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Kees Koedijk, Charles N. Noussair,
Rachel Pownall and Ayse Terzi

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Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801
www.cepr.org

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Abstract

It is well-established that reference points are a feature of decision making under risk. In this paper we report an experiment, in which we investigate which of three potential reference points: (1) a status quo payoff level, (2) the average expected earnings of peers, and (3) a stated expectation of the experimenter, best describes behavior in a decontextualized risky decision making task. We find heterogeneity among individuals in the reference points they employ. The status quo level is the modal reference point, followed by the experimenter's stated expectation of participant earnings, and in turn by the average expected earnings of peers. A sizeable share of individuals show multiple reference points simultaneously. Reference points can be affected by a change in the income level.

Keywords: experiment, reference point

Kees Koedijk c.koedijk@uvt.nl
Tilburg University and CEPR

Charles N. Noussair c.n.Noussair@uvt.nl
Tilburg University

Rachel Pownall r.a.j.pownall@uvt.nl
Tilburg University

Ayse Terzi A.Terzi@uvt.nl.
Tilburg University

1 Introduction

Reference dependence, an asymmetry in the treatment of payoffs above vs. below a benchmark payoff level, has been a robust finding since it was first proposed and documented by Kahneman and Tversky (1979). It is a cornerstone of prospect theory, the most influential behavioral model of decision making under risk. Reference points have been shown to characterize decision making in laboratory research, surveys, and in field data from numerous domains. These include household saving, labor market participation, consumer behavior, education, and investment decisions (e.g. Camerer (2004), Starmer (2000), Grinblatt and Han (2005), Hardie, Johnson, and Fader (1993), Camerer (1997)). Experimental studies have documented the effect of reference point formation on effort provision (Abeler, Falk, Goette, and Huffman (2011)), the pricing of securities (Kahneman, Knetch and Thaler, 1990) and exchanging and valuing consumer products (Ericson and Fuster (2011)).

However, while there is general agreement that reference points are important, little is known about which payoff levels will come to serve as reference points. In many studies reference points are given as exogenous or are defined for a particular situation. Typically, in empirical work, the reference points of the decision maker are taken as evident given the decision context. This is reasonable in some settings. However, there are no widely-accepted general accounts of how a particular payoff level emerges as a reference point.

Furthermore, Kahneman (1992) raises the possibility of multiplicity of reference points and characterizes it as an important topic. Sullivan and Kida (1995) demonstrate that corporate managers form multiple reference points, specifically the status quo profit level as well as earnings targets. In an experimental study Baucells, Weber, and Welfens (2011) show that the reference trading price is a combination of potential reference prices.

Most commonly, a status quo, or initial, payoff level has been used in modeling reference dependent preferences (Tversky and Kahneman (1991)).The status quo level appears to be an important reference point in pension choices (Samuelson and Zeckhauser (1988)), consumer valuation (Hartman, Doane, and Woo (1991)) and financial markets (Odean (1998)). Other studies find that the lagged status quo is an important driver of reference levels (Thaler and Johnson (1990) and Gomes (2005)). A class of prominent theories of reference point formation is based on the expectations of the individual (Bell (1985), Loomes and Sugden (1986), Kőszegi and Rabin (2006), Kőszegi and Rabin (2007), Heidhues and

Kőszegi (2008)). Expectations-based reference points have been able to explain insurance choices (Barseghyan, Prince, and Teitelbaum (2011)), and labor supply decisions (Farber (2005), Farber (2008), Crawford and Meng (2011)). Additional sources of reference points that have been proposed and tested empirically are social reference groups, aspiration levels, goals, and contracts (Heath, Larrick, and Wu (1999), Gali (1994), Abel (1990), Vendrik and Woltjer (2007), Linde and Sonnemans (2012)). Experimental work has largely supported the models of inequity aversion proposed by Fehr and Schmidt (1999) and Bolton and Ockenfels (2000), which assume the average payoff of peers serve as a reference point.

Thus, there are three drivers of reference levels that are most commonly discussed in the literature: (i) the status quo, (ii) the expectation of another party, and (iii) the payoffs of peers.[1] This begs the question of whether the heterogeneity in reference points is a consequence of the different contexts in which decisions take place, or whether individuals differ in their propensity to use different reference points. The research question here considers which of these three candidate reference points is most likely to emerge in a decontextualized setting. To investigate this, we conduct an experiment which allows a participant to use any or all of three competing reference points in a risky decision making task. The three reference points are as listed above: (1) the status quo level of earnings that subjects are endowed with at the outset of a session, (2) an earnings level that is announced as expected by the experimenter, (3) the average earnings level obtained by peers in previous sessions.

In our experimental design we present the reference points simultaneously, in order to conduct a horse race between the three alternatives. In the experiment, we elicit certainty equivalents of a large number of lotteries and obtain estimates of individual reference points. The design permits detection of individuals who use none or one unique reference point, a well as those who employ multiple reference points concurrently. By using one fixed probability for gains and losses throughout the experiment, we attenuate the impact of probability weighting on our results.

[1] Rabin (2006) and Koszegi and Rabin (2007) argue that the implications of reference dependence differ depending on the specification of the reference point. They emphasize that the curvature of the utility function generates mutually inconsistent predictions depending on the reference point. Distinguishing reference points might be cumbersome since some reference points may coincide. For example, the status quo and expectations of an individual are closely related when individuals expect to maintain their status quo level.

It is also important to understand whether reference points change in response to changing payoffs. Some studies have considered this topic. Arkes, Hirshleifer, Jiang, and Lim (2008) show that subjects are more likely to adapt their reference points to gains than to losses. Chen and Rao (2002) stress the importance of the order of presentation of two equally-sized gains and losses. They suggest that the first event leads to a more significant adaptation of the reference point than the second. In a financial market setting, Baucells, Weber, and Welfens (2011) show in an experimental study that reference prices are a function of the first and the last trading price. Masatlioglu and Ok (2005) model the theory of choice in a static setting where the initial endowment or status quo plays a key role. They show that a reference dependent agent prefers to stay at his status quo as long as another option is not better in all dimensions from his current endowment. Post, Van den Assem, Baltussen, and Thaler (2008) find evidence of path dependence in reference levels in choices under risk. One of the treatments in our experiment is complementary to this strand of research, and allows us to study the adjustment of the reference point after a shock to one's income level.

Our results show that if all individuals are classified by the one reference point that they adhere to most closely, the status quo level is employed most frequently, by almost 35 percent of all individuals. The experimenter's expectation is chosen almost as commonly as the social comparison level. Multiple reference points are observed for a sizable share of individuals, and others show no evidence of having any reference point. Importantly, many individuals use a discounting heuristic which discounts the certainty equivalent of a lottery with a fixed percentage of the expected value. Finally, we find evidence for a change in the reference level after a payoff shock has occurred, suggesting a considerable effect of the income level on reference points. These results indicate that there is individual-level heterogeneity in forming reference points. Thus, reference point choice is driven in part by personal inclination, as the use of diverse reference points is observed within a identical decontextualized setting.

The remainder of this paper is organized as follows. Section 2 describes the experimental design. In Section 3 we discuss the results and Section 4 concludes the paper.

2 Experimental Design

2.1 Conduct of sessions and procedures

A total of 42 sessions were conducted at the Centerlab of Tilburg University in The Netherlands. The sessions were conducted between November 2013 and June 2014. Subjects were all students in Economics and Business Administration. A total of 190 subjects participated in the experiment. The experiment was executed with the z-Tree computer program (Fischbacher (2007)). There was a varying number of participants per session and each subject acted independently in this individual decision making experiment. Each session lasted approximately 45 minutes, including the time during which the experimenter read the instructions. The payoffs in the experiment were expressed in terms of an experimental currency, which was converted to a Euro payment to subjects at the end of the sessions. The average earnings per subject were 16 Euros (1 Euro = \$1.30 approximately at the time the experiment was conducted).

A session consists of 60 periods. In each period t, subjects are presented with a binary prospect (1/2, y) which results in outcome y with probability .5 and in outcome 0 with probability .5. This prospect is paired with eight certain payment levels $x_{it}, i = 1, ..., 8$ in a price list format during each of 60 trials. The sixty trials are divided into three 20-period segments, in which x_{it} increases in constant increments within each segment. The magnitude of the certain payment ranges in value from 40 percent up to 180 percent of the expected value of the prospect. The certain payments appear in ascending order of magnitude in the price list on the computer screen. Subjects are asked to make a choice between each certain amount and the prospect.

The lowest certain amount x_{it} chosen by the subject serves as a measure of the certainty equivalent for the prospect for that subject. The 60 periods were divided into three 20-period segments, and each segment was designed to focus on the use of one of the three reference points. In each segment, twenty different prospects were presented to the subjects. The expected value of these prospects spans one potential reference point. The expected value of the prospects presented in the first 10 periods lies below the particular reference point of interest. These prospectsl form the loss domain that belongs to this particular reference point. The expected value of the subsequently presented twenty prospects

exceed the value of the reference point. Thus, these prospects lie in the domain of gains. Since we have three potential reference points to test for, the experiment therefore consists of three sets of 20 periods, where participants face 8 questions per prospects, totalling 480 questions.

At the beginning of a session, the experimenter read the instructions for the experiment. The instructions included three key statements about earnings, which were intended to introduce the candidate reference points with equal prominence. The instructions are given in Appendix B. At the start of the experiment, each subject was given information about her initial balance. We refer to this initial balance as the status quo. We also indicated the expectation of the experimenter about the final earnings of the subject. It was emphasized that the expectation of the experimenter was not based on any specific knowledge about the final outcome, but only about what could be expected beforehand based on the way the experiment was designed. The last statement was the historical average of earnings of participants from previous sessions. The three reference points were also available on the subjects' screens. We varied the magnitudes of the status quo, the experimenter's expectation, and historical average in different trials. The values of each of the three candidate reference points for each session are shown in Table 1. Payoffs were denominated in terms of an experimental currency that was convertible to Euro at the end of the session.

At the end of the session, the computer randomly chose one round and one of the decisions of that round to count as each subject's earnings. Depending on the choice of the subject, the subject either played the lottery and received one of the outcomes of the prospect or the certain amount.[2]

2.2 Treatments

The last subsection describes the Baseline treatment. In this and the other treatment, called Shift, we use a number of different parameters in order to identify the choice of reference point while controlling for unobservable underlying drivers of a particular selection of a reference point. One potential driver for the choice of a specific reference

[2]This procedure removes wealth effects. Starmer and Sugden (1991) have shown that this procedure generates behavior that is similar to that when all periods are paid .

point might be the wealth level associated with a particular reference point compared to the alternatives. An element of wishful thinking might be at work, if individuals tend to use the reference point with the highest payoff. It is possible that subjects mechanically select a certain reference point due to its ranking among potential reference points. An alternative scenario could be that a subject is likely to choose the reference point which is intermediate in magnitude compared to the two others.

To attempt to identify the selection of a certain reference point regardless of it's magnitude, we vary the ranking in terms of payoffs of the reference points and assign different payoff levels to the three potential reference points in different treatments. Several different parameterizations of the experiment are conducted, which place each reference point at greater and lower values than the others. These are given in Table 1. The first column of the table indicates the session, and each row groups together sessions conducted under identical parameters. The next three columns, indicate the values, in terms of experimental currency, of each of the three reference points. The Status Quo and Experimenter's Expectation reference points differ by individual and the ranges in each session are indicated in columns 2 and 3.[3] Columns 5 and 6 indicate the exchange rate from experimental currency to Euro in effect, and whether there was a payoff shock after period 40.

In the sessions of the Shift treatment we induced a shock to income after the 40th period by paying a bonus that was unanticipated by subjects. It was emphasized that the shock was independent of the earlier choices participants made.[4] Subjects were informed about their new initial balance, and were told that the change was independent of their choices in previous rounds. At the beginning of the 41st period, their balance increased by 50 percent of the initial endowment. For those sessions in which the shock occurred, if the shock is integrated into the status quo, it would shift the status quo from having the lowest payoff level of the three reference points to the second position, where it exceeds the

[3]The formulation of the social comparison reference point was changed in the sessions conducted beginning in session 24. We provided subjects information on the expected average payoff of others of the session they are playing in instead of the average earnings of previous participants which was used up till session 24. We think this formulation creates a more relevant social comparison level for the subject.

[4]The shock was described to participants in the following manner. "If during the course of the experiment any new information will be shown to you on the screen, please note that this is not due to the decisions you have previously made in the experiment. The computer does not do anything with your decisions until the experiment finishes."

Table 1: Parameters used in the experiment

Session	Status Quo	Experimenter's expectation	Social Comparison	Exchange Rate	Treatment
1*	3500-6500	5500-8500	-		Baseline
2-3	4500-7000	7000-9500	15600	1300	Baseline
4-5	4500-7000	7000-9500	13500	1300	Baseline
6-7	4500-7000	7000-9500	12700	1300	Baseline
8-10	8500-10500	15500-17000	13100	1500	Baseline
11-12	12500-13500	19000-20000	16000	1500	Baseline
13-24	35000-45000	45000-60000	28500	6500	Baseline
25-32	50000-60000	70000-85000	100000**	8500	Shift
33-44	50000-60000	70000-85000	100000**	9000	Shift

* Session 1 is excluded from the analyses due to the absence of a historical peer average.

** Social comparison reference level is formulated as the expected earnings of peers in the same session.

expectations of the experimenter, but is still lower than the social comparison reference level.

3 Results

This section is organized in the following manner. Section 3.1 describes and documents the widespread use of a rule, called the Proportional Discounting Heuristic, used by 37 percent of our participants. Section 3.2 contains our analysis of the prevalence of the three different reference points. The analysis is conducted separately for the proportional discounters (subsection 3.2.1) and the rest of the sample (subsection 3.2.2).

3.1 The Proportional Discounting Heuristic

Figures 1 and 2 illustrate two typical decision patterns in our data. The horizontal axis gives the period number, while the vertical axis shows monetary amounts expressed in terms of experimental currency. The points displayed in black are the expected values of the prospects presented in the indicated period. The certainty equivalent elicited from the subject in the period is given by the grey points. The left panel shows the expected values of the prospects and the certainty equivalents in the first twenty periods. The

expected values of these prospects include values both above and below the status quo level. When the reference point of this individual is equal to the status quo level, the first ten prospects lie in the domain of losses, while the last ten prospects are mixed in the domain of gains and losses. The left panel shows that the certainty equivalents of subject 28, who is depicted in the figure, exceed the expected value for almost all prospects. Thus, the subject exhibits risk seeking behavior.

The panel in the center shows the expected values of the prospects and the certainty equivalents between period twenty and forty. The expected values of these prospects span the expectation level of the experimenter. If the expectation of the experimenter is the reference point, then the lotteries of periods twenty to thirty lie in the domain of losses while the prospects of periods thirty to forty lie in the mixed domain. We observe that the certainty equivalents indicated by subject 28 for these prospects are almost all higher than the expected value of the prospects. This indicates risk seeking preferences. The right panel shows the expected values and elicited certainty equivalents of the prospects between period forty and sixty. The expected value of these prospects span the social comparison level and define a domain of losses and gains around this potential reference point. In this segment, when the expected value of the prospect lies in the domain of losses relative to the social comparison reference point, the certainty equivalent is greater than the expected value of the prospect. Similarly, this behavior is consistent with risk-seeking preferences. When the expected value of the prospect lies in the domain of gains, the subjects certainty equivalent equals the expected value of the lottery. When the expected value of the lottery lies farther above the social comparison reference point, the certainty equivalent is less than the expected value of the prospect. This indicates risk aversion in the domain of gains, relative to a reference point equal to the social comparison level.

Another example, for subject 32, presented in Figure 2. The certainty equivalents of this subject are all equal to the expected value of the prospect, whenever the expected value of the prospect is less than the social comparison level. This is true for all prospects between period one and fifty. This indicates that the individual is risk neutral in the domain of losses, based on the social comparison level being the reference point. When the expected value of the prospect lies in the domain of gains, relative to the social comparison reference point, the individual became risk averse.

A very common decision rule, employed by 37 percent of individuals, is proportional

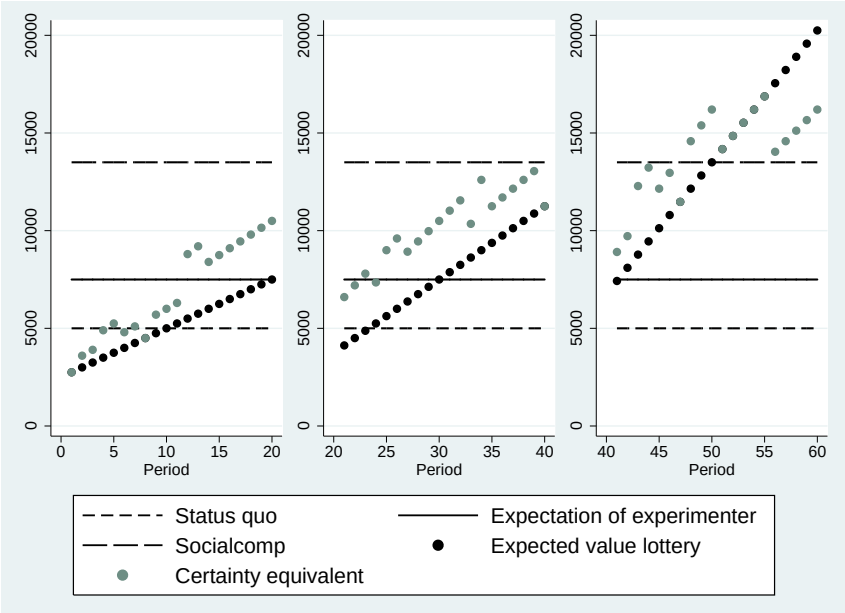


Figure 1: Certainty equivalents of subject 28

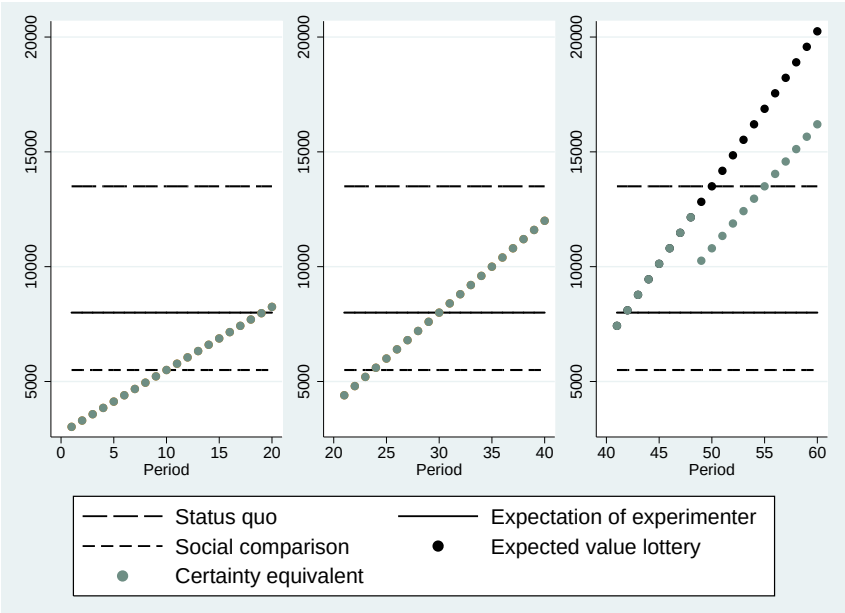


Figure 2: Certainty equivalents of subject 32

discounting. This rule involves setting a certainty equivalent equal to a constant fraction of the expected value of the lottery (or alternatively the maximum possible outcome of the lottery) as is depicted in Figure 4. The certainty equivalent of individuals who proportionally discount is based on the following heuristic:

$$\textit{Certainty equivalent} = \alpha * \textit{Expected value lottery} \tag{1}$$

If $\alpha = 1$, the individual is risk neutral. Another heuristic which is observationally equivalent is the rule: *Certainty equivalent* $= \theta *$ *Maximum outcome lottery*, where $\theta = \alpha/2$. Our setting is conducive to uncovering proportional discounting, because of the price list format and the sequence of presentation of the choices. This is because if a subject switches from the safe choice to the risky choice at the same row on the table in all periods, his behavior is consistent with the heuristic. Thus, an individual who wishes to apply the heuristic would not find it excessively cognitively demanding to do so. It is possible, if individuals have reference-dependent preferences, that α can differ between the domains of losses and gains. The average α parameter for this subsample is 0.94, equalling 0.95 for male subjects and 0.93 for female subjects. Such a shift in proportional discounting can be clearly seen on the right panel of Figure 2. This behavior reveals a discrete change in attitude toward risk above vs. below a certain reference point. However, in data such as ours, a classification of individuals according to the behavioral rules they employ, such as proportional discounting, must allow for some trials to exhibit deviations from the rule. To measure constant proportional discounting we estimate the following formula:

$$\begin{aligned}(\Delta \textit{proportional valuation}) =& (\textit{certainty equivalent/expected value lottery}_t) - \\ & (\textit{certainty equivalent/expected value lottery}_{t-1})\end{aligned} \tag{2}$$

We classify individuals as proportional discounters if there are no more than six violations of the rule in equation (2) between one period and the next. Figure 3 illustrates how common the use of the heuristic is. It shows a histogram of the change in proportional valuation for the complete dataset. The change in proportional valuation is zero in most cases.

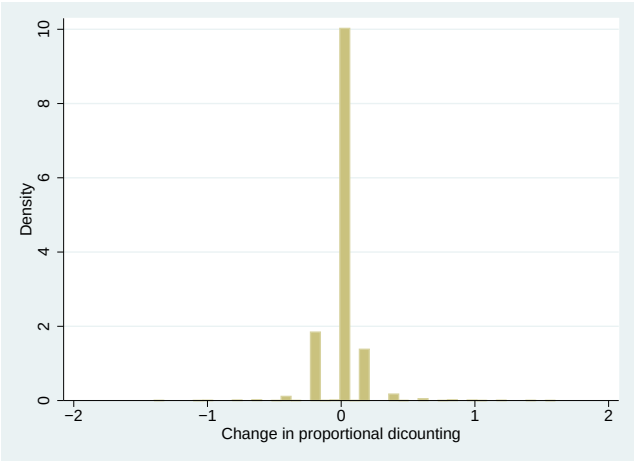


Figure 3: Density of changes in discount proportion parameter α between periods t and t+1

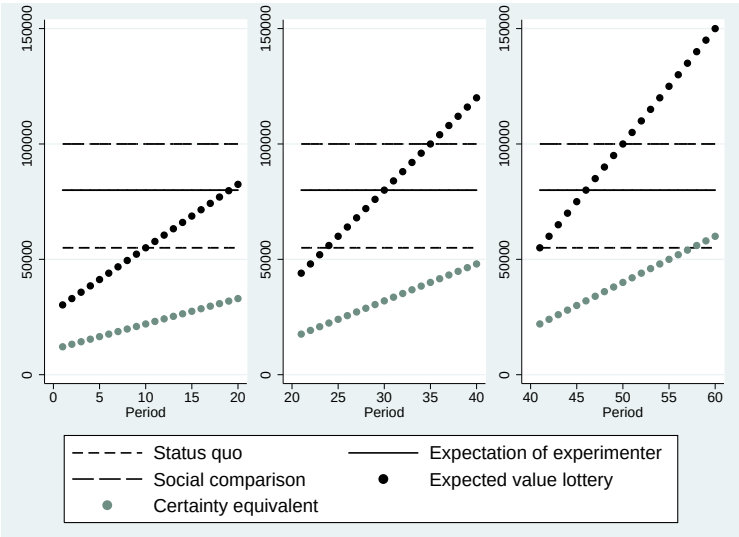


Figure 4: Certainty equivalents of subject 183, who did not employ a reference point

3.2 Reference point assignment

3.2.1 Proportional Discounters

To determine the reference points which are adopted in the experiment, our sample can be divided into two types of subjects, those who exhibit proportional discounting and those who do not. A total of 90 subjects (37 percent of all participants) are classified as individuals who proportionally discount the expected value of the lottery by a constant fraction. In determining the selected reference point by these individuals we estimate the certainty equivalent of each individual with a model which includes the expected value of the lottery and a shift in the certainty equivalent of an individual around a reference point as given by equation 3. The dummy variable D_k equals 1 if the expected value of a lottery is less than reference point k.

$$CE_i = \alpha_i + \beta_{1,i} EV\ lottery + \gamma_i D_k + \epsilon \tag{3}$$

The model is estimated for each individual and each reference point separately. An F-test is performed to test for the significance of the restriction $D_k = 0$. If the resulting F-statistic is above the critical level we will say that k is a reference point for the individual. Significance of the restriction indicates a difference in the valuation of payoffs above and below the reference point. Based on the result of this test, we assign an individual to either none, one, or multiple, reference points. The results of the regression using the pooled data from all subjects is shown in Table 2. It shows that subjects do decrease their certainty equivalent once the expected value of the lottery reaches the domain of gains.

The proportions of subjects in our subsample of proportional discounters who use each of the reference points are presented in Table 3. The individuals who did not form a reference point showed constant proportional discounting, (including the 2 percent of the sample that make all risk-neutral choices). An example of this is shown in Figure 4. We find that a majority of subjects who have formed a reference point exhibit more than one. For the complete subsample of individuals who proportionally discount, the status quo and the expectations of the experimenter are used with a similar frequency as reference points. When we split the sample by gender, we find that females who show proportional

Table 2: Estimation of reference point use by individuals who discount proportionally

	(1)	(2)	(3)
	CE	CE	CE
EV lottery	0.823***	0.843***	0.845***
	(81.21)	(70.07)	(83.41)
Shift Status quo	-1.586**		
	(-2.33)		
Shift Expectations		-3.638***	
		(-4.63)	
Shift Socialcomp			-0.879
			(-1.24)
Constant	4.209***	3.816***	2.856***
	(6.80)	(6.23)	(5.18)
Observations	2699	2219	2760
R^2	0.718	0.695	0.720

Notes: t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors.

Table 3: Reference point use by of subjects who proportionally discount

	All sample	Female	Male
None	36%	35%	32%
Status Quo	4%	0%	9%
Expectations	4%	6%	4%
Social Comparison	7%	6%	6%
Status Quo and Expectations	4%	3%	4%
Status Quo and Social Comparison	12%	15%	11%
Expectations and Social Comparison	3%	0%	6%
All	29%	35%	28%

discounting are somewhat less likely to choose the status quo level as their only reference point, while being more likely to choose all reference points simultaneously. However, this gender difference is not significant.

3.2.2 The rest of the sample

The remainder of our sample, 63 percent, do not employ the heuristic discussed above. To identify the reference points they are using, we focus on the manner whereby a reference point influences decisions. We test for the presence of a target payoff level by investigating the choice between playing the lottery or receiving the certain amount. We expect that individuals will give up some expected payoff when the expected value of the lottery is close to the targeted payoff level and choose the certain amount offered in order to receive their reference level payoff. To test for this pattern we run the following regression at the individual level:

$$\begin{aligned} Z_i = \alpha_i + \beta_{1,i} EV\ lottery + \beta_{2,i} Certain\ amount + \gamma_{statusquo,i} D_{statusquo} \\ + \gamma_{expectations,i} D_{expectations} + \gamma_{socialcomp,i} D_{socialcomparison} + \epsilon \end{aligned} \tag{4}$$

$$D_k = \begin{cases} 1; if\ Certain\ amount > reference\ point\ k \\ 0; if\ Certain\ amount \leq reference\ point\ k \end{cases}$$

Where Z_i is a binary variable which represents the choice of the individual between playing the lottery or preferring the certain amount offered. Z_i takes the value 1 if the individual chooses the lottery and 0 otherwise. A negative and significant coefficient of the gamma terms would indicate the use of that particular reference point as it reveals a decrease in the likelihood of choosing the lottery when the certain amount it is paired with exceeds the reference level. In the regression, we control for the expected value of the lottery and the level of the certain amount.

We evaluate whether an individual's decision pattern contains a reference point by testing the significance for each potential reference point given the condition of the coefficient being negative. For each individual, the test is applied for each of the potential reference points. When this test is significant for candidate reference point k, we say that the individual is using k as a reference point. Table 4 presents the incidence of each possible reference point profile in the sample. The regression on the aggregate data will provides an overall picture of the estimated parameters. Table 5 shows the estimated model for the aggregate sample. Specification 1 includes the choices of individuals who have formed a reference point. An increase in the expected value of the lottery increases the probability of choosing the lottery. To illustrate, a one standard deviation increase in the expected value of the lottery increases the probability of choosing the lottery by 19 percent. On the other hand, increasing the value of certain option by decreases the probability of choosing the lottery by a similar magnitude. When the certain option is larger than the status quo level, it leads to a decrease in the probability of choosing the lottery by 31 percent. If the certain amount exceeds the expectations of the experimenter or the social comparison level, the decrease is equal to about 5 and 13 percent, respectively.

Specification 2 shows the regression for the aggregate data of individuals who base their reference point, among potential others, on the status quo level. For this subsample the probability of choosing the lottery decreases by 34 percent if the certain amount offered surpasses the reference level. Specification 3 and 4 conducts the same analysis for individuals who used, respectively, the expectations of the experimenter or the social comparison level as their reference point. For these subsamples this decrease is equal to 23 and 35 percent. The effect of the expected value of the lottery or the level of the certain amount on the preferences are higher for specification 3 and 4.

The table shows that many subjects use multiple reference points, and most of these

Table 4: Reference points of subjects who do not proportionally discount

	All sample	Female	Male
None	10%	12%	9%
Status Quo only	31%	35%	29%
Expectations only	4%	6%	3%
Social Comparison only	6%	1%	7%
Status Quo and Expectations only	17%	18%	18%
Status Quo and Social Comparison only	19%	19%	18%
Expectations and Social Comparison only	1%	0%	3%
All	12%	9%	13%

individuals use the status quo level paired with either the expectations of the experimenter or the social comparison level. A sizable portion of individuals use all three reference points. The status quo level is the most commonly used reference point by individuals who used only one reference level. The expectations of the experimenter is almost as widespread as the social comparison level. Lastly, a non-negligible portion of individuals did not appear to use any of the candidate reference points.

3.3 Income shock

In the Shift treatment we study the effect of a change in the income level and investigate whether it changes the likelihood of choosing a particular reference point. As in the baseline treatment, we provide subjects with information on their initial balance, the expectations of the experimenter and the historical average or the expected average earnings of peers in that session. In addition, in the Shift treatment, at the end of period 40, subjects are informed about a change in their initial balance. We increase the initial balance of subjects by fifty percent. This new initial balance is higher than the previous one in order to avoid any disappointment effect. Then, in the last 20 periods of the experiment the same set of twenty lotteries which were shown in the first 20 periods of the experiment are presented to the subjects. We consider the effect of the shock on the choices of individuals in the last twenty periods of the experiment and compare these to the choices elicited in the first segment of twenty periods. With this procedure we obtain paired lotteries of equal expected value and obtain the choices of subjects belonging to

Table 5: Estimated reference points used

	(1)	(2)	(3)	(4)
	choice	choice	choice	choice
Expected value lottery	0.000006***	0.000006***	0.000008***	0.000010***
	(68.83)	(62.57)	(58.61)	(56.89)
Certain amount	-0.000006***	-0.000005***	-0.000007***	-0.000007***
	(-74.08)	(-68.82)	(-56.36)	(-45.05)
Dummy status quo	-0.312177***	-0.342772***	-0.239615***	-0.190441***
	(-73.76)	(-77.10)	(-36.48)	(-29.87)
Dummy expectation	-0.048198***	-0.048771***	-0.233104***	-0.071044***
	(-10.62)	(-10.17)	(-33.80)	(-10.82)
Dummy social comparison	-0.132742***	-0.106509***	-0.078723***	-0.354514***
	(-35.18)	(-26.30)	(-12.84)	(-62.35)
Constant	0.645933***	0.651310***	0.695382***	0.651711***
	(206.55)	(198.17)	(148.49)	(141.87)
Observations	62120	54464	23928	25808
R^2	0.428	0.437	0.492	0.501

Notes: Specification 1 includes the choices of individuals who have formed a reference point. Specification 2 includes the choices of subjects who have formed their reference point(s) based on, among potential others, the status quo level. Similar to specification 2, the data for specification 3 and 4 are constructed for the expectations of the experimenter and the social comparison reference point. t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors.

Table 6: Reference points of subjects before and after the income shock

	Before Shock	After Shock
None	64%	54%
Status Quo only	19%	32%
Expectations only	10%	10%
Social Comparison only	5%	2%
Status Quo and Expectations only	2%	0%
Status Quo and Social Comparison only	0%	0%
Expectations and Social Comparison only	0%	2%
All	0%	0%

these lotteries. We expect that when a subject changes his reference point due to the income shock, the choice between playing the lottery or receiving the certain amount of the paired lotteries will show a difference.

With a two-sided matched pair sign test we test whether the differences of each paired lottery is significantly different from zero for individuals who did initially form a reference point. A two sided test is conducted since we do not hypothesize any direction of a change in the preferences between playing the lottery or receiving the certain amount. It appears that subjects show a change in their choices after a change in their income at 1 percent significance level. Next, we investigate whether the increase in income has changed the reference point(s) individuals use.

We report the proportions of reference points formed by these individuals in Table 6. Our result points to a change in formed reference points as the use of the status quo level increases, while the use of the social comparison level decreases slightly. This supports findings in previous studies on dynamic reference point formation as is found by Arkes, Hirshleifer, Jiang, and Lim (2008) who found that reference point adaptation is larger in magnitude following a positive change in the reference point. However, as we test for a positive change in the income level of the individual and show that a change in a socio-economic factor, regardless of being directly the reference point itself, might have an effect on his reference level.

4 Conclusion

In this paper, we isolate the effect of a personal inclination to form a particular reference point, holding the economic context constant. While it is known from previous work that the reference point employed depends on the setting in which the decision is taking place, we show here that it also differs by individual within a given setting. We have compared the strength of the tendency to use three important candidate reference points in a horse race laboratory setting. Our results show that when individuals use a single reference point, the status quo level is most frequently employed. The incidence of the expectation of the experimenter and the social comparison level is similar for the aggregate sample, although the social comparison level is relatively more frequently used by male participants. We also find that a sizable portion of individuals employ multiple reference points. The most common combinations of reference points are the status quo level with either the expectation level of the experimenter or the social comparison level provided to them in the experiment.

We also find that a considerable share of subjects tend to proportionally discount their certainty equivalent by a constant percentage of the expected payoff of the risky lottery, while changing their discount levels around their reference points. This finding shows that diminishing sensitivity and loss aversion might not be present in the value curves of a sizable part of individuals, while the effect of reference point formation is still present. These individuals are not sensitive to the size of the payoff deviation from their reference point.

Since the information available to individuals changes as they are exposed to new information and alternatives, the regions considered as the domains of gains and losses might evolve. It is important to understand how individuals adjust their reference points over time. As a first step in understanding parameter changes on reference point formation we have investigated the change in reference point induced by a change in income level. When we shock the income level of subjects we observe a positive probability of a change in their reference point. This indicates that a change in an income can be absorbed and reflected in the formation of one's reference level.

A Instruction sheet

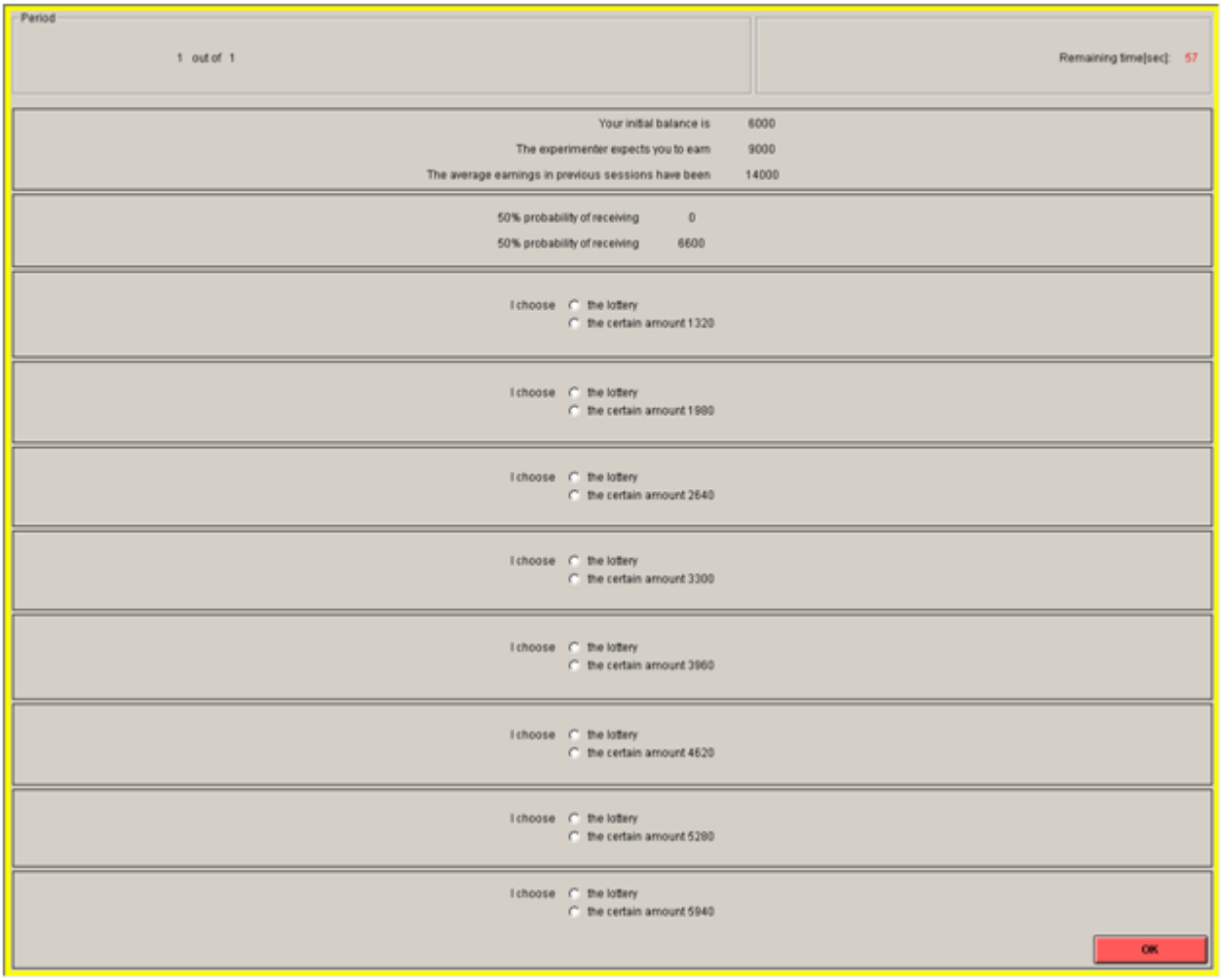
This experiment is about decision making. The experiment consists of 60 periods. Each period you will be presented a sequence of choices. The currency used in the experiment is francs. The amounts which are presented to you are all in terms of francs. You will be paid in cash in Euros according to your realized earnings by bank transfer the very same day. The conversion rate is 8500 francs to 1 Euro. You start with an initial amount of francs. The experimenter expects you to earn francs. The average amount earned in this experiment by other participants is francs. In each period you will see a computer screen like the one shown below:

Each presented choice consists of two options. One option is a sure amount of francs, the other option is a lottery with two possible outcomes. Each outcome of the lottery has a probability of one half to be realized. This is true for all lotteries presented to you throughout the experiment. In each period you have to indicate for each choice whether you prefer the lottery of that period, as shown at the upper part of the screen, or the certain amount of money. At the end of the experiment, the computer will randomly select one period and one choice of that period to determine your earnings of this experiment. Each period has equal probability of being selected by the computer and each choice has equal probability of being be selected by the computer. Then, depending on how you decided in the period and choice that counts, you either receive the sure payment or the lottery.

You will start with an initial balance of francs. After you have finished the experiment by indicating your choices, the outcome of the round which will be played for real will be added to your initial earnings and this will become your final earning of the experiment.

The experimenter expects that you will earn francs in this session. However, please notice that the expectations of the experimenter are not driven by any knowledge about the outcome.

Average earnings in previous sessions of this experiment have been francs. However, conditions may be changed from session to session and average earnings may be considerably different in this session from previous ones.


Period
1 out of 1
Remaining time[sec]: 57
Your initial balance is 6000
The experimenter expects you to earn 9000
The average earnings in previous sessions have been 14000
50% probability of receiving 0
50% probability of receiving 6600
I choose the lottery
the certain amount 1320
I choose the lottery
the certain amount 1980
I choose the lottery
the certain amount 2640
I choose the lottery
the certain amount 3300
I choose the lottery
the certain amount 3960
I choose the lottery
the certain amount 4620
I choose the lottery
the certain amount 5280
I choose the lottery
the certain amount 5940
OK

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