MEASURING DECISION WEIGHTS OF AMBIGUOUS EVENTS BY ADAPTING DE FINETTI'S BETTING-ODDS METHOD TO PROSPECT THEORY

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This paper extends de Finetti's betting-odds method for assessing subjective probabilities to ambiguous events, i.e. events for which beliefs of decision makers cannot be quantified through subjective probabilities. De Finetti's method is so transparent that decision makers can evaluate the relevant tradeoffs even in relatively complex situations, for prospects with three or more uncertain outcomes. The rank-dependent novelty of modern theories such as prospect theory and rank-dependent utility shows up only for such prospects, and several empirical properties of these theories of belief can be directly tested only there. The extension of de Finetti's method is implemented in an experiment on predicting next-day's performance of the Dow Jones and Nikkei indexes. Evidence is found for the rank dependence that underlies the aforementioned theories, for likelihood insensitivity ("inverse-S shape") as posited by prospect theory, and for pessimism as mostly assumed in economic studies. Part of the deviations from expected utility in the data are due to factors beyond any current decision model.

KEY WORDS: Ambiguity, rank-dependent, prospect theory, Choquet expected utility, inverse-S, pessimism, optimism, regret

1. INTRODUCTION

The importance of decision making with unknown probabilities has been emphasized by Keynes (1921), Knight (1921), and many after. Although Knight called such probabilities unmeasurable, Borel (1924), Ramsey (1931), and de Finetti (1931) demonstrated that they can be measured after all, at least in principle. De Finetti proposed a betting-odds system for such measurements that has been widely used ever since (Winkler 1972). It recently received new interest in experimental economics (Nyarko & Schotter 2002). De Finetti's system, and all of its applications up to now, are based on the Bayesian approach of expected utility. They are distorted by the empirical violations of this approach that have been documented in the literature (Camerer & Weber 1992, Starmer 2000).

This paper adapts de Finetti's betting-odds system to prospect theory, so as to account for violations of expected utility. We use the new version of prospect theory (Tversky & Kahneman 1992), which incorporates rank dependence. Quiggin (1981) introduced rank dependence for given probabilities, which enabled Kahneman and Tversky to correct some theoretical problems in their original prospect theory of 1979.

Schmeidler (1989) introduced rank dependence for events with unknown probabilities. Schmeidler's work allowed Kahneman and Tversky to extend prospect theory from given probabilities to the more important context of unknown probabilities. The approach of Schmeidler, Kahneman, and Tversky, developed 60 or 70 years after Keynes (1921) and Knight (1921), constitutes the first full-blown and empirically testable theory for decisions with unknown probabilities that allows for ambiguity.[1] This paper will consider only positive outcomes, and for those Schmeidler's theory coincides with prospect theory (the term used throughout this paper). Our findings, therefore, apply to both theories.

The novelty of rank dependence shows up, and can be tested, only for prospects with three or more outcomes. Its restriction to two outcomes had been known long before (Allais 1953, Eq. 19.1; Pfanzagl 1959 p. 288). Prospects with three or more

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[1] The multiple-priors model existed before, and was axiomatized by Gilboa & Schmeidler (1989). It has not yet reached the stage of empirical implementability.

outcomes can be complex, and hard to implement in experiments. We developed a design for three-outcome prospects that incorporates rank dependence but at the same time makes de Finetti's betting odds transparent, so that subjects can still relate to the choices in a meaningful manner without major cognitive effort. In this way, direct measurements of nonlinear decision weights can be obtained.

We implemented our method in an experiment. Thus, we obtained direct quantitative tests of rank dependence, and some often-discussed properties thereof. In particular, we could investigate to what extent decision weights are convex ("pessimistic" or "uncertainty averse"), a condition mostly assumed in theoretical economic studies, and to what extent they are likelihood-insensitive ("inverse-S" or "boundedly subadditive"), a condition suggested by empirical studies mostly from psychologists. The latter condition entails that people's perception is biased in the direction of fifty-fifty.

We also tested for effects that violate prospect theory, such as the effects of collapsing outcomes (Birnbaum & Navarrete 1998, Luce 2000, Starmer & Sugden 1993). Finally, we tested the extent to which decisions can be predicted from introspective assessments of emotions such as regret, which are not based on revealed preferences.

2. A Reformulation of Prospect Theory through Decision Weights and Rank Dependence

The uncertain events that we examined in the experiment are related to the performance of two stock exchange indexes, the Dow Jones industrial average and the Nikkei 225. U denotes the "Up" event that both indexes will go up tomorrow, D the "Down" event that both will go down, and R the "Rest" event that either one will go up and the other one down or at least one will remain constant. A *prospect* (u,d,r) yields \$u if U obtains, \$d if D obtains, and \$r if R obtains. The *outcomes* u,d,r, are always positive in this paper. A prospect (x,x,x), yielding x for sure, is also denoted simply by the amount it yields, i.e. x. For the sake of exposition, and to be consistent with the experiment described later, we restrict attention to three-outcome prospects. Generalizations to four or more outcomes are straightforward.

Subjective expected utility holds if there exists a *utility function* v and *subjective probabilities* π_U, π_D, and π_R that are nonnegative and sum to one, such that a prospect (u,d,r) is evaluated by $\pi_U v(u) + \pi_D v(d) + \pi_R v(r)$. Prospect theory generalizes subjective expected utility by allowing the π's to depend on the "ranking position" of the events. Formally, the *ranking position* of an event is defined through the event that is ranked above it in the sense of yielding better outcomes. The term rank dependence refers to this dependence. We use the term *decision weight* instead of subjective probability to reflect this dependence. For example, consider the prospect (5,9,7). Event D yields the best outcome and has the best ranking position. Event R has the middle ranking position, and event U the worst. The *prospect theory* value of the prospect is

$$(5,9,7) \rightarrow \pi_U^w v(5) + \pi_D^b v(9) + \pi_R^{m,D} v(7)$$

where the superscript w reflects the worst ranking position, b the best one, and m the middle one. The middle decision weight can depend on which of the other events is best, indicated by the superscript D in this case. In this manner, there are four decision weights for event U, π_U^b, π_U^w, $\pi_U^{m,D}$, and $\pi_U^{m,R}$, and, similarly, there are four decision weights for the events D and R.

TABLE 2.1.

	π_U	π_D	π_R
u ≥ d ≥ r	π_U^b	$\pi_D^{m,U}$	π_R^w
u ≥ r ≥ d	π_U^b	π_D^w	$\pi_R^{m,U}$
d ≥ u ≥ r	$\pi_U^{m,D}$	π_D^b	π_R^w
d ≥ r ≥ u	π_U^w	π_D^b	$\pi_R^{m,U}$
r ≥ u ≥ d	$\pi_U^{m,R}$	π_D^w	π_R^b
r ≥ d ≥ u	π_U^w	$\pi_D^{m,R}$	π_R^b

Decision weights for a prospect (u,d,r), depending on the ranking positions of U,D,R.

The general formula for prospect theory is

$$(u,d,r) \rightarrow \pi_U v(u) + \pi_D v(d) + \pi_R v(r) \tag{2.1}$$

where superscripts are to be added to the π's according to the ranking positions of events, described in Table 2.1.For events that yield the same outcomes, such as D and R in (0,1,1), the ranking can be chosen arbitrarily. Eq. 2.3 below will ensure that each possible ranking leads to the same evaluation; we do not elaborate on this point. Some examples of prospect-theory evaluations are

$$(9,2,1) \rightarrow \pi_U^b v(9) + \pi_D^{m,U} v(2) + \pi_R^w v(1),$$
$$(5,3,6) \rightarrow \pi_U^{m,R} v(5) + \pi_D^w v(3) + \pi_R^b v(6), \tag{2.2}$$

etc.

Schmeidler (1989) and Tversky and Kahneman (1992) stated their theories in terms of a weighting function, instead of directly in terms of rank-dependent decision weights as we do. The weighting function in the mentioned papers is defined as the decision weights π_E^b of events E when in the best ranking position. In general we can have

$$\pi_U^b + \pi_D^b + \pi_R^b \neq 1,$$

reflecting the nonadditivity of the weighting function. Decision weights are then derived from the weighting function as described in the references mentioned. Our presentation is equivalent. We chose our alternative presentation so as to make the role of rank dependence more clear.

Decision weights for a single prospect should still sum to one. That is:

All rows in Table 2.1 should sum to one. (2.3)

By incorporating this aspect of rank-dependent utility, the current version of prospect theory avoids the violations of stochastic dominance that hampered the developments of original prospect theory (Kahneman and Tversky 1979). Decision weights for middle ranking positions show up only for prospects with three or more outcomes.

Consequently, such prospects are needed for direct measurements of such decision weights, and for tests that concern them.

De Finetti's betting-odds system is based on the assumption of linear utility v(x) = x, an assumption maintained in our extension. It is reasonable for the moderate outcomes, not very close to zero, that are used in our experiment, and is commonly assumed in studies on belief elicitation (Nyarko & Schotter 2002). It will be discussed further in the Discussion section.

3. OUR EMPIRICAL PREDICTIONS

We now turn to empirical phenomena that cannot be modeled by expected utility, but can be by prospect theory. We focus on event U. Similar observations apply to the events D and R. *Pessimism* holds if decision weights increase as events get ranked lower. For U this means

$$\pi_U^w \geq \{\pi_U^{m,R}, \pi_U^{m,D}\} \geq \pi_U^b, \qquad (3.1)$$

where the braces $\{\pi_U^{m,R}, \pi_U^{m,D}\}$ indicate that the inequalities hold for both $\pi_U^{m,R}$ and $\pi_U^{m,D}$. Pessimism will be the attitude of a person who (erroneously) believes that events get more likely as their outcomes are more unfavorable, or, more rationally, of a person who deliberately decides that more attention should be given to the unfavorable events in decisions. It can be seen that pessimism corresponds with convex weighting functions, a point not elaborated on here. *Optimism* refers to the opposite phenomenon, with

$$\pi_U^w \leq \{\pi_U^{m,R}, \pi_U^{m,D}\} \leq \pi_U^b. \qquad (3.2)$$

(*Likelihood) insensitivity*, a mix of the above two phenomena, holds if

$$\pi_U^w \geq \{\pi_U^{m,R}, \pi_U^{m,D}\} \text{ and } \pi_U^b \geq \{\pi_U^{m,R}, \pi_U^{m,D}\}. \qquad (3.3)$$

It implies an overweighting of extreme outcomes, both worst (as under pessimism) and best (as under optimism), and an underweighting of intermediate outcomes. It corresponds with inverse-S shaped, or bounded subadditive, weighting functions, a point that we, again, do not elaborate on (Tversky & Fox 1995; Tversky & Wakker 1995).

Pessimism has mostly been assumed in the economics literature (Dow & Werlang 1992), and terms such as uncertainty aversion and ambiguity aversion have been used.

Empirical studies, mostly by psychologists, have suggested that insensitivity is important (Abdellaoui, Vossmann, & Weber 2003, Gonzalez & Wu 1999, Tversky & Fox 1995). The prevailing pattern can be expected to be a mix of pessimism and insensitivity, with strong inequalities $\pi_U^w > \{{}^{m,R}_{U}, {}^{m,D}_{U}\}$ and weaker inequalities $\pi_U^b \geq \{{}^{m,R}_{U}, {}^{m,D}_{U}\}$; the latter may be reversed if the effect of pessimism is stronger than that of insensitivity. Insensitivity can explain the simultaneous existence of gambling and insurance, a classical paradox in economics, where the former is explained by the overweighting of best outcomes and the latter by the overweighting of worst outcomes. We display two predictions, our main research hypotheses.

PREDICTION 1 [Rank dependence]. Decision weights depend on the ranking position (e.g., $\pi_U^w \neq \{\pi_U^{m,R}, \pi_U^{m,D}\} \neq \pi_U^b$).

PREDICTION 2 [Insensitivity and some pessimism]. $\pi_U^w \geq \{\pi_U^{m,R}, \pi_U^{m,D}\}$ and $\pi_U^b \geq \{\pi_U^{m,R}, \pi_U^{m,D}\}$, with the former inequality stronger than the latter.

We chose a design that is optimal for the testing of these two hypotheses, even if at the cost of testing other hypotheses. Details will be discussed later.

To critically test prospect theory, we also tested for factors beyond prospect theory, in particular for collapsing effects. To explain their role, we first discuss the *certainty effect*, i.e. a general tendency to prefer sure outcomes to risky prospects. In expected utility, such a tendency is modeled through concave utility (risk aversion). Allais' (1953) paradox demonstrated that utility alone cannot explain all of the certainty effect, and that other factors must play a role. One such other factor is pessimism: In every nontrivial choice between a sure outcome and a risky prospect, the lowest outcomes of the risky prospect are worse than the sure outcome and, therefore, overweighting those enhances a preference against the risky prospect. Prospect theory with pessimism (through the first inequality of Eq. 3.1), or also insensitivity (through the first inequality of Eq. 3.3), can explain the Allais paradox.

There are factors that affect risk attitudes and the certainty effect, but that are beyond prospect theory and that cannot be captured by utility or decision weights. Such factors will often be volatile, depending on the framing of prospects and particular context-dependent emotions. To investigate a factor of that kind, we measured the π^b and π^w weights of each event in two different ways, called *collapsed* (one of the prospects involved is riskless) and *noncollapsed* (all prospects are risky). The experimental details will be explained later. Prospect theory does not distinguish between collapsed and noncollapsed measurements of decision weights because in each case the event is in the same ranking position. However, factors beyond prospect theory are likely to generate differences between such measurements. We investigated if such factors were present, and if they would reinforce or weaken the certainty effect.

Many studies have suggested that emotions play an important role in decisions (Elster 1998). We, therefore, also asked the subjects for direct assessments of their emotions, and considered to what extent these were related to preferences. The traditional economic view is that such assessments will not be as suited to analyze and predict economic choices as revealed preferences.

4. MAKING DECISION TRADEOFFS TRANSPARENT THROUGH DE FINETTI'S BETTING ODDS SYSTEM

Before reading on, the reader is invited to determine her preference between the following two prospects

$$(33,46,65) \text{ and } (19,52,71), \qquad (4.1)$$

where the events U, D, R refer to the performance of the Dow Jones and Nikkei indexes on the day of reading. This choice concerns comparisons of three outcome pairs, contingent on three events with three different levels of subjective likelihoods. Such choices are complex and hard to evaluate in a short time span (which the above question was intended to illustrate). For the experiment, we developed a special format of questions so as to induce subjects to make their tradeoffs along the lines of de Finetti's betting-odds system, which makes choices transparent.

Traditionally, de Finetti's betting-odds system reveals indifferences such as (20,0,0) ~ (6,6,6), to conclude that $\pi_U = 6/20$ for subjective probability π_U. In our model, this preference reveals only $\pi_U^b = 6/20$, i.e. it reveals the decision weight of event U only when ranked best. To reveal, for instance, that $\pi_U^w = 6/20$, regarding the decision weight of U when in the worst ranking position, we add side payments, called reference prospects, to generate the desired rank ordering. In our experiment, for instance, we considered the above choices with added the reference prospect (13,46,65). Consider an indifference (20,0,0) + (13,46,65) ~ (6,6,6) + (13,46,65), i.e., (33,46,65) ~ (19,52,71) (see Eq. 4.1). Taking the reference prospect as point of departure, 20 more under U is equally preferred as 3 more for sure. In these considerations, event U is always ranked worst. After some algebraic manipulations, presented later, it follows that $\pi_U^w = 6/20$. An experimental layout to make these tradeoffs transparent to subjects (in contrast with Eq. 4.1 as presented above) will be described in the next section.

In general, we elicit indifferences of the form

$$(B,0,0) + (r_1,r_2,r_3) \sim (s,s,s) + (r_1,r_2,r_3), \qquad (4.2)$$

where the left prospect is $(B+r_1,r_2,r_3)$, and the right one is $(s+r_1,s+r_2,s+r_3)$. The prospect (r_1,r_2,r_3) is the *reference prospect*, and $B > s > 0$ (B designates big and s small or sure). If r_2 or r_3 exceed r_1, then they exceed it by so much that they also exceed r_1+B, for all the stimuli in our experiment. Indeed, in the preceding paragraph $r_2 = 46$ and $r_3 = 65$ exceeded $r_1 = 13$ by so much that after adding B = 20 to r_1 the result was still below r_2 and r_3. In this manner, the ranking positions of the events for both prospects are the same as for (r_1,r_2,r_3). We apply Eq. 2.1 to Eq. 4.2. For v we take the identity, and each event has the same decision weight with the same superscript for both prospects, which we suppress. The result is

$$\pi_U(B+r_1) + \pi_D r_2 + \pi_R r_3 = \pi_U(s+r_1) + \pi_D(s+r_2) + \pi_R(s+r_3).$$

Cancelling the prospect-theory value of the reference prospect yields

$$\pi_U B = \pi_U s + \pi_D s + \pi_R s = s,$$

where we used the unit summation $\pi_U + \pi_D + \pi_R = 1$ (Eq. 2.3). It follows that

$$\pi_U \quad = \quad s/B.$$

As a result, the decision weight of U will be equal to the betting odds s/B, exactly as in the original betting-odds system of de Finetti where the reference prospect was (0,0,0). The generalization of this paper is that we incorporate rank dependence of π_U (through the superscript that we suppressed here for simplicity of notation). We chose a layout, presented in the next section, so as to induce psychological processes that match the preceding algebraic derivation of the decision weight from Eq. 4.2.

5. Experimental Stimuli and Layout that Make de Finetti's Betting Odds System Transparent to Subjects

Figure 5.1 gives an example of the stimuli used in our experiment, and referred to in the preceding section. We concentrate, for now, on the first table to the left. The rest of Figure 5.1 will be explained in the next section. In the first table, the middle, grey, column depicts the reference prospect (r_1,r_2,r_3) = (13,46,65), where event U is indicated by ↑↑, D by ↓↓, and R by ↑↓=.

			+++
↑↑	33	13	16
↓↓	46	46	49
↑↓=	65	65	68
Choice ❒			❒

			+++
↑↑	33	13	19
↓↓	46	46	52
↑↓=	65	65	71
Choice ❒			❒

			+++
↑↑	33	13	22
↓↓	46	46	55
↑↓=	65	65	74
Choice ❒			❒

. . .

			+++
↑↑	33	13	37
↓↓	46	46	70
↑↓=	65	65	89
Choice ❒			❒

			+++
↑↑	33	13	40
↓↓	46	46	73
↑↓=	65	65	92
Choice ❒			❒

			+++
↑↑	33	13	43
↓↓	46	46	76
↑↓=	65	65	95
Choice ❒			❒

FIGURE 5.1. Stimuli used in our experiment.

The left column, indicated by a single large plus, designates the left side of Eq. 4.2, i.e. a gamble of B (= 20) extra on the event U. The right column, indicated by three small plusses, designates the right side of Eq. 4.2, yielding s = 3 more than the reference prospect with certainty. For both prospects in the table, U is ranked worst with decision weight π_U^w, D is ranked middle with decision weight $\pi_D^{m,R}$, and R is ranked best with decision weight π_R^b.

In the instructions to the subjects, it was explained that the left prospects in tables always result from the middle prospects through single big increases of the outcome for one event, and the right prospects always result from the middle ones through a same (small) increase of all three events. This layout and presentation of tables should make the tradeoffs transparent, of either getting B extra under event U or s extra for sure, as in de Finetti's betting odds. At the same time, the initial focus on the reference prospect should make the rank-ordering of the events salient. We hope that the layout of the left matrix in Figure 5.1 makes the relevant tradeoffs in Eqs. 4.1 and 4.2 transparent to the subjects.

6. EXPERIMENT

Participants. 186 students, all from Tilburg University, took part. There were 62 psychology students divided into six groups. There also was a group of 124 students in general social sciences who participated in one big session. The average age of the participants was 20.1, and 32.8% were male.

Procedure. The experiment was carried out in classroom sessions. All items were administered with paper-and-pencil questionnaires. The participants were asked to fill out the questionnaire at their own pace. This usually took about 45 minutes (including the instructions).

The subjects received brief verbal instructions, followed by detailed written instructions that took about 15 minutes to read (Appendix A). A transparency with a graph depicting the performances of the stock indexes during the last two months, up to the day of the experiment, was projected during the task (Appendix B). A brief text in the written instruction discussed the likelihood of the stocks increasing or decreasing, referring explicitly to the last two months. As different groups participated on different days, the information about the stocks varied from group to group. The text in Appendix A concerns May 16, 2001.

FIGURE 6.1. Order of Pages after the Instructions

- 2 learning-question pages
- page with questions about difficulty etc.
- 2 experimental-question pages →
- 1 filler-question page
- 6 experimental-question pages → order of these was completely randomized
- 1 filler-question page
- 10 experimental-question pages →
- pages with questions about emotions such as regret.

Stimuli; organization between pages. Besides a test-choice in the instructions, there were 22 pages with 10 choice questions each. These were organized as follows. The experiment started with two learning-task pages, followed by 18 experimental-task pages and two filler-question pages. The filler-question pages were always on the 3^{rd} and 10^{th} place after the learning-question pages, and served to discourage subjects from using heuristics such as switching at the same place on each page. Other than that, the order of the experimental-question pages was randomized. The randomization was generated through random permutations of 1, ..., 18 and a manual reordering of the pages.

After the two learning-question pages and before the first experimental-question page, there was a page with three questions about the difficulty of the other questions and about whether the participants paid attention to their perceived likelihoods of the events (Appendix C). The questions about likelihood served to focus subjects' attention on this aspect.

The outcomes of the experiment ranged between between Dfl. 10 (approximately €4.50) and Dfl. 99. At the end of the experiment, there were self-assessment questions about the knowledge and competence of subjects about stock-exchanges, their feelings of happiness, pride, relief, disappointment, regret, frustration, their general feeling, if they felt better or worse relative to the beginning of the investigation, and about age and gender (Appendix D).

Stimuli; organization within one page. Each page contained 10 tables, reflecting 10 choice questions. The complete set of choice 10-tuples is given in Table 6.1. Of the fifth 10-tuple, Figure 5.1 presents six tables, the first three and the last three. Figure 6.2 depicts the general format of a kth table on a page when the big increase B is for event U.

FIGURE 6.2. The general format of the kth table on a page.

	+		+++
↑↑	$B+r_1$	r_1	$kx+r_1$
↓↓	r_2	r_2	$kx+r_2$
↑↓=	r_3	r_3	$kx+r_3$
Choice	❐		❐

All ten tables on one page had the same grey middle column, i.e. the same reference prospect. They also had the same left columns, with the same single increase B (B = 20 in Figure 5.1). The payoffs of the right prospects were increased stepwise with step size x (x=3 in Figure 5.1) and with $10x \geq B$. Hence, the right prospect $(10x+r_1,10x+r_2,10x+r_3)$ in the last choice on each page always dominated the left one because $10x+r_1 \geq B+r_1$. In Figure 5.1, the right prospects dominate the left ones for all $k \geq 7$ and, hence, for all three tables displayed on the right.

The 10-tuples no 2, 6, 8, 12, 14, and 18 of Table 6.1 contained a riskless, **C**ertain, option, indicated by superscript c, where all outcomes **C**ollapse. Then either $B+r_1 = r_2 = r_3$ or $r_1 = r_2 = r_3$ in Figure 6.2. All of these choices concerned elicitations of decision weights for best or worst ranking positions. Elicitations of such decision weights when there is **N**o collapse of outcomes, indicated by superscript n, occurred for the 10-tuples 1, 5, 7, 11, 13, and 17. Collapses of outcomes as above cannot occur for elicitations of decision weights in middle ranking positions.

TABLE 6.1 (stimuli and results).

		+			+++			
		U	D	R	U	D	R	
#	π	$(B+)r_1$	$(B+)r_2$	$(B+)r_3$	$xk + r_1$	$xk + r_2$	$xk + r_3$	mean (st.dev.) of π
1	$\pi_U^{b,n}$	20 + 44	29	13	3k + 44	3k + 29	3k + 13	.465 (.22)
2	$\pi_U^{b,c}$	30 + 24	24	24	3k + 24	3k + 24	3k + 24	.414 (.18)
3	$\pi_U^{m,D}$	20 + 31	65	14	3k + 31	3k + 65	3k + 65	.473 (.23)
4	$\pi_U^{m,R}$	20 + 23	14	59	3k + 23	3k + 14	3k + 59	.485 (.23)
5	$\pi_U^{w,n}$	20 + 13	46	65	3k + 13	3k + 46	3k + 65	.505 (.23)
6	$\pi_U^{w,c}$	30 + 16	46	46	3k + 16	3k + 46	3k + 46	.430 (.17)
7	$\pi_D^{b,n}$	18	40 + 56	35	4k + 18	4k + 56	4k + 35	.334 (.18)
8	$\pi_D^{b,c}$	37	30 + 37	37	4k + 37	4k + 37	4k + 37	.352 (.19)
9	$\pi_D^{m,R}$	11	40 + 18	59	4k + 11	4k + 18	4k + 59	.314 (.19)
10	$\pi_D^{m,U}$	59	40 + 15	10	4k + 59	4k + 15	4k + 10	.310 (.19)
11	$\pi_D^{w,n}$	59	40 + 10	56	4k + 59	4k + 10	4k + 56	.334 (.19)
12	$\pi_D^{w,c}$	58	30 + 28	58	4k + 58	4k + 28	4k + 58	.355 (.20)
13	$\pi_R^{b,n}$	42	26	20 + 63	2k + 42	2k + 26	2k + 63	.525 (.20)
14	$\pi_R^{b,c}$	17	17	20 + 17	2k + 17	2k + 17	2k + 17	.506 (.20)
15	$\pi_R^{m,U}$	74	12	20 + 37	2k + 74	2k + 12	2k + 37	.493 (.21)
16	$\pi_R^{m,D}$	16	61	20 + 27	2k + 16	2k + 61	2k + 29	.513 (.20)
17	$\pi_R^{w,n}$	77	51	20 + 13	2k + 77	2k + 51	2k + 13	.498 (.20)
18	$\pi_R^{w,c}$	49	49	20 + 29	2k + 49	2k + 49	2k + 29	.488 (.20)
L1		30 + 50	10	30	3k + 50	3k + 10	3k + 30	.367 (.15)
L2		45	20 + 10	55	4k + 45	4k + 10	4k + 55	.367 (.24)
F1		30 + 35	11	24	2k + 35	2k + 11	2k + 24	.347 (.14)
F2		32	30 + 49	13	2k + 32	2k + 49	2k + 13	.271 (.14)

Each row refers to a numbered 10-tuple of choice questions. After the number follow: the decision weight (π) measured, the three event-contingent outcomes of the single large-size plus prospect, the three event-contingent outcomes of the three-small-plusses prospects (k ranging from 1 to 10) and, finally the means and standard deviations of the elicited decision weights.

Motivating the participants. As explained to the participants in the instructions, one of every ten participants was selected to play one of their choices, randomly selected, for real. The participants collected the money gained the next morning, when the relevant uncertainties about the stock indexes had been resolved. In addition, the 62 psychology students received course credits, and each student of the large group of 124 received a flat payment of Dfl. 25.

Analysis. On each experimental page, we assessed the point at which the participants switched from a choice for the left column to a choice for the right column. This should happen at one place. Other choice patterns violate dominance and were coded as missing values. Assuming that indifference is halfway between the two choices where preferences switch, and assuming linear utility as discussed elsewhere, we could calculate the decision weights. For example, imagine that the switch for 10-tuple 5 in Table 6.1, also depicted in Figure 5.1, is from the second to the third table:

$$(6,6,6) + (13,46,65) \prec (20,0,0) + (13,46,65) \prec (9,9,9) + (13,46,65).$$

We then assume that an approximate indifference

$$(20,0,0) + (13,46,65) \sim (7½,7½,7½) + (13,46,65)$$

holds, and estimate $\pi_U^w = 7½/20 = 0.375$.

We discuss the analysis of decision weights for event U in more detail. The analyses for the other events are similar. The "best" and "worst" decision weights were measured with Collapsed outcomes (denoted $\pi_U^{b,c}$ and $\pi_U^{w,c}$, see 10-tuples 2 and 6 in Table 6.1), and with Noncollapsed outcomes (denoted $\pi_U^{b,n}$ and $\pi_U^{w,n}$, see 10-tuples 1 and 5 in Table 6.1). The middle decision weights were measured with event D yielding the best outcome ($\pi_U^{m,D}$; 10-tuple 3), and with event R yielding the best outcome ($\pi_U^{m,R}$; 10-tuple 4). This leads to six measurements of decision weights per event and, thus, to 18 measurements in total, given in the last column of Table 6.1. Before turning to the study of these separate decision weights, we first consider overall estimates of the decision weights in the various ranking positions. For this purpose, we define averages

$$\pi_U^b = (\pi_U^{b,c}+\pi_U^{b,n})/2,\ \pi_U^w = (\pi_U^{w,c}+\pi_U^{w,n})/2,\ \pi_U^m=(\pi_U^{m,D}+\pi_U^{m,R})/2,$$

with averages for the events D and R defined similarly. According to prospect theory, we should have $\pi_U^{b,c} = \pi_U^{b,n}$ and $\pi_U^{w,c} = \pi_U^{w,n}$, so that π_U^b and π_U^w are genuine estimations of single decision weights. Middle weights such as $\pi_U^{m,D}$ and $\pi_U^{m,R}$ may be different, so that π_U^w etc. are averages of two different decision weights. All statistical tests in this paper will be two-tailed paired-samples tests for normal distributions.

We computed indexes of risk aversion, pessimism, and insensitivity. We took:
(a) One minus the average decision weight of the events as an index of risk aversion;
(b) the average difference between decision weights in worst ranking positions and in best ranking positions as index of pessimism; and (c) the sum of decision weights in worst and best ranking positions minus twice the decision weights in middle ranking positions as index of insensitivity. We related the indexes defined to the other measurements.

Because we study decisions under uncertainty, there is no known objective probability for the different events. The most plausible, and we think only rational, answer to the question which event is most likely, is that it is event R, in agreement with historical data. Therefore, we took this question as a test of rationality.

7. Results

The different groups exhibited the same patterns, and their data were pooled. Four subjects were dropped because a test question at the beginning of the experiment suggested that they did not understand the stimuli. Ten subjects were dropped because they had more than two incorrect choice-switches (from the right column to the left column), suggesting that they did not understand the stimuli.
The main results are summarized in Figure 7.1, and will be explained thereafter.

FIGURE 7.1. Means (standard deviations) of decision weights.

	best	middle	worst
collapse	.41 (.18)		.43 (.17)
π_U	.44 (.18)	.48 (.20)	.46 (.18)
noncollapse	.46 (.22)		.51 (.23)

Up-event suggests pessimism

	best	middle	worst
collapse	.35 (.19)		.35 (.20)
π_D	.34 (.18)	.31 (.17)	.34 (.17)
noncollapse	.33 (.18)		.33 (.19)

Down-event suggests insensitivity

	best	middle	worst
collapse	.51 (.20)		.49 (.20)
π_R	.52 (.18)	.50 (.19)	.50 (.18)
noncollapse	.53 (.20)		.50 (.20)

Rest-event suggests optimism

*: different ($p \leq 0.05$); ***: different ($p \leq 0.001$).

The means and standard deviations of the average decision weights π_U, π_D, and π_R are given in the middle rows of the boxes in the figure. Rank dependence, with weights depending on ranking positions, is confirmed by these results.

For event U we find some pessimism, because π_U^b is less than π_U^m ($t_{165} = -4.18$, p < .001) and less than π_U^w ($t_{168} = -3.24$, p = .001). Whereas pessimism suggests that $\pi_U^m < \pi_U^w$, there is no significant difference in our data ($t_{168} = 0.93$, ns).

Event D exhibits likelihood insensitivity. That is, $\pi_D^b > \pi_D^m$ ($t_{168} = 3.35$, p = .001) and $\pi_D^w > \pi_D^m$ ($t_{169} = 3.12$, p = .002). There is no significant difference between π_D^b and π_D^w ($t_{168} = 0.13$, ns).

Event R suggests some optimism because $\pi_R^b > \pi_R^w$ ($t_{168} = 2.17$, p = .03). The differences between π_R^b and π_R^m ($t_{169} = 1.36$, ns) and between π_R^m and π_R^w ($t_{169} = 1.19$, ns) are not significant.

None of our hypotheses predict a relation between $\pi_U^{m,D}$ and $\pi_U^{m,R}$, or between $\pi_D^{m,U}$ and $\pi_D^{m,R}$, or between $\pi_R^{m,U}$ and $\pi_R^{m,D}$. It is nevertheless plausible to conjecture equalities between these pairs of weights. Indeed, none of these equalities is rejected statistically (t_{170} = –.86, ns, t_{171} = –.05, ns, and t_{171} = 1.52, ns, respectively).

The following table summarizes the significant inequalities and their support for properties of decision weights.

TABLE 7.1.

	$\pi_U^b < \pi_U^m$	$\pi_U^b < \pi_U^w$	$\pi_D^b > \pi_D^m$	$\pi_D^w > \pi_D^m$	$\pi_R^b > \pi_R^w$
insensitivity	–	0	+	+	0
pessimism	+	+	–	+	–
optimism	–	–	+	–	+

We now turn to results regarding violations of prospect theory. There are six tests of collapsing effects, given in Table 7.2. The inequalities given in the top row of the table are those found for means in our data, and are not statistical hypotheses. The statistical null hypothesis is always equality of the weights, the alternative hypothesis always claims inequality of the weights, and all tests are two-tailed. The first two equalities are rejected which suggests collapse effects, in violation of prospect theory, and the last four equalities are accepted, in agreement with prospect theory.

TABLE 7.2. Testing invariance of decision weights for same ranking positions of events.

	$\pi_U^{b,n} > \pi_U^{b,c}$	$\pi_U^{w,n} > \pi_U^{w,c}$	$\pi_D^{b,n} < \pi_D^{b,c}$	$\pi_D^{w,n} < \pi_D^{w,c}$	$\pi_R^{b,n} > \pi_R^{b,c}$	$\pi_R^{w,n} > \pi_R^{w,c}$
t-statistic	t_{170} = 3.22	t_{172} = 4.74	t_{170} = –1.81	t_{172} = –1.09	t_{170} = 1.63	t_{171} = 0.52
p-value	**p = .002**	**p = .000**	p = .07	ns	ns	ns

ns: not significant; p = .07: marginally significant.

Rank dependence predicts that the rows in Table 2.1 sum to one (Eq. 2.3). The average weights measured sum to more than one, though. We obtain

$$\pi_U^b + \pi_D^{m,U} + \pi_R^w = .438 + .310 + .496 = 1.244 > 1,$$

$$\pi^b_U + \pi^{m,U}_R + \pi^w_D = .438 + .493 + .343 = 1.274 > 1,$$

$$\pi^b_D + \pi^{m,D}_U + \pi^w_R = .343 + .473 + .496 = 1.312 > 1,$$

$$\pi^b_D + \pi^{m,D}_R + \pi^w_U = .343 + .513 + .465 = 1.321 > 1,$$

$$\pi^b_R + \pi^{m,R}_U + \pi^w_D = .515 + .485 + .343 = 1.343 > 1,$$

$$\pi^b_R + \pi^{m,R}_D + \pi^w_U = .515 + .314 + .465 = 1.294 > 1.$$

For the question which event was considered most likely, 141 out of the 186 subjects gave the rational answer that event R is most likely. The average decision weight of R was clearly higher than that of U and D (Figure 7.1). The self-assessments of competence and knowledge about stocks were significantly higher among the other subjects, who thought that U or D was most likely to happen (t_{184} = 2.84, p = 0.005, and t_{184} = 2.45, p = 0.015).

The risk aversion index correlated significantly with age (r = 0.22, p = 0.007), but not with gender. It had a marginally significant correlation with two introspective questions about emotions asked at the end of the experiment, one about feeling happiness when gaining a large amount, (r = 0.14, p = 0.09), the other about feeling regret when losing a large amount (r = –0.14, p = 0.08). The pessimism and insensitivity indexes did not correlate significantly with age and gender. The pessimism index had a marginally significant positive correlation with regret (r = 0.14, p = 0.07) and, remarkably, a significant positive correlation with the momentary "positive" feeling (r = 0.17, p = 0.04). The insensitivity index had a negative correlation with the self-assessment of competence (r = –0.16, p = 0.05).

8. Discussion

Before discussing the results, let us mention some aspects of our study that may have systematically influenced the results. In all pages, sure payments were always increasing from left to right, and final choices could be governed by dominance but initial choices never. Thus, biases upwards in our measurements will have been generated, leading to more risk seeking and explaining the violations of unit summation in Table 2.1. We did not counterbalance for these effects, or for the positions of events on pages, for a number of pragmatic reasons, given that the biases generated do not affect our main research questions, which concern the existence and nature of rank dependence.

Our design may have encouraged subjects to focus on the big and small changes B and s, and to ignore the reference prospects. This reduces rank dependence and leads to a loss of power, but it does not bias or invalidate our tests. Different groups of subjects participated in the experiment at different times, and accordingly received different information about the stocks during the preceding two months, leading to additional variation between individuals. It is natural that different individuals have different information and different attitudes. These differences again lead to a loss of power but they do not distort our empirical predictions.

We find no collapse effects for events D and R, but do find them for event U. $\pi_U^{b,c}$ was elicited from choices between (54,24,24) and (24+s,24+s,24+s). The inequality found, $\pi_U^{b,c} < \pi_U^{b,n}$, suggests that preference switches to (24+s,24+s,24+s) relatively soon, i.e. for small s. This suggests that there is additional preference for certainty beyond prospect theory, and that the factors beyond prospect theory reinforce the certainty effect.

The weight $\pi_U^{w,c}$ was elicited from choices between (46,46,46) and (16+s,46+s,46+s). The inequality found, $\pi_U^{w,c} < \pi_U^{w,n}$, suggests that preferences switch to (16+s,46+s,46+s) relatively soon, for small s. It suggests that there is additional preference against certainty beyond prospect theory, i.e., here the factors beyond prospect theory reduce the certainty effect.

Historical data suggest that the probability of the Dow Jones or Nikkei indexes going up or down are very close to 0.5, and that these events are virtually uncorrelated. That is, R has probability 0.5, and U and D have probability 0.25. The decision weights of R are all close to 0.5, its true probability. The decision weights of U and D considerably exceed 0.25. If we correct for the general overweighting of decision weights in our data, then it follows that the probability of R is underestimated and those of U and R are overestimated. Apparently, people overestimate the correlation between the movements of the two indexes. This effect may have been enhanced by a general regressive nature of judged probabilities, where people overestimate small probabilities and underestimate moderate and high probabilities (Tversky & Fox 1995). The performances of the stocks in the months preceding the experiment were positive, with more movements up. Given that subjects received information about the two preceding months, it is natural that they weighted U more heavily than D.

If insensitivity is taken as an index of irrationality (Tversky & Wakker 1995, p. 1266), then the positive correlation between insensitivity and the self-assessment of competence suggests that the latter may, paradoxically, be an index of incompetence. This interpretation is supported by the higher self-assessments of competence in the group that, irrationally, did not judge that event R is the most likely.

Many alternative layouts and framings were tested in pilot studies, and subjects were asked to give feedback on transparency, decision strategies used, etc. The layout of the stimuli chosen for the experiment was found to be most suited to make the decision-relevant tradeoffs transparent to the subjects. In pilot studies, we found that grouping the 10-tuples by events, instead of a completely randomized order of presentation that we chose, and some other changes in our design, induced participants to resort to heuristics often amounting to expected value maximization (e.g. by ignoring events and simply adding outcomes), instead of expressing subjective preferences. The resort to expected-value heuristics occurred more frequently if we used three symmetric events instead of the events now chosen.

Had we assumed concave instead of linear utility, then the resulting decision weights would have been higher than in our calculations. Many references have argued for linear utility for small stakes (de Finetti 1937; Edwards 1955; Fox, Rogers, & Tversky 1996; Lopes & Oden 1999 p. 290; Luce 2000 p. 86; Rabin 2000; Ramsey 1931 p. 176; Samuelson 1959 Point 7 on p. 35; Savage 1954 p. 91). Many empirical studies have found that the curvature of utility is most nonlinear around zero (Tversky & Kahneman 1992), a phenomenon incorporated in the most commonly used parametric utility family, the logpower family, which has infinite derivative at zero. Our outcomes are all remote from zero, with minimal outcome Dfl. 10, so as to have approximately linear utility. An additional reason for avoiding the zero outcome is that it induces several biases in the evaluation of prospects (Birnbaum, Coffey, Mellers, & Weiss 1992). An axiomatic foundation of de Finetti's betting-odds system for prospect theory with linear utility is given by Diecidue & Wakker (2001). Chateauneuf (1991) gave an alternative axiomatization of the same underlying decision-model.

One direction for future improvements of decision theories may be the incorporation of emotions, and empirical inputs not based on revealed preference. In this respect it is remarkable that some introspective questions about emotions explained part of our data. Pennings & Smidts (2000), to the contrary, found no significant relations between actual behavior and psychometric scales. Establishing relations between decision making and empirical inputs that are not based on decisions, is an important topic for future research (Kahneman 1994).

9. CONCLUSION

We measured decision weights of prospect theory by means of de Finetti's betting-odds system. We found evidence for rank dependence of decision weights, and as much evidence for likelihood-insensitivity as for pessimism. Both effects seem to play a role. We found less evidence for optimism. Part of our findings are due to factors beyond current decision models.

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APPENDIX A. INSTRUCTIONS FOR: CHOOSING BETWEEN TWO ALTERNATIVES (MAY 16, 2001)

Welcome to this investigation into choice behavior, and thanks for your willingness to participate.

In this investigation we will ask you to make a number of choices. You will choose between different options, indicated as columns in figures, with uncertain outcomes. The situations in which you will choose are depicted as follows:

	+		+++
↑↑	20	10	12
↓↓	40	40	42
↓↑=	70	70	72
Choice	❐		❐

In the middle of the figure you see a grey column. This column is the “reference-option”. The amounts in this colum are the amounts, in guilders, that you might win if you were to receive this option. In this case, these amounts are Dfl. 10, Dfl. 40 or Dfl. 70. Which of these amounts you win depends on the outcome in the first column. The outcome in the first column is determined by the results today of two stock-exchange indexes: the *Dow Jones IA* (DJ; the most important stock-index in New York) and the *Nikkei 225* (NK; the most important stock-index in Tokio). It is unknown at this moment whether the indexes will increase or decrease. This will only be known after the next closures of the stock-exchanges. If both the DJ and the NK increase (indicated by ↑↑ in the first column) then the grey colum yields Dfl. 10. If both stock-indexes decrease (indicated by ↓↓ in the first column) then the grey column yields Dfl. 40. In all other cases, so if one index decreases and the other increases, or if one or both remain constant (indicated by ↓↑= in the first column), then the grey column yields Dfl. 70.

To illustrate, we give the information regarding yesterday:

Yesterday both indexes decreased. The grey column would have yielded Dfl. 40. Of course, past results are no guarantee for future results. Let us return to the experiment, which concerns the increases or decreases of today and not those of yesterday.

Consider the above choice again. On both sides of the grey column you see another column, the left one indicated with a big plus (+) and the right one with three small plusses (+++). In this investigation we ask you each time to choose between these two columns. As you can see, both columns are improvements compared to the grey column, the “reference-option”:

- The column with the single large plus (+) gives a single large improvement. This means that one of the outcomes is considerably better than in the grey column. The other two outcomes are the same as in the grey column. In the example you see that the outcome Dfl. 10 has been increased by Dfl. 10, it is now Dfl. 20.
- The column with the three small plusses (+++) gives three small improvement. This means that all outcomes are somewhat better than those of the grey column. In the example you see that all outcomes have been increased by Dfl. 2 (they are now Dfl. 12, Dfl. 42 and Dfl. 72).

Therefore, if both indexes increase (↑↑), then you receive Dfl. 20 if you chose the (+) column and Dfl. 12 if you chose the (+++) column. If both indexes decrease (↓↓), then you receive Dfl. 40 if you had chosen the (+) column and Dfl. 42 if you had chosen the (+++) column. In all other cases (↓↑=) you receive Dfl. 70 if you chose the (+) column and Dfl. 72 if you chose the (+++) column.

In this investigation we ask you to indicate in various figures which of the two improvements you prefer, the (+) column or the (+++) column. You can indicate your choices by putting a cross under the column of your choice. We want to emphasize that there are no right or wrong answers, only your own preference matters. We are interested in your preferences.

Do you have questions about the explanation so far?

[2]The performances of the indexes on a specific day are hard to predict. It is, therefore, still uncertain at this moment what will happen today. Will both indexes increase (↑↑), will both decrease (↓↓), or will another case occur (↓↑=)? Although we do not know what will happen today, we do know that these three possibilities were not equally likely during the last two months. The most likely possibility was ↓↑=. This occurred in almost half of the cases. Of the other two possibilities, ↑↑ occurred considerably more often than ↓↓; ↑↑ occurred in about 1/3 of the cases and ↓↓ in about 1/5 of the cases. Thus, after having mostly decreased for over a year, the indexes performed well during the last two months. When deciding, you will pay most attention to ↓↑=, because this is most likely possibility. Obviously, markets today are in a different position than in the past, and results obtained in the past are no guarantee for results in the future.

[2] The information on this page varied some between different groups, depending on the day of the experiment.

We next show what a page of the questionnaire looks like.

Each page contains a row with 10 choice-situations. For the moment, let us only consider the first choice situation:

	+		+++
↑↑	80	50	53
↓↓	10	10	13
↓↑=	30	30	33
Choice	❒		❒

Here you have to choose again between the two improvements: the (+) column, an improvement of Dfl. 30 if both indexes increase, or the (+++) column, an improvement of Dfl. 3 in all cases. Put a cross indicating your choice. When you are done, consider the second choice-situation in the row, depicted below. You see that the (+) column and the grey column are still the same, but that each outcome in the (+++) column has been further improved by an additional Dfl. 3, so it is now Dfl. 6 better than the grey column.

	+		+++
↑↑	80	50	56
↓↓	10	10	16
↓↑=	30	30	36
Choice	❒		❒

Indicate again which of the two columns you prefer, the (+) column or the (+++) column. In the third choice situation the same thing is repeated. The first two columns remain the same, whereas each outcome in the third column has been further improved by an additional Dfl. 3, so that it is now Dfl. 9 better than the grey column.

	+		+++
↑↑	80	50	59
↓↓	10	10	19
↓↑=	30	30	39
Choice	❒		❒

Indicate again which of the two columns you prefer, the (+) column or the (+++) column.

The whole row consists of 10 such choice-situations. In all ten choice-situations the (+) columns are the same, and the grey column likewise, where in the first one amount has been increased relative to the grey column (e.g., Dfl. 80 instead of Dfl. 50).

In the (+++) column all three amounts are increased compared to the grey column, where the increase augments with fixed step sizes as we move more to the right. The (+++) column, therefore, becomes more and more favorable.

You will mostly prefer the (+) column in the first choice situation. Because the other column, the (+++) column, becomes increasingly favorable, you will probably change preference in one of the choice-situations. Then you choose the (+++) column. Because this column continues to become more favorable, you will probably continue choosing the (+++) column in the rest of the series.

We next explain the payment that you receive for this investigation. You surely receive a fixed amount of Dfl. 25 for your participation. In addition, there is a chance to make more money. How much more you earn depends on the choices that you make during this investigation. At the end of the investigation, we will randomly select 1/10 of you. For those selected we will, again randomly, select one of the choices from the whole set, and on the basis of the choice of the participant and the result of the indexes, the selected participant will be paid. If you have been selected to play for real then you can collect your gain starting tomorrow in office B. 9.11. It is, therefore, important to carefully indicate the option of your preference, because it is possible that you will really play the chosen column eventually with real payments. Again, there are no right or wrong answers, the only relevant thing is what you prefer yourself! This is also what we are interested in.

To conclude, a practice question. Imagine that we would play the following choice for real money. Indicate which column you would choose:

	+		+++
↑↑	80	50	62
↓↓	10	10	22
↓↑=	30	30	42
Choice	❒		❒

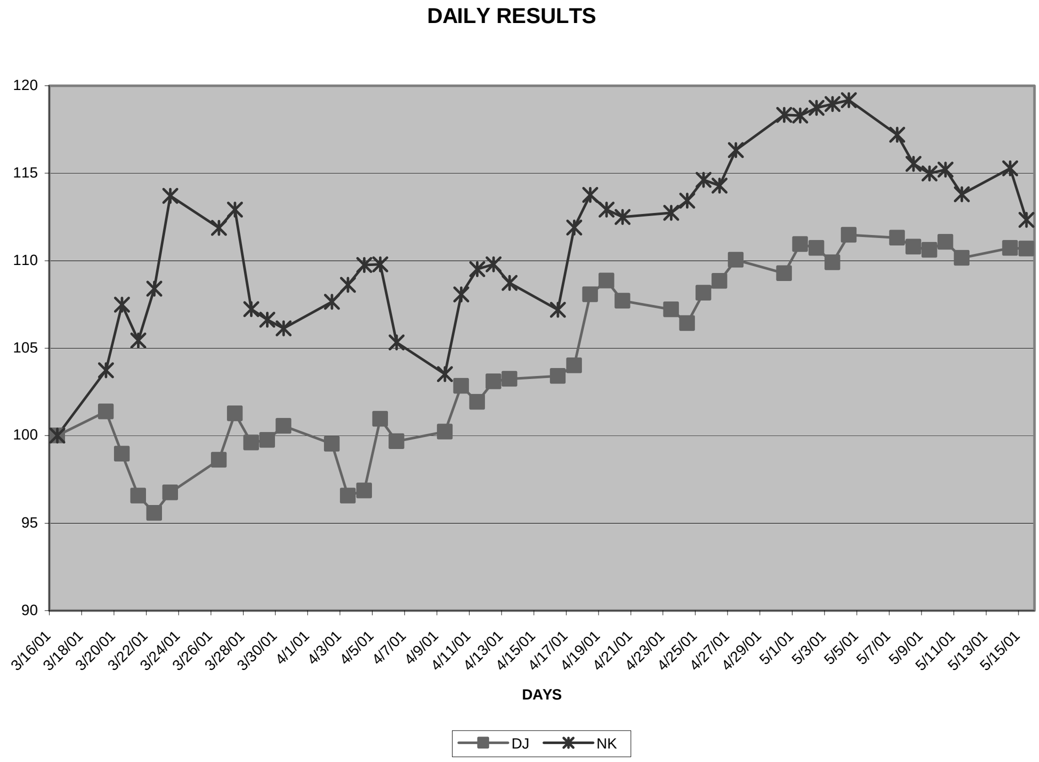
Imagine the tomorrow it turns out that both indexes have decreased. How much would you receive with your choice?

(fill in your answer) ……

Do you have any questions? If not, then good luck with the experiment.

APPENDIX B. A CHART

The chart given to the students on May 16, 2001 was stated in Dutch, was twice the size of the picture below (printed in landscape orientation), and used colors.



APPENDIX C. INTERMEDIATE QUESTIONS

Do you find it easy or difficult to decide which column you prefer?	❐	easy
	❐	difficult

Do you consider, during your decision, how often the events ↑↑, ↓↓ and ↑↓= have happened in the past?	❐	yes
	❐	no

Which of the events seems to be most likely today?	❐	↑↑
	❐	↓↓
	❐	↑↓=

Good luck with the remaining questions!

APPENDIX D. EMOTIONAL QUESTIONS

You have now made all choices and we want to ask you some general questions. For the choices that you have made, the resulting payment depends on the developments in the stock-exchanges.

How much do you know about stock-exchanges?

Nothing	1	2	3	4	5	6	7	*Much*

As far as predicting the increases or decreases of stock exchanges are concerned, do you consider yourself competent or not?

Not Competent	1	2	3	4	5	6	7	*Competent*

Now imagine that you will be selected to play one of the choices you made for real money.

If the choice works out well and you gain a large amount, then what will you feel?

Happiness

not	1	2	3	4	5	6	7	*much*

pride

not	1	2	3	4	5	6	7	*much*

relief

not	1	2	3	4	5	6	7	*much*

If your choice turns out bad and you win a small amount, then what will you feel?

disappointment

not	1	2	3	4	5	6	7	*much*

regret

not	1	2	3	4	5	6	7	*much*

frustration

not	1	2	3	4	5	6	7	*much*

How do you feel now?

bad	1	2	3	4	5	6	7	*good*
sad	1	2	3	4	5	6	7	*happy*
negative	1	2	3	4	5	6	7	*positive*

If you compare how you feel now and how you felt at the beginning of this investigation, do you feel better or worse now, or the same?

the same

worse	3	2	1	0	1	2	3	*better*

Finally, some questions about yourself:

How old are you? …. Years

Are you: ❒ male

❒ female

****

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