ECARES

Framing, Expectations and Reference Points

Oliver März
ECARES, Université libre de Bruxelles

November 2016

ECARES working paper 2016-40

ECARES
ULB - CP 114/04
50, F.D. Roosevelt Ave., B-1050 Brussels BELGIUM
www.ecares.org

Framing, Expectations and Reference Points

By Oliver März

Recent theories of expectation-based reference-dependent preferences offer a structured approach of the formation of reference points, yet do not incorporate important context-specific characteristics. One implicit assumption is that individuals form their reference point as expectations by correctly predicting the probabilistic environment they are facing. In an experimental setup, we demonstrate that a simple change in the framing of a decision problem alters the reference point formation by evoking a different moment of first focus. Apart from providing evidence on the limitations of current theories of expectation-based reference dependence, this paper further offers a theoretical extension that overcomes these limitations and allows reference points to be contingent on contextual effects.

JEL: C91,D03,D81,D84
Keywords: Framing, Expectations, Stochastic Reference Points, Salience Effects

I. Introduction

In the literature of behavioral economics there is now much support for models of reference-dependent preferences. Compared to traditional neoclassical expected utility theory, reference-dependent preferences describe an alternative way how individuals perceive and evaluate economic outcomes. Outcomes are compared to a reference point, resulting in an evaluation either as a gain or a loss. [1] In general, people tend to exhibit risk aversion in the domain of gains and risk-seeking in the domain of losses, with a significantly greater aversion to losses than appreciation of gains. It is this feature of loss aversion which allows reference-dependent preferences to successfully explain various phenomena in economics which are at odds with expected utility theory, such as the endowment effect (Kahneman, Knetsch and Thaler 1990), the equity-premium puzzle (Benartzi and Thaler 1995) or low-labor-supply of taxi drivers during peak-demand (Crawford and Meng 2011, Doran 2014).

As the reference point partitions the domains of losses and gains, assumptions about it are pivotal in any application of reference-dependent preferences. Originally, the reference point was left undetermined and chosen in an ad-hoc way, often assumed to be given by the status quo (Kahneman and Tversky 1979). This additional degree of freedom allowed researchers to successfully explain

[1] Expected utility theory defines preferences over total wealth, such that outcomes are solely evaluated based on their impact on the absolute level of wealth.

non-standard behavior by choosing the reference point in accordance with the context-related decision problem. Recently, models of expectation-based reference dependent preferences have provided necessary modelling discipline and specified which reference points are admissible within a given context. Due to their very nature, however, reference points are not directly observable and are thus difficult to model. The literature therefore distinguishes between two approaches. Either the referent point could be a single fixed element, implying that any outcome is perceived uniquely as a gain or as a loss (Bell 1985, Loomes and Sugden 1986, Gul 1991). Alternatively, the reference point could be given as a stochastic reference distribution (Kőszegi and Rabin 2006, 2007). In this case each outcome is compared with the full distribution of stochastic outcomes, implying that an outcome could be perceived simultaneously as a gain and a loss. Recent studies found support for the predictions of these expectation-based reference dependent models. Expectations have been shown to matter in the formation of the reference point and are a key driver to explain effort-provision in tedious tasks (Abeler et al. 2011, Gill and Prowse 2012), valuation of products and exchange behavior (Ericson and Fuster 2011, Heffetz and List 2014), consumer choice (Karle, Kirchsteiger and Peitz 2015), risk-taking in game shows (Post et al. 2008) or professional golf performance (Pope and Schweitzer 2011). This evidence consequently led to the application of models of expectation-based reference dependence to broader economic concepts. These models could provide novel explanations and predictions in the contexts of price competition (Heidhues and Kőszegi 2008), price stickiness (Heidhues and Kőszegi 2014), contracting in principal-agent settings (Herweg, Müller and Weinschenk 2010) or the effects of expectation-based loss aversion in oligopoly models (Karle and Peitz 2014).

Interestingly, a key element in models of expectation-based reference-dependent preferences, is an implicit requirement of rational expectation formation. Kőszegi and Rabin (2007) illustratively state this condition in their model by arguing, "[...] as an imperfect but at the same time disciplined and largely realistic first pass, we assume that a person correctly predicts her probabilistic environment [...], so that her beliefs fully reflect the true probability distribution of outcomes (p.1048)". Insights from the literature of psychology, however, challenge this assumption. In fact, the perception of the probabilistic environment can be affected by contextual effects as there exists plenty of evidence about the importance of framing effects on cognition, preferences and decision-making (Kahneman 1992). [2] One particular element which is likely to be important in the perception of the probabilistic outcomes and thus in the formation process of reference points is the element which attracts the moment of "first focus". The significance of the

[2] We use the terms contextual effects and framing effects interchangeably to explain situations when a small change in the presentation of an issue produces (often large) changes in options or behavior (Chong and Druckman 2007). Formally, the conventional expectancy value model by Ajzen and Fishbein (1980) describes an attitude towards an object by $Attitude = \sum v_i w_i$, where w_i is the salience weight associated to attribute $v_i (\sum w_i = 1)$. Framing can affect the weights w_i put on attributes or shift attention between different attributes v_i. For a recent survey of the literature consult Borah (2011) .

moment of first focus has been documented by psychologists, who describe it as the stimulus to which other stimuli are seen in relation to (Rosch 1975), as well as in multi-person domains where behavior is organized around initial reactions to experimental environments (Sprenger et al. 2015). The impact of the moment of first focus could thus be akin to an "anchoring effect", a well-known psychological phenomenon which states that behavior is organized around specific salient pieces of information (Furnham and Boo 2011).

In this paper we conduct a laboratory experiment to study the impact of the moment of first focus on the formation of expectation-based reference points. In our experiment, subjects are spread across three groups, one control group and two treatment groups. All groups are contacted by e-mail one day before they have to appear in the lab. For the control group the e-mail says that participants will either receive 7.50€ or 12.50€ with an equal probability of 50% for their participation in the experiment. In the gain-treatment the e-mail says that participants will receive a fixed amount of 5€ and will additionally receive either 2.50€ or 7.50€ with an equal probability of 50%. Conversely, in the loss-treatment the e-mail says that participants will receive a fixed amount of 15€ but have to give back either 2.50€ or 7.50€ with an equal probability of 50%. These e-mails unambiguously clarify the payments that could be earned, principally allowing straightforward expectations about identical and multiple uncertain outcomes across all groups. However, the treatments are designed in order to direct the moment of first focus on an arbitrary non-achievable outcome. Models of expectation-based reference-dependence, as well as standard prospect theory and the neoclassical model, predict that this minor contextual change should not affect the formation of the reference point. In order to test the effect of our treatment, experimental subjects appear in the lab on the following day where their risk preferences are elicited after the uncertainty about earnings is resolved. Subjects face simple decisions under uncertainty in which they have to decide whether to keep the payment they just earned or to bet them in a lottery, potentially yielding a higher or a lower payoff.

The results document significantly different risk attitudes between participants in the control group and the treatment groups, thus deviating from predictions of current models of expectation-based reference dependence. However, we find these different risk attitudes only for a sub-group of participants. Only those subjects in both treatment groups who end up with the lower payoff of 7.50€ are significantly more risk averse than comparable participants in the control group. For those participants who end up with the higher payoff of 12.50€ we observe no difference in risk preferences across groups. Therefore, at least for some participants it seems that through manipulation of the moment of first focus, they expect an arbitrary non-achievable outcome as their reference point with some probability. The weight put on that arbitrary reference point affects decision making under uncertainty by shifting the relative importance of other potential reference points. Furthermore, our results indicate that disappointment seems to be a crucial factor when studying reference points. If expectations are disappointed, the moment of first focus could act an anchor and be brought back to memory when contemplating about imminent risky decisions. On the other hand, when expectations are satisfied, choice problems could be approached in isolation, as no unpleasant memories are activated, and decisions are thus unaffected from the moment of first focus. These results suggest that several additional factors, such as context, emotions or cognitive limitations matter in the formation process of reference points and should be considered in theoretical modelling.

We offer a theoretical framework of expectation-based reference point formation that incorporates the findings of our experiment and allows reference points to be sensitive to contextual changes. To appropriately model such reference points, we rely on insights from the psychological literature on salience perception. [3] Two components of this framework differ from current models of expectation-based reference dependence. First, we allow that the moment of first focus influences expectation formation as people put relatively higher weights on more prominent pieces of information that attract the first focus as compared to other less prominent information. Furthermore, we allow expectations about arbitrary outcomes which are not in the support of the probabilistic distribution specifying future outcomes. Second, once expectations are formed and uncertainty gets resolved, lagged expectations are taken as exogenous when considering subsequent choice sets. Lagged expectations about monetary outcomes are then ranked by salience according to how they compare to the outcomes of the choice set. To do so, we introduce the notion of a salience function which formally captures important psychological concepts of salience perception that we consider relevant for reference point formation. In particular, we consider a reference point to be more salient if it can be both undercut and overcut by the outcomes of the choice set, and less salient if it can only be undercut or overcut. Combining these two features yields novel insights into how salience affects reference point formation. The moment of first focus could give rise to an expectation about an arbitrary non-achievable outcome, which in turn could alter the salience ranking of reference points. A changed salience ranking gives rise to a different composition of the stochastic reference point and translates into changed risk preferences. As a consequence, it should be possible to exogenously manipulate behavior via simple framing devices without physical endowments, leaving scope for marketers and policy-makers to influence behavior with menus alone (Sprenger et al. 2015).

This work contributes to the small literature that investigates the limits of expectation-based reference dependence. In an experimental study, Gneezy et

[3]Bordalo, Gennaioli and Shleifer (2012) offer a formal theory how differences in salience between outcomes can affect individual decision making. Their motivation to consider salience effects is that "[...] salience detection is a key attentional mechanism enabling humans to focus their limited cognitive resources on a relevant subset of available sensory data [...] (p.1244)". We apply the same motivation, that salient pieces of information matter, to the study the formation of reference points.

al. (2012) investigate an particular prediction of expectation-based reference dependence, namely that behavior monotonically changes as expectations rise. In their experiment, subjects have to exert effort in a tedious task and are rewarded, after they finished the task, either through a high outside option, a low outside option or a piece-rate payment. [4] The authors report non-monotonic changes in effort provision when the size of the low outside option is increased or when the likelihood of receiving the high outside option increases. Similarly, Goette, Harms and Sprenger (2014) directly test predictions of the Kőszegi and Rabin (2007) model in a market exchange experiment. In the experimental setup they exogenously fix a probability of forced exchange. The theory predicts that individuals should become more willing to trade if the probability of forced exchange increases, which should ultimately eliminate the endowment effect. Their experimental results report contradictory evidence and report a higher valuation of sellers' than buyers' under all probabilities of forced exchange, effectively replicating the endowment effect in all scenarios. The current work is in line with these studies as it likewise falsifies predictions of current theories of expectation-based preferences. At the same time, we go beyond the mere highlighting of the limitations of current models and provide a theoretical framework that can rationalize our observed results.

The work also addresses the question how exactly expectations determine the reference point. Recently, authors have approached this question by analysing the differences between specifications of fixed reference-points (Bell 1985, Loomes and Sugden 1986, Gul 1991) and stochastic reference points (Kőszegi and Rabin 2006, 2007). Sprenger (2015) uses an experimental setup to measure individual risk preferences either by eliciting probability equivalents or certainty equivalents. If a stochastic reference-points is employed, subjects should behave risk-averse in the probability equivalent treatment and risk neutral in the certainty equivalent treatment. This is exactly what he finds, thus refuting the theory of fixed reference points which predict identical risk preferences under both elicitation methods. Closest to our work is the experimental study by Song (2015). Song manipulates expectations of experimental subjects by sending out e-mails 24 hours before the lab session begins, thereby specifying information about starting endowments for three treatment groups. Treatments differ in the presented probability distribution over identical outcomes and generate opposing predictions of risk preferences using fixed or stochastic reference point specifications. Song finds more risk-seeking behavior among participants who were presented lotteries with higher expected values, in line with stochastic reference points. Compared to these studies, this paper does not directly investigate opposing predictions between the specifications of fixed versus stochastic reference points, as both predict no impact of contextual effects. Instead, we offer a new perspective on how to treat expectation-based reference points. In the proposed

[4]The prediction of monotonic responses to increasing expectations is not limited to the study of effort provision but holds in general.

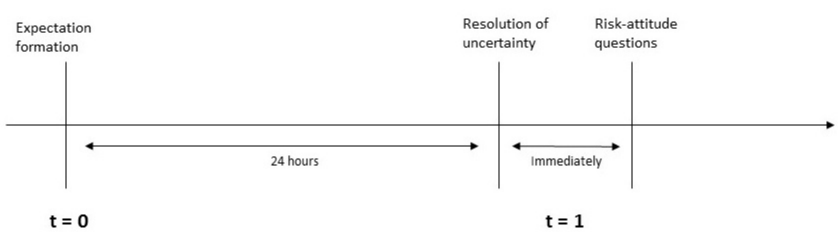
theoretical framework, we do not distinguish between fixed and stochastic reference points, but combine the characteristics of both concepts. Our results are best described by assuming that people evaluate outcomes subject to a stochastic reference point but assign unproportionally high probability masses on certain salient fixed elements.

The remainder of the paper is organized as follows. Section II introduces the experimental setup. Section III presents the theoretical framework and derives theoretical predictions. Section IV shows the experimental results, Section V offers a discussion and Section VI concludes.

II. Experimental setup

The experimental builds on the design of Song (2015) and includes two periods of time. The first period ($t = 0$) represents the time in which expectations about future outcomes are formed and in which treatments take place. The second period ($t = 1$) represents the time in which decisions under uncertainty have to be made and in which lagged expectations from $t = 0$ are taken as the reference point. The timing of the experiment is depicted in Figure 1.

FIGURE 1. TIMING OF THE EXPERIMENT



A. Expectation formation

Experimental subjects are randomly assigned to three groups: the control group, the gain group and the loss group. The treatments consist of different e-mails which are sent out to participants and which specify the probabilistic distribution over outcomes that can be earned in the experiment. These different e-mails across groups are the only treatments that take place over the whole course of the experiment. Furthermore, as we are assuming the reference point to be lagged expectations it is important to allow for a sufficient time lag between the presentation of probabilistic outcomes and the resolution of uncertainty. In order to do so, we send out e-mails 24 hours before subjects appear in the lab, giving individuals sufficient time to ponder about what they can earn on the next day. For the control group the e-mail says, "You signed up for an experiment which starts tomorrow. During this experiment you will complete a survey. For your participation in the experiment and the completion of the survey you will receive a monetary compensation which is randomly determined. You will earn either 7.50€ (with a probability of 50%) or 12.50€ (with a probability of 50%)."

For participants assigned to the gain group and the loss group the description is changed to direct the moment of first focus on an arbitrary non-achievable outcome. In the gain group the e-mail says, "For your participation in the experiment you receive 5€. After the survey, you will earn some additional money. The amount you earn additionally will be randomly determined. You will additionally earn either 2.50€ (with a probability of 50%) or 7.50€ (with a probability of 50%)." In the loss-treatment the e-mail says, "For your participation in the experiment you receive 15€. After the survey, you will lose some of your money. The amount you lose will be randomly determined. You will lose either 2.50€ (with a probability of 50%) or 7.50€ (with a probability of 50%)." It is easily observable that the initial starting endowments of 5€ and 15€ in the gain-treatment and loss-treatment, respectively, are non-achievable outcomes and should be treated as such when forming expectations. Furthermore, it is important to note that the e-mails do not mention the fact that participants have to make a decision under uncertainty at the following day. This design closely resembles the "surprise" situation in Kőszegi and Rabin (2007) in which expectations are formed independently of choice sets. Since the e-mails unambiguously clarify that final earnings are uncertain, we expect subjects to consider the stochastic referents of 7.50€ and 12.50€ for the formation of their reference point.

B. *Decision-making*

On the next day, subjects appear in the lab and are randomly endowed with a tablet computer. Half of the tablets are programmed to pay the lower outcome of 7.50€, the other half to pay the higher outcome of 12.50€. As announced in the e-mail the day before, subjects subsequently complete a short survey answering questions about socioeconomic background data, including a question how much they expect to take away from the experiment. The information provided in the survey has no effect on finals payments and the instructions make clear that all subjects are aware of this fact. Finally, the resolution of uncertainty follows directly after the completion of the survey when subjects learn whether they earn 7.50€ or 12.50€.

In the second part of the experiment the subjects have to make decisions under risk. As reference points are not directly observable, we apply an indirect approach to infer them by eliciting subjects' risk preferences. Participants have to answer 20 risk-attitude questions following the procedure by Holt, Laury et al. (2002) which are designed to derive probability equivalents of each participant. In each question subjects have to decide whether to keep the earning they have just received (Option A) or to bet it in a lottery (Option B). The lottery payoffs

TABLE 1—RISK-ATTITUDE QUESTIONS

	Option A	Option B			
Question	Payment	Payment	Probability	Payment	Probability
1	7.50€	2.50€	95%	10€	5%
2	7.50€	2.50€	90%	10€	10%
3	7.50€	2.50€	85%	10€	15%
4	7.50€	2.50€	80%	10€	20%
5	7.50€	2.50€	75%	10€	25%
...	...	...	...	...	...
...	...	...	...	...	...
18	7.50€	2.50€	10%	10€	90%
19	7.50€	2.50€	5%	10€	95%
20	7.50€	2.50€	0%	10€	100%

Note: In each question participants had to choose between Option A and Option B. Option A represents 7.50€ with certainty while Option B represents a lottery. After all questions have been answered, one question is chosen at random and the choice in this question determines final payments.

differ slightly for those who received 7.50€ or 12.50€, but always pay a fixed higher amount with probability p, and a fixed lower amount with probability $(1 - p)$. Across the 20 questions, p increases progressively in 5% steps until in the final question the lottery pays a higher amount with certainty, guaranteeing that Option B strictly dominates Option A. In order to enforce incentive compatibility, subjects receive information about how their choices affect their final earnings. They are told that at the end of the experiment, the computer selects one of the questions at random and the choice made in this question determines the final payment. For example, if Question 5 is randomly selected and the subject picked the lottery (Option B), the computer would draw a random number between 0 and 1. If the random number was smaller than the probability p to receive the high amount, the high amount would be paid. Otherwise the low amount would be paid. If the subject picked Option A, he would just keep his previous earnings for sure. Due to the design of the questions, final payments depend only on the choices in the risk-attitude questions and not on the sum of the first lottery and the risk-attitude questions. The Holt & Laury table for participants who received 7.50€ is depicted in Table 1.

The decisions made in the risk-attitude questions provide a measure of each individual's risk preference. Given that the probability under Option B to receive the higher payment increases with each question, there should be a unique point at which subjects switch from Option A to Option B, and prefer Option B over Option A for all subsequent questions. Therefore, we infer the probability equivalent for each participant by observing the number of risky decisions (Option B) the individual makes. The later the participant switches, the lower the number of Option B decisions and the more risk averse the subject.

The experimental design facilitates two between-subject comparisons which are

Table 2—Summary of treatment groups

	Control-treatment	Gain-treatment	Loss-treatment
Those who receive 7.50€	Comparison group 1	Comparison group 1	Comparison group 1
Those who receive 12.50€	Comparison group 2	Comparison group 2	Comparison group 2

displayed in Table 2. Those who end up with earnings of 7.50€ are assigned to comparison group 1, while those who end up with earnings of 12.50€ are assigned to comparison group 2. These groups allow us to study the treatment effect under two different scenarios. In comparison group 1 we measure the difference in risk preferences for individuals whose expectations have been shattered and who have to make a decision under uncertainty immediately after the sensation of disappointment. Conversely, for comparison group 2 we analyze differences in risk preferences immediately after expectations have been satisfied.

The experiment was conducted using z-Tree (Fischbacher 2007) at the Université libre de Bruxelles. Subjects were invited using ORSEE (Greiner et al. 2003). There were no restrictions concerning participation eligibility. Undergraduate, graduate and doctoral students from various fields signed up. In total, 96 subjects participated in the experiment (31 in the control group, 35 in the gain-treatment and 30 in the loss-treatment). 50 participants were assigned to comparison group 1, whereas 36 were assigned to comparison group 2. 10 participants made inconsistent choices and were excluded from the data set. [5]

III. Theoretical considerations

This section presents the theoretical framework which is used to analyze our experiment. We adopt a piece-wise utility function from Kahneman and Tversky's (1979) prospect theory,

$$u(x|r) = \begin{cases} x - r & \text{if } x \geq r \\ \lambda(x - r) & \text{if } x < r \end{cases} \tag{1}$$

where $\lambda > 1$ is the loss aversion parameter and r the reference point. A few simplifying assumptions are made. Apart from loss aversion Kahneman and Tversky (1979) highlight the concepts of diminishing sensitivity and probability

[5] Excluding these participants does not affect our qualitative results. The 10 participants are distributed across several groups, so there is no indication of a selection bias. In general, there are two or more switching points for each participant. As the experiment included a question which separately asked for participants probability equivalents in the presented task, we tested the robustness of our results by inferring the number of risky choices from the stated probability equivalents.

weighting as central components of prospect theory. We abstract from these two concepts for the following reasons: First, diminishing sensitivity is likely to play a limited role as we are dealing with small-stake decisions. Small stakes decisions are considered such that consumption utility can be taken as approximately linear, and a piecewise-linear gain-loss utility function can be adopted (Kőszegi and Rabin 2006, 2007). [6] Second, probability weighting captures the fact that extreme-probability outcomes are perceived differently than moderate-probability outcomes. It accounts for the empirical observation that people tend to overweight low probabilities and underweight high probabilities. In this paper we propose a concept of probability weighting based on the salience of reference points. Therefore, we abstract from probability weighting in order to focus on the effects of reference point weighting in isolation. Finally, due to the experimental design, the analysis is limited to situations in which a decision maker is unexpectedly being confronted to make a decision under risk. Such situations are closely related to the "surprise" situation in Kőszegi and Rabin (2007), in which expectations are assumed to be exogenously given and not dependent on the actual choice set. It is likely that contextual effects also influence reference point formation if the choice set is known at the period of expectation formation. Investigating such a scenario is, however, beyond the scope of this text.

A. Expectation formation

We denote the period in which expectations are formed by $t = 0$. At $t = 0$, the decision maker observes a probability distribution of payoffs which can be achieved at $t = 1$. There is no decision-making involved between the time of expectation formation and the resolution of uncertainty. Decision making is only required at $t = 1$, immediately after the resolution of uncertainty. As we are dealing with probabilistic outcomes, we need be very precise with the notation of reference points and expectations. We denote $R = (r_1, r_2, \ldots, r_k) \in \mathbb{R}^K$ as the "set of referents". Each $r_i \in R$ is called a "referent" and corresponds to an *expected* monetary outcome in the early future. Accordingly, we denote $Q = (q_1, q_2, \ldots, q_k) \in \mathbb{R}^K$ as the "set of expectations". Each $q_i \in Q$ corresponds to the probabilistic weight put on "referent" $r_i \in R$. Combining these two sets, we have a "reference distribution" $(R, Q) = (q_1 r_1, q_2 r_2, \ldots, q_k r_k) \in \mathbb{R}^K$ defined as a distribution in which each referent $r_i \in R$ is expected with a corresponding probability $q_i \in Q$ such that $\sum_{i \in Q} q_i = 1$.

We assume the reference point to be stochastic and given by the full distribution of "referents", as specified in Kőszegi and Rabin (2007). When evaluating a monetary outcome at a later point in time, each monetary outcome is compared separately with each referent in the "set of referents". Hence, each outcome can be perceived both as a gain and a loss, depending on which referents are ex-

[6]Without loss of generality we can abstract from separately accounting for consumption utility in this case

pected. Formally, the stochastic reference point is given directly by the reference distribution,

$$r_{stoch} = (R, Q) = (q_1 r_1, q_2 r_2, \ldots, q_k r_k) \in \mathbb{R}^K$$

Note that under this general notation a decision maker could in principle expect any monetary outcome, as the "set of referents" $R = (r_1, r_2, \ldots, r_k) \in \mathbb{R}^K$ does not put any formal restrictions on which "referent" should be included. Yet, a common implicit assumption in models and applications of reference-dependent preferences is that expectations are based on principles of rationality. To focus on the impact of the moment of first focus in this analysis, we likewise assume that the initial "set of referents" R and "set of expectations" Q are based purely on rational considerations. R reflects the true set of referents that can rationally be expected and Q the corresponding true probability distribution. Now, let r_0 be the "referent" which corresponds to the most prominently perceivable outcome in the presentation of outcomes. The prominent "referent" r_0 will then be expected with probability q_0. We call $\tilde{R} = (r_0, r_1, r_2, \ldots, r_k) \in \mathbb{R}^{K+1}$ the "full set of referents" and $\tilde{Q} = (q_0, q_1, q_2, \ldots, q_k) \in \mathbb{R}^{K+1}$ the "full set of expectations". Compared to the rational expectations case, all expectations need to be adjusted, since one prominent "referent" receives a disproportional high weight. The adjusted probabilities $\tilde{q}_i$ are derived by:

$$\tilde{q}_i = (1 - q_0) q_i \quad \text{for } i = 1, 2, ..., k$$

In principle, two possible scenarios can arise under this specification. First, r_0 can correspond to an outcome which lies within the true set of achievable outcomes ($r_0 \in R$). In this case $R = \tilde{R} \in \mathbb{R}^K$ and there exists an $r_i \in R$ for which $r_0 = r_i$. Referent r_i is then expected with probability $\tilde{q} = q_0 + (1 - q_0) q_i$ while all other "referents" $r_j \in R \quad (j \neq i)$ are expected with $\tilde{q} = (1 - q_0) q_i \quad (j \neq i)$. Second, as it is the case in our experiment, r_0 can correspond to an arbitrary non-achievable outcome which cannot be rationally expected ($r_0 \notin R$). The imaginary referent r_0 is expected with probability q_0 and all other expectations q_i are adjusted as specified above. Using this extension, rational expectation formation is only a special case and prevalent when $q_0 = 0$, that is, when the decision maker is not influenced by contextual factors. Formally, the stochastic reference point is given by the "full reference distribution",

$$\tilde{r}_{stoch} = (\tilde{R}, \tilde{Q}) = (q_0 r_0, q_1 r_1, q_2 r_2, \ldots, q_k r_k) \in \mathbb{R}^{K+1}$$

B. Ranking multiple referents

Since the choice set is unknown at the period of expectation formation, Kőzegi and Rabin (2007) assume that in such situations lagged expectations are taken as the exogenous reference point. In this section we allow for the fact that the choice set itself can affect the reference point. To be precise, the reference point is only exogenous with respect to the "full set of referents" $\tilde{R}$ which are considered as exogenously given. The weights put on these "referents", as specified in the "full set of expectations" $\tilde{Q}$, however, could be affected by the composure of the choice set.

Formally, consider a decision problem with a choice set specifying probabilistic monetary outcomes $X = (x_1, x_2, \ldots, x_n) \in \mathbb{R}^N$. It is important to understand the difference between the choice set X and the full set of referents $\tilde{R}$. While X is unknown at $t = 0$ and specifies outcomes which can actually be achieved at $t = 1$, $\tilde{R}$ specifies the outcomes that the decision maker expected to achieve at $t = 1$ given his information at $t = 0$. Monetary outcomes in X are compared with the "full set of referents" $\tilde{R} = (r_0, r_1, r_2, \ldots, r_k) \in \mathbb{R}^{K+1}$ with weights put on each referent, as specified by the "full set of expectations" $\tilde{Q}$. In order to describe how the composure of the choice set affects the weights put on referents we introduce a salience function which captures differences in salience between various referents and allows to rank referents accordingly.

Consider "referents" $r, \tilde{r} \in R$ and the set of monetary payoffs X. Let x_{min}, x_{max} denote the smallest and largest payoffs in X, respectively. The salience of referent r_i is a discontinuous and bounded function $\sigma(r_i|X)$ that satisfies two properties

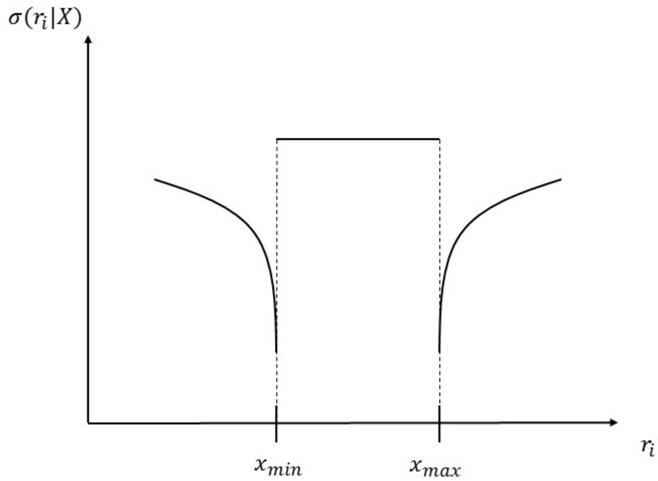
1) **Inner-Dominance**: If referent $r \in [x_{min}, x_{max}]$ and referent $\tilde{r} \notin [x_{min}, x_{max}]$ then
$$\sigma(r|X) > \sigma(\tilde{r}|X)$$

2) **Outside-Ordering**: If referents $r, \tilde{r} \notin [x_{min}, x_{max}]$ and $r > \tilde{r} > x_{max}$ or $r < \tilde{r} < x_{min}$ then
$$\sigma(r|X) > \sigma(\tilde{r}|X)$$

A hypothetical salience function which satisfies these properties is displayed in Figure 2. The two properties of the salience function, inner-dominance and outside-ordering, define how the choice set influences the decision maker's perception of different referents. Loosely speaking, a "referent" is more salient, if it can both be undercut and overcut with respect to monetary outcomes in set X. On the other hand, a "referent" is less salient, if it can only be undercut or overcut. Both properties are grounded on insights in the literature of psychology how people perceive and evaluate risky choices.

Property 1 builds on the central concept of loss aversion which explains why individuals display extreme reluctance to accept mixed gambles (Kahneman and Tversky 1979). In a mixed gamble, the reference point can be overcut or undercut thus creating strong emotional reactions through the mixed sensations of gains and losses. Prospect theory, however, comprises only one reference point which is usually the status quo. When individuals use multiple reference points the emotional response to risky prospects becomes more complex. Wang and Johnson's (2012) Tri-Reference Point theory considers three reference points which

Figure 2. Example of a salience function



determine how monetary outcomes are perceived. [7] Given a set of monetary payoffs, the three reference points carve the outcome space into four distinct regions. Tri-reference point theory predicts that a constant increase in the outcome space will be subjectively more impactful when it results in crossing a reference point into a different outcome region. [8] At the same time, Wang and Johnson allow their model to reduce to a two-referent point model, or even one referent point, if a referent point is clearly untouchable by monetary outcomes. Property 1 of our salience function takes the idea a step further and describes the role of reference points more generally, without limiting the analysis to three reference points. When a referent falls within the set of monetary outcomes, it can be overcut or undercut and is thus more salient than a referent that cannot be touched by the choice outcomes. For simplicity we assume that all referents are equally salient once they fall within the set of monetary outcomes. [9] On the other hand, instead of assuming that referents which do not fall within the set of monetary outcomes are simply omitted, we propose a different mechanism which is described in Property 2.

Property 2 is more intuitive and builds on characteristics of human perception

[7]The three reference points are labelled as the status quo (SQ), the minimium requirement (MR) and the goal (G). This notation of Goal-referent points and/or Minimum requirement reference points has previously been used by several authors (Lopes 1987, March and Shapira 1992, Mellers et al. 1997). For a literature overview see Koop and Johnson (2012) who also provide empirical evidence in line with Tri-Referent-Point theory.

[8]For instance, a potential pay increase of 100€ will generate greater utility gains, if it shifts income above a threshold of 10'000€, rather than "only" moving income closer to that threshold.

[9]This requirement could be relaxed if necessary. Wang and Johnson (2012) suggest differences in the importance of multiple reference points. According to their theory, people devote highest attention to first surpass the MR-reference point while thereafter focusing on achieving their goals.

of signals. Principles of neural science tell us that the intensity with which humans perceive a signal depends on the signal's magnitude but also on the context (Kandel et al. 2000). The signal in our context of multiple reference points is the difference between the referents and the lottery payoffs. The greater this difference, the higher the signal perceived and the higher the perceived salience of a referent. If two referents fall, say, above the set of choice outcomes, both generate a feeling of a loss, as there exists no monetary outcome that overcuts the two referents. The higher the magnitude of the loss, unsurprisingly, the more painful the loss and the higher the salience of the referent that generates this feeling of a loss.

Finally, the salience function does not specify how referents would be treated which fall outside the set of choice outcomes but on opposite sides. In our experiment, this case does not arise, therefore we refrain from a formal specification. A straightforward description would base the perceived salience on the magnitude of the difference between high referents and the supremum of the set of monetary payoffs, and low referents and the infimum of the set of monetary payoffs.

Given its characteristics, we now describe how different values of the salience function translate into changes in the "full set of expectations" $\tilde{Q}$. To do so, we apply the concept of salience weighting by Bordalo, Gennaioli and Shleifer (2012). First, given a salience function σ, its values are replaced by their rank. Let $k_i \in 1, ..., |\tilde{R}|$ be the salience ranking of referents $r_i \in \tilde{R}$. A lower k_i indicates higher salience, such that the most salient referent, which is the referent with the highest value of the salience function, is assigned rank $k = 1$. The least salient referent, which is the referent with the lowest value of the salience function, is assigned rank $k = |\tilde{R}|$. Referents with the same salience receive the same ranking. This ranking of referents allows us to describe the relative importance of referents, given a choice set, without the need to specify an explicit salience function. Given a salience ranking, the weight $\tilde{q}_i$ put on referent r_i, from the first period of expectation formation, is transformed by

$$\hat{q}_i = \omega_i \tilde{q}_i,$$

where $\omega_i = \frac{\delta^{k_i}}{\sum_i \delta^{k_i} \tilde{q}_i}$. Parameter $\delta \in (0, 1]$ captures the degree by how much the decision maker focuses on the most salient referents and disregards less salient referents. When $\delta = 1$, the decision maker is a rational decision maker. He is not affected by the salience of referents and continues to put the same weight on each referent as in the period of expectation formation. When $\delta < 1$ the decision maker is affected by salience effects, meaning he inflates the weight put on the most salient "referents" and deflates the weight put on the least salient ones. In the limiting case of $\delta \to 0$ the decision maker focuses only on the most salient referent.

C. Decision-making

We can now turn to describe how the described transformation of expectations affects decision-making in our experimental setup. In the period of expectation formation ($t = 0$) experimental subjects receive different descriptions about probabilistic outcomes that can be earned in the early future. Expectation formation varies between the three groups as the moment of first focus is different. For the control group, no information is displayed prominently such that $R_C = (r_1, r_2) = (7.50, 12.50)$ with $Q_C = (q_1, q_2) = (0.5, 0.5)$. In the gain group and the loss group the moment of first focus is directed towards an imaginary payment such that this non-achievable outcome will be expected with some probability. Therefore, we have for the gain group $\tilde{R}_G = (r_0, r_1, r_2) = (5, 7.5, 12.5)$ with $\tilde{Q}_G = (q_0, \tilde{q}_1, \tilde{q}_2) = (q_0, 0.5(1 - q_0), 0.5(1 - q_0))$ and for the loss group $\tilde{R}_L = (r_0, r_1, r_2) = (15, 7.5, 12.5))$ with $\tilde{Q}_L = (q_0, \tilde{q}_1, \tilde{q}_2) = (q_0, 0.5(1 - q_0), 0.5(1 - q_0))$. This completes the period of expectation formation.

The period of decision making ($t = 1$) starts, after participants in the lab learn their payment and have to decide whether to keep this payment or to bet it in a lottery. For participants in comparison group 1 who earned 7.50€, the set of monetary outcomes is given by $X_{CG1} = (x_1, x_2, x_3) = (2.50, 7.50, 10)$ while for comparison group 2 who earned 12.50€, it is given by $X_{CG2} = (x_1, x_2, x_3) = (10, 12.50, 15)$. In the risk-attitude questions, Option A always refers to keep outcome x_2 and Option B refers to playing a lottery yielding outcomes x_1 or x_3 with probabilities $(1 - p)$ and p, respectively $(x_1 < x_2 < x_3)$. Applying Conditions 1 and 2 of the salience function, the salience of referents is described in Figure 3.

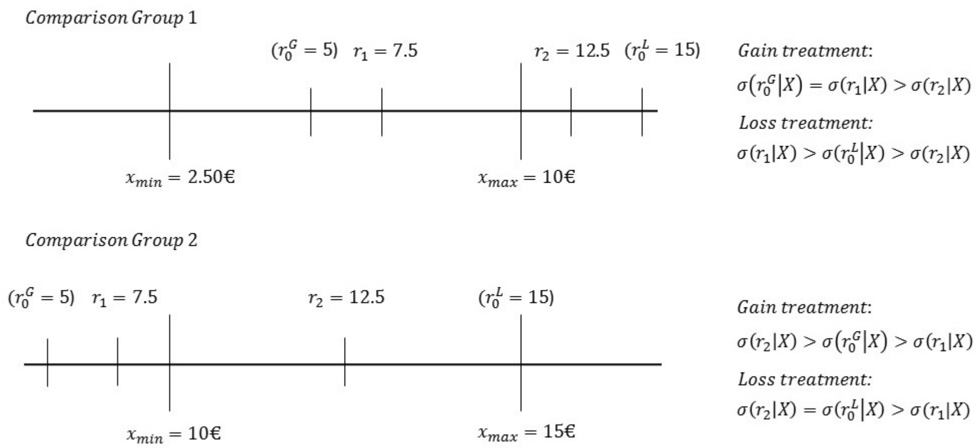
To understand the ordering of the referents, consider participants in comparison group 1 who observe $X_{CG1} = (2.50, 7.50, 10)$. These set of outcomes is compared with the "full set of referents". For the control group $R_C = (7.50, 12.50)$, and thus $r_1 \in [x_{min}, x_{max}]$ and $r_2 \notin [x_{min}, x_{max}]$. Under Condition 1 of the salience function, r_1 is more salient than r_2. For the gain group $\tilde{R}_G = (5, 7.5, 12.5)$, and $r_0^G \in [x_{min}, x_{max}]$. Under Condition 1, r_0^G is therefore more salient than r_2 and equally salient as r_1. Finally, for the loss group $\tilde{R}_L = (15, 7.5, 12.5)$ and $r_0^L \notin [x_{min}, x_{max}]$. Under Condition 1, r_0^L is therefore less salient than r_1, but because of Condition 2 it is more salient than r_2. For comparison group 2 the salience of referents is derived likewise.

As described above, each referent is subsequently assigned a rank, which allows to transform the weights that are put on the referents. The transformation gives rise to the set of expectations

$$\hat{Q}_C = (\hat{q}_1, \hat{q}_2) = (0.5\omega_1, 0.5\omega_2)$$
$$\hat{Q}_G = \hat{Q}_L = (\hat{q}_0, \hat{q}_1, \hat{q}_2) = (q_0\omega_0, 0.5(1 - q_0)\omega_1, 0.5(1 - q_0)\omega_2)$$

This completes the period of decision-making.

Figure 3. Salience of Reference Points



Finally, we can derive utilities of choosing Option A and Option B in the risk-attitude questions. For illustration, consider participants in the control group who earned 7.50€, where

$$\begin{aligned} u_A =& \hat{q}_2\lambda(x_2 - r_2) + \hat{q}_1(x_2 - r_1) \\ u_B =& \hat{q}_2[p\lambda(x_3 - r_2) + (1-p)\lambda(x_1 - r_2)] \\ &+ \hat{q}_1[p(x_3 - r_1) + (1-p)\lambda(x_1 - r_1)] \end{aligned}$$

A person is indifferent between the certain outcome (Option A) and the lottery (Option B) when $u_A = u_B(p^*)$. Thus, the probability equivalent for the control group is given by,

$$p^*_{Control} = \frac{\lambda(x_2 - x_1)}{\hat{q}_2^C(\lambda - 1)(x_3 - r_1) - \lambda(x_1 - r_1) + (x_3 - r_1)}$$

Probability equivalents for participants in the treatment groups who earned 7.50€ are derived accordingly and given by,

$$p^*_{Gain} = \frac{\lambda(x_2 - x_1) - \hat{q}_0^G(\lambda - 1)(x_2 - r_0)}{\hat{q}_2^G(\lambda - 1)(x_3 - r_1) - \lambda(x_1 - r_0) + (x_3 - r_0) + (1 - \hat{q}_0^G)(\lambda - 1)(x_2 - r_0)}$$
$$p^*_{Loss} = \frac{\lambda(x_2 - x_1)}{\hat{q}_1^L(\lambda - 1)(r_1 - x_3) + \lambda(x_3 - x_1)}$$

Probability equivalents for participants in comparison group 2 are derived analogously. We can therefore state the following:

PROPOSITION 1: *For experimental subjects who put some weight on the arbitrary "referent" r_0, that is $q_0 > 0$, and are affected by the salience of referents, that is $\delta < 1$, there exists a threshold θ such that a small weight put on "referent" r_0, ($q_0 \in (0, \theta)$) results in higher risk aversion in <u>both</u> treatment groups compared to the control group.*

PROPOSITION 2: *If experimental subjects put no weight on the arbitrary "referent" r_0, that is $\hat{q}_0 = 0$, there is no difference in risk taking behavior across treatment groups and control groups.*

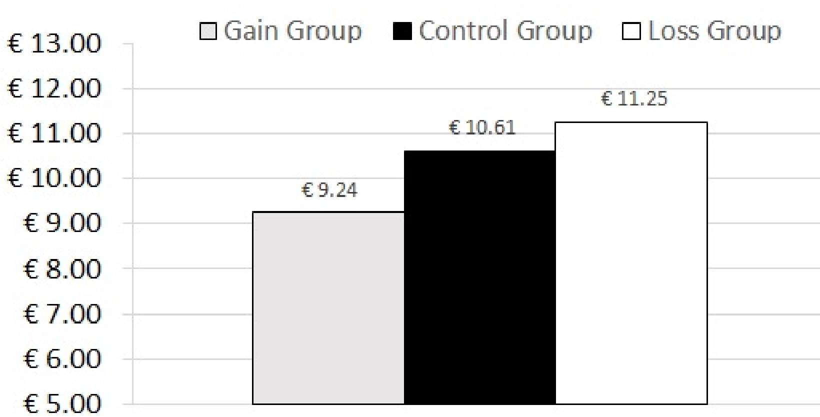
The proof of Proposition 1 is related to the appendix. The proof for Proposition 2 follows directly from comparing probability equivalents when $q_0 = 0$, and represents the special case of rational reference point formation predicted by models of expectation-based reference dependence. Intuitively, if subjects across different groups correctly predict the probabilistic environment they are facing, they are all comparing the monetary outcomes they are facing with exactly the same set of referents. Consequently, no differences in risk preferences should be observable.

Proposition 1 might at a first glance appear counter-intuitive. In fact, the presentation of the moment of first focus is achieved through framing contingencies in terms of losses and gains. One might therefore expect that a loss frame should induce more risk-seeking behavior. A closer look at the dynamics of reference point formation reveals why this need not to be the case. Again, for illustration, consider participants who earned 7.50€. Whenever a decision maker puts some weight on the moment of first focus $q_0 > 0$, he compares the outcomes in the choice set with "referent" r_0. For the gain group with $r_0^G = 5$, the intuition is straightforward as the majority of the outcomes in the choice set lies above this "referent", thus triggering additional risk averse behavior as we are in the domain of gains. For the loss group with $r_0^L = 15$ the picture is reversed as the majority of outcomes in the choice set lies below this "referent", thus triggering additional risk-seeking behavior as we are in the domain of losses. To determine the overall effect on risk preferences, the salience ranking in $t = 1$ additionally needs to be considered. As we could see in Figure 5, referent r_0^L is not the most salient referent. Due to the salience ranking, the weight put on referent r_0^L is deflated in favor of the most salient referent r_1 which is inflated upwards. This deflation mitigates the sensation of losses under referent r_0^L. The effects of the moment of first focus and of the salience ranking thus work in opposite directions such that for small weights put on referent r_0^L, the effect of salience ranking dominates and the decision maker becomes more risk averse, despite being in the loss-domain for this referent.

IV. Experimental results

We start with a descriptive analysis of how a different moment of first focus affects expectation formation. Figure 4 presents the self-reported expected earnings across the three groups. We observe that a simple change in the wording of the e-mails for the treatment groups creates differences in expectations about the amount of money that could be earned. Subjects in the loss group expect payoffs which are higher than the expected value of 10€, while subjects in the gain group seem to expect an amount lower than 10€. In order to test whether expectations are statistically different between the groups we use a non-parametric Wilcoxon-Mann-Whitney test. The results from the test indicate that we can reject the hypothesis that expectations are identical between the gain group and the control group (p=0.03). On the other hand, we cannot reject the hypothesis concerning the equality of expectations between the loss group and the control group (p=0.36). This result for the gain group directly contradicts the implicit assumption of current models of expectation-based reference dependence that people correctly predict the probabilistic environment they are facing. Concerning the insignificant estimate for the loss group it should be noted that the survey question requires a single estimate about the expected earnings. Clearly, a single estimate can hardly describe the mental process when considering multiple relevant outcomes. [10]

Figure 4. Average expected earnings



Furthermore, the effect of the moment of first focus might affect participants sub-consciously. If we were to find differences in risk preferences between the loss

[10]Some participants asked the experimenter what they should reply to this question, since they expect both 7.50€ and 12.50€ with equal probability of 50%.

group and the control group, subjects might be affected by the framing device, despite pretending to disregard any uninformative information.

RESULT 1: *A different presentation about otherwise identical stochastic outcomes which changes the moment of first focus can change expectations about these uncertain outcomes.*

Next, we turn to investigate actual choice behavior in the period of decision making $t = 1$. Figure 5 shows the average number of risky options (Option B) participants chose in the risk-attitude questions. For both groups of participants, those who earned 7.50€ or those who earned 12.50€, we observe the same pattern of risk preferences. Subjects in the gain groups choose an average fewer risky options than participants in the respective control group, and are thus more risk averse. Participants in the loss groups are on average most risk averse as they choose even fewer risky option than participants in the respective gain groups. These descriptive findings are generally in line with Proposition 1 and suggest that a different moment of first focus affects reference point formation and changes risk preferences. Using a Wilcoxon-Mann-Whitney test, however, reveals that we cannot reject the hypothesis that choice behavior in the control group is identical to the gain group or loss group. With p=.91 this failure of rejection is very strong for participants who earned 12.50€. For participants who earned 7.50€ the p-value is much lower with p=.25, but still insignificant. Without further controls we therefore conclude that no treatment effect is observable.

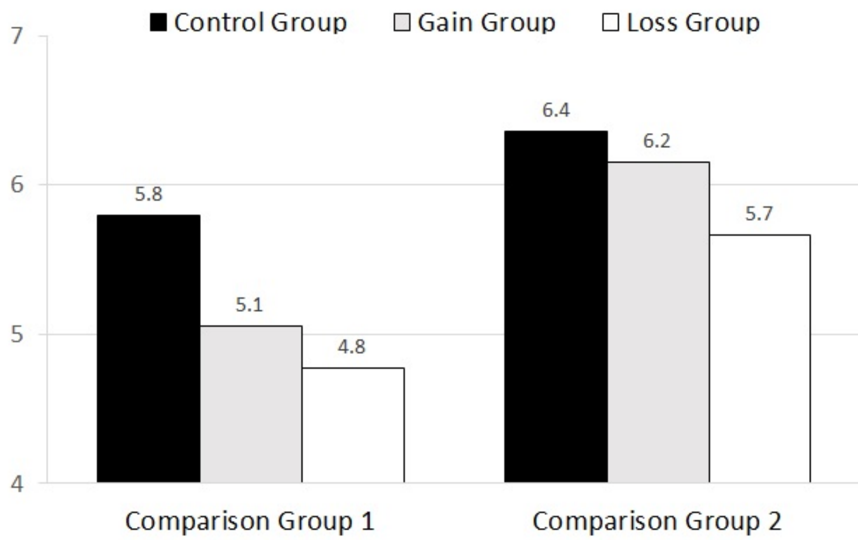
We further explore whether the reason we do not find a treatment effect in the summary statistics is because individual heterogeneity is not controlled for by experimental randomization. In order to do so we estimate in a first step a regression model using OLS:

$$y_i = \beta_0 + \beta_G G_i + \beta_L L_i + \phi \mathbf{X} + \epsilon_i$$

where y_i represents the number of risky options (Option B) each participant chooses. Dummy variables G_i, L_i indicate whether the subject was assigned to the gain group or to the loss group, respectively. The vector $\mathbf{X}$ constitutes a number of other control variables which include gender, education, ethnicity and experience with experiments. In a second step, we estimate a zero-truncated negative binominal regression model to account for the fact that the dependent variable can only take a limited number of discrete values. Due to the design of the risk-attitude questions each subject chooses at least once Option B, that is when the high payment is awarded with certainty.

Table 3 shows the results of these exercises. In columns (1) and (3) we report estimates without controlling for individual heterogeneity. In line with the previous finding we do not observe significant treatment effects using either methodology. The results change, once we include additional control variables which

FIGURE 5. AVERAGE RISKY CHOICES



determine individual risk preferences. In column (2), we report the OLS estimates for both comparison groups. We observe that in comparison group 1, once controlling for individual heterogeneity, participants who receive a treatment on average choose around two fewer risky options than participants in the control group. The results are significant for both treatments with a higher significance level for participants who were assigned to the loss group (p=.046) than for participants who were assigned to the gain group (p=.081). Conversely, we do not observe any significant treatment effects when we consider the behavior of participants in comparison group 2, who earned 12.50€. In line with the descriptive results the estimated treatment effect is negative for both groups but by no means statistically significant. A Wald-test for joint significance of β_G and β_L cannot reject the hypothesis that assignment to the treatment groups does not influence risk preferences. In column (4) we report the results from the zero-truncated negative binominal regression, including controls, which might be a better fit given the limited character of the dependent variable. The results are generally in line with the OLS-estimates. For comparison group 2 we cannot find any significant treatment effects, for both Gain-Treatment and Loss-Treatment. For comparison group 1, estimating risk preferences using a zero-truncated negative binominal regression leads to even higher levels of significance. The estimated treatment effect for the loss group is significant at the 2% level (p=.015) and for

Table 3—Regression output

	Number of risky choices			
	OLS		Zero-Truncated Negative Binominal	
	(1)	(2)	(3)	(4)
Comparison Group 1				
Gain group	-.941	-2.249^{*}	-.200	$-.527^{**}$
	[1.32]	[1.26]	[.28]	[.24]
Loss group	-1.167	-2.515^{**}	-.254	$-.607^{**}$
	[1.31]	[1.22]	[.29]	[.25]
Controls	No	Yes	No	Yes
R-square	.017	.240	-	-
Observations	50	50	50	50
Comparison Group 2				
Gain group	-.203	$-.898$	-.038	$-.164$
	[1.68]	[1.57]	[.30]	[.29]
Loss group	-.690	$-.784$	-.134	$-.101$
	[2.01]	[2.48]	[.39]	[.39]
Controls	No	Yes	No	Yes
R-square	.004	.123	-	-
Observations	36	36	36	36

Note: In each question participants had to choose between Option A and Option B. Option A represents 7.50€ with certainty while Option B represents a lottery. After all questions have been answered, one question is chosen at random and the choice in this question determines final payments. Standard errors in parentheses. Level of significance: $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

the gain group it is significant at the 3% level (p=.028).

RESULT 2: *We observe higher risk aversion across treatment groups, in support with Proposition 1, only if subjects end up with the lower payment of 7.50€ - that is when their expectations are disappointed. In contrast we do not observe any treatment effects, in support with Proposition 2, if subjects end up with the higher payment of 12.50€ - that is when their expectations are satisfied.*

V. Discussion

The obtained results support prior work demonstrating the importance of expectations for reference points. Our treatments are explicitly designed to manipulate expectations and the finding of heterogeneous behavior between experimental subjects confirms that different expectations result in different reference-point formation. Yet, our results are not consistent with any current model of expectation-based reference dependence. More complex behavioral pattern than currently accounted for seem to influence how expectation-based reference points are formed. Our experiment offers insights about two additional factors which should be considered when modelling reference-dependent preferences.

First, we observe that participants who earn 12.50€ are apparently not affected by the very same treatment effect which alters the behavior of participants who earn 7.50€. One potential explanation for this difference in observed behavior might be the role of emotions. Participants who earn 7.50€ are likely to be disappointed because they did not receive the higher payment of 12.50€. This sensation of disappointment may trigger different risk preferences. Several authors have described the link between emotions and decision-making under uncertainty. For example, Forgas (1995) asserts that a positive mood tends to evoke risk-seeking behavior, due to a focus on the positive aspects on a risky situation, while in turn a negative mood tends to evoke risk averse behavior. Several models of anticipatory emotional response show that the hedonic intensity of success or failure and the respective probabilities are dependent of each other (Atkinson 1957, Bell 1985, Loomes and Sugden 1986, Loewenstein et al. 2001). Our results offer an alternative explanation by linking the perception of reference points to emotional aspects. For illustration, consider participants who earn 12.50€ and who are likely to be in a good mood as they earn more than the expected value. These participants seem to disregard unrelated and uninformative information which was generated through the treatments' different moment of first focus. Regardless which "referents" were expected, after the uncertainty is resolved, the feeling of satisfied expectations allows the participants to part with their earlier expectations, label them as successfully accomplished, and to focus their full mental resources on the next problem at hand. Consequently, we do not observe differences in behavior across participants who earn 12.50€, as they could uniquely focus on the subsequent decision problem detached from their earlier expectations. Satisfaction of expectations might therefore allow participants to "narrowly frame" and to consider stochastic scenarios in isolation of each other (Barberis, Huang and Thaler 2006). [11] Conversely, participants who earn 7.50€ face very different mental conditions. Because their expectations are disappointed they could not easily part with them, as this would require them to accept and to handle a loss. The theory of mental accounting by Thaler (1999) posits that individuals have huge difficulties to close a mental account as a loss. Instead the expectations which were generated through the moment of first focus are likely still being processed in the mind and consequently influence subsequent decision making. Emotions are thus likely to play a direct role in the manner how reference points are perceived whenever uncertainty is resolved early. [12]

Second, when participants earn 7.50€, we observe higher risk aversion in the treatment groups, regardless whether a subject was assigned to the gain-treatment or the loss-treatment. This indicates that expectations as reference

[11]Narrow framing is related to the observation that people evaluating decisions under uncertainty in isolation of each other, and thus potentially acting non-utility maximizing

[12]Song (2015) argues in line with this by stating that It is likely that emotions are just one source of the Kőszegi and Rabin (2006) model rather than the confounding of it."

points are not sensitive to stochastic outcomes being described in terms of losses or gains. [13] Instead, framing at the expectation formation stage affects the perception of multiple monetary outcomes by changing the moment of first focus. When modeling reference points based on expectations, it is therefore important to consider under which contextual frames these expectations were formed. This finding empirically confirms the conjecture by Sprenger et al. (2015) that slightly changed choice environments may induce very different behavior. This is of particular importance for general experimental studies as it implies that one should process with great care when designing the presentation of stochastic outcomes. Additionally, if outside parties such as sales executives can influence reference points with menus alone, there exists scope for an exploitation of consumers' susceptibility to contextual effects. Developing an understanding of the multifaceted drivers of reference point formation provides an important step to detect such abusive behavior and to initiate necessary countermeasures.

Summarizing, our findings suggest a two-step procedure when working with expectation-based reference points. First, when expectations are formed, it is important to understand under which frames these expectations are formed and which information gave rise to the moment of first focus. Second, after uncertainty is resolved, expectations are necessarily either disappointed or satisfied. If subsequent decisions under uncertainty have to be made immediately, these emotions affect decision-making by giving rise to a different composition of the reference point. If expectations are satisfied subjects are less likely to be influenced by prior arbitrary contextual characteristics than subjects whose expectations are disappointed.

VI. Conclusion

In this paper we studied whether contextual effects matter in the formation of expectation-based reference points. Recently, theories of expectation-based reference-dependence preferences have been applied to a variety of economic environments because they could successfully rationalize a wide range of puzzling behavior which is observable in financial investment decisions, labor supply or consumer choice (Barberis, Huang and Thaler 2006, Crawford and Meng 2011, Heidhues and Kőszegi 2014). Assumptions about the formation of the reference point are at the heart of these theories as they determine which outcomes are considered as losses or as gains. Yet, there has not been much scrutiny about the sensitivity of the reference point to potentially distracting or uninformative contextual features. So far, models of expectation-based reference dependence rely on the assumption that people can correctly predict the probabilistic environment they are facing (Bell 1985, Loomes and Sugden 1986, Kőszegi and Rabin 2006).

[13] Traditionally, the literature predicts that behavior changes if outcomes are frames as losses or as gains. A gain-frame triggers risk averse behavior will a loss-frame triggers risk-seeking behavior (Kahneman and Tversky 1979).

Our experimental study tests the limits of these models by exogenously manipulating a single contextual feature, the moment of first focus, while maintaining an identical probabilistic environment. The results show that a different moment of first focus can lead to different expectations about stochastic outcomes which ultimately result in changed risk preferences. In particular, we find risk averse tendencies among participants who were induced to firstly focus on an arbitrary and non-achievable monetary outcome. Participants who did not receive such a framing treatment appear comparably less risk averse. No current model of reference-dependent preferences can explain these observed results. The reason might be that, despite the simplicity of the treatment, the triggered consequences of a changed first focus can become very complex. Our theoretical framework proposes a two-step procedure of reference point formation which can rationalize the observed behavior, by introducing novel properties in the periods of expectation formation and decision-making. Apart from allowing for the possibility of expectations about non-achievable outcomes, we describe how reference points can be ranked according to how they compare to outcomes in a choice set. Together, these two features incorporate important insights from the literature of psychology about salience perception into the study of reference-point formation to allow a closer to reality description of individual preferences.

Our results further highlight an understudied aspect in the formation process of reference points, which is the role of emotions. In our study, contextual effects, such as the moment of first focus, only seem to influence decision making if participants' expectations have previously been disappointed. This sensation of disappointment could arise as we elicited risk preferences *after* the resolution of uncertainty. Previous comparable work, studying the role of expectation-based reference points cannot find an emotional impact because they elicit risk preferences *before* the resolution of uncertainty (Abeler et al. 2011, Ericson and Fuster 2011, Gneezy et al. 2012, Heffetz and List 2014, Goette, Harms and Sprenger 2014). In real-life environments, where people constantly form expectations and make decisions, feelings of disappointed expectations may frequently arise. Our findings suggest that disappointed expectations have a lagged influence on stochastic reference points and can thus affect individual decision making even in unrelated environment. Future research in this direction is certainly needed in order to develop a more complete theory of expectation-based reference dependence. In particular, it would be very interesting to study the formation of the reference points in more dynamic settings which comprise multiple periods of expectation formation, resolution of uncertainty and decision-making.

REFERENCES

Abeler, Johannes, Armin Falk, Lorenz Goette, and David Huffman. 2011. "Reference Points and Effort Provision." *The American Economic Review*, 101(2): 470–492.

Ajzen, Icek, and Martin Fishbein. 1980. *Understanding attitudes and predicting social behaviour.* Englewood Cliffs, NJ:Prentice-Hall.

Atkinson, John W. 1957. "Motivational Determinants of Risk-Taking Behavior." *Psychological review*, 64(6): 359.

Barberis, Nicholas, Ming Huang, and Richard H Thaler. 2006. "Individual Preferences, Monetary Gambles, and Stock Market Participation: A Case for Narrow Framing." *The American economic review*, 96(4): 1069–1090.

Bell, David E. 1985. "Disappointment in Decision Making under Uncertainty." *Operations research*, 33(1): 1–27.

Benartzi, Shlomo, and Richard H Thaler. 1995. "Myopic Loss Aversion and the Equity Premium Puzzle." *The Quarterly Journal of Economics*, 110(1): 73–92.

Borah, Porismita. 2011. "Conceptual Issues in Framing Theory: A Systematic Examination of a Decade's Literature." *Journal of communication*, 61(2): 246–263.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer. 2012. "Salience Theory of Choice Under Risk." *The Quarterly Journal of Economics*, 127(3): 1243–1285.

Chong, Dennis, and James N Druckman. 2007. "Framing Theory." *Annu. Rev. Polit. Sci.*, 10: 103–126.

Crawford, Vincent P, and Juanjuan Meng. 2011. "New York City Cabdrivers' Labor Supply Revisited: Reference-Dependent Preferences with Rational-Expectations Targets for Hours and Income." *The American Economic Review*, 101(5): 1912–1932.

Doran, Kirk. 2014. "Are Long-term Wage Elasticities of Labor Supply More Negative than Short-term Ones?" *Economics Letters*, 122(2): 208–210.

Ericson, Keith M Marzilli, and Andreas Fuster. 2011. "Expectations as Endowments: Evidence on Reference-Dependent Preferences from Exchange and Valuation Experiments*." *The Quarterly journal of economics*, 126(4): 1879–1907.

Fischbacher, Urs. 2007. "z-Tree: Zurich toolbox for ready-made economic experiments." *Experimental economics*, 10(2): 171–178.

Forgas, Joseph P. 1995. "Mood and Judgment: The Affect Infusion Model (AIM)." *Psychological bulletin*, 117(1): 39.

Furnham, Adrian, and Hua Chu Boo. 2011. "A literature review of the anchoring effect." *The Journal of Socio-Economics*, 40(1): 35–42.

Gill, David, and Victoria Prowse. 2012. "A Structural Analysis of Disappointment Aversion in a Real Effort Competition." *The American economic review*, 102(1): 469–503.

Gneezy, Uri, Lorenz Goette, Charles Sprenger, and Florian Zimmermann. 2012. "The Limits of Expectations-Based Reference Dependence."

Working Paper.

Goette, Lorenz, Annette Harms, and Charles Sprenger. 2014. "Randomizing Endowments: An Experimental Study of Rational Expectations and Reference-Dependent Preferences." Working Paper.

Greiner, Ben, et al. 2003. *The online recruitment system ORSEE: a guide for the organization of experiments in economics.* Max-Planck-Inst. for Research into Economic Systems, Strategic Interaction Group.

Gul, Faruk. 1991. "A Theory of Disappointment Aversion." *Econometrica*, 59(3): 667–686.

Heffetz, Ori, and John A List. 2014. "Is the Endowment Effect an Expectations Effect?" *Journal of the European Economic Association*, 12(5): 1396–1422.

Heidhues, Paul, and Botond Kőszegi. 2008. "Competition and Price Variation when Consumers are Loss Averse." *The American Economic Review*, 98(4): 1245–1268.

Heidhues, Paul, and Botond Kőszegi. 2014. "Regular Prices and Sales." *Theoretical Economics*, 9(1): 217–251.

Herweg, Fabian, Daniel Müller, and Philipp Weinschenk. 2010. "Binary Payment Schemes: Moral Hazard and Loss Aversion." *The American Economic Review*, 100(5): 2451–2477.

Holt, Charles A, Susan K Laury, et al. 2002. "Risk Aversion and Incentive Effects." *American economic review*, 92(5): 1644–1655.

Kahneman, Daniel. 1992. "Reference Points, Anchors, Norms, and Mixed Feelings." *Organizational behavior and human decision processes*, 51(2): 296–312.

Kahneman, Daniel, and Amos Tversky. 1979. "Prospect Theory: An Analysis of Decision under Risk." *Econometrica*, 47(2): 263–291.

Kahneman, Daniel, Jack L Knetsch, and Richard H Thaler. 1990. "Experimental tests of the Endowment Effect and the Coase theorem." *Journal of Political Economy*, 98(6): 1325–1348.

Kandel, Eric R, James H Schwartz, Thomas M Jessell, et al. 2000. *Principles of Neural Science.* Vol. 4, McGraw-hill New York.

Karle, Heiko, and Martin Peitz. 2014. "Competition under Consumer Loss Aversion." *The RAND Journal of Economics*, 45(1): 1–31.

Karle, Heiko, Georg Kirchsteiger, and Martin Peitz. 2015. "Loss Aversion and Consumption Choice: Theory and Experimental Evidence." *American Economic Journal: Microeconomics*, 7(2): 101–120.

Koop, Gregory J, and Joseph G Johnson. 2012. "The Use of Multiple Reference Points in Risky Decision Making." *Journal of Behavioral Decision Making*, 25(1): 49–62.

Kőszegi, Botond, and Matthew Rabin. 2006. "A Model of Reference-

Dependent Preferences." *The Quarterly Journal of Economics*, 121(4): 1133–1165.

Kőszegi, Botond, and Matthew Rabin. 2007. "Reference-Dependent Risk Attitudes." *The American Economic Review*, 97(4): 1047–1073.

Loewenstein, George F, Elke U Weber, Christopher K Hsee, and Ned Welch. 2001. "Risk as Feelings." *Psychological bulletin*, 127(2): 267.

Loomes, Graham, and Robert Sugden. 1986. "Disappointment and Dynamic Consistency in Choice under Uncertainty." *The Review of Economic Studies*, 53(2): 271–282.

Lopes, Lola L. 1987. "Between Hope and Fear: The Psychology of Risk." *Advances in experimental social psychology*, 20(3): 255–295.

March, James G, and Zur Shapira. 1992. "Variable Risk Preferences and the Focus of Attention." *Psychological review*, 99(1): 172.

Mellers, Barbara A, Alan Schwartz, Katty Ho, and Ilana Ritov. 1997. "Decision Affect Theory: Emotional Reactions to the Outcomes of Risky Options." *Psychological Science*, 423–429.

Pope, Devin G, and Maurice E Schweitzer. 2011. "Is Tiger Woods Loss Averse? Persistent Bias in the Face of Experience, Competition, and High Stakes." *The American Economic Review*, 101(1): 129–157.

Post, Thierry, Martijn J Van den Assem, Guido Baltussen, and Richard H Thaler. 2008. "Deal or No Deal? Decision Making under Risk in a Large-Payoff Game Show." *The American economic review*, 101(1): 38–71.

Rosch, Eleanor. 1975. "Cognitive reference points." *Cognitive psychology*, 7(4): 532–547.

Song, Changcheng. 2015. "An Experiment on Reference Points and Expectations." Working Paper.

Sprenger, Charles, et al. 2015. "An Endowment Effect for Risk: Experimental Tests of Stochastic Reference Points." *Journal of Political Economy*, 123(6): 1456–1499.

Thaler, Richard H. 1999. "Mental Accounting Matters." *Journal of Behavioral decision making*, 12(3): 183.

Wang, XT, and Joseph G Johnson. 2012. "A Tri-Reference Point Theory of Decision Making Under Risk." *Journal of experimental psychology: general*, 141(4): 743.

Appendix A: Proofs

PROOF OF PROPOSITION 1: *First we consider probability equivalents for participants in comparison group 1 which have been derived in the text.*

$$p^*_{Control} = \frac{\lambda(x_2 - x_1)}{\hat{q}^C_2(\lambda - 1)(x_3 - r_1) - \lambda(x_1 - r_1) + (x_3 - r_1)}$$
$$p^*_{Gain} = \frac{\lambda(x_2 - x_1) - \hat{q}^G_0(\lambda - 1)(x_2 - r_0)}{\hat{q}^G_2(\lambda - 1)(x_3 - r_1) - \lambda(x_1 - r_0) + (x_3 - r_0) + (1 - \hat{q}^G_0)(\lambda - 1)(x_2 - r_0)}$$
$$p^*_{Loss} = \frac{\lambda(x_2 - x_1)}{\hat{q}^L_1(\lambda - 1)(r_1 - x_3) + \lambda(x_3 - x_1)}$$

We have to show that $p^*_{Gain} > p^*_{Control}$ and $p^*_{Loss} > p^*_{Control}$ if q_0 is smaller than some threshold θ.

Case $p^*_{Loss} > p^*_{Control}$:
Proving this inequality is equivalent to showing $\hat{q}^L_1 + \hat{q}^C_2 > 1$ which follows from comparing the denominators. Since $\hat{q}^C_2 = \omega^C_2 q_2$ as $q^C_0 = 0$ and $\hat{q}^L_1 = \omega^L_1(1 - q^L_0)q_1$ the distribution of the salience rankings of reference points needs to be taken into account. In particular, when $x_1 < x_2 = r_1 < x_3 < r_2 < (r^L_0)$ the salience ranking gives rise to

$$\omega^C_2 = \frac{\delta^2}{\delta q_1 + \delta^2 q_2}$$

and,

$$\omega^L_1 = \frac{\delta}{\delta(1 - q^L_0)q_1 + \delta^2 q^L_0 + \delta^3(1 - q^L_0)q_2}$$

Plugging in and solving for q^L_0 yields,

$$q^{L*}_0 < \frac{q_1 q_2(1 - \delta)}{q_1 + q_1 q_2(1 - \delta)}$$

It is easily observable that as long as $\delta < 1$ the right-hand-side of the equation is strictly greater than 0, such that there always exists a q^L_0 for which $p^*_{Loss} > p^*_{Control}$.

Case $p^*_{Gain} > p^*_{Control}$:
The salience ranking in the gain treatment gives rise to

$$\omega^G_0 = \frac{\delta}{\delta q^G_0 + \delta(1 - q^G_0)q_1 + \delta^3(1 - q^G_0)q_2}$$

and

$$\omega_2^G = \frac{\delta^3}{\delta q_0^G + \delta(1-q_0^G)q_1 + \delta^3(1-q_0^G)q_2}$$

After plugging in and solving $p^*_{Gain} > p^*_{Control}$, we obtain as an intermediate step:

$$q_0^{G*}[q_1q_2\delta(1-\delta)\lambda(x_1-x_2)+q_1(r_0-x_2)+\delta\lambda q_2(r_0-x_1)] > q_1q_2\delta(1-\delta)\lambda(x_1-x_2)$$

Note that the right hand side of the equation is strictly smaller than zero if $\delta < 1$. The sign of the expression in the square brackets cannot be globally determined since it depends on the differences in lottery payoffs and reference point r_0. In this experiment the specific exogenous values are given by $x_1 = 2.5$, $x_2 = 7.5$, $r_0 = 5$, $q_1 = 0.5$ and $q_2 = 0.5$. This simplifies the inequality to,

$$q_0^{G*}[1-\delta^2\lambda] < \delta\lambda(1-\delta)$$

Two cases are conceivable: 1) If $\delta^2\lambda < 1$

$$q_0^{G*} < \frac{\delta\lambda(1-\delta)}{1-\delta^2\lambda} \quad whereby \quad \frac{\delta\lambda(1-\delta)}{1-\delta^2\lambda} > 0$$

2) If $\delta^2\lambda \geq 1$,

$$q_0^{G*} > \frac{\delta\lambda(1-\delta)}{1-\delta^2\lambda} \quad whereby \quad \frac{\delta\lambda(1-\delta)}{1-\delta^2\lambda} < 0$$

By definition $q_0^G > 0$, therefore in the second case $p^*_{Gain} > p^*_{Control}$ for all q_0^G. In the first case, $p^*_{Gain} > p^*_{Control}$ for small enough q_0^G which completes the proof.