)		0.170		0.194		0.150
		(0.114)		(0.164)		(0.166)
Age		0.029		0.025		0.069
		(0.024)		(0.023)		(0.072)
Male		0.167		0.299		0.056
		(0.165)		(0.243)		(0.251)
French (mother tongue)		-0.326*		-0.268		-0.195
		(0.178)		(0.221)		(0.385)
Regular smoker		0.209		0.075		0.338
		(0.214)		(0.210)		(0.427)
UNIL		-0.243		-0.065		-0.405
		(0.159)		(0.230)		(0.246)
Swiss citizen		0.070		0.032		0.104
		(0.149)		(0.194)		(0.236)
Constant	3.245***	4.149***	3.144***	3.700***	3.698***	3.901**
	(0.156)	(0.771)	(0.188)	(1.018)	(0.177)	(1.559)
R^2	0.054	0.277	0.058	0.340	0.044	0.229
Observations	249	249	123	123	126	126

OLS estimation on dummies for treatments. Robust standard errors in parentheses. Sample consists uniquely of participants in the ex-ante treatment. The dependent variable is the reservation price for the second lottery (ranging from 0 to 6). Risk aversion ranges from 0 (very willing to take risks in general) to 10 (not at all willing to take risks in general). Lambda is an estimate of the loss aversion parameter λ. Levels of significance: $*p < 0.1, **p < 0.05, ***p < 0.01$.

5 Discussion

The KR-model predicted that our treatments would generate large myopic loss aversion and a big endowment effect for risk. Our experiment could however not generate such data. Before drawing final conclusions, we investigate how EUT could help rationalize our data. We show that both risk neutral EUT maximizers, and risk averse EUT maximizer cannot account for the behavior observed in our experiment. We then calibrate the KR model in a way which would allow to rationalize data within each treatment and show that the treatment effects predicted by KR are unrealstically high.

5.1 Expected Utility Theory

Under EUT, risk neutral agents are predicted to remain unaffected by the treatments. The reservation price is expected to be equal to 4, the expected value of the second lottery. A simple t-test on means rejects the null hypothesis that the average reservation price reported by the participants (3.119) equals the expected value of lottery 2 ($p < 0.0001$). Adding risk aversion to the picture does not help EUT in any way. While the agents' ex-ante reservation price is predicted to monotonically increase in π_1, we cannot reject the null hypothesis that the reservation price is actually *decreasing* in π_1. Moreover, a simple calibration exercise suggests that EUT with risk aversion can only unlikely rationalize our data. Table 6 depicts the coefficients of RA implied by the indifference equation 5 and the average reservation prices of the participants in each EX-ANTE condition. Striking is that most of these coefficient are rather (too) high. For instance, the coefficient of relative risk aversion implied by the average reservation price of participants in the ME-GAIN treatment (3.14) is 0.83. With an initial wealth of approximately zero, an agent characterized by such a coefficient prefers a sure amount of 55 to a 50-50 lottery in which she can get either 1000 or 0.[13] In addition, it is extremely unlikely that the *real* average levels of risk aversion of our participants is as dispersed (i.e. heterogeneous) as suggested by the different groups in table 6. Finally, while EUT with concavity predicts a difference in the ex-post reservation price of first stage winners and first stage losers, a simple t-test reject the null hypothesis that they are equal ($t = 0.793$). Altogether, these results suggest that EUT with concavity is very unlikely the appropriate model to rationalize behavior observed in our experiment.

		Domain of the background risk K	
		GAIN	LOSS
Probability background risk (π_1)	0.1	0.66 [3.14]	0.22 [3.70]
	0.5	0.83 [3.14]	0.92 [3.04]
	0.9	1.98 [2.53]	1.16 [3.16]

Table 6: Coefficients of relative risk aversion r rationalizing data (solving equation 5). Average reservation price per group in brackets.

5.2 Calibrating the KR model

In section 4 we showed that the main behavioral predictions of the KR-model do not translate into actual behavior within our sample. We investigate the degree by which our data fail to match the behavior predicted by the KR-model by calibrating it to our experimental parameters. We show that, under reasonable parameters (η, λ), the treatments effects are predicted to be unrealistically large; further casting doubt on the accuracy of the model.

To derive orders of magnitude for the predicted treatment effects, we use the estimates of the parameter of loss aversion λ we elicited at the end of the experiment through a hypothetical questionnaire. The mean level of self-reported loss aversion in our sample is $\lambda = 1.87$. The null hypothesis of zero loss aversion, i.e. that $\lambda = 1$, is overwhelmingly rejected ($p < 0.001$).

[13] Holt and Laury (2002) classified only 13% of their sample as very risk averse (with estimated coefficient of risk aversion $r \in [0.68, 0.97]$) and 4% as highly risk averse (with $r > 1$).

Plugging our experimental parameters into equation 3 and considering the treatments in which $\pi_1 = 0.5$, the predicted magnitude of MLA is $\Delta p = \eta(1 - \lambda)$. Setting $\eta = 1$ and considering the average degree of loss aversion prevailing in our data ($\lambda = 1.87$), the price difference between participants in the EA and EP conditions is expected to be CHF 0.87, which corresponds to 22% of the expected value of the lottery.[14]

Using a similar argument, we can compute the size of the endowment effect for risk predicted by KR (using equation 1). It is given by

$$p_A(0.5) - p_A(0.1) = p_A(0.5) - p_A(0.9) = 0.64\eta(\lambda - 1)$$

where $p_A(x)$ corresponds to the agent's ex-ante reservation price for lottery 2, when the probability of realizeation of the first lottery is x. Setting $\eta = 1$ and considering the average amount of loss aversion prevailing in our data ($\lambda = 1.87$), participants in the ME-GAIN (ME-LOSS) conditions are expected to overprice lottery 2 by CHF 0.55 in comparison of participants in the LO- and HI- conditions.

These predicted treatment effect seem unrealistically large, and lie far away from the small (if any) effects we identified. Moreover, it is worth underlining that these predictions are likely to be lower bounds since we apparently underestimated the loss aversion parameter λ.[15] The literature usually documents values of λ ranging between 2 and 3 (e.g. see Sprenger (2010), page 25). Higher degrees of loss aversion would inflate the predicted treatment effects even further, rendering them even less realistic. The only way to rationalize data with our levels of loss aversion (or higher values) would be to drive η down to zero. This again does not conform with the usual benchmark of losses being felt twice as severely as gains, implying the dyad $(\lambda, \eta) = (3, 1)$.

In order to further investigate the predictive (in-)accuracy of the KR model, we compare the empirical distribution of the reservation price to the theoretical one. We generate the theoretical distribution by simply plugging the experimental parameters of each observation and the participant's estimated loss aversion parameter λ in the equation for the ex-ante and the ex-post reservation price. The Pearson correlation index between the theoretical prices and the empiric prices (for any value of eta) is $r = 0.3645$. Figure 6 gives a sense of the overall fit between the model and the data.

The large treatments effects predicted by KR did not translate into actual laboratory behavior.

[14] An alternative way of constructing the argument would be to infer values of λ from the observed difference between the ex-ante and the ex-post reservation prices. Considering the observations from the GAIN treatment would lead to $\Delta p = 3.13 - 2.66 = \eta(1 - \lambda)$. Assuming, as is standard in the literature, that $\eta = 1$ would necessitate non loss-averse agents ($\lambda = 0.53$) to rationalize behavior. This is clearly unreasonable in light of the extensive evidence that people are indeed loss-averse.

[15] This is not a surprise since we elicited it through a hypothetical questionnaire.

However, the fact that we confidently reject EUT, that individuals display significant loss aversion, and that we document significant differences across the EX-ANTE treatments are a good indication that the subjects are forward looking at the moment they evaluate lottery 2. Such a behavior is in line with any prospective utility formulation, KR being one of them.

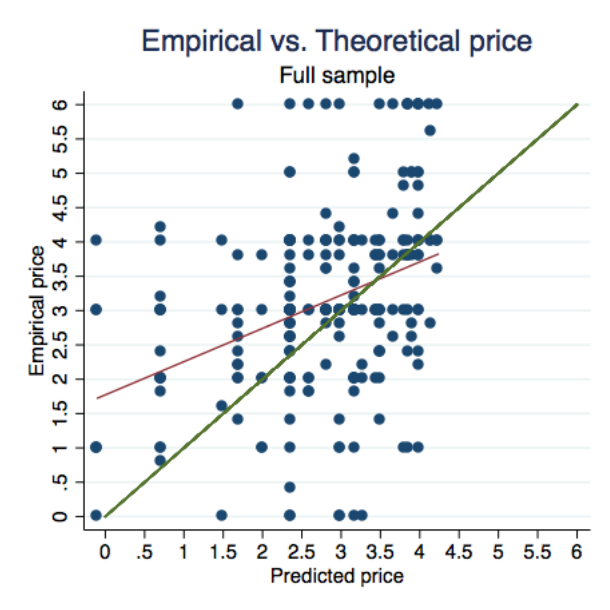


Figure 6: Correspondance between theoretical and empirical prices. Pearson correlation index $r = 0.3645$. 45-degrees line in green. The maximal predicted price is CHF 4. However, participants could pay up to CHF 6 for the second lottery.

6 Conclusion

Myopic loss aversion is a 20-years-old concept resting on two behavioral accounts : loss aversion and mental accounting. It has been put forward by Benartzi and Thaler (1995) as a solution to the Equity Premium Puzzle. Their study engendered a mushrooming literature aiming at experimentally validating MLA and identifying its causes. While generating empirically interesting results, the existing literature crucially lacks formalism in the definition of MLA. The absence of a theoretical framework to rationalize behavior renders the interpretation of the empirical evidence difficult, and makes it hard to understand the exact underpinnings of the phenomenon.

Our first contribution is theoretical : we demonstrate that the increasingly popular model of reference-dependent preferences with loss aversion advocated by Kőszegi and Rabin (2006, 2007) rationalizes MLA-behavior. Along with this prediction, the model precisely identifies the channels through which MLA strikes in. Notably, we show that MLA and the endowment effect for risk (Sprenger, 2010) are tightly connected : as the reference point of the agent becomes riskier, her willingness to take risks increases. This effect is solely driven by the anticipation of future gains and losses. The more risky the agent's prospects are, the less likely it is for her “to get what she expected”. The mismatch between what might arise and what is expected generates the sensations of gains and losses, loss aversion rendering riskier situation less desirable. Crucially, if the agent is given the ex-ante opportunity to “make up” for the potential losses she might face by taking one additional gamble, her willingness to pay for the additional gamble increases in the level of unavoidable risk.

Our second contribution is empirical : in a purposefully simple experiment, we investigate each predictions derived from the KR-model. In our design, participants face either a positive or a negative background risk (lottery 1). Their willingness to pay for an avoidable risk (lottery 2) is elicited either prior to the realization of the background risk (EX-ANTE treatment), or after it (EX-POST treatment). In the GAIN (LOSS) conditions, lottery 1 is a 50-50 lottery between a gain (loss) of CHF 8 and zero, and lottery 2 is a 50-50 lottery between a gain of CHF 8 and zero. MLA implies that the average reservation price for the avoidable risk is higher in the EX-ANTE than in the EX-POST treatment. Another key theoretical result is that MLA is predicted to be driven by the endowment effect for risk. We investigate this relationship by varying the amount of risk of the background risk in three additional EX-ANTE conditions (LO vs. ME vs. HI). In the LO condition, the probability of realization of the background risk is set to 0.1, to 0.5 in the ME condition, and to 0.9 in the HI condition. KR predicts that the reservation price for the avoidable risk should be the highest in the ME condition, and that the reservation prices in the LO and the HI conditions should be equal.

Overall, our results hardly confirm the predictions made by KR. While we cannot reject MLA in the gain domain, we clearly reject MLA in the loss domain. More importantly, we show that the EER predicted by KR does not survive our experiment. Not only do we reject the concave relationship between the probability of realization of the background risk and the reservation price for the second lottery, we also reject the equality of the reservation price between the LO and the HI conditions. In addition, using data on individual loss aversion, we calibrate the KR model to our experimental parameters and derive the expected magnitude of the treatment effects. We show that, despite a positive correlation between predicted behavior and actual behavior, the large magnitude of the treatment effects predicted cannot be reconciled with actual behavior. We also demonstrate that EUT does not help rationalize data.

In a nutshell, the paper contributes to the literature on MLA, and on the recent literature devoted at testing models of reference dependent preferences in which the reference point is expectation-based, as advocated by KR. While expectation-based reference dependence has gained a substantial amount of empirical and experimental support, the particular formulation of KR does not seem to survive tight experimental tests. This paper, along with Goette et al. (2014) and Gneezy et al. (2014) provides evidence on the limits of the KR model. An especially striking finding of this experiment is the difference between the predicted magnitude of the treatment effects, and their actual realization. Not only do we almost never identify treatment effects which are directionally coherent with KR, but whenever we do they are of a relatively small size compared to what is predicted by the model.

A recurrent problem of the KR model seems to be its inability to realistically formalize the way agents anticipate future sensations of gains and losses. Our design makes it especially clear in the EX-ANTE conditions, where agents are asked their willingness to pay for the second lottery before the realization of the first lottery. At that stage, the agents must decide by solely relying on their show-up fee, the expected values of the lotteries, and their expectation of future elation and disappointment. Striking is that our participants did not conform with the behavior of a KR-maximizer. As suggested by Goette et al. (2014), a potentially promising avenue for future research could be to consider that agents are "unable to fully forecast their sensations of gain and loss when developing their plan of action"; A phenomenon referred to as *projection bias* (Loewenstein et al., 2003).

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Appendix

The instructions for participants in the EA-GAIN (ex-ante reservation price elicited, positive background risk) facing a probability $\pi_1 = 0.5$ of winning CHF 8 in the first lottery follow. The instructions for the other treatments are essentially similar.

Explanations for this experiment

Welcome!

Please read carefully the following instructions.

From now on, **it is strictly forbidden to talk to other participants**. To ensure a successful development of the experiment, it is important that you follow this rule. If you have any questions, raise your hand and ask one of the assistants. If you do not respect that rule, we will have to exclude you from the experiment.

For your participation, **your initial payoff is CHF 6.-.**

The money you will earn throughout the experiment will be handed to you at the end of the experiment.

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G_50_EA

A. What is it about?

You will automatically take part in the first lottery. This first lottery gives you the opportunity to win CHF 8.- in 50% of the cases (one in two chance).

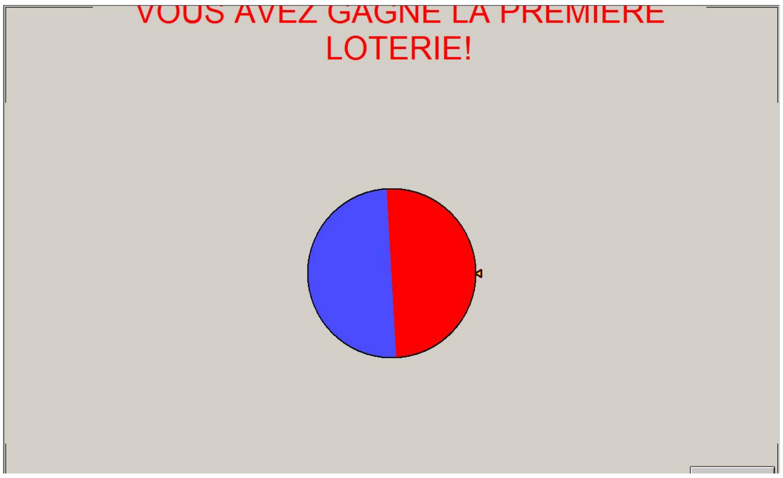
<u>Before playing the first lottery and finding out the outcome</u>, you will have to decide at what maximal price you would like to buy a second lottery. The second lottery allows you to win CHF 8.- in 50% of cases (one in two chance).

Once you have made your buying decision, you can play the first lottery.

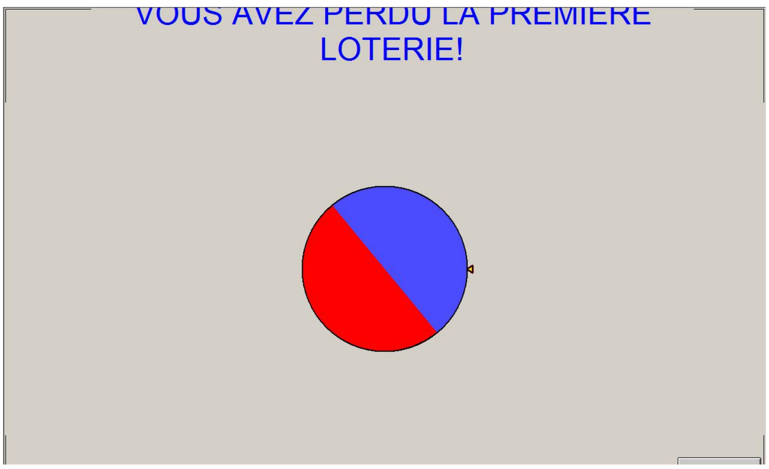
B. The first lottery

You automatically take part in the first lottery. The first lottery has the following features :

- With a **probability of 50% (one in two chance) you earn CHF 8.-** (red area) :



- With a **probability of 50% (one in two chance) you earn nothing** (blue area) :



Therefore, you have **one in two chance of winning CHF 8.-** at the first lottery.

C. The second lottery

Before you find out the outcome of the first lottery, you have the opportunity of buying a second lottery. The second lottery has the following features :

- With a **probability of 50% (one in two chance) you earn CHF 8.-**
- With a **probability of 50% (one in two chance) you earn nothing.**

Therefore, you have **one in two chance of winning CHF 8.-** at the second lottery.

You have to pay to take part in this second lottery. To that end, you can use can use all or a fraction of your initial payoff (CHF 6.-).

For each price of the list that will appear on the screen (similar to the one below), you will have to indicate whether you prefer to pay the price displayed and play the second lottery, or if you would rather not take part in the second lottery and keep your CHF 6.-.

		I prefer to buy the lottery	*I prefer to keep my money*
1	If the randomly drawn price is 0.20CHF, …	○	○
2	If the randomly drawn price is 0.40 CHF, …	○	○
…	If the randomly drawn price is … CHF, …	○	○
29	If the randomly drawn price is 5.80 CHF, …	○	○
30	If the randomly drawn price is 6 CHF, …	○	○

The final price of the lottery (the one you will actually pay) will be determined with a random drawing. It will range from CHF 0,20 to CHF 6.- and will be the same for all participants. **It is impossible that you influence the price.** You can only decide if, at a given price, you prefer to buy the lottery at the randomly drawn price, or if you prefer to keep your CHF 6.-.

D. Progress of the experiment

1. You decide at what prices you prefer to buy the second lottery.
2. The final price of the second lottery is randomly drawn.

If you chose to play the second lottery at the randomly drawn price

3. The randomly drawn price is subtracted from your initial payoff
4. You find out the outcome of the first lottery, in which you have
    - a probability of 50% (one in two chance) of winning CHF 8.-
    - a probability of 50% (one in two chance) of winning nothing
5. You find out the outcome of the second lottery, in which you have
    - a probability of 50% (one in two chance) of winning CHF 8.-
    - a probability of 50% (one in two chance) of winning nothing

If you chose not to play the second lottery at the randomly drawn price

3. You keep your entire initial payoff
6. You find out the outcome of the first lottery, in which you have
    - a probability of 50% (one in two chance) of winning CHF 8.-
    - a probability of 50% (one in two chance) of winning nothing
4. You do not take part in the second lottery.

Please read the example on the following page.

Example

Imagine that you decide not to play the second lottery for all price higher to CHF 2.-. You then need to check

- « I prefer to play the lottery » if the price is CHF 2.- (line 10)
- « I prefer to keep my money » if the price is CHF 2.20 (line 11)

The computer will then automatically fill in the rest of the table as follows :

		I prefer to play the lottery	I prefer to keep my money
1	If the randomly drawn price is 0.20CHF, …	X	O
2	If the randomly drawn price is 0.40CHF, …	X	O
…	If the randomly drawn price is … CHF, …	X	O
9	If the randomly drawn price is 1.80CHF, …	X	O
10	If the randomly drawn price is 2.00CHF, …	X	O
11	If the randomly drawn price is 2.20CHF, …	O	X
12	If the randomly drawn price is 2.40CHF, …	O	X
…	If the randomly drawn price is … CHF, …	O	X
29	If the randomly drawn price is 5.80 CHF, …	O	X
30	If the randomly drawn price is 6 CHF, …	O	X

In other words : you prefer to buy the lottery when the price is lower or equal to CHF 2.-. If the price is higher to CHF 2.-, you prefer not to buy it.

Process:

- If the randomly drawn price is CHF 1.-
    - At that price, you prefer to buy the second lottery.
    - CHF 1.- is subtracted from your initial payoff.
    - You find out the outcome of the first lottery, in which you have
        - a probability of 50% (one in two chance) of winning CHF 8.-
        - a probability of 50% (one in two chance) of winning nothing
    - You find out the outcome of the second lottery, in which you have
        - a probability of 50% (one in two chance) of winning CHF 8.-
        - a probability of 50% (one in two chance) of winning nothing

- If the randomly drawn price is CHF 3.-
    - At that price, you refuse to buy the second lottery.
    - Therefore, you keep your entire initial payoff.
    - You find out the outcome of the first lottery, in which you have
        - a probability of 50% (one in two chance) of winning CHF 8.-
        - a probability of 50% (one in two chance) of winning nothing
    - You do not take part in the second lottery.